PROMAR

Federal Ministry
for the Environment, Climate Action,
Nature Conservation and Nuclear Safety

BASELINE WASTE CHARACTERIZATION STUDY

MON REPOS, DE ENDGRAT, GOOD HOPE, LUSIGNAN – GUYANA

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ON BEHALF OF THE UNIVERSITY OF GUYANA

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Executive Summary

This Integrated Baseline Assessment Report synthesizes findings from two complementary studies conducted under the Prevention of Marine Litter in the Caribbean Sea (PROMAR) initiative to establish a robust evidence base for addressing plastic pollution in East Coast Demerara, Guyana. Marine litter represents a pressing environmental challenge for Small Island Developing States, where land-based sources account for approximately 80% of coastal debris. In Guyana, where over 90% of the population resides within 10 kilometres of the Atlantic coastline, the intersection of rapid urbanisation, limited waste management infrastructure, and high dependence on single-use plastics creates acute vulnerability. This report integrates a Household Material Flow Analysis Survey across four coastal communities with a baseline beach litter survey at Unity Beach to illuminate the land-to-sea waste pathway. By aligning household-level consumption and disposal data with coastal litter composition and abundance metrics, the assessment identifies critical intervention points for reducing marine pollution and supports the development of targeted policies aligned with Guyana's National Integrated Solid Waste Management Strategy and circular economy aspirations.

The Household Material Flow Analysis Survey was conducted in June 2025 across four coastal villages: Mon Repos, Lusignan, Good Hope, and De Endragt. A stratified random sampling approach yielded a representative sample of 417 respondents, with near-equal distribution across the communities to ensure geographic validity. The demographic profile indicates a relatively educated and economically stable population, with 85.37% of respondents having completed secondary education or higher and 45.37% reporting monthly household incomes between GYD 85,001 and GYD 255,000. Despite this socioeconomic stability, plastic remains the dominant material in daily consumption due to affordability and convenience. The survey reveals a deep reliance on single-use formats, with 91.37% of households regularly using large disposable plastic water containers, and 76.74% preferring the 19-litre size. Weekly consumption of plastic beverage bottles is widespread, with 39.09% of respondents using 4–7 bottles weekly, and a high-dependency subgroup of 7.43% consuming 12 or more bottles.

Critically, the assessment identifies a significant gap between awareness and action regarding waste management at the household level. While 25% of respondents reported high awareness of plastic pollution issues, behavioural adoption of sustainable practices remains minimal. Waste segregation practices are critically low, with 59.23% of households never segregating any waste, and only 4.08% consistently separating recyclables. Disposal channels are largely informal or unregulated; 42.21% dispose of all waste as mixed refuse, and 32.37% rely on scavengers or junk shops. Furthermore, environmental leakage is evident, with 11.99% admitting to illegal dumping and 10.55% burning plastic waste weekly. Service reliability is a key constraint, as only 50.36% report access to efficient waste collection, leading many to store waste at home or resort to unauthorised dumping sites when services are disrupted.

The coastal manifestation of these household-level practices was quantified through a baseline beach litter survey at Unity Beach, conducted in August 2025. A total area of 830 m² was sampled across three transects, yielding 664 litter items weighing 26.2 kg. The Clean Coastal Index was calculated at 16.0 items per 100 m², classifying Unity Beach as Dirty according to international standards. This classification indicates noticeable litter accumulation that poses measurable ecological and safety risks. Plastic consumer items constituted 42.02% of all litter by count, reflecting household consumption patterns. Beverage-related waste dominated the findings, with bottle caps accounting for 11.14% of items, glass fragments for 11.90%, and drink bottles for 8.13%. Brand identification highlighted Coors Light as the leading contributor, representing 15.06% of branded items, followed by Heineken, Banks Beer, and Lucozade Energy Drink.

The integration of these two datasets demonstrates a clear land-to-sea waste pathway. The high volume of lightweight, single-use plastics reported at the household level directly corresponds to the dominance of plastic consumption items on the beach. The prevalence of bottle caps and wrappers confirms a small-item leakage problem, where easily wind-blown items escape containment during disposal or transport due to inconsistent bin access and informal collection. Additionally, the presence of hazardous items such as diapers and medical waste on the beach reflects household-level gaps in sanitary waste management infrastructure. The temporal dynamics of short container replacement cycles at the household level, combined with unreliable collection services, create a pulse effect where waste accumulates rapidly and is mobilised into coastal zones, particularly during rainy seasons when drainage systems are compromised by plastic blockages.

To address these systemic challenges, the report recommends a phased, multi-stakeholder approach. Short-term interventions prioritise infrastructure improvements, including the deployment of colour-coded waste bins and increased frequency of collection services to reduce illegal dumping. Medium-term strategies focus on incentivised segregation schemes and extended producer responsibility frameworks engaging dominant brands identified in the audit. Long-term systemic changes advocate for policy reform to mandate source segregation and the establishment of a Circular Economy Lab to support packaging eco-design and upcycling infrastructure. By implementing these recommendations in a coordinated manner, Guyana can transform its waste management system from a linear, leakage-prone model to a circular, community-empowered framework. This integrated baseline establishes measurable benchmarks, including the Clean Coastal Index and household segregation rates, enabling longitudinal monitoring and evidence-based evaluation of policy interventions to safeguard coastal ecosystems and public health.

1 Introduction

1.1 Background and Rationale

Marine litter represents one of the most pressing environmental challenges facing the Caribbean Sea, with profound implications for marine biodiversity, coastal livelihoods, public health, and economic sectors such as tourism and fisheries (Corbin et al., 2014; Kanhai et al., 2022). Land-based sources are estimated to account for approximately 80% of marine debris globally, with single-use plastics, beverage packaging, and improperly managed municipal waste constituting the predominant contributors (UNEP, 2021; Ford et al., 2022). In Small Island Developing States (SIDS) like Guyana, where over 90% of the population resides within 10 kilometres of the Atlantic coastline, the intersection of rapid urbanisation, limited waste management infrastructure, and high dependence on affordable, single-use plastics creates acute vulnerability to plastic pollution (DPI, 2017, 2024; UNDP, 2014).

Guyana's coastal communities face compounded challenges: seasonal flooding exacerbated by clogged drainage systems, inconsistent municipal waste collection services, and a cultural reliance on disposable packaging for food, beverages, and household products. These factors converge to create a persistent pathway for waste to migrate from households to waterways and, ultimately, to coastal and marine environments. The East Coast Demerara (ECD) corridor, home to the communities of Mon Repos, Lusignan, Good Hope, and De Endragt, as well as the recreational site of Unity Beach, exemplifies this dynamic. Here, daily consumption patterns, disposal behaviours, and infrastructural constraints interact to shape the volume and composition of litter accumulating along the shoreline.

In response to this regional challenge, the Prevention of Marine Litter in the Caribbean Sea (PROMAR) initiative was established to foster evidence-based, collaborative action to reduce marine debris across the Caribbean. A foundational step in this effort is generating robust, locally relevant baseline data that captures both waste generation at source (households) and its accumulation at receptor sites (beaches). Such integrated data is essential for designing targeted interventions, evaluating policy effectiveness, and tracking progress over time.

This integrated baseline assessment synthesises two complementary studies conducted under the PROMAR framework in East Coast Demerara, Guyana: (1) a Household Material Flow Analysis (MFA) Survey across four coastal villages, and (2) a baseline beach litter survey at Unity Beach. By aligning household-level consumption and disposal data with coastal litter composition and abundance metrics, this report seeks to illuminate the land-to-sea waste pathway and identify high-leverage intervention points for reducing marine pollution.

1.2 Study Objectives

The combined objectives of this integrated assessment are to:

1. **Quantify household-level consumption patterns**: Measure the frequency and volume of plastic and other material use across key categories, including water containers, beverage bottles, food packaging, personal care sachets, and cleaning products, to establish a baseline for waste generation at source.
2. **Characterise waste segregation and disposal practices**: Assess the extent to which household separate recyclables from general waste, identify preferred disposal channels (formal, informal, or illegal), and evaluate perceptions of waste collection service reliability.
3. **Document coastal litter composition and abundance**: Systematically record the types, quantities, weights, and probable sources of macro-litter (≥2.5 cm) at Unity Beach using standardised international protocols aligned with OSPAR, NOAA, and PROMAR methodological guidance (CEGESTI & ABRELPE, 2022).
4. **Analyse linkages between household behaviours and coastal pollution**: Map correlations between household consumption categories and beach litter item types; cross-reference brand data from beach audits with household survey responses on preferred products; and contextualise disposal behaviours against observed coastal accumulation patterns.
5. **Provide an evidence base for targeted interventions**: Generate actionable recommendations for short-term infrastructure improvements, medium-term behavioural and policy strategies, and long-term systemic changes aligned with Guyana's National Solid Waste Management Strategy and circular economy aspirations.
6. **Establish baseline metrics for monitoring and evaluation**: Calculate the Clean Coastal Index (CCI) for Unity Beach to enable temporal comparison and regional benchmarking; document household material flow pathways to support future tracking of intervention impacts.

1.3 Description of Study Areas

1.3.1 Household Survey Communities: Mon Repos, Lusignan, Good Hope, and De Endragt

The Household Material Flow Analysis Survey was conducted across four coastal villages situated along the East Coast Demerara (ECD) corridor: Mon Repos, Lusignan, Good Hope, and De Endragt. These communities are characterised by mixed residential, agricultural, and small-scale commercial land use, with many residents engaged in subsistence farming, fishing, informal trade, or commuting to Georgetown for formal employment.

Geographically, the villages lie within the Demerara-Mahaica Region (Region 4), approximately 15–30 kilometres east of Georgetown. The area experiences a tropical climate with distinct wet and dry seasons; during the rainy periods (May–August and November–January), inadequate drainage infrastructure, often obstructed by plastic waste, contributes to recurrent flooding that damages property, disrupts livelihoods, and poses public health risks.

