TUVALU WASTE SURVEY REPORT

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Implemented by the

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i). ACKNOWLEDGEMENT

Without the funding and support of the Government of Tuvalu through the Ministry of Home Affairs and Rural Development (MHARD), the implementation of this important survey would not be possible. The completion of this important work fulfils one of the key tasks under the Ministry`s Corporate Plan 2016 – 2018 and at the same time satisfies the requirement under the Waste Management Act 2017 for the provision of waste surveys when required for waste management purposes.

The implementation of this survey tasks in all the eight islands is a milestone for MHARD to achieve as it is the first time for this type of assessment to cover all the eight islands of Tuvalu during a survey. Not only that but also, it has put to test the capacity of its designated Waste Management Department to carry out such a survey task in all the key eight inhabited islands of Tuvalu. This is an important development for the local staff`s capacity building to ensure the sustainable provision of waste baseline information in the future for planning and decision making purposes in line with their lawful obligations under the Waste Management Act 2017. This survey exercise has equipped the Department of Waste Management with the knowledge and skills to prepare, organize and implement similar surveys in the future.

In light of the above information, I would like to acknowledge the great effort of my staff and workers for this important work. This is just the beginning of your journey with more similar tasks and challenges in the years to come.

Let me also take this opportunity to thank our communities in Funafuti and the outer islands for the support given to our survey team during the implementation of this survey. Without your collaboration, we would not be able to complete this important task.

Fakafetai.

……..
Mr. Iete Avanitele
Ag. Permanent Secretary
MINISTRY OF HOME AFFAIRS AND RURAL DEVELOPMENT.

ii). EXECUTIVE SUMMARY

KEY FINDING OF THE SURVEY

1). Municipal Solid Waste

- The findings of the survey show that the generated municipal solid waste is dominated by the domestic waste originating from **households activities by 80%.** The remaining **20% comes from the few commercial and institutional sources.** This clearly reflects the level of economic development in the country.

- The overall unit generation rate of the households` wastes in Tuvalu is **0.42kg per person per day. The average waste density is 168kg per cubicmeter**. The organic waste category has dominated the overall generated households` wastes throughout the Tuvalu islands by **60%, 15% for nappies, 7% for plastics, 5% for papers, 4% for metals and glasses, 2% for textiles and 3% for others.** These characteristics of the households waste fall within the range for developing and poor countries in line with the Guides for Municipal Solid Waste Management in Pacific Island Countries (WHO,1996).

- The estimated **annual amounts of wastes on the islands** based on the households wastes are 904 tonnes in Funafuti, 263 tonnes in Vaitupu, 69 tonnes in Nanumea, 74 tonnes in Nanumaga, 69 tonnes in Niutao, 77 tonnes in Nui, 106 tonnes in Nukufetau and 55 tonnes in Nukulaelae.

- The estimated annual amount of collected municipal solid waste in Funafuti on an annual basis is 4,479m3. About 70% of the collected waste is disposed of at the disposal site including the nappies (5%), recyclable waste (1.4%) because of lack of storage space at the time of this study. About 30% is diverted for composting purposes. The information from the other islands lacks consistency and accuracy and thus requires improvement of recording in the field in the future.

- More than 50% of the green waste is uncollected based on the 50% green waste collection coverage. Households need to be encouraged to make good use of this service. Similarly, the use of the bulky and hazardous waste collection by members of the public is very low and therefore requires some review of other options.

- The management of the generated Municipal Solid Waste has improved a lot in recent years with the increasing support from the government and its development partners. The government waste collection service with EFD10 support has extended in 2013 to the rest of the country including the seven outer islands. This makes Tuvalu one of the few countries in the Pacific region with more than 90% of the country`s population is covered by the provided waste collection services.

- While several good progresses have been made in recent years, **there are still areas for future improvement as briefly highlighted below:**

  a). **To improve waste storage at source** to address the difficulties encountered by the collection crews during the collection services particularly in Funafuti as a result of poorly packed wastes and damaged plastic bins.

  b). **Consider the use of a prepaid rubbish bag** to standardise the use of plastic bags as waste storage for Funafuti. This system has been successfully introduced to Vanuatu and Kiribati and therefore should have no major issues with its introduction to Tuvalu. The enforcement of the use of special rubbish bags will have good impact to the management of the waste disposal sites. With the usual plastic blockage effect, it will reduce the generation of leachate during rains and its direct seepage through the porous islands soil profile.

  c). **Review and consider the use of medium size rubbish trucks** with rear low loading ends for easier loading of the waste bins if the plastic/rubbish bags ideas do not work. This is an option to address the spillage of the generated leachate on the road including the bad odour generated during the provision of this service. This also addresses the concern for the workers Occupational and Health Risks as a result of lifting heavy bins above their breast height. However, this is only an option if it is proven practical and manageable in the long term based on the running and maintenance costs and availability of spare parts.

  d). **All the disposal sites in the country are classified as open dumpsites and thus need physical improvements to upgrade to proper and safe disposal landfills.** Their close locations to the coastline, shallow soil profile and porous structure make the current locations not suitable for waste disposal purposes. However, there are no other alternative sites given the islands low atoll conditions. The Funafuti disposal site based on the April 2017 observation shows about eight months remaining for the site to remain operational if regular maintenances are carried out and without fire. A design has been developed under the Technical Assistance provided by SPREP in the Tuvalu Waste Baseline Report (refer section 4.4.) for consideration. For the outer islands some typical designs are also provided to provide low cost improvements to control the current conditions. Providing full improvements similar to Funafuti are constrained by the unavailability of heavy equipment and other supporting resources including power supply for aeration and leachate treatment.

  e).**The littering and illegal dumping problems in Tuvalu are common throughout the islands and it is polluting the marine environment**. Strict monitoring and enforcement of the Waste Regulations is needed to control

the situation with more public awareness and education focusing on primary and tertiary school levels.

f).**The introduction of a Container Deposit Levy based on the experiences from Kiribati and Palau should provide part of the long term solution for the littering problem** particularly for cans and plastic bottles.

2). Other Waste Streams

- The **generation of bulky waste is a concern due to the increasing ownership of vehicles and motorbikes as well as white goods** particularly refrigerators and washing machines. These waste items are difficult to manage on the islands because of their large sizes and potential hazardous nature of some components embedded in their physical structures. It requires a system to control their importation and ensure the safe recovery and collection when reaching their end of life.

- The **Coastal litter generation is largely driven by illegal dumping and littering problems in the country.** These bad habits must be seriously controlled and those responsible must be penalized under the Waste Management (Litter and Waste Control) Regulations 2017 to change their attitudes.

- The **Used Lubricant Oil (ULO) generation** was not studied in details during this assessment as it is a different specialized field requiring a special expertise**.** However, this investigation has discovered 4,000 litres of ULO have been shipped to Fiji by Pacific Energy under an agreement made with the Department of Waste Management and endorsed by the Ministry of Environment of Fiji. Under the agreement, 20,000 litres of ULO are allowed to be shipped on an annual basis. The stockpile of ULO at the Hangar was estimated at 10,000 Litres. A follow up detailed assessment will provide better information to understand the extent of this unique waste stream which this study was not able to investigate deeper.

- The **Healthcare Waste generation** was not adequately assessed due to the level of specialized expertise needed for this type of waste stream. However, investigations made during this study discovered an overall low amounts at the outer islands hospitals. This is partly due to the level of medical operations conducted at these rural hospitals, which are mainly restricted to minor health problems. The Funafuti Hospital on the other hand based on waste generation per hospital bed is low. There is a need for more training to educate the nurses and workers on waste segregation at source including the introduction of the special bins with appropriate colours. With the special incinerator funded under the PACWASTE project in 2016, it provides assurance of the proper treatment of the generated healthcare waste in Funafuti. However, it requires a firm commitment

from the hospital management for financial support to operate this important plant properly in line with its operating manual to prevent any adverse impacts.

- **The Ship waste** generation was assessed but not thoroughly due to the remote and mobile location of the generating sources. The findings show that there is a management system already in place where any wastes generated on the ships are stored in the provided bins. These bins are emptied at the provided drop off large bins at the Funafuti wharf for final disposal. The wastes can also be disposed of in the outer islands if needed. Some unconfirmed reports raised the illegal dumping of wastes from ships, but could not be investigated and confirmed during this study.

3). Level of Acceptance of Existing & Proposed Waste Management Initiatives

a). Monthly Waste Fee for Waste Management Services

About 43% of the surveyed population have indicated full appreciation of the provided waste services. About 50% indicated that the provided waste services are just fine with some areas for improvements. The remaining 7% thought that the services are poor.

b). Monthly Waste Fee for Waste Management Services

About 59% of the surveyed population indicated their willingness to pay $10 and below for a waste monthly fee. People who afford $11 to $50 a month is about 30% with only 7% indicated their willingness to pay more than $50tala a month.

c). Prepaid Rubbish Bag for Storing and Collection of Wastes

A high support was received from the surveyed population for the proposed idea of using a prepaid trash bag in the future to improve the storage of waste and the collection service. About 43% supported the option of a prepaid bag below 50cent, 48% for 50cent, 2.6% between 50cent and $1 and 5.7% for $1 and more.

d). Introduction of a Container Deposit Levy for Recycling Purposes

- ✓ 100% supported the idea
- ✓ 100% indicated their full participation if the initiative is introduced.

There has been an overwhelmingly support for the Container Deposit System to promote recycling in the country and this is a timely survey during the planning of the CDL initiative.

4). Public Awareness and Education

Much effort has been made in the past to promote public awareness on waste management through radio programmes, workshops, school programmes and other approaches.

About 76% of the surveyed population throughout the 8 islands indicated radio as the main means of getting waste management information. Workshop and visits by the Kaupule offices throughout the country were indicated by 17% of the surveyed population as one of the main public awareness and educational means to get the messages across the country.

This information is useful for future on going public awareness programmes.