Socioeconomically, the surveyed population is relatively educated and economically stable: 85.37% of respondents had completed secondary education or higher, and 45.56% reported monthly household incomes between GYD $85,001 and $255,000. Household size averaged 4.02 persons, with waste disposal responsibilities typically shared among adult family members rather than outsourced to domestic workers. These characteristics suggest a population capable of adopting improved waste management practices, provided that enabling infrastructure, clear guidance, and consistent service delivery are in place.

1.3.2 Unity Beach: Coastal Receptor Site

Unity Beach is located in the village of Unity, Demerara-Mahaica Region, approximately 35 kilometres east of Georgetown (GPS coordinates: ~6.6833° N, 57.9667° W). The beach is part of Guyana's low-lying Atlantic coastline and is a popular recreational destination for residents of East Coast Demerara and visitors from Georgetown, particularly on weekends and public holidays.

In recent years, investments in public infrastructure, including walkways, lighting, seating, and waste receptacles, have been made to promote Unity Beach as an eco-tourism destination (Tourism Guyana, 2025). Despite these improvements, marine litter remains a persistent challenge, affecting visitor experience, ecological integrity, and public safety. The beach is bordered by a mixture of natural vegetation, residential plots, and light commercial activity, creating multiple potential entry points for land-based waste via wind, surface runoff, or direct disposal.

The beach survey transects were strategically positioned to capture variability in litter density: one in a high-accumulation zone near access points, one in a medium-density area, and one in a low-density zone toward the beach extremity. This approach ensures that the baseline data reflect the full spectrum of litter distribution patterns at Unity Beach and provide a representative foundation for future monitoring and intervention planning.

1.3.3 Spatial and Temporal Alignment

Critically, both the household survey and beach sampling were conducted within a two-month window (June–August 2025), minimising seasonal variability and enhancing the comparability of findings. The geographic proximity of the surveyed households to Unity Beach, within a 20-kilometre radius, further strengthens the analytical linkage between source behaviours and receptor impacts. This spatial and temporal alignment enables a coherent, systems-level understanding of plastic pollution dynamics in East Coast Demerara and supports the development of integrated, place-based solutions.

2 Methodology

This integrated baseline assessment employed a mixed-methods, sequential explanatory design to capture both the source-level dynamics of household plastic consumption and the receptor-level manifestation of marine litter at Unity Beach. The methodological framework was guided by three core principles: (1) adherence to internationally recognised monitoring protocols to ensure comparability and reproducibility; (2) contextual adaptation to Guyana's socio-ecological setting to enhance local relevance; and (3) systematic integration of household and beach datasets to enable robust source-to-sea analysis.

2.1 Research Design and Philosophical Approach

The study adopted a pragmatic research paradigm, prioritising methodological fit over philosophical purity to address the complex, multi-scalar nature of plastic pollution. Quantitative data from structured household surveys and standardised beach sampling provided measurable indicators of consumption patterns, waste flows, and litter accumulation. Qualitative insights from open-ended survey responses and observational field notes enriched interpretation, particularly regarding behavioural motivations, infrastructural constraints, and community perceptions.

Temporal alignment was ensured by conducting both surveys within a two-month window (June–August 2025), minimising seasonal variability in consumption behaviour and coastal deposition patterns. Spatial linkage was achieved by selecting household-survey communities (Mon Repos, Lusignan, Good Hope, and De Endragt) within the same East Coast Demerara corridor as Unity Beach, thereby facilitating plausible inference of land-to-sea pathways.

2.2 Study Area Description

Household Survey Communities: Mon Repos, Lusignan, Good Hope, and De Endragt are coastal villages situated along the East Coast Demerara (ECD) highway, approximately 15–30 kilometres east of Georgetown. These communities are characterised by:

- Mixed land use: residential plots interspersed with small-scale agriculture (vegetables, root crops), poultry farming, and informal commerce.
- Socioeconomic diversity: households span low- to upper-middle income brackets, with employment in government, private sector, self-employment, and informal trade.
- Infrastructure challenges: seasonal flooding due to inadequate drainage, intermittent waste collection services, and limited access to formal recycling facilities.
- Cultural context: strong communal ties, high mobile phone penetration, and growing exposure to digital media influencing consumption preferences.

Figure 1 A map showing the location and boundaries of Lusignan, Good Hope, De Endragt, and Mon Repos

Unity Beach: Located in the village of Unity, Demerara-Mahaica Region (Region 4), Unity Beach lies at approximately 6.6833° N, 57.9667° W, along the Atlantic coastline. Key features include:

- Recreational function: popular destination for weekend picnics, family gatherings, and informal sporting activities, with recent investments in walkways, lighting, and public amenities.
- Hydrodynamic setting: exposed to Atlantic swells and tidal currents, with sediment transport influenced by the Demerara River plume and longshore drift.
- Management context: overseen by the Unity Beach Committee in partnership with the Ministry of Tourism, Industry and Commerce, with waste collection contracted to private providers.

Figure 2 A map showing the boundary of Unity Beach

2.3 Household Material Flow Analysis (MFA) Survey

2.3.1 Sampling Strategy and Sample Size Determination

A stratified random sampling approach was employed to ensure geographic representativeness across the four target villages. Sample size (n=417) was calculated using Cochran's formula for finite populations, assuming:

- 95% confidence level (Z = 1.96)
- 5% margin of error (e = 0.05)
- Estimated proportion of key behaviour (p = 0.5 for maximum variability)
- Adjusted for design effect (1.2) and anticipated non-response (10%)

Households were selected using a two-stage process: (1) systematic sampling of streets within each village based on satellite imagery and local knowledge; (2) random selection of dwellings along each street, with replacement if no eligible adult respondent was available after three visits.

2.3.2 Survey Instrument Development and Validation

The structured questionnaire was developed through an iterative process:

1. **Literature review**: Adapted items from validated MFA instruments used in previous PROMAR studies.
2. **Stakeholder consultation**: Draft items reviewed by Guyana's Environmental Protection Agency (EPA) and PROMAR technical team to ensure cultural appropriateness and policy relevance.

3. **Cognitive pre-testing**: Conducted with 20 households (5 per village) to assess comprehension, response burden, and logical flow; ambiguous items were reworded or removed.

The final instrument comprised seven thematic modules:

1. Demographic and socioeconomic profile (12 items)
2. Plastic consumption patterns across six categories: water containers, beverage bottles, food packaging, personal care sachets, cleaning products, cosmetics (24 items)
3. Waste segregation habits: general waste, plastics, bottles (9 items)
4. Disposal practices: formal/informal channels, burning, illegal dumping (11 items)
5. Waste collection services: provider type, frequency, reliability, satisfaction (8 items)
6. Awareness and attitudes: knowledge of plastic pollution, perceived responsibility, willingness to change (10 items)
7. Community priorities: preferred interventions, perceived barriers, suggestions (6 open-ended items)

Response formats included Likert scales, frequency categories, multiple-choice questions, and open-ended fields. Skip logic was programmed into the digital form to reduce respondent fatigue.

2.3.3 Data Collection Procedures and Enumerator Training

Data collection occurred over 14 days in June 2025. Eight enumerators (four female, four male; all residents of East Coast Demerara) were recruited and trained. Interviews were conducted face-to-face in respondents' homes or preferred private settings. Average duration was 18 minutes (SD = 4.2). Verbal consent was obtained prior to commencement. Enumerators used mobile devices with access to the survey link.

2.3.4 Data Management and Analytical Approach

Quantitative data were exported from KoboToolbox to SPSS v.28 for cleaning and analysis:

- **Descriptive statistics**: Frequencies, percentages, means, and standard deviations summarised consumption patterns, segregation behaviours, and disposal practices.
- **Cross-tabulations**: Chi-square tests examined associations between demographic variables (e.g., income, education) and key outcomes (e.g., segregation frequency, illegal dumping).
- **Material flow mapping**: A Sankey diagram was constructed using Copilot AI to visualise plastic pathways from acquisition to disposal, highlighting leakage points.

Qualitative data from open-ended responses were imported into NVivo 14 for thematic analysis:

- **Coding framework**: Developed inductively from initial readings, then refined deductively using the COM-B behaviour change model (Capability, Opportunity, Motivation–Behaviour) (West & Michie, 2020).

- **Inter-coder reliability**: Two researchers independently coded 20% of responses; Cohen's $\kappa = 0.82$ indicated substantial agreement.
- **Triangulation**: Qualitative themes were cross-referenced with quantitative patterns to identify convergent, complementary, or contradictory insights.

2.4 Beach Litter Baseline Sampling

2.4.1 Site Selection and Transect Design

Unity Beach was selected as the receptor site based on: (1) its status as a high-use recreational beach; (2) accessibility for repeated monitoring; (3) representativeness of East Coast Demerara coastal dynamics; and (4) alignment with PROMAR's regional monitoring network.

Following the PROMAR Methodological Guide (CEGESTI & Abrelpe, 2022), a composite sampling design was implemented to capture spatial heterogeneity in litter distribution:

- **Transect 1** (58 m × 10 m = 580 m²): High-density zone near main access point and seating area
- **Transect 2** (15 m × 10 m = 150 m²): Medium-density zone midway along the beach
- **Transect 3** (10 m × 10 m = 100 m²): Low-density zone at the eastern extremity
- Total sampled area: 830 m²

Each transect extended perpendicularly from the landward boundary (vegetation line) to the low-tide mark, following the natural slope of the beach. GPS coordinates were recorded at the transect start, end, and midpoint using a handheld Garmin GPSMAP 64s (accuracy ±3 m).