1.0. INTRODUCTION

1.1. Background Information

Under the Ministry of Home Affairs and Rural Developments (MHARD) Corporate Plan 2016 -2018, the implementation of waste surveys for all the Tuvalu islands has been scheduled for the year 2017. This survey task is a lawful responsibility of the Department of Waste Management (DWM), formerly known as the Solid Waste Agency of Tuvalu, to carry out in accordance with its legal obligations under the Waste Management Act 2017.

Having baseline information and data on the generated waste including their management at the generating sources is a necessity for better waste management planning and decision makings. The most recent waste surveys conducted in Tuvalu was in 2014 in Funafuti and 2010 in Nanumaga island. These surveys however, did not cover the other outer islands and other waste streams. Therefore, little information was made available to fully understand the actual situation of waste generation and management practices involved.

1.2. Purpose of the Survey

The primary purpose of conducting this survey is to collect update baseline information on the generated wastes and the management practices involved including public perception on these provided services and proposed future improvements.

1.3. Key Objectives

The general objectives of this survey task are to:

Objective One:

Establish baseline information and data as practical and measurable parameters for future monitoring purposes on the progress of waste management in the country.

Investigating and extracting key waste data and information such as households unit waste generation rate (kg per person per day), amount of collected (tonnes or m3 per annum), recycling rate (%) collection coverage (%) and final disposed waste amounts (tonnes per annum) are measurable waste parameters, which can be used as baseline data and indicators to measure future progress on the different aspects of waste management. This is important for the future monitoring of the Integrated Waste Management Policy 2016 - 2027 including the Integrated Waste Action Plan 2017- 2020 future progress.

Objective Two:

To investigate the status of provided waste management programmes and services for future adjustments and necessary practical improvements

Understanding the progress of delivered waste programmes and services can provide some information on areas where future improvements are needed. Investigations made under this survey focused on the current status of the provided collection and disposal system (right from waste storage at source to final disposal), monitoring and enforcement as well as supporting public awareness programmes**.**

1.4. State of Limitation

The nature of this waste assessment task with a wide range of waste streams covered (domestic, commercial, institutional, ship waste, coastline waste, bulky waste, healthcare waste and used lubricant oil) would require different waste expertise and more experienced manpower to adequately cover the different eight islands. However, it was an important opportunity for the local staff of MHARD to learn and build their capacity for future similar assessment tasks. For this reason, the extracted information may lack depth, details and validity especially in the gathered information from the outer islands in the absence of the waste consultant. Therefore, follow up detailed assessments may be needed in the future to complement these information and data, particularly when planning and designing waste management facilities for the non-municipal solid waste streams.

2.0. ASSESSMENT METHODOLOGIES

Different survey methodologies and approaches are commonly used to extract waste baseline information and data when it comes to baseline information for waste management planning purposes. The choice for the assessment methodology depends on the type of waste, available resources and other general survey aspects. For this survey, a mixture of survey approaches have been used from fieldwork assessment of the waste using standard procedures to face to face interviews with the waste generators, public opinion assessment, photos analysis and geographic information system.

2.1. Waste Amounts & Composition Survey (WACS)

2.1.1. Households (Domestic) Solid Waste

The seven days assessment procedures recommended in the Guides for Municipal Solid Waste Management in Pacific Island Countries (WHO, 1996) were considered for this survey. A briefing was conducted at SWAT`s office on the survey procedures (refer Annex 1: Waste Generation and Composition Survey Procedures) and other general aspects including the surveys statistical principles and concepts for the survey team to learn and know in order to minimise and avoid errors during the implementation of the survey. Following the briefing session, an actual fieldwork practical survey was implemented for one day to get some hands on experiences for the survey team before the commencement of the survey in Funafuti.

Photo 1: Households` briefing on the 1st Day in Funafuti

Photo 2: Collection of the trash bags

Photo 3: Weighing of the collected trash bags

Photo 4: Preparation for waste composition assessment

Photo 5: Studying the composition of different types of waste

Table 1: Information on the Islands Waste Assessment.

Island	Survey Sample Size	Comments
1. Funafuti Island	40 Households The recommended number of households for Pacific islands is between 10-20 households.[1] The selected 40 households for Funafuti aimed to cover the different income levels(low, medium and high).	The selection was done randomly covering 75% of the island length from the southern end to the central and populated area. The 40 households were briefed of the purpose of the survey on the first day. During the same day, trash bags and plastic waste bins (75L) were distributed to the selected 40 households for storing of their generated daily waste within the seven days period of the survey. These trash bags were collected from the 2nd to the 8th day of the survey for measurement and assessment in line with the Surveys Procedure (see Annex 1). The Funafuti survey was a good learning platform for the survey team members before moving to the outer islands to conduct similar assessments. The trained members of the Department of Waste Management after the Funafuti survey have providedtheleadingroleduringthe implementation of the same survey tasks in all the remaining 7 outer islands. They were divided into three separate individual teams with the supporting survey teams being recruited in the islands. The same briefing sessions was made by these trained staff to their islands survey teams before the commencement of their surveys in the first three outer islands.

[1] WHO, 1996: Guides for Municipal Solid Waste Management in Pacific Island Countries.

2. Vaitupu	30 households Like Funafuti, the 30 Households aimed to cover the different income levels.	The 30 survey samples used for Vaitupu island was based on its population as the next island to Funafuti in terms of the population size. One of the threemembers`surveyteamledthe implementation of this survey in Vaitupu following the same procedures implemented in Funafuti. The measurements were recorded in the provided survey forms, which were sent to SWAT office in Funafuti for further reviews and analysis of the gathered data and information.
3. Nanumea, Nanumaga Niutao, Nui, Nukufetau Nukulaelae	20 households The rest of the outer islands do not have any clear income differences among the households compared to Funafuti and Vaitupu, therefore 20 households would appropriate to represent the income levels of the smaller islands.	The rest of the smaller islands survey samples were 20 households in line with their small populations compared to Funafuti and Vaitupu. The same survey procedures were used throughout all the islands and the information were recorded in special survey forms and sent to SWAT Office for further review and analysis as presented in the later sections of this report.

2.1.2 Businesses (Commercial) Solid Waste

Due to the limited manpower resources available during the survey, the same detailed procedures implemented in Funafuti was not conducted in the other seven outer islands. There was an assumption of the small amounts of commercial waste from the few small canteens in the outer islands, which are highly mixed with the households waste based on an earlier visit by the consultant in December 2016. For this reason, a detailed assessment of the outer islands commercial waste was not significant given the small amounts expected.

The primary focus of the commercial waste assessment was placed on Funafuti island, which is the official businesses and commercial center of the country. Eight businesses were selected in Funafuti from 2 accommodations, 3 small shops and 3 large supermarkets. The recovered wastes in these businesses bins and cages were assessed on a daily basis for seven days.

2.1.3. Institutional Solid Waste

The institutional waste was assessed using the generated wastes from the main Government Building, which houses more than 90% of the government agencies. The daily generated waste from all the agencies were collected by the responsible cleaners and delivered to the designated area for assessment. A briefing was conducted for the cleaners on the purpose of the survey. Trash bags were also given to the cleaners for 5 working days as being considered for this assessment. These trash bags were collected at the end of the day and stored at a central location for assessment by the survey team.

Photo 6: Government Building Cleaners Briefing

2.1.4. Bulky Waste

The assessment of bulky waste was conducted through field observations, combined with the responses from households to the survey questionnaires that were filled by surveyed households: Funafuti - 40, Vaitupu - 30, Nanumea - 20, Nanumaga - 20, Niutao - 20, Nui - 20, Nukufetau - 20 and Nukulaelae - 20. In addition, the information of imported white goods and vehicles was obtained and analysed to understand the future generation of bulky waste in the country.

Photo 7: End of Life Vehicles as the main Bulky Waste in Tuvalu

2.1.5. Ship Waste

The assessment of the ships waste focussed on the recovered and collected waste from the ships, which were disposed of at the bins placed at the Funafuti main wharf and collected by SWAT on a weekly basis for final disposal at the Funafuti Disposal site. The wastes that were offloaded and disposed of on other islands were not possible to obtain.

Photo 8: Bins located at the wharf for the recovery and collection of ship wastes

2.1.6. Coastline Litter Waste

The coastline litter was assessed using the transect line assessment method, where five plots of 100m long (total 500m) were marked along the road sides. These five 100m plots were randomly located along the road. The adjacent coastline areas for both the lagoon and ocean sides were monitored and observed for the presence of litter during a seven days period.

Photo 9: Litter at both the ocean (left) and lagoon side (right)

2.1.7. Healthcare Waste

The wastes generated from hospitals were assessed at the main hospital in Funafuti and the outer islands hospitals based on the actual recovered and collected wastes in these healthcare facilities. The number of daily collected bags including wheelie bins was recorded for an estimate of this special waste.


Photo 10: Collected Trash bags and full bins being assessed

2.1.8. Used Lubricant Oils (ULO).

ULO was assessed by investigating the number of the recovered and collected containers of ULO from the outer islands and in Funafuti. These containers of ULO are transported and stored at the Department of Waste Management`s Hangar before sending to Fiji by a local company.

2.2. Investigating the Waste Storage Conditions

Fieldwork visits were made to observe the bins situation as well as through the use of structured questionnaires (refer Annex 4) that gathered information from the outer islands. The assessment of the bins was focussed on the following aspects:

- Bins conditions - without lids, wheels or damaged.
- Bins availability to households

2.3. Studying of the Collection System Efficiency

A Time and Motion Study was used to study the collection system efficiency including the analysis of information from the questionnaires. The key areas assessed under this assessment are:

- Collection coverage of the provided collection services
- Equipment and workers
- Suitability of the equipment for collection
- Any issues and challenges affecting the collection efficiency in the islands

2.4. Investigating the Waste Disposal Conditions

Field observations were made to all the islands to investigate the conditions of their dumpsites as presented in the latter sections of the report mainly on the following aspects:

- Disposal area and location
- Waste Disposal Types - Open dumping, Controlled Dumps, etc.
- Area suitability in terms of soil profile and porosity.