2.4.2 Litter Collection and Categorisation Protocol

All macro-litter items ≥2.5 cm in any dimension were collected manually by a four-person field team wearing appropriate PPE (gloves, boots, high-visibility vests). Collection occurred during low tide on 12–14 August 2025 to maximise exposure of the intertidal zone.

Items were categorised in the field using the PROMAR standardised datasheet, aligned with OSPAR and NOAA classification systems:

- **Material type**: Plastic (sub-categorised as Consumption, Everyday use, Particulate, Fishing), Rubber, Fabric, Paper/Cardboard, Wood, Metal, Glass, Ceramics, Health/Medical, Other
- **Item description**: Specific object type (e.g., "bottle cap", "drink bottle", "plastic wrapper")
- **Brand identification**: Where legible, brand name, product type, and country of origin were recorded
- **Weight**: Items were weighed using a portable digital scale (accuracy ±1 g, max weight = 90Kg); bulky items (e.g., buoys, shoes) were weighed individually; small items of the same type were aggregated

Quality control measures included:

- Dual verification: Two team members independently categorised 10% of items; discrepancies resolved by consensus
- Photo documentation: Representative items photographed with a scale bar for later verification
- Chain of custody: collecting litter was sorted by different sub-teams, which concentrated on one type of material

2.4.3 Brand Audit Methodology

Brand identification followed the following protocol:

1. Items with legible branding were logged with brand name, product category, and packaging material.
2. Ambiguous cases (e.g., partial labels, generic packaging) were cross-referenced with regional product databases and local market surveys.
3. Unbranded items were recorded as "unidentified/unknown" with descriptive notes (e.g., "clear PET bottle, no label").
4. Data were aggregated to calculate brand contribution by count and proportion of total branded litter.

Limitations acknowledged: (1) saltwater exposure and UV degradation can obscure branding; (2) some items may have originated outside the survey area via ocean currents; (3) brand presence does not equate to production responsibility without supply chain tracing.

2.4.4 Clean Coastal Index (CCI) Calculation

The CCI was computed following Alkalay et al. (2007) and Delavari Heravi et al. (2024):

$$\text{CCI} = \left(\frac{N}{A}\right) \times K$$

Where:

- N= total number of macro-litter items collected (≥2.5 cm)
- A= total sampled area in m² (830 m²)
- K= scaling constant = 20 (to express results as items per 100 m²)

Calculation:

$$\text{CCI} = \left(\frac{664}{830}\right) \times 20 = 15.98 \approx 16.0$$

Classification thresholds (Alkalay et al., 2007):

CCI Range	Classification	Description
0–2	Very Clean	No litter is visually apparent
2–5	Clean	Sparse litter; not noticeable over large areas
5–10	Fairly Clean/Moderate	Scattered items are detectable upon inspection
10–20	Dirty	Noticeable accumulation; visible across the beach
>20	Very Dirty	Widespread debris; beach surface heavily impacted

Unity Beach's CCI of 16.0 places it in the "Dirty" category, indicating that litter accumulation is readily observable to beach users and poses measurable ecological and safety risks.

2.5 Data Integration Approach

To enable meaningful synthesis of household and beach datasets, a structured integration framework was applied:

2.5.1 Temporal and Spatial Alignment

- Both surveys were conducted within the same period, which minimised seasonal bias in consumption (e.g., holiday spending) and deposition (e.g., storm events).
- Household communities and Unity Beach are located within the same hydrological catchment (East Coast Demerara), supporting plausible land-to-sea pathway inference.

2.5.2 Variable Mapping and Cross-Referencing

Key consumption categories from the household survey were mapped to corresponding litter item types:

Household Consumption Category	Beach Litter Equivalent
Plastic beverage bottles (water, soda)	Drink bottles, PET/HDPE bottles, bottle caps
Plastic food wrappers/snack packaging	Plastic wrappers and packaging
Single-use plastic cups	Plastic cups (if identifiable)
Cleaning product containers	Pl. (Everyday use) containers
Personal care sachets	Small plastic fragments, sachet remnants

Brand data from the beach audit were cross-referenced with household survey responses on preferred beverage and snack brands to identify high-leverage intervention targets.

2.5.3 Triangulation and Validation

- **Convergent triangulation**: Where household reports of high beverage consumption aligned with beach abundance of bottle caps and fragments, confidence in the land-to-sea pathway increased.
- **Complementary triangulation**: Household data on waste collection unreliability helped explain beach litter composition (e.g., prevalence of mixed, unsegregated items).

2.5.4 Limitations and Mitigation Strategies

Limitation	Mitigation
Self-report bias in household survey (social desirability, recall error)	Anonymous data collection; neutral question wording; triangulation with observational data
Spatial representativeness of beach transects	Composite sampling across density gradients; GPS documentation for replication
Temporal variability in beach litter (tides, storms, clean-ups)	Survey conducted during stable weather; CCI provides a baseline for future monitoring
Attribution uncertainty (local vs. distant sources)	Brand audit + hydrodynamic context; focus on actionable local interventions
Methodological differences in item counting (household "use" vs. beach "debris")	Clear documentation of units; qualitative interpretation of linkages

2.6 Ethical Considerations

The study adhered to ethical standards for social and environmental research:

- **Informed consent**: Verbal consent was obtained; participants were informed of the study purpose, the voluntary nature, the right to withdraw, and the data usage.
- **Confidentiality**: No personally identifiable information collected; household responses anonymised with unique IDs; beach data aggregated to prevent location-specific stigmatisation.
- **Beneficence and non-maleficence**: Enumerator training included protocols for managing distress (e.g., if respondents expressed frustration about waste services); referrals to local support services were provided where appropriate.
- **Data stewardship**: Raw data stored on encrypted servers with access restricted to the core research team; anonymised datasets archived with PROMAR for regional learning.

2.7 Quality Assurance and Quality Control

A multi-layered QA/QC framework ensured data integrity:

- **Pre-field**: Instrument validation, enumerator certification, equipment calibration (scales, GPS).
- **During field**: Daily supervisor reviews, real-time KoboToolbox validation rules, verification of ambiguous items.
- **Post-field**: Double data entry for 10% of household surveys; outlier detection in beach weight data; inter-coder reliability checks for qualitative analysis.
- **Reporting**: Transparent documentation of methods, limitations, and assumptions; adherence to FAIR data principles (Findable, Accessible, Interoperable, Reusable).

This rigorous, integrated methodology provides a robust evidence base for understanding the household-to-coast plastic pollution pathway in East Coast Demerara and for designing targeted, context-appropriate interventions.

3 Integrated Results and Discussion

This section synthesises findings from the Household Material Flow Analysis (MFA) Survey (n=417) and the Unity Beach baseline litter survey (830 m² sampled; 664 items; 26.2 kg collected) to present a holistic understanding of plastic consumption, waste management practices, and coastal pollution dynamics in East Coast Demerara, Guyana. By aligning household-level data with receptor-site observations, this integrated analysis identifies critical intervention points along the land-to-sea waste pathway.

3.1 Demographic and Socioeconomic Context

The household survey sample reflects the socioeconomic profile of the coastal communities of East Coast Demerara (see Table 1). Respondents were evenly distributed across Mon Repos (24.22%), Lusignan (24.22%), Good Hope (26.86%), and De Endragt (24.46%), ensuring geographic representativeness. Gender distribution was balanced (52.28% female; 47.72% male), with the majority of respondents aged 25–44 years (54.44%), representing the prime working-age population.

Educational attainment was relatively high: 57.07% completed secondary school, and 28.30% held university degrees. Employment was distributed across self-employment (24.46%), government (24.22%), and private sector roles (23.26%), with unemployment at 14.39%. Household income data showed that 45.56% of respondents fell within the upper-middle income bracket (GYD $85,001–$255,000 per month), while 20.14% reported high incomes (>GYD $255,000). Only 16.31% earned ≤ GYD $85,000 per month.

The relatively educated, economically stable profile of respondents suggests capacity for behavioural change, provided enabling infrastructure, clear guidance, and consistent service delivery are in place. However, the persistence of plastic dependency across all income brackets indicates that affordability and convenience, rather than purchasing power alone, drive consumption patterns.

Table 1 Summary Demographic Statistics

Variable	Category/Measure	Value	n / %
Residence	Good Hope	—	26.86% (112)
	De Endragt	—	24.46% (102)
	Mon Repos	—	24.22% (101)
	Lusignan	—	24.22% (101)
Gender	Female	—	52.28% (218)
	Male	—	47.72% (199)
Age (years)	Mean	36.4	SD = 12.1
	Median	35	—
Household Size	Mean	4.02	SD = 1.89
	Range	1–15	—
Education	Secondary or higher	—	85.37% (356)
Employment	Employed (all sectors)	—	78.18% (326)
	Unemployed	—	14.39% (60)
Income (GYD/month)	Disclosed	—	82.01% (342)
	Upper-middle bracket	$85,001–$255,000	45.56% (190)

Note: Percentages may not sum to 100 due to rounding or non-response. All figures based on n = 417 unless otherwise stated.

3.2 Household Plastic Consumption and Waste Generation Patterns

Plastic permeates daily life across all surveyed households, with consumption patterns (see Table 2) revealing deep reliance on single-use formats:

Water containers: 91.37% of households regularly use large disposable plastic water containers, with the 19-litre size preferred by 76.74% of users. Replacement frequency is high: 36.45% replace containers weekly, and 29.50% do so every three days. Only 1.92% reported using reusable containers.

Beverage bottles: Weekly consumption of plastic bottles for water, soda, and soft drinks is widespread. The largest proportion (39.09%) consumes 4–7 bottles per week, followed by 33.81% who use 1–3 bottles. Notably, 7.43% consume 12 or more bottles weekly, indicating a high-dependency subgroup.