2.5. Investigating Public Awareness Programme & Support for future waste improvements and developments

The assessment was done using a structured questionnaire that was distributed to the surveyed populations in all the islands to investigate the following aspects:

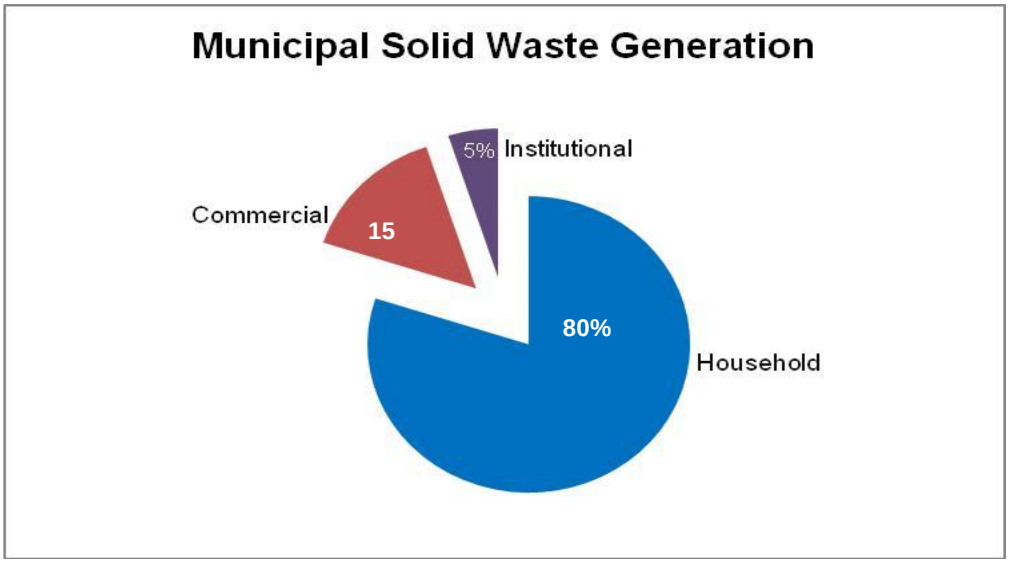
- Public awareness approaches effectiveness
- Level of Appreciation of the Provided Services
- Public Opinions on an Introduced Waste Fee in the future
- Public Opinions on Potential Future Waste Developments (E.g. CDL and Prepaid Bag).

3. PRELIMINARY RESULTS AND FINDINGS

3.1. MUNICIPAL SOLID WASTE GENERATION

Figure 1 below summarises the composition of the generated municipal solid waste with 80% originating from households activities, while the other 20% constituting the commercial and institutional solid waste.

Figure 1: Composition of the Generated Municipal Solid Waste in Tuvalu



The dominance by households waste of the generated municipal solid waste highly echoes the low level of the country`s economic development as displayed with the estimated 15% of the resulting waste from businesses activities. The small percentage of the waste from institutions on the other hand shows the small size of the country`s institutional establishments.

Table 2: Generated Municipal Solid Waste

Municipal Waste	Total Collected (kg)	Percentage (%)
Households Waste	3,947.442[2]	80.3
Commercial Waste	680.158	15
Institutional Waste	230	5
Total Collected	**4,857.58**	**100**

[2] *Refer Table 5 for the total collected wastes from eight islands*

3.1.1. Waste Amounts & Composition Results

(i). Households

- **Waste Amounts and Density**

Table 3 below presents the key findings of the generated households in all the eight islands - waste generation per capita (kg per person per day) and waste density (kg per m3).

Table 3: Households Waste Unit Generation and Density by Island

Extracted Waste Data	F/futi	N/Mea	N/Maga	N/tao	Nui	V/tupu	N/Fetau	N/lae	Average
Unit Waste Generation (kg/person/day)	0.40	0.34	0.42	0.31	0.39	0.46	0.54	0.47	0.42
Waste Density (Kg per m3)	176	163	93	199	203	173	176	164	168

The waste unit generation (kg per person per day) ranges from 0.31 to 0.54kg per person per day with waste density from 93 to 203 kg per m3. The information on unit waste generation and density are the key baseline data used to estimate the overall waste amounts on a daily, monthly and annual basis as presented below in table 4:

Table 4: Estimating Key Waste Information using Waste Generation Rates and Densities

Data	F/futi	N/mea	N/maga	N/tao	Nui	V/tupu	N/fetau	N/laelae
1). Population (2012 Est)	6,194	556	481	606	541	1,565	540	324
2). Generation Rate kg/person/day	0.40	0.34	0.42	0.31	0.39	0.46	0.54	0.47
3). Density of the Generated Waste	176	163	92.96	199	203	173	176	164.25
4).Daily Amount of Waste on each island (kg)	2,478	189	202	188	211	720	292	152
5). Annual Amount of the waste on each island (tonnes)	904	69	74	69	77	263	106	55
6). Estimated Annual Volume of the generated waste on each island (m3).	5,138	423	793	345	379	1,519	605	337

Row 4 = Row 1 x Row 2 **Row 5 = Row 4 x 365 days** **Row 6 = Row 5 x 1000kg ÷ Row 3**

Table 5 below presents the summary of Daily, Monthly and Annual amounts of wastes generated in all the eight islands assessed during this survey.

Table 5: Estimated Amounts of Households Wastes in all the Islands

Island	Daily (kg)	Monthly (kg)	Annual (tonnes)	Annual Volume (m3)
1. Funafuti	2,478	75,360	904	5,138
2. Vaitupu	720	21,897	263	1,519
3. Nanumea	189	5,750	69	423
4. Nanumaga	202	6,145	74	793
5. Niutao	188	5,714	69	345
6. Nui	211	6,418	77	379
7. Nukufetau	292	8,870	106	605
8. Nukulaelae	152	4,612	55	337
Total Waste	**4,431**	**134,765**	**1,617**	**9,539**

These estimates above do not include wastes that are diverted to other purposes like food wastes for pigs, green wastes for gardening mulching, plastic bottles for local soft drinks storage purposes.

- **Primary Waste Composition**

The following table presents the primary composition of the households` solid waste in Tuvalu, which is briefly summarized into seven categories. The details of these seven categories are presented in table 7.

Table 6: Composition of the Households Waste in the Islands (%)

	Nmea	Nmaga	Ntao	Nui	Vtupu	Nftau	Ffuti	Nlaelae
1. Organic wastes	69.1	62.6	55.6	55.0	76.4	83.0	37.0	75.1
2. Papers	3.3	5.2	3.6	6.6	2.3	2.6	8.8	2.7
3. Metals	4.2	4.9	4.0	6.4	2.8	4.0	5.2	2.1
4. Plastics	9.3	9.2	6.8	5.0	2.7	4.5	19.7	4.4
5. Glasses	5.5	4.5	2.7	3.4	3.5	1.7	3.1	4.1
6. Textiles	2.0	2.8	1.3	0.9	1.0	0.4	3.3	4.0
7. Others	6.6	11.0	26.1	22.6	11.4	3.8	22.9	7.6

N.B. The Others Category consists of Nappies and Styrofoam

Organic wastes dominated the generated households` solid waste in Tuvalu with an average of 60% coming from food and green wastes. Funafuti island has the lowest amounts of organic waste about 37%. This does not reflect the actual amount of organic waste generated at source due to the effect of the special generated green waste collection under the government`s initiative for composting purposes.

- **Secondary Waste Composition**

Table 7: Detailed Breakdown of the Primary Composition

ITEM	Nmea	Nmaga	Ntao	Nui	Vtupu	Nkfetau	F/Futi	N/lae	TOTAL
1. Organic Waste									
• **Food Waste**	0.375	0	0.245	0.445	0	0	4.055	0	**5.12**
• **Green waste**	227.66	218.143	142.025	197.945	465.005	317.585	437.15	351.555	**2357.06**
2. Papers									
• **Papers**	7.96	6.035	5.695	6.97	5.095	1.865	35	5.525	**74.145**
• **Cardboards**	2.77	11.965	3.51	16.655	9.125	8.065	69.58	6.94	**128.61**
3. Metals									
• **Aluminium Cans**	1.82	0.492	0.185	0.235	1.56	0.75	19.95	0.655	**25.647**
• **Steel Cans**	10.995	7.54	5.21	21.95	10.245	12.02	21	3.515	**92.475**
• **Others**	0.955	8.98	4.935	0.92	5.035	2.49	20.53	5.845	**49.69**
4. Plastics									
• **PET/PE**	7.74	4.108	2.21	3.105	4.165	2.135	68.53	4.56	**96.553**
• **Plastic bags**	12.11	11.995	9.095	12.045	7.115	7.045	122.92	9.52	**191.845**
• **Other hard plastics**	10.935	15.825	6.08	2.98	5.045	8.1	43.75	6.3	**99.015**
5. Glasses									
• **Glasses bottles**	12.28	12.525	5.315	12.365	19.775	6.67	19.53	18.507	**106.967**
• **Other glasses**	5.94	3.102	1.47	0	1.27	0	17.85	0.89	**30.522**
6. Textiles									
• **Clothes, socks, etc**	6.6	9.63	3.305	3.275	5.965	1.525	39.34	18.695	**88.335**
7. Others									
• **Nappies**	21.34	36.77	66.55	81.375	65.74	14.005	273.42	34.36	**593.56**
• **Styrofoams**	0.6	1.495	0.205	0.265	3.39	0.405	0.28	1.25	**7.89**
TOTAL	**330.08**	**348.605**	**256.035**	**360.53**	**608.53**	**382.66**	**1192.8**	**468.117**	**3947.44**

Table 7 presents the overall makeup of the households` solid waste in all the eight islands. Based on the above details, the total number of collected wastes during the survey was 3,947.44 kg from 8 islands. The overall percentages of the different collected waste categories in Tuvalu based on the actual collected waste in all the islands are estimated as follow:

E.g. Organic Waste %

$$\frac{\text{Total Food Waste + Total Green Waste collected in 8 Islands (refer Table 7)}}{\text{Total Collected Wastes in 8 islands}} = \frac{2{,}362.18\text{kg}}{3{,}947.44\text{kg}} = 59.84\,\% = 60\,\%$$

The estimates for the other generated waste categories throughout the country as presented below (refer Figure 2) are estimated using the same above approach.