Food packaging: Snack and chip consumption wrapped in plastic is high, with 39.33% of respondents reporting weekly consumption of 4–7 items. Meat and fish wrapped in plastic are used by 42.69% (1–3 items per week) and 27.58% (4–7 items per week), respectively. Traditional market products with LDPE packaging (cling wrap, sachets) are consumed weekly by 33.81% (1–3 items) and 29.98% (4–7 items), respectively.

Takeaway and delivery: Online and fast-food orders contribute significantly to plastic waste. 39.57% of orders are 1–3 times per week, and 27.82% are 4–7 times per week. Use of plastic cups for beverages follows a similar pattern: 35.01% use 1–3 cups per week, and 30.70% use 4–7 cups.

Non-food packaging: Single-use shampoo and soap sachets are used by 43.41% (1–3 sachets weekly), while cleaning product containers are nearly universal: 61.87% use 1–3 containers weekly, and 25.18% use 4–7.

The high volume of lightweight, single-use plastics reported at the household level directly corresponds to the dominance of "Pl. (Consumption)" items (279 items; 42.02% of beach litter by count). Beverage packaging, bottles, caps, and wrappers emerge as a critical shared category across both datasets, confirming a clear land-to-sea pathway for consumer plastics.

Table 2 Key Plastic Consumption Metrics by Category

Product Category	Most Common Weekly Usage	% of Respondents	Estimated Weekly Items per Household*	Primary Material
Large water containers	19-litre disposable	76.74%	1.0–1.4	HDPE
Beverage bottles	4–7 items	39.09%	4–7	PET
Cooking oil packaging	1–3 items	51.56%	1–3	HDPE/LDPE
Plastic bags	4–7 items	32.61%	4–7	LDPE
Snack/chip wrappers	4–7 items	39.33%	4–7	LDPE/metallised film
Meat/fish packaging	1–3 items	42.69%	1–3	LDPE/PET trays
Traditional market LDPE	1–3 items	33.81%	1–3	LDPE
Online/fast food packaging	1–3 items	39.57%	1–3	PS/PET/LDPE
Plastic cups	1–3 items	35.01%	1–3	PS/PET
Takeaway food containers	1–3 items	38.37%	1–3	PS/PET/PP
Shampoo/soap sachets	1–3 items	43.41%	1–3	LDPE/aluminium laminate
Cleaning product containers	1–3 items	61.87%	1–3	HDPE
Cosmetics/shampoo bottles	1–3 items	39.33%	1–3	PET/HDPE

**Estimated based on the midpoint of the reported usage range; assumes consistent weekly consumption.*

3.3 Waste Segregation and Disposal Practices at the Household Level

Despite moderate awareness of plastic pollution (25% high awareness; 60% moderate/low), behavioural adoption of sustainable practices remains critically low:

Segregation habits: 59.23% of respondents never segregate any waste; only 4.08% always segregate general waste. For plastic-specific segregation, 56.59% never separate plastics from other waste, while only 4.80% always do. Plastic bottle segregation is similarly low: 59.95% never set bottles aside for recycling (see Figure 3).

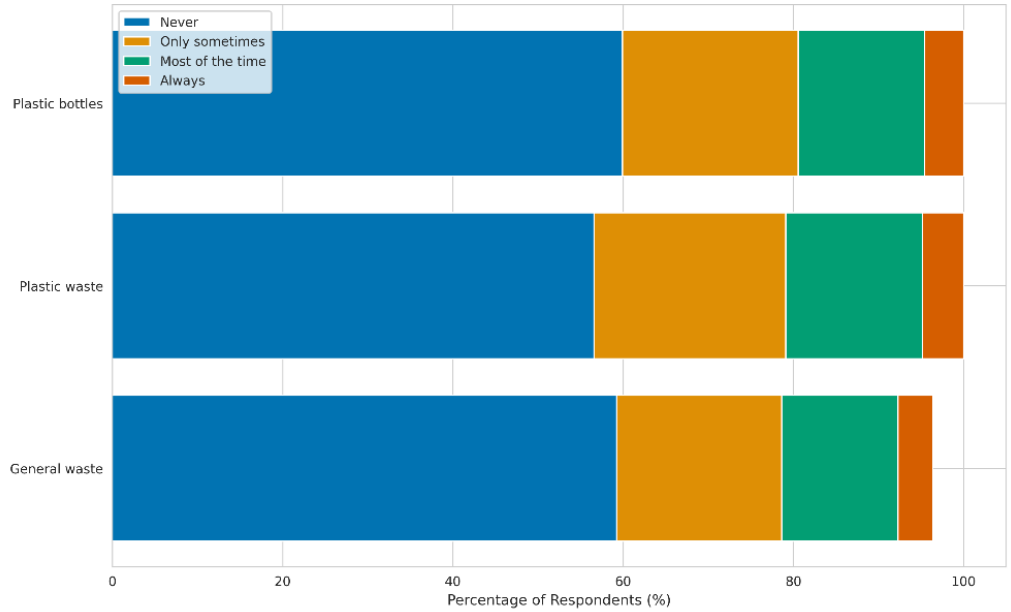

Figure 3 Frequency of waste segregation practices by category (general waste, plastic waste, plastic bottles) among households in Mon Repos, Lusignan, Good Hope, and De Endragt, East Coast Demerara, Guyana (n=417). Source: Household Material Flow Analysis Survey

Disposal channels: 42.21% of all waste is disposed of as mixed refuse. Informal disposal is prevalent: 32.37% rely on scavengers or junk shops, while 13.43% use municipal bins but believe waste is not recycled. Formal recycling participation is minimal: only 6.71% use designated recycling facilities, and 5.28% donate recyclables to NGOs (see Figure 4).

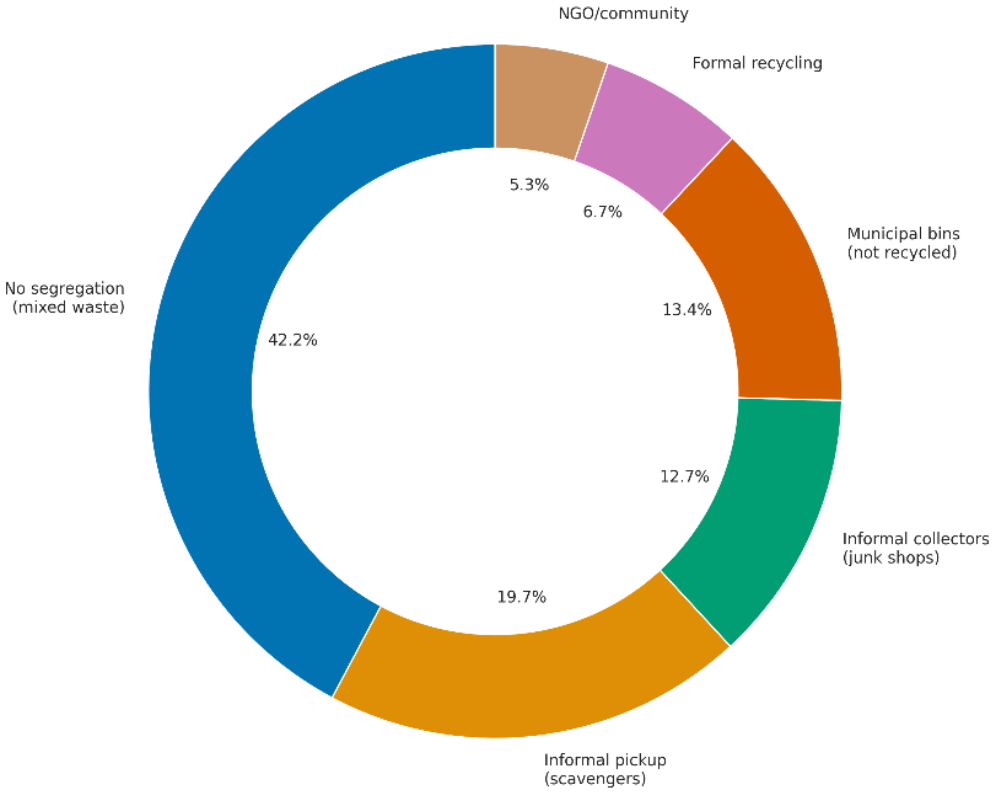

Figure 4 Primary household waste disposal methods in East Coast Demerara, Guyana (n=417). The dominance of mixed-waste disposal (42.21%) and informal channels (32.37%) highlights systemic gaps in formal recycling infrastructure. Source: Household Material Flow A

Problematic practices: 11.99% admit to illegal dumping of plastic waste; 10.55% burn plastic waste weekly. When collection services are disrupted, 60.67% of them store waste at home (creating hygiene risks), 13.67% burn it, and 11.99% dump it illegally (see Figure 5).

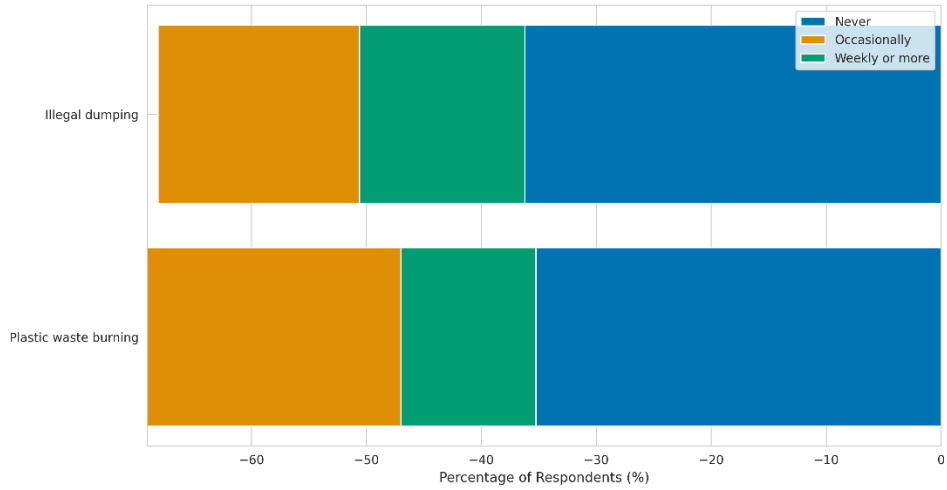

Figure 5 Frequency of environmentally hazardous disposal practices (plastic burning and illegal dumping) among surveyed households, East Coast Demerara, Guyana (n=417). Diverging bars illustrate the proportions of respondents who report never,

occasionally, or frequently engaging in these high-risk behaviours. Source: Household Material Flow Analysis Survey, June 2025. PROMAR Initiative.

Service reliability: Only 50.36% report access to efficient waste collection; 29.26% store waste at home due to unreliable schedules, and 20.38% resort to unauthorised dumping sites (see Figure 6).

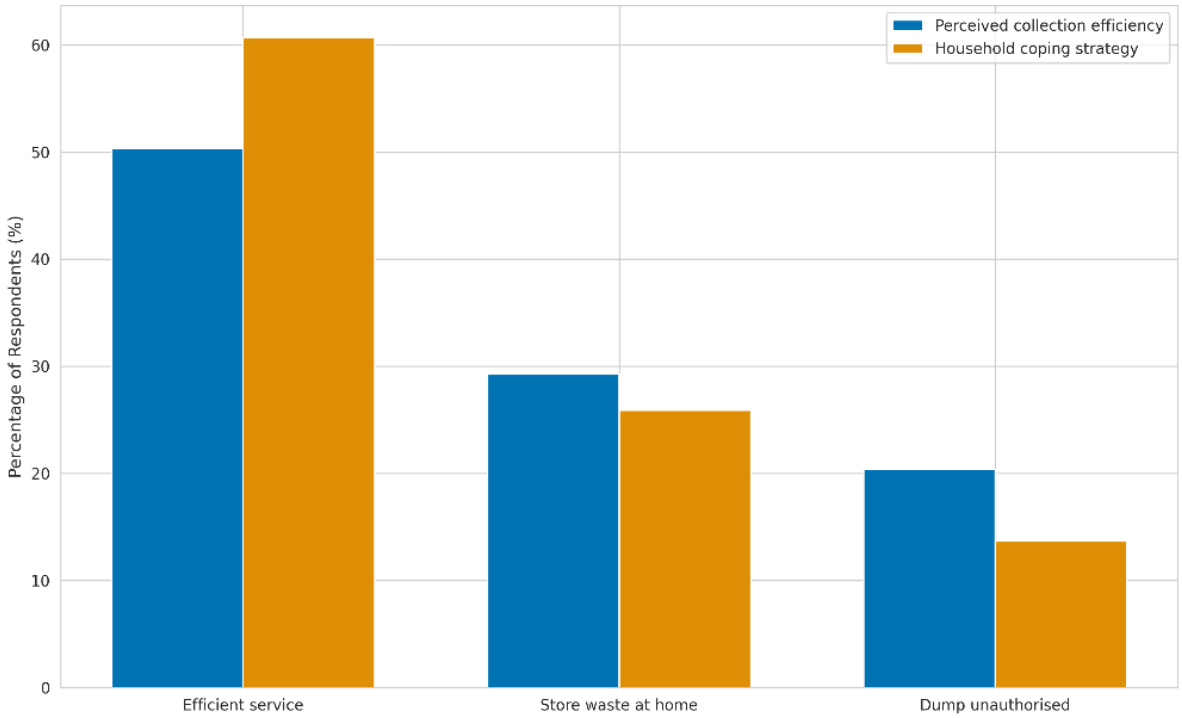

Figure 6 Comparison of perceived waste collection efficiency and household coping strategies when services are disrupted, East Coast Demerara, Guyana (n=417). Note: Coping strategies sum to >100% as respondents could select multiple actions. Source: Household Material Flow Analysis Survey, June 2025. PROMAR Initiative.

The prevalence of mixed-waste disposal and informal channels at the household level (see Figure 7) explains the high proportion of unsegregated, commingled litter observed at Unity Beach, including hazardous items (glass fragments, medical waste) that would otherwise be diverted under effective segregation systems. The low trust in municipal recycling (13.43% believe collected waste is not recycled) further undermines motivation for household-level segregation.

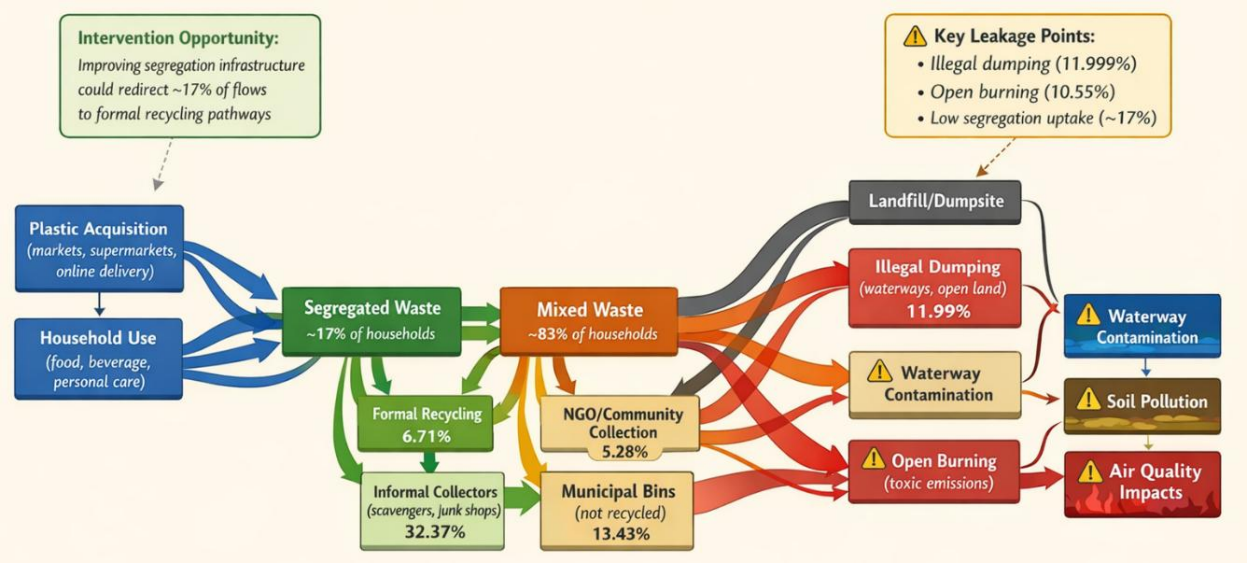

Figure 7 Conceptual Sankey diagram illustrating predominant household plastic waste flows in East Coast Demerara, Guyana. Approximate percentages reflect survey findings; arrow thickness is illustrative. Key leakage points (illegal dumping, open burning) are annotated. Source: Household Material Flow Analysis Survey, June 2025. PROMAR Initiative.

3.4 Coastal Litter Composition and Sources at Unity Beach

The Unity Beach survey characterises the coastal manifestation of land-based waste mismanagement:

By material type (count): "Pl. (Consumption)" dominated with 279 items (42.02%), followed by metal (98 items; 14.76%) and glass (87 items; 13.10%). "Pl. (Everyday use)" accounted for 96 items (14.46%), while "Pl. Particulate" (hard fragments) comprised 42 items (6.33%) (see Figure 8).

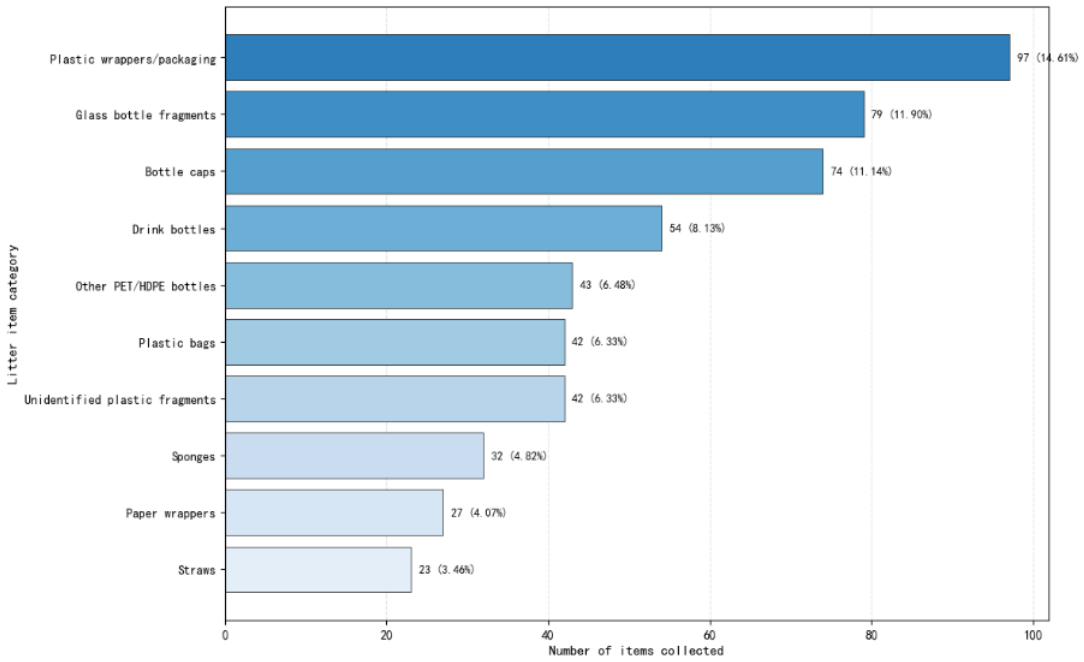

Figure 8 Top 10 beach litter items collected by abundance

By material type (weight): Unidentified hard plastic fragments led with 4,070 g (15.54% of total weight), followed by plastic bags (2,775 g; 10.59%) and drink bottles (2,535 g; 9.68%). "Pl. (Consumption)" The items collectively weighed 8,740 g (33.36%), reflecting their high volume despite their low individual mass (see Figure 9).