Figure 2: Overall Waste Composition Result in Eight Surveyed Islands

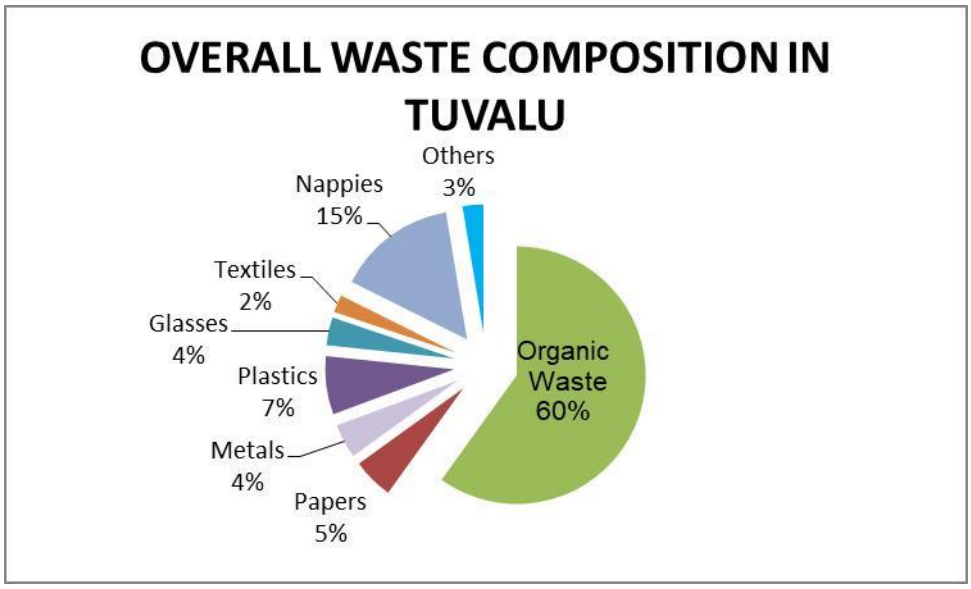
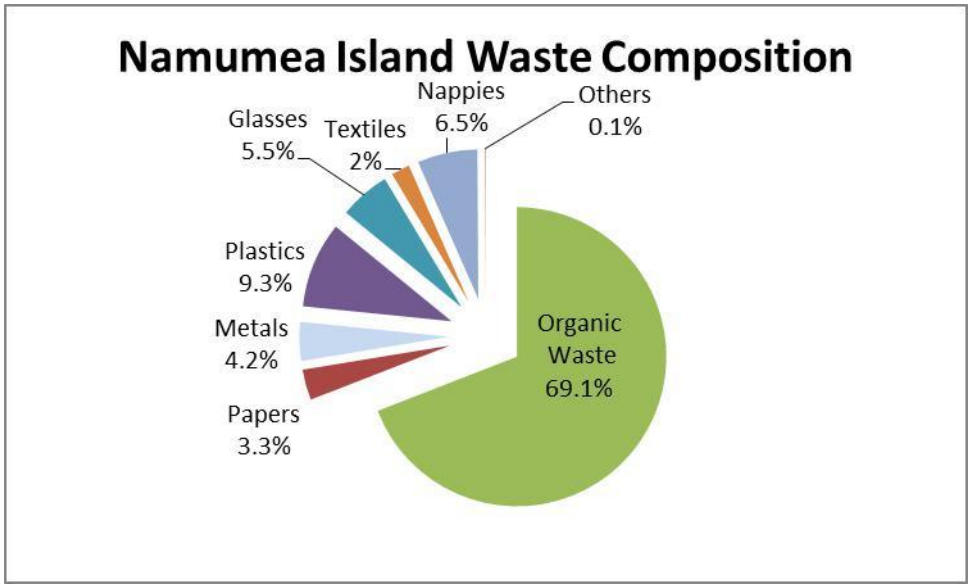


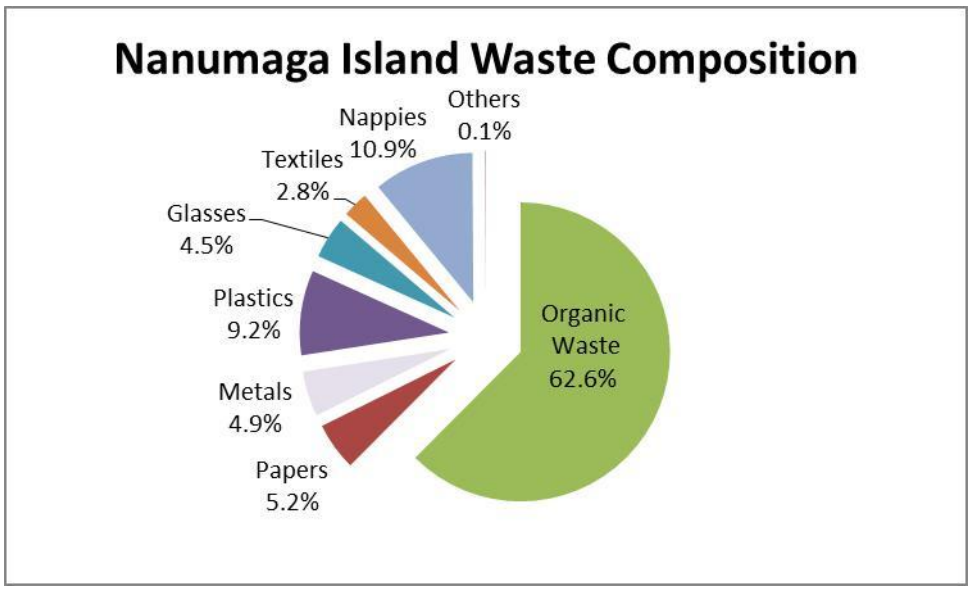
Figure 2 represents the average waste composition of all the islands based on the outcome of this study and should be considered if referring to the waste composition of the entire country. Figure 3 to 9 on the other hand refer to the waste composition at the island level and must be considered when planning specific waste management planning for the different islands to reflect the real nature of waste generation at the different islands. The key overall findings show that the organic waste is the dominant waste type in Tuvalu about 60% follows by nappies at 15%, plastics at 7%, papers at 5%, metals and glasses at 4%, textiles at 2% and others at 3%.

Figure 3: Nanumea Island Waste Composition Result



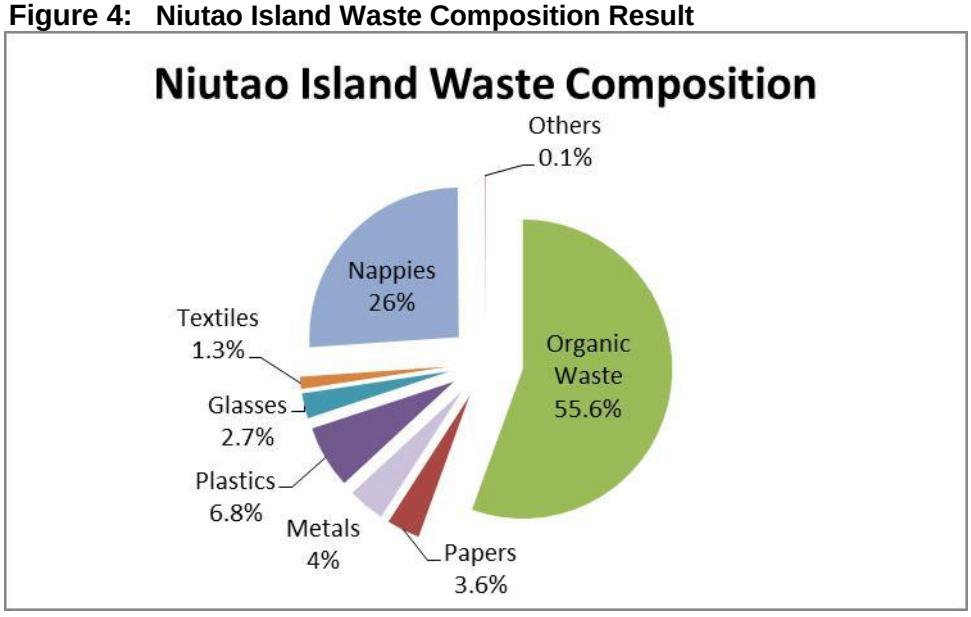
Organic wastes also represent the highest percentage at 69.1%, follow by plastics at 9.3%, nappies at 6.5%, glasses at 5.5.%, metals at 4.2%, papers at 3.3.%, textiles at 2% and others at 0.1%..

Figure 3: Namumaga Island Waste Composition Result



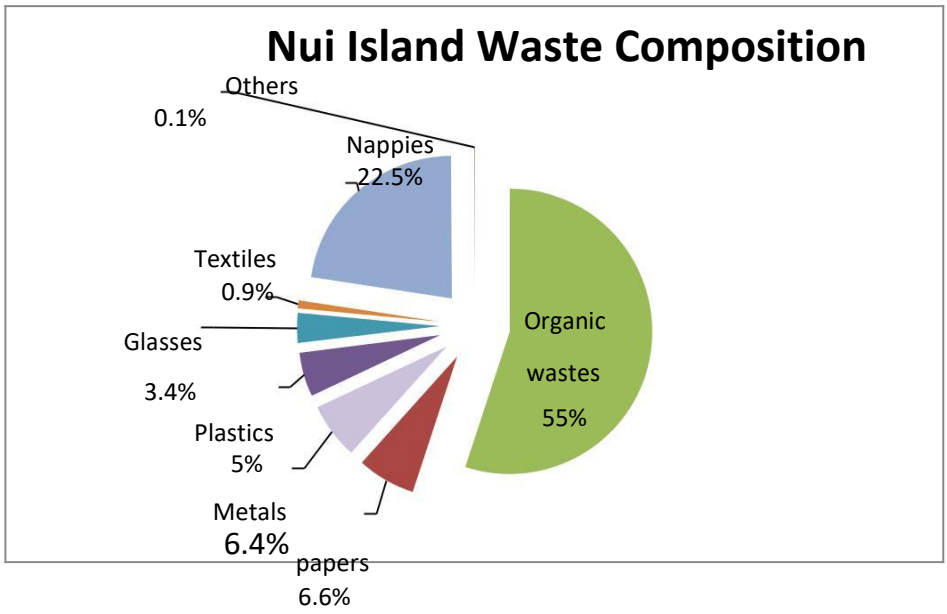
Organic waste also represents about 62.6% of the generated households` solid waste with nappies as the second highest at 10.9%, plastics at 9.2%, papers at 5.2%, metals at 4.9%, glasses at 4.5%, textiles at 2.8% and others at 0.1%

Figure 4: Niutao Island Waste Composition Result



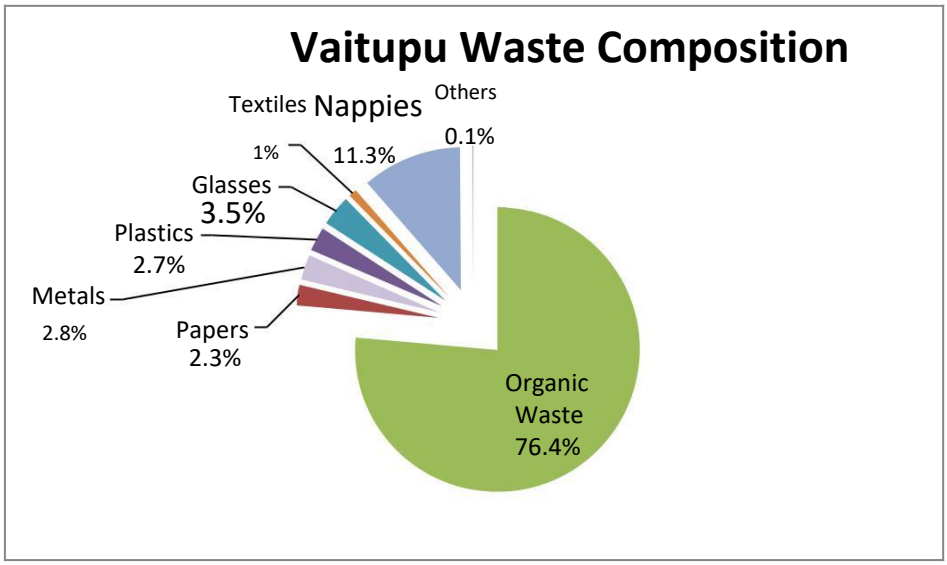
Organic waste constitutes 55.6% of the Niutao island households` solid waste. Nappies consist the second highest with 26%, plastics at 6.8%, metals at 4%, papers at 3.6%, glasses at 2.7% and textiles at 1.3%. Nappies represent quarter of the households wastes and therefore should be highly considered for appropriate long term management of this waste stream with potential negative impacts to the environment and human health.

Figure 5: Nui Island Waste Composition Result



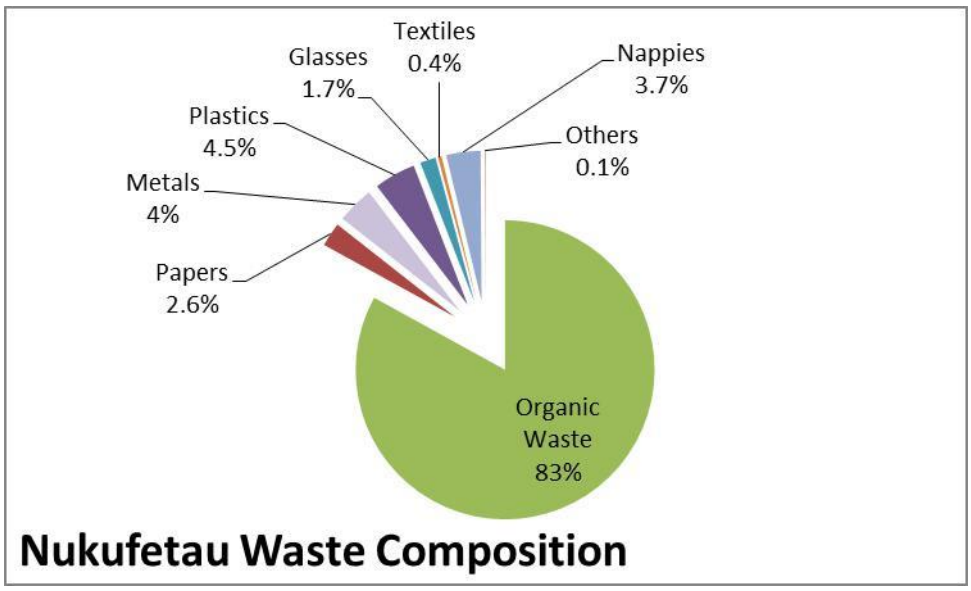
Organic waste continues to dominate the generated households` solid waste in Nui Island at 55% with nappies as the second highest at 22.5%. The rest are papers at 6.6%, metals at 6.4%, plastics at 5%, glasses at 3.4%, textiles at 0.9% and others at 0.1%.

Figure 6: Vaitupu Island Waste Composition Result



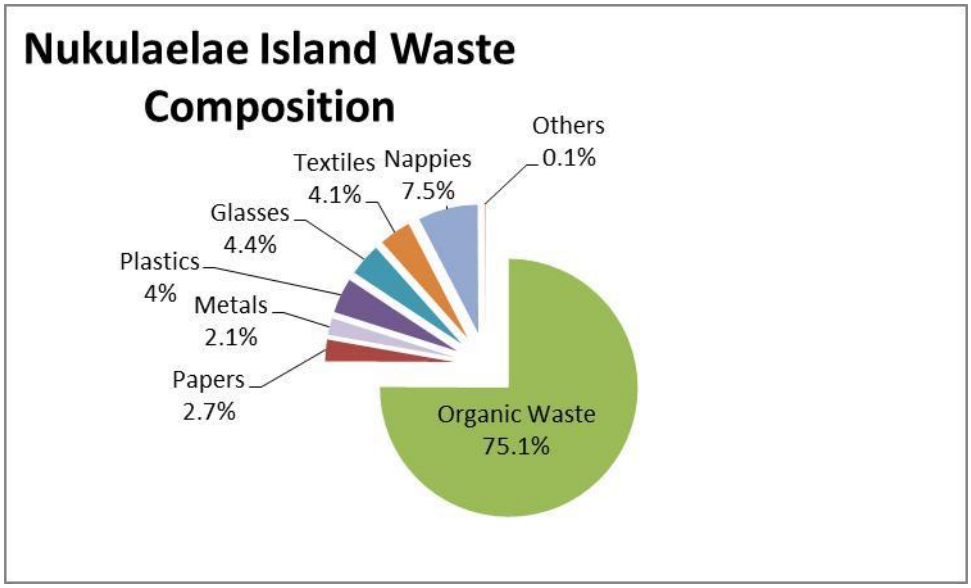
Vaitupu island waste composition like the other islands is dominated by organic waste (76.4%), follow by nappies (11.3%), glasses 3.5%, metals 2.8%, plastics 2.7%, papers 2.3% and textiles at 1%.

Figure 7: Nukufetau Island Waste Composition Result



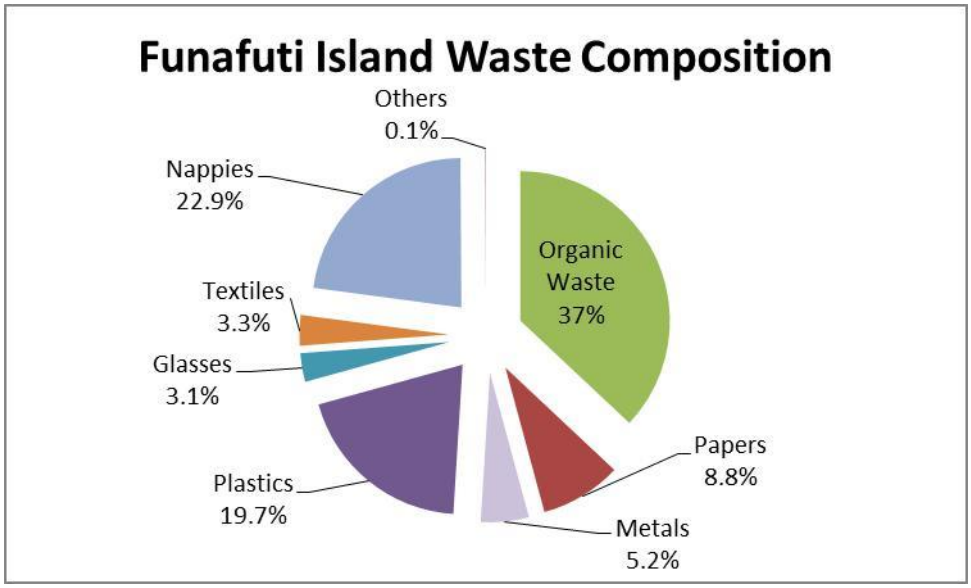
Nukufetau has the highest amount of organic waste in Tuvalu based on this survey with 83%. Unlike the other islands with nappies as the second highest waste item, plastics make up the second highest with 4.5%, follow by metals at 4% then nappies at 3.7%. The low amount of nappies on the island may due to the few number of babies at the selected households for this survey.