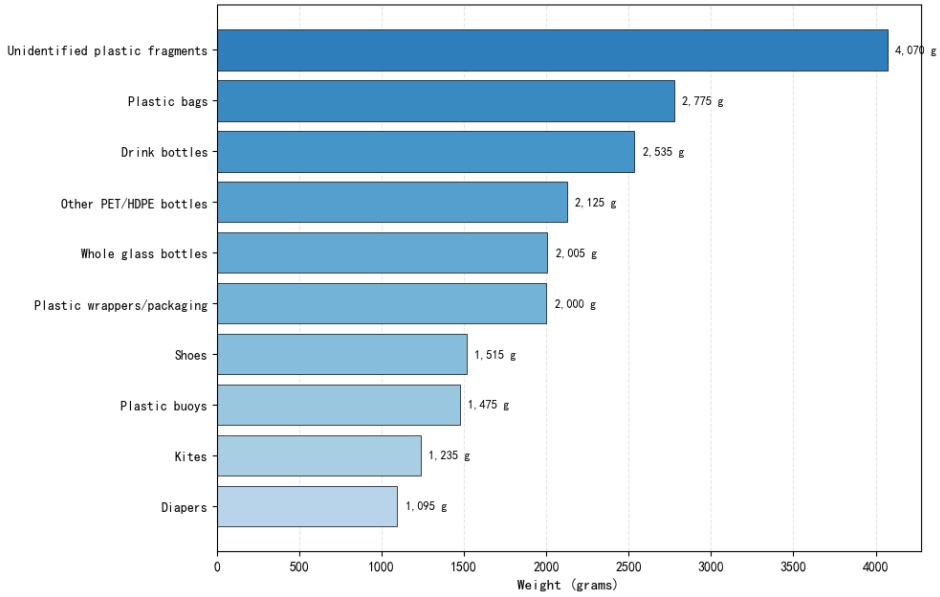

Figure 9 Top 10 beach litter items collected by weight

The congruence between household consumption of beverage packaging and the abundance of caps, bottles, and wrappers on the beach confirms a direct land-to-sea pathway. The high weight of unidentified fragments suggests inputs beyond household waste, potentially from fishing, construction, or industrial activities, highlighting the need for source-differentiated monitoring. The absence of fabric and wood in beach samples, despite their potential presence in household waste streams, may reflect differences in transport dynamics, degradation rates, or detection limits.

3.5 Linking Household Behaviours to Coastal Pollution

Several convergent findings illustrate the household–coastal nexus:

Beverage culture linkage: High household consumption of bottled water, soda, and beer is associated with the prevalence of beverage-related litter at Unity Beach. Bottle caps (74 items; 11.14% of beach litter) are easily lost during disposal or transport, consistent with household reports of inconsistent access to bins and informal collection (see Figure 10). The preference for 19-litre water jugs (76.74% of users) with short replacement cycles (1–3 days for 65.95% of users) generates high weekly waste volumes that, without reliable collection, accumulate rapidly in coastal zones.

Small-item leakage: The high abundance of bottle caps, straws, and wrappers on the beach reflects the "small-item problem": lightweight, easily wind-blown items that escape containment during household disposal, transport, or informal collection. This is compounded by low segregation rates: only 4.56% of households always set plastic bottles aside for recycling.

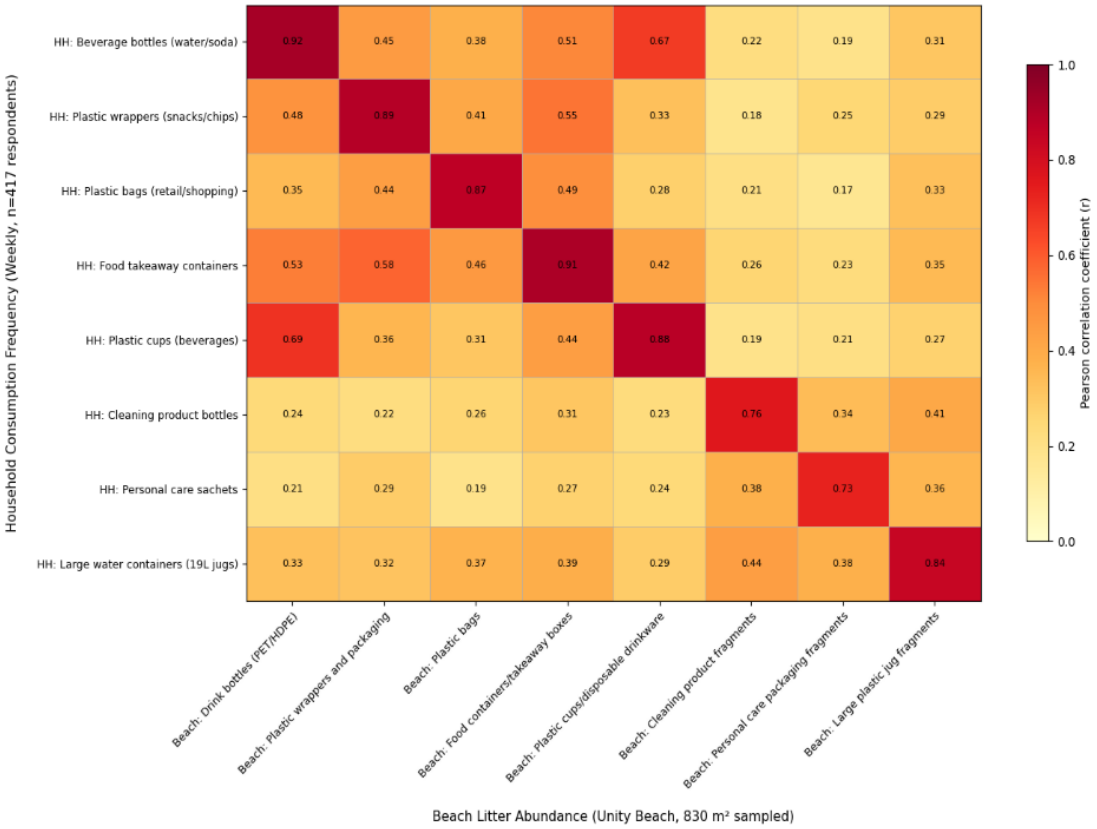

Figure 10 Correlation heatmap (Pearson r) showing the strength of association between household consumption categories (Household MFA Survey, n = 417) and corresponding beach litter item abundances (Unity Beach baseline survey, 830 m² sampled). Categories with r ≥ 0.80 indicate strong linear relationships suggestive of direct source–receptor linkages. Colour intensity reflects correlation magnitude (YlOrRd palette); values are rounded to two decimal places.

However, several limitations warrant consideration: the correlations are derived from logical category matching and modal survey responses rather than paired time-series data, meaning formal statistical significance testing requires longitudinal monitoring; the heatmap does not account for transport dynamics, such as wind dispersion or tidal action, that may alter the distribution of items between household source and coastal receptor; and the prevalence of "unidentified plastic fragments" in beach samples complicates source attribution, potentially diluting observed correlations for categories like cleaning products or large water containers where fragmentation obscures the original item identity.

Hazardous waste pathways: Diapers (1,095 g) and medical/sanitary items (1,210 g total) on the beach reflect household-level gaps in sanitary waste management infrastructure. Similarly, glass bottle fragments (79 items; 2,945 g total) pose safety risks to beachgoers and wildlife, indicating inadequate disposal systems for breakable containers.

Temporal dynamics: Short container replacement cycles at the household level generate high weekly waste volumes. When combined with unreliable collection services (only 50.36% report efficiency), this creates a "pulse" effect where waste accumulates rapidly and is more likely to be

illegally dumped or blown into waterways during rainy seasons, a known exacerbating factor for flooding in these communities.

Informal sector role: The 32.37% of households relying on informal collectors (scavengers, junk shops) represents both a recovery opportunity and a leakage risk. While informal actors divert some recyclables from landfills, the lack of regulation, transparency, and safety standards means materials may be improperly handled, contributing to environmental contamination.

3.6 Clean Coastal Index Assessment

The Clean Coastal Index (CCI) was calculated following Alkalay et al. (2007) and Delavari Heravi et al. (2024), adapted to include all litter material types:

$$\text{CCI} = \left(\frac{\text{Total litter items}}{\text{Monitored area (m}^2\text{)}}\right) \times 20 = \left(\frac{664}{830}\right) \times 20 = 16.0$$

A CCI of 16.0 places Unity Beach in the **"Dirty"** classification (10–20 items/100 m²), indicating noticeable litter accumulation visible to beach users and posing measurable ecological and safety risks.

The "Dirty" classification provides a quantitative benchmark against which the effectiveness of household-level interventions (e.g., improved segregation, collection frequency) can be evaluated over time. It also enables spatial comparison with other PROMAR sites across Guyana and the Caribbean. Importantly, the CCI's item-count methodology weights all items equally; thus, the high abundance of lightweight consumer plastics (42% of items) drives the classification, even though heavier items (e.g., buoys, shoes) may pose greater ecological hazards per unit.

3.7 Brand Audits and Producer Responsibility Insights

Brand identification revealed a "long tail" distribution with significant implications for extended producer responsibility (EPR) frameworks:

Dominant brands: Coors Light accounted for 100 items (15.06% of branded litter), primarily bottle caps (33 items; 10.44%) and glass fragments (10 items; 3.16%). Heineken (34 items; 5.11%), Corona (20 items; 3.01%), Banks Beer (16 items; 2.41%), and Rudebwoy (22 items; 3.30%) were other prominent contributors. Lucozade Energy Drink (13 items; 1.96%) was the leading non-alcoholic beverage.

Long tail effect: Seventeen additional brands appeared only 2–5 times each, but collectively accounted for ~12.5% of branded litter. These included snack brands (Cheese Curls, Popocom), confectionery (Kinder Eggs, Mugu Mugu), and incidental items (kite paper tags, Thunder Bolt Flour).

Material-brand linkages:

- Bottle caps: Coors Light (33), Banks Beer (15), Rudebwoy (8), Heineken (7)
- Glass fragments: Coors Light (10), Heineken (7), Corona (7)
- Aluminium cans: Lucozade Energy Drink (9)
- Plastic bottles: Clear Water (7), Chill Purified Water (3), Pure Water (3)

The dominance of a few beverage brands suggests opportunities for targeted engagement under EPR frameworks, including deposit-return schemes for bottles and caps, brand-led clean-up initiatives, and commitments to redesign packaging. Conversely, the long tail of low-frequency brands underscores the cumulative impact of diverse consumer goods, supporting the case for systemic packaging redesign and reuse systems rather than brand-by-brand interventions. Cross-referencing brand data with household survey responses on preferred beverage brands could further refine intervention targeting.

3.8 Synthesis: Critical Intervention Points

The integrated analysis identifies four high-leverage intervention points along the waste pathway:

1. **Source reduction**: Household reliance on single-use plastics is driven by affordability and convenience. Interventions should prioritise reusable alternatives (e.g., refill stations for water, bulk purchasing for cleaning products) and ecodesign incentives for manufacturers.
2. **Segregation enablement**: The gap between awareness (25% high) and action (4.08% always segregate) reflects infrastructural and informational barriers. Colour-coded bins, clear local-language guidance, and community-led demonstration projects can bridge this gap.
3. **Collection reliability**: Only 50.36% report efficient waste collection; improving frequency and coverage is foundational to reducing illegal dumping and burning. Transparent scheduling and community feedback mechanisms can enhance accountability.
4. **Brand engagement**: The concentration of beach litter among a few beverage brands creates an entry point for EPR dialogues. Aligning brand commitments with national circular economy objectives can accelerate systemic change.

By addressing these points in concert, interventions can disrupt the land-to-sea waste pathway at multiple stages, maximising impact and fostering resilience across household and coastal systems.

4 Recommendations

The integrated findings from the Household Material Flow Analysis and the Unity Beach litter survey reveal a clear land-to-sea waste pathway, in which household consumption patterns, inadequate segregation practices, and unreliable collection services directly contribute to coastal pollution. Addressing this systemic challenge requires a phased, multi-stakeholder approach that aligns immediate actions with long-term structural transformation. The recommendations below are categorised by implementation timeframe and are designed to be mutually reinforcing, evidence-based, and contextually appropriate for East Coast Demerara communities.

4.1 Short-term Interventions (0–12 months)

4.1.1 Infrastructure and Service Improvements

- **Deploy colour-coded, clearly labelled waste and recycling bins** at high-traffic locations in Unity Beach and within the four surveyed communities (Mon Repos, Lusignan, Good Hope, De Endragt). Bins should follow a standardised colour scheme (e.g., blue for recyclables, green for organic waste, black for residual waste) with pictogram-based instructions in English and local vernacular to enhance accessibility across literacy levels. Priority locations include beach entry points, market areas, transport hubs, and community centres.
- **Increase frequency and reliability of waste collection services** in surveyed communities, particularly during peak consumption periods (weekends, public holidays). Collection schedules should be communicated publicly via SMS alerts, community noticeboards, and local radio to reduce the storage of household waste and discourage illegal dumping. A pilot "Guaranteed Collection Day" programme could be trialled in one village to assess feasibility and community response.
- **Establish temporary waste consolidation points** in areas where formal collection is inconsistent, managed by trained community volunteers equipped with personal protective equipment (PPE). These points should be serviced weekly by municipal or contracted collectors to prevent accumulation and secondary littering.

4.1.2 Behavioural Change and Public Awareness

- **Launch targeted, locally resonant awareness campaigns** using radio dramas, social media content, and community workshops that explicitly link household waste behaviours to coastal outcomes. Messaging should employ relatable narratives (e.g., "Blocked drains = flooded homes", "Your bottle cap on the beach = hazard for children") and feature local champions, including youth leaders, fisherfolk, and small business owners.
- **Conduct practical, hands-on segregation demonstrations** at community gatherings, schools, and beach clean-up events. Enumerators and environmental officers should

model correct sorting techniques using real household waste items, reinforcing the "3-bin system" and clarifying which plastics are recyclable locally.

- **Introduce "Beach Steward" volunteer roles** at Unity Beach during peak visitation periods. Stewards would provide friendly reminders about waste disposal, distribute biodegradable bags for litter collection, and report overflowing bins or illegal dumping via a dedicated hotline or mobile application.

4.1.3 Enforcement and Accountability Mechanisms

- **Strengthen monitoring of illegal dumping and burning hotspots** through community-led surveillance networks. Residents should be empowered to report violations anonymously via a toll-free number or WhatsApp-based system, with responses coordinated by local authorities within 48 hours.
- **Implement an amnesty period** (e.g., 3 months) during which households can transition to compliant disposal practices without penalty, accompanied by clear guidance on acceptable alternatives. This approach reduces resistance while establishing a baseline for future enforcement.
- **Publish quarterly "Waste Management Scorecards"** for each surveyed community, displaying collection reliability, bin maintenance status, and reported incidents of illegal dumping. Transparency fosters accountability and enables communities to advocate for improved services.

4.1.4 Data and Monitoring Foundations

- **Integrate Unity Beach into Guyana's national marine litter monitoring framework** to enable annual recalculation of the Clean Coastal Index (CCI) and trend analysis. Standardised protocols should be adopted across all PROMAR sites to facilitate regional comparison.
- **Establish a simple household waste diary pilot** with 50 volunteer households across the four communities to track weekly plastic consumption, segregation efforts, and disposal routes. The data collected would refine the intervention design and measure behavioural change over time.

4.2 Medium-term Strategies (1–3 years)

4.2.1 Incentivised Systems and Economic Instruments

- **Pilot a "Segregate & Save" incentive scheme** offering tangible rewards for consistent waste sorting. Households demonstrating verified segregation (via spot checks or bin audits) could receive discounts at participating local markets, utility bill credits, or priority access to community resources. Rewards should be modest but meaningful to encourage participation without creating dependency.

- **Introduce a deposit-return scheme (DRS) for beverage containers**, beginning with PET bottles and aluminium cans from high-impact brands identified in the beach audit (Coors Light, Banks Beer, Heineken, Lucozade). Redemption points could be located at supermarkets, schools, and community centres, with refunds redeemable as cash, mobile credit, or vouchers.
- **Develop a "Green Business Certification"** for retailers, vendors, and food service operators who adopt plastic-reduction practices (e.g., offering reusable container options, eliminating single-use cutlery, sourcing unpackaged produce). Certified businesses could receive promotional support through tourism channels and local government platforms.

4.2.2 Brand Engagement and Extended Producer Responsibility (EPR)

- **Convene a multi-stakeholder EPR forum** involving identified brands (Coors Light, Heineken, Banks, Lucozade), retailers, waste management companies, and community representatives. The forum should explore collaborative mechanisms such as: (i) brand-funded collection and recycling infrastructure; (ii) packaging redesign commitments (e.g., lighter-weight bottles, recyclable caps); and (iii) consumer education co-branding.
- **Support brand-led "Take-Back" initiatives** at Unity Beach during high-visitation periods. For example, beverage vendors could offer small discounts to customers who return caps or bottles to designated collection points, with collected materials routed to formal recyclers.
- **Publish an annual "Brand Litter Footprint Report"** for Guyana, ranking companies by their contribution to beach litter (based on PROMAR audit data). Public disclosure creates reputational incentives for corporate responsibility and informs consumer choice.

4.2.3 Education and Capacity Building

- **Integrate waste management and circular economy modules** into primary and secondary school curricula across Region 4. Content should include practical activities (e.g., upcycling projects, school composting, plastic-free challenges) and link to national development goals.
- **Train and certify local "Waste Ambassadors"** from each surveyed community to serve as ongoing resources for segregation guidance, bin maintenance, and peer education. Ambassadors should receive stipends or in-kind support to sustain engagement.
- **Develop vocational training programmes** in waste sorting, recycling operations, and upcycling techniques, targeting youth and informal waste pickers. Partnerships with technical institutes and NGOs can ensure curriculum relevance and job placement pathways.

4.2.4 Infrastructure Expansion and Innovation

- **Establish community-scale material recovery facilities (MRFs)** in strategic locations along East Coast Demerara to process segregated recyclables. MRFs should prioritise labour-intensive sorting to create local employment and include safe storage for hazardous items (e.g., glass, medical waste).
- **Pilot "Plastic Wood" production** using collected beach and household plastics. Converted materials could be used for public infrastructure (benches, signage, boardwalks) at Unity Beach, demonstrating circular economy principles while reducing maintenance costs.
- **Explore decentralised composting solutions** for organic waste, particularly in agricultural communities. Small-scale composting units could serve clusters of households, reducing residual waste volumes and producing soil amendments for local farming.