Figure 8: Nukulaelae Island Waste Composition Result



Nukulaelae`s generated households waste is also dominated by organic waste about 75.1% follow by nappies at 7.5%. Glasses, plastics and textiles are all around 4%, while metals and papers are 2.1% and 2.7% respectively.

Figure 9: Funafuti Island Waste Composition Result



Unlike the rest of the islands with large amounts of organic waste, Funafuti`s generated households waste although it was dominated by organic waste but it was less than the usual situation for Pacific islands with an amount of 37%. This can be due to the impact of the green waste collection service and on-going illegal dumping practices.

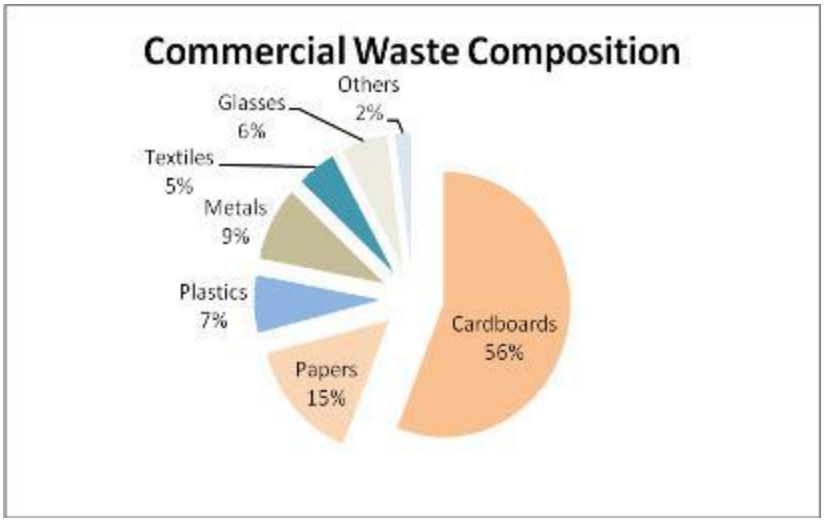
Photo 11: Diversion of Green Waste in Funafuti for gardening and illegal dumping

Photo 12: Green waste collections service in Funafuti

ii). Commercial Waste

The estimated average amount of daily recovered waste at the surveyed businesses waste storages and bins was 97kg with a total of 680.158kg for the period of seven days. With the estimated total number of employees of 50 at the surveyed businesses, the unit generation for commercial waste was estimated at 1.9kg per person per day.

Figure 10: Composition of the Commercial Waste in Funafuti



Unlike the households` waste composition with high amounts of organic waste driven by the generated green waste, the commercial waste was dominated by cardboards 56% followed by papers (15%), metals (9%), plastics (7%) and glasses (6%). There was no organic waste recovered, but mostly packing materials of imported goods and products.

Photo 13: Wholesaler and Supermarket Waste

Photo 14: Recovered waste at Accommodations in Funafuti

iii). Institutional Waste

An average daily amount of 46kg waste was estimated from the government building on a daily basis, which houses more than 95% of the institutions in Tuvalu. The composition of the waste shows 35% was papers, 32% plastics, 18% cardboards, 5% metals, 3% food waste and 7% others. Because of the low density nature of the generated waste from papers, plastics and cardboards particularly, about two to three 240L wheelie bins are needed to store the generated waste for collection.

Photo 15: Collected Institutional Rubbish Bags with stored bulky wastes

Figure 11: Waste Composition of the Institutional Waste in Funafuti

iv). Bulky Waste

The bulky waste based on field observations and the outcome of the questionnaires have shown that more than 50% of the surveyed households have some bulky waste from old washing machines and other white goods around their houses. Table 6 below shows the ownership percentage of the common white goods in 2011 and based on the lifespan of these white goods, some of these items may have already become bulky waste and the future projected ownership suggest this waste stream as a real concern for waste management in Tuvalu because of their complex nature to deal with in terms of size and hazardous substances embedded in their structure.

Table 8: Ownership of the Common White Goods

Bulky Goods	2011 Ownership %	2020 Projected Ownership %
1. Refrigerators / Freezers	90	90
2. Washing Machines	70	80
3. Televisions	55	60
4. Computers	30	40
5. Microwaves	5	5
6. Air Conditions	5	5

The analysis of white goods and vehicles imports show an average annual number of 200 units for washing machines, 250 for refrigerators and over 20 for vehicles. With the current status, appropriate mechanisms must be introduced to control the generation of this waste stream and ensure that the items are recovered, collected and processed for potential recyclable components. This is to respond to the limited land resources in the country for waste disposal options including the unsuitability of the islands land to dispose of these wastes. There are number of shipwrecks, which are difficult to manage and therefore require a special shipwrecks dismantling and management project to properly manage these special wastes due to the high costs involved including the special resources and expertise needed.

v). Ship Waste

The results of the assessment have shown that about 1m3 of waste is recovered and collected on a daily basis from ship activities. Since the same bins are also used to dispose of some of the generated waste within the wharf facilities, this was taken into account in making the estimate for the ship waste generation. The composition of the waste was not possible to assess during this study because of the busy movement of cargoes and vehicles around these bins. The overall management of the government passengers` ships seems acceptable with the provision of bins on the ships for waste disposal including their removal and final disposal on the islands when needed. Otherwise, most of the wastes from the ships are disposed of at the provided cages at the Funafuti wharf on their return to Funafuti. There have been a number of unconfirmed reports regarding some illegal dumping from ships, which require follow up investigations to confirm any violation of national and international laws. Indeed, there are acceptable waste management practices under international laws which can be applied to specific waste, which require direct disposal into the sea. These practices are in line with international and national maritime laws.

vi). Coastal Litter

The coastline litter based on Funafuti island`s assessment suggests about 0.5m3 of litter is generated within 1km (both lagoon and ocean sides) on a daily basis. This equates to an amount of 6.5m3 throughout the entire islands. In general, coastal litter is largely driven by illegal dumping and littering along the coastline, which is a big problem in Tuvalu particularly in Vaitupu and Nui islands based on this study investigations. These deposited wastes are carried and moved around by the sea especially during high tide and deposited wherever they ended up depending on the wind and water current directions. Due to this nature of the generated coastal litter, it is difficult to make and establish a standard unit generation for such a waste.

viii). Healthcare Waste

The healthcare wastes generated from the outer islands hospital are generally low based on the responses from the islands hospitals management. This is due to the absence of major operations that are performed at Funafuti hospital. Most of the generated wastes come from contaminated textiles from minor injuries wrapping and covers, injection needles as well as expired medicines and empty medicines containers. An average amount of 120L has been estimated from most of the outer islands hospitals on a monthly basis, which equates to a monthly amount of 840L and 10,080L per annum. The Funafuti hospital on the other hand has around 10-14 trash bags of 10kg capacity. This equates to about 100kg-160kg of healthcare waste. The generated waste was mostly contaminated tissues and papers, plastics and empty small glasses. There was also a significant amount of expired medicine being observed piling up at the side of the incineration facility, with some bags found at the dumpsite near the old incineration facility. These wastes should not be stored overnight, but due to the location of the facility, the incineration process according to the hospital management can only begin once the wind`s direction is right to avoid complaints from the hospital staff and workers and nearby Nauti Primary School and residence due to the bad odour generated.

ix). Used Lubricant Oil (ULO)

Based on the information and record of the Department of Waste Management, about 4,000litres of ULO have been shipped to Fiji by the Pacific Energy Company under an agreement made with the Department of Waste Management with endorsement from the Ministry of Environment in Fiji. This programme is now extending to the outer islands and is recovering ULO from the outer islands. About 10,000 Litres of ULO was stored at the Hangar at the time of this assessment. In line with the agreement made with the Pacific Energy, about 20,000litres of ULO is allowed to be shipped to Fiji on an annual basis. This arrangement is one of the great successes for Tuvalu waste management. Several Pacific Island Countries are struggling to find ways to manage their generated ULO.

3.2. WASTE STORAGE BINS CONDITIONS

The findings of this study have shown that the conditions of the bins in Funafuti are deteriorating with more than 90% of the current bins are no longer fit for the purposes they were designed to do, which is to safely keep the waste within the bins from the outside weather conditions and to prevent any associated bad odour and flies.

Table 9: Conditions of Waste Storage

Bin Situation	Funafuti	Vaitupu	Nanumaga	Nanumea	Nui	Niutao	Nukufetau	Nukulaelae
1. In good conditions	33	263	109	97	114	82	123	100
2. Without Lid or wheels	685	7	0	1	0	13	5	3
3. Damaged		3	0	1	0	0	0	-
4. Without Bins	100+	67	30	34	4	77	10	3

The outer islands bins on the other hand are mostly in good conditions with few of the bins with missing lids and wheels including some damaged ones. There are also a number of households without bins as indicated in the above table.

Photo 16: Damaged Bins in Funafuti

3.3. STATUS OF THE COLLECTION SYSTEM

3.3.1. Available Collection Services and Facilities

The summary of investigations on the provided collection services are outlined and summarised under this section of the report.

Table 10: Checklist for Waste Collection Services in all Islands

Waste Types	IS THERE ANY COLLECTION SERVICES PROVIDED							
	F/futi	N/Mea	N/Maga	N/tao	Nui	V/tupu	N/Fetau	N/laelae
Households	✓	✓	✓	✓	✓	✓	✓	✓
Commercial	✓	✓	✓	✓	✓	✓	✓	✓
Institutional	✓	✓	✓	✓	✓	✓	✓	✓
Ships	✓	The wastes generated on the ships are recovered and disposed of at the bins located at the main wharf in Funafuti. These are transported by SWAT and disposed of at the Funafuti dumpsite.						
Coastal Litter	The Kaupule arranges some cleaning up with the communities from time to time.							
Bulky	✓	This waste is collected together with other wastes under the current available services delivered by the Kaupules in the islands.						
Healthcare	Currently collected and disposed off by the Ministry of Health through the different hospitals management in all the islands							
Used Lubricating Oil	A programme has been recently introduced to recover and collect used oil from the outer islands. The collected oil containers are shipped to Fiji under a partnership with one of the importers (Pacific Energy Ltd) of petrol and oils in the country.							
Electronic and Electrical Waste	✓	All included in the only collection services available in the islands. No special collection service but mixed up in the same service.						