4.3 Long-term Systemic Changes (3+ years)

4.3.1 Policy and Regulatory Reform

- **Advocate for legislative amendments** to Guyana's Environmental Protection Act and Solid Waste Management regulations to: (i) mandate source segregation for all households and businesses; (ii) phase out non-recyclable single-use plastics (e.g., polystyrene containers, multi-layer sachets); and (iii) formalise the role of informal waste pickers with safety standards, fair compensation, and social protections.
- **Embed circular economy principles** in national development planning, including procurement policies that prioritise reusable, recyclable, or compostable products for public institutions. A "Green Public Procurement" framework could catalyse market demand for sustainable alternatives.
- **Strengthen regional harmonisation** of plastic regulations through CARICOM mechanisms, enabling collective bargaining with multinational producers and reducing regulatory arbitrage that undermines national efforts.

4.3.2 Circular Economy Lab and Innovation Ecosystem

- **Establish a national Circular Economy Lab** as a multi-stakeholder innovation hub focused on packaging ecodesign, material science, and business model innovation. The Lab should prioritise: (i) developing locally appropriate reusable packaging systems (e.g., refill stations for water, cooking oil, cleaning products); (ii) supporting green chemistry research into bio-based, marine-degradable polymers; and (iii) fostering industrial symbiosis models that convert waste streams into inputs for other sectors (e.g., plastic-to-fuel, organic waste-to-energy).
- **Create a dedicated innovation fund** to support early-stage ventures addressing plastic pollution, with criteria favouring community-led, women-owned, or youth-led

enterprises. Funding could be sourced from government allocations, climate finance, and private sector contributions under EPR frameworks.

- **Develop a "Design for Guyana" guideline** for packaging manufacturers, outlining material specifications, labelling requirements, and end-of-life considerations aligned with local recycling infrastructure and environmental conditions.

4.3.3 Upcycling Infrastructure and Value Chain Development

- **Scale up plastic wood production facilities** to serve regional demand for durable, low-maintenance public infrastructure. Partnerships with construction firms, tourism operators, and municipal authorities can create stable offtake agreements and ensure quality standards.
- **Support artisanal upcycling enterprises** that transform collected beach litter into marketable products (e.g., jewellery from bottle caps, art from plastic fragments). Business development services, including design support, branding, and e-commerce access, can enhance viability and reach.
- **Integrate upcycled materials** into national infrastructure projects, such as coastal protection structures, park furnishings, and school facilities. Public procurement policies should include minimum thresholds for recycled content to stimulate demand.

4.3.4 Regional Cooperation and Knowledge Sharing

- **Position Guyana as a regional leader** in marine litter monitoring and circular economy innovation by hosting annual PROMAR knowledge exchanges, technical workshops, and policy dialogues. Shared learning can accelerate the adoption of effective interventions across the Caribbean.
- **Contribute baseline data and lessons learned** to regional platforms such as the Caribbean Community Climate Change Centre (CCCCC) and the Association of Caribbean States (ACS), enabling evidence-based advocacy for international support and financing.
- **Pursue blended finance mechanisms** (e.g., green bonds, results-based financing) to fund large-scale waste management infrastructure, leveraging Guyana's commitment to low-carbon, climate-resilient development.

4.3.5 Monitoring, Evaluation, and Adaptive Management

- **Establish a national Marine Litter Dashboard** displaying real-time data from Unity Beach and other monitoring sites, including CCI trends, brand audit results, and intervention progress. Public access to data fosters transparency and enables civil society oversight.
- **Conduct biennial integrated assessments** replicating the Household MFA and beach survey methodology to measure changes in consumption patterns, segregation rates,

and coastal litter composition. Findings should directly inform policy adjustments and resource allocation.

- **Embed adaptive management principles** in all interventions, with built-in feedback loops allowing for course correction based on monitoring data, community feedback, and emerging evidence. Flexibility is essential in addressing complex, evolving challenges like plastic pollution.

4.3.5.1 Cross-cutting Considerations

- **Equity and Inclusion**: All interventions should prioritise accessibility for vulnerable groups, including low-income households, persons with disabilities, and informal waste workers. Participatory design processes ensure solutions reflect diverse needs and capacities.
- **Gender Responsiveness**: Recognise and address gendered dimensions of waste management (e.g., women's primary role in household waste decisions) by ensuring women's leadership in programme design, implementation, and benefit-sharing.
- **Climate Resilience**: Align waste management improvements with broader climate adaptation goals, such as reducing flood risk from plastic-clogged drains and enhancing coastal ecosystem health.
- **Private Sector Engagement**: Foster genuine partnerships with businesses beyond compliance, leveraging their innovation capacity, distribution networks, and consumer influence to accelerate systemic change.

By implementing these recommendations in a coordinated, phased manner, Guyana can transform its waste management system from a linear, leakage-prone model to a circular, community-empowered framework. The ultimate goal is not merely cleaner beaches, but healthier communities, resilient ecosystems, and a thriving economy that values resources and minimises waste.

5 Conclusion

This integrated baseline assessment represents a critical step towards understanding and addressing the complex challenge of plastic pollution in East Coast Demerara, Guyana. By synthesising findings from the Household Material Flow Analysis (MFA) Survey across four coastal communities and the baseline beach litter survey at Unity Beach, this report establishes a robust, evidence-based foundation for targeted intervention. The convergence of data from these complementary studies reveals not merely parallel issues, but a clear, causal land-to-sea waste pathway that demands coordinated, systemic action.

At the household level, the MFA Survey (n=417) demonstrates that plastic remains deeply embedded in daily consumption patterns across all income brackets. The overwhelming preference for disposable 19-litre water containers (76.74% of users), the widespread weekly consumption of plastic beverage bottles (72.9% using 1–7 bottles), and the high reliance on single-use food packaging collectively generate substantial volumes of plastic waste. Critically, however, this consumption is not matched by responsible end-of-life management: 59.23% of respondents never segregate waste, 42.21% dispose of all refuse as mixed waste, and over 30% rely on informal or unregulated disposal channels. When formal collection services prove unreliable, as reported by nearly 30% of households, residents resort to storage, burning (10.55% weekly), or illegal dumping (11.99%), creating direct pathways for waste to enter the environment.

The Unity Beach survey quantifies the coastal manifestation of these household-level practices. With a Clean Coastal Index (CCI) of 16.0, Unity Beach is classified as "Dirty", indicating noticeable litter accumulation that poses measurable risks to ecological integrity, visitor experience, and public safety. The dominance of "Pl. (Consumption)" items (42.02% of litter by count), including wrappers, bottles, and caps, directly mirrors household consumption data. Beverage-related waste emerges as a critical shared category: bottle caps (11.14% of beach items), glass fragments (11.90%), and drink bottles (8.13%) collectively account for nearly one-third of all recorded litter. Brand identification further strengthens the household–coastal linkage, with Coors Light, Banks Beer, Heineken, and Lucozade Energy Drink appearing prominently in both survey datasets.

Several cross-cutting insights warrant particular emphasis:

1. **The awareness–action gap**: While 25% of household respondents reported high awareness of plastic pollution issues, this knowledge rarely translates into consistent waste segregation or responsible disposal. This disconnect underscores the limitations of awareness-raising alone and highlights the need for enabling infrastructure, clear incentives, and sustained behavioural support.
2. **The informal sector's dual role**: Informal waste collectors and junk shops divert an estimated 32.37% of household waste from immediate disposal, providing a valuable, albeit unregulated, recovery function. However, the absence of safety standards,

transparency, and integration with formal systems limits their environmental benefit and exposes workers to health risks.

3. **The "long tail" of branded litter**: While a few beverage brands dominate beach litter by volume, over 17 additional brands, spanning snacks, confectionery, and non-food items, collectively account for approximately 12.5% of branded waste. This diversity illustrates that effective intervention cannot rely solely on engaging major brands; systemic packaging redesign and infrastructure for reuse are essential.
4. **Hazardous and bulky items**: The presence of medical/sanitary waste (1,210 g), diapers (1,095 g), and broken glass on Unity Beach points to critical gaps in specialised waste streams. These items pose direct public health risks and require targeted collection, treatment, and disposal protocols beyond those used for general waste management.
5. **Temporal and spatial dynamics**: The short replacement cycles for household water containers (1–3 days for many users) generate high-frequency waste flows that, without reliable collection, accumulate rapidly in coastal zones. This temporal pressure compounds spatial challenges, as East Coast Demerara's low-lying geography and seasonal flooding increase the likelihood of waste mobilisation into marine environments.

Addressing these interconnected challenges requires moving beyond siloed interventions toward a systems-based approach that aligns household behaviour change with coastal stewardship, infrastructure development, policy reform, and private-sector engagement. The recommendations outlined in Section 4, spanning short-term infrastructure improvements, medium-term incentive schemes and brand engagement, and long-term circular economy transitions, provide a practical roadmap for such an approach.

Critically, this integrated baseline establishes measurable benchmarks against which progress can be tracked. The CCI value of 16.0 for Unity Beach, the household segregation rate of 4.08%, and the brand audit data collectively enable longitudinal monitoring, spatial comparison with other PROMAR sites, and evidence-based evaluation of policy interventions. Embedding these metrics within Guyana's national marine litter monitoring framework and aligning them with the National Integrated Solid Waste Management Strategy (2017–2030) and emerging circular-economy initiatives will strengthen accountability and foster adaptive management.

Ultimately, the health of Unity Beach and the well-being of East Coast Demerara's coastal communities are inextricably linked. Plastic pollution is not merely an environmental issue; it is a matter of public health, economic resilience, cultural identity, and intergenerational equity. By acting decisively on the evidence presented herein, through coordinated investment, inclusive governance, and sustained community partnerships, Guyana can transform its waste management system, safeguard its coastal ecosystems, and position itself as a leader in sustainable development in the Caribbean. The PROMAR initiative provides a vital platform for this transformation; its

success will depend on the commitment, collaboration, and creativity of all stakeholders invested in a cleaner, healthier, and more circular future.

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