Funafuti as the main island has some arrangements in place for most of the waste streams. The outer islands have one collection service, which is also used for the collection of bulky wastes, green wastes and nappies. Healthcare wastes are managed by the Ministry of Health through the hospitals management. Ship wastes and used lubricant oils are managed in line with the arrangements made from Funafuti by the responsible agencies.

All the waste collection services with the exception of large supermarkets and wholesalers in Funafuti are funded by the Government of Tuvalu through the appropriate government agencies. The large supermarkets and wholesalers in Funafuti make their own arrangements for the collection and transportation of their wastes to the disposal sites.

3.3.2. Waste Collection Services Detailed Information.

Table 11: Details of the Provided Collection Services in Funafuti

1. FUNAFUTI ISLAND			
Waste Type	**Waste Storage at Source**	**Weekly Collection Frequency**	**Estimate Households Coverage**
1. General Mixed Waste	80L/120L Wheelie Bins for Households 240L / 1100L Bins Institutions & Businesses Sacks & Plastic bags for Households without bins & Extra waste	New Schedule since Jan 2017 Mon & Wed: Block 1 & 2 Tues & Thu: Block 3 & 4 Friday: Along the main roads covering Block 1-4	90% -95%
2. Green Waste	Sacks & Plastic bags for leaves and lawn As Loose waste (tree branches) placed along the collection routes	Same as the schedule for the General Waste	45% - 50%
3. Bulky & Hazardous Waste	As Loose waste to be placed along the collection route or approved pickup points	Current 2017 On Friday (8.30am – 12noon)	30%-35%
4. Nappies	Pack in plastic bags or sacks then transport to the Central Drop off Bins at the Hanger. There is another bin for the Hospital Patients, which the nearby families and hospital workers seem to use.	Two times 1st : Monday 2nd : Friday N.B. The bins are emptied once all the nappies bins are full, regardless of what day.	90%-95%
2. OUTER ISLANDS			
Mixed Waste No special service for green, bulky and nappies. All are mixed in one service	Wheelie Bins	2-3 times	95-100% for Nukufetau and Nukulaelae islands 75% for Vaitupu, 80% for other islands

Table 12: Funafuti Time and Motion Study

Date	Trip No.	No. of Stops	Total Time of Collection (minutes)	Average Number of households per stop	Average Pickup Time (mins)	Average type and conditions of Waste Storage	Unloading Time at the Disposal Site (mins)
17/4/17	1	98	185	2	1min.14second	Full Plastic bins	6
	2	57	160	2	1min 40 seconds	Full Plastic bins	5
18/4/17	1	87	115	2	46 seconds	Full Plastic bins	4
	2	60	117	2	1min 17 seconds	Full Plastic bins	5

Table 12 summarises the results of the Time and Motion Study in Funafuti to investigate the collection efficiency for the Municipal Solid Waste, which covers households, small businesses and institutions.

The findings suggest the overall longer time taken to pick up and unload wastes during every stop. This is due to the difficulties faced by the collection crew when emptying the unpacked wastes in the bins. Most wastes were not properly packed before putting in the bins. Therefore the workers had to handpick the wastes or lift the bins to make it quicker. However, most bins are without lids and it is a challenge for the workers to lift the bins when partly filled with water during rainy days. These conditions expose the collection crew to Occupational and Health Safety Risks. The repetition of lifting heavy bins above the workers breast height and long exposure to bad odour can lead to permanent health problems and should be taken into account.

Table 13. Outer Islands Time and Motion Study

Trip No	Task	Nmea	Nmaga	NTO	Nui	VTP	Nkfetau	Nklaelae
Trip One	Collection Starting Time	9.20am	8.15am	8.20am	10.30am	8.15am	11.25am	8.15am
	Collection End Time	12.20pm	8.48am	10.00am	1.15pm	9.32am	12.30pm	8.40am
	Collection Time	180mins	33mins	100mins	165mins	77mins	25mins	25mins
	Number of Stops during the collection	26	7	29	31	9	37	7
	Trailer level	Full	Full	Full	Full	Full	¾ Full	Full

Trip Two	**Collection Starting Time**	-	9.30am	10.40am	-	10.05am	-	9.10am
	Collection End Time	-	10.05am	11.55am	-	11.20am	-	9.50am
	Total Collection Time		**35mins**	**75mins**		**75mins**		**40mins**
	No. of Stops during collection	-	**9**	**33**	**-**	**11**	**-**	**8**
	Trailer level	-	**Full**	**Full**	**-**	**Full**	**-**	**Full**
Trip Three (if any)	**Collection Starting Time**	-	10.35am	-	-	12.22pm	-	10.20am
	Collection End Time	-	11.35am	-	-	2.12pm	-	11.00am
	Total Collection Time		**60mins**			**110mins**		**40mins**
	No. of Stops during collection	-	**11**	**-**	**-**	**29**	**-**	**8**
	Trailer level	-	**half**	**-**	**-**	**Full**	**-**	**Full**

The analysis of the Outer Islands Time and Motion Studies suggest lots of improvements needed to improve the efficiency of collection services on the islands. Collection time to fill a full trailer load ranges from 35 minutes to 110 mins and number of stops ranges from 7 to 37. These differences are hard to justify without getting additional information to understand why it has taken 9 stops to fill the trailer in Nanumea compared to 33 stops in Nanumaga. This is important to consider for proper monitoring forms in the future to collect additional information. Generally, the collection services issues on Occupational Safety and Health are similar with the unloading of rubbish bins on the trailers as highlighted above.

Table 14: Standard Average Unloading Time for Specific Storage Types

Storage Type	Unloading Time
Rubbish bag	10 second
Plastic / Metal Bin	15 - 20 second
Half size drum	14 - 24 second
Full size drum	30 - 60 seconds
Open piles	1min - 5minutes

Source: Guides for Municipal Solid Waste Management in PICs, 1996.

Table 14 information was gathered from past similar studies implemented in other countries including PICs. As noted, the expected time for the unloading of plastic bins similar to the bins used in Tuvalu is 15 - 20 seconds. The shorter time links to the use of appropriate rubbish trucks with the low rear loading ends that are adjusted at the workers` waist level. In addition, the wastes are properly packed in plastic bags (any type

of plastic bags) before putting in the bins making it easier for the workers to remove the wastes.

Photo 17: Municipal Solid Waste Collection Service

Photo 17 shows the actual situation during the collection service with the lifting of bins for unloading on the trailers. This can be addressed if people properly pack their waste in plastic bags to contain the wastes.

Photo 18: Special Green Waste Collection Service

A new dump truck has been used to collect the green waste in recent months this year along with a trailer. While the truck has increased the loading and carrying capacity per load compared to the trailer with no cage, the experience and difficulty with the loading of the waste becomes an issue to the workers. The Time and Motion Study findings have revealed similar concern from the workers on the difficulty involved with the loading of the green waste on the truck. The trailer on the other hand is easier to work with but it fills up quickly.

Similar to the green waste service, both the dump truck and the trailer are used for the collection of the bulky waste. Large items like end of life vehicles requires the use of the fork lift to raise the vehicle on to the trucks tray. The use of the trailer with no cage suits the low generated volume of the bulky waste generated in the islands on a weekly basis for collection.

The nappies collection has two central drop-off points. The main one is located at the Hangar and the other one is located at the hospital. There has been some concern with the effectiveness of this method for the coverage of the entire Funafuti island especially with the access of remote households at the northern and southern sides of the island. However, no major issues and concerns have been indicated to the survey team during this survey interviews from the members of the public. One area of concern is the

generation of leachate during rainy days, which generate contaminated leachate at both locations. This can be avoided if some lids or tarpaulin sheets are placed on the top of the bins during rainy days.

Photo 19: Central Drop-Off Points for Nappies at the Hangar (left) and Hospital (right)

The nappies bin at the Hospital has been always full and beyond the bins capacity during a couple of visits during this study (refer photo 19). This is due to some nearby residences using the hospital bin instead of using the larger bins at the Hangar. The arrangement for this hospital bin needs to be reviewed to prevent any associated health problems.

3.3.3. Collected Amounts of Wastes

Table 12 presents the total amounts of the collected wastes by type on a monthly and annual basis for the different collection services provided in Funafuti. Similar information from the outer islands were not updated and reviewed.

Table 15: Monthly and Annual Collected Wastes under the Funafuti Collection System

Waste	Monthly Amounts (m3)	Annual (m3)	Distribution %
1. Green waste	111	1,332	30%
2. General waste	238	2,856	64%
3. Recycled waste	5.3	64	1.4%
4. Nappy waste	18.9	227	5%
TOTAL	**373**	**4,479**	100%

The general municipal solid waste collection provided by the Kaupule collects about 64% of the waste (General waste). The Department of Waste Management (SWAT) collect 36% of the wastes based on the monthly records maintained by the Department of Waste Management.

3.4. STATUS OF WASTE DISPOSAL FACILITIES & PRACTICES

This section discusses the current status of official waste disposal sites in Tuvalu including informal disposal practices.

3.4.1. Official Waste Disposal Sites in the Islands

The table below summarises the details on the different available waste disposal facilities in eight different islands. With the exception of Funafuti Disposal Site with some level of daily control and management as well as the newly established Nanumea Waste Landfill, the rest of the outer islands disposal facilities are operated as open dumpsite with little daily control

Table 16: Details of the Waste Disposal Sites in the Islands

ITEM	Ffuti	Vtupu	Nmea	Nmaga	Ntao	Nui	Nfetau	Nlaelae
Status								
Area	4.38acr	2.8acr	0.5ac	0.5acr	0.24ac	0.49ac	0.46ac	0.50ac
Type	OD/WSM	OD/WSM	OD	OD	OD	OD	OD	OD
D-status	PTR	AR	PTR	PTR	PTR	PTR	PTR	PTR
Suitability for waste disposal								
Less than 50m from costline	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Less than 5m Soil Profile Depth (m)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Soil Conditions	Sandy-porous	Sandy-porous	Sandy-porous	Sandy-porous	Sandy-porous	Sandy - porous	Sandy-porous	Sandy-porous

OP - Open Dumping (Meaning no soil cover). WSM –With Some Maintenance. PTR – Plan to Rehabilitate

- **Suitability of Current Sites**

All the current sites for waste disposal in Tuvalu do not meet the basic requirements for waste disposal purposes because of their location along the coastline and the unsuitability of the soil structure (inadequate soil profile of 1-3m depth with loose and porous soil). The **close location to the sea makes it easier for pollutants from the dumpsites to reach the sea.** The situation is worsening with the loose and porous state of the underground soil **as any leaked pollutants from the dumpsites will be very hard to contain from reaching the underground water and eventually to the sea.** This puts the nearby marine environment at high risk from on-going underground flow of toxic substances to the sea, affecting the marine resources which the islands communities depend on for daily living.

However, there are no other options for Tuvalu as an atoll country and thus the use of the existing sites will continue to provide waste disposal needs for the generated waste in the islands with some improvement works to address the above concern. The choice on the use of the current sites is largely driven by the availability of land from landowners. Releasing lands for waste disposal purposes is difficult unless special lese arrangements are made with the landowners.

Photo 20: Nanumaga Dumpsite

Photo 21: Nui Dumpsite

The location of the dumpsites in Nanumaga and Nui are close to some swampy and mangrove areas. This makes any improvement works very difficult.

Photo 22: Nukufetau Dumpsite

Photo 23: Nukulaelae Dumpsite

The above dumpsites in Nukufetau and Nukulaelae are along the beach areas and without natural buffer zones to protect the waste from being carried away towards the sea. Based on field observations, there is a high possibility of such unwanted situation during the cyclone seasons. This is a great threat to the safety of the marine resources from the on-going pollution from these disposal sites.

Photo 24**:** Vaitupu Dumpsite

Photo 25: Niutao Dumpsite

Similar open dumping conditions with no waste cover at Vaitupu and Niutao dumpsites. The amounts of green waste collected and disposed of at Vaitupu dumpsite is high.

Photo 26: New Cleared Site at Namumea

Photo 27: Created open ditch for Waste Disposal at Manumea

3.4.2. Littering, Burning and Illegal Dumping

Littering and illegal dumping throughout the country is a problem and issue to address in order to achieve the overall vision of the current National Tuvalu Integrated Waste Management Policy and Action Plan 2017-2026 for a Cleaner and Healthier Islands.

Photo 28: Littering and illegal dumping in Funafuti Island

Littering and illegal dumping problems by few negligent people have ruined the beautiful image of Tuvalu islands. Even in Funafuti island where waste management services have greatly improved in recent years, cases of littering and illegal dumping are still common. With the provided collection services in Funafuti (5 days per week for the mixed municipal solid waste, 4 days for the green waste and 1 for the bulky waste) these unpleasant scenes should have not happened.

The situation in the outer islands is worse especially in Vaitupu and Nui with several scenes of illegal dumping observed along the coast areas. A tougher approach must be taken to put an end to these bad practices which are ruining the good effort of the government and put the environment and health of the people at risk. The legal provisions of the Waste Regulations must be strictly monitored and enforced along with on going public awareness and education. This is important in putting an end to these environmental polluting practices especially in Funafuti.

3.5. STATUS OF PUBLIC AWARENESS & SUPPORT ON POTENTIAL FUTURE WASTE DEVELOPMENT

3.5.1. How the public get information

The outcome of the survey generally suggest the use of radio programme as the best tool of communication of getting the message across to the people in the eight different islands. About 76% of the surveyed population from all the islands have indicated radio as the way they received waste management messages. Workshops and Kaupule visits represent around 14% each with 11% from other means.

Table 17: Public Awareness Delivery Methodologies

How did they get the information	No. of Households								Total
	Ffuti	Nmea	Nmaga	Ntao	Nui	Vtupu	Nfetau	Nlaelae	
1. Radio	25	15	11	15	10	30	20	19	145
2. Visit / Kaupule	10	10	0	4	2	0	0	0	26
3. Workshop	3	1	9	0	2	0	0	11	26
4. Others	2	0	2	1	6	0	0	0	11

3.5.2. Level of Appreciation of the Provided Services

There has been an overall high support from the public of the provided waste management services as shown by the outcome of this assessment. About 43% of the surveyed population have indicated their full satisfaction with the provided services with 50% thought that the service was just average. The remaining 7% thought that the service is poor.

Table 18: Level of Public Satisfaction on the Delivered Waste Collection Services

Level of Appreciation	No. of Households								Total
	Ffuti	Nmea	Nmaga	Ntao	Nui	Vtupu	Nfetau	Nlaelae	
Very Good	25	2	18	12	1	5	0	19	**82**
Average	14	15	2	8	18	18	20	1	**96**
Poor	1	3	0	0	1	7	0	0	**12**

3.5.3. Public Opinion on Potential Future Waste Developments

- **Public Position on a Proposed Monthly Waste Fee**

About 59% of the surveyed population indicated their willingness to pay $10 and below for a waste monthly fee. People who afford $11 to $50 a month is about 30% with only 7% indicated their willingness to pay more than $50tala a month.

Table 19: Affordability Level for Potential Future Waste Fees

Monthly Fee	No. of Households								Total
	Ffuti	Nmea	Nmaga	Ntao	Nui	Vtupu	Nfetau	Nlaelae	
1. $10 & Less	10	14	18	14	16	0	20	20	**112**
2. $11 to $50	20	3	0	2	2	30	10	0	**57**
3. Above 50	10	0	0	4	**0**	0	0	0	**14**

- **Public Opinion on the Prepaid Trash Bag Concept**

A high support was received from the surveyed population for the proposed idea of using a prepaid trash bag in the future to improve the storage of waste and the collection service. About 43% supported the option of a prepaid bag below 50cent, 48% for 50cent, 2.6% between 50cent and $1 and 5.7% for $1 and more.

Table 20: Affordability Level for a Potential Introduced Prepaid Bag

Prepaid Bag	No. of Households								Total
	Ffuti	**Nmea**	**Nmaga**	**Ntao**	**Nui**	**Vtupu**	**Nfetau**	**Nlaelae**	
1. Below 50cent	20	10	0	3	14	30	0	6	**83**
2. 50cent	10	8	19	14	6	0	20	14	**91**
3. More than 50cent and less than $1	5	0	0	0	0	0	0	0	**5**
4. $1 or more	5	2	1	3	0	0	0	0	**11**

- **Public Opinion on the Container Deposit Levy Concept (CDL).**

A full 100% support has been received from the surveyed population on all the eight islands on the idea of introducing a CDL in the future. It is not clear if the reason for the high support is linked to the impacts of this system in keeping the island clean when the targeted items are recovered, collected and shipped overseas.

Table 21: Level of Support for the CDL

CDL Proposal	Ffuti	Nmea	Nmaga	Ntao	Nui	Vtupu	Nfetau	Nlaelae	Total
Support the Idea	40	20	20	20	20	30	20	20	**190**
Support to participate	40	20	20	20	20	30	20	20	**190**

This is a timely exercise when the government levy committee was exploring some options for the creation of some waste financing mechanisms for the sustainable financing of waste management in the long term. The outcome of this assessment was considered in the development of the CDL framework for Tuvalu.

3.6. STATUS OF WASTE MINIMISATION MEASURES

There are number of waste minimization initiatives (3Rs + R) that are currently being implemented in Tuvalu and are parts of the practices associated with the management of the generated waste in the country. These have contributed in some ways in the reduction, reuse and recycling of the generated wastes as summarized in table 18. The Return of waste as applies to the export of recyclable wastes to overseas markets has been put on hold for some reasons as discussed further under this section.

Table 22: Current Waste Minimization Practices in the islands

Waste Minimization Measure	F-futi	V-tupu	N-mea	Nmaga	Ntao	Niu	Nfetau	Nlaelae
1. Reduce	No free shopping bags initiative in some shops reduces shopping bags generation	The high reliance on local food and less spending on groceries with an average spending of $30-$100 plays a part in the overall reduction of packaging materials in the islands compared to Funafuti						
2. Reuse	The reuse of PET bottles for homemade drinks is common in all islands and has effectively reduced PET bottles. The reuse of large containers for gardening and for pigs food storage is a good reuse practice keeping these plastic materials in use for some time before ending up at the dumpsites. All the generated food wastes are diverted for feeding pigs							
3. Recycling	50% recycling rate for the households generated green waste Other 50% goes to on site mulching practices	Mulching practices for controlling weeds and cooling agriculture crops in the islands is common, which divert most of the generated green waste. The good initiative is perfect if the non-biodegradable waste is properly removed for collection by the existing collection services						
4. Return to Overseas	There has not been any export of recyclable waste since last year 2016							

3.6.1. Reduce and Reuse

There are some waste reduction and reuse initiatives currently being implemented by some households and businesses. E.g. non free shopping bags at some shops which help to reduce plastic bags generation; reuse of plastic containers for pigs` food storage and local drinks production; gardening and landscaping purposes, etc. These sorts of initiatives even if they operate in small scale basis are contributing to the overall minimization of the generated waste, keeping the waste involved away from entering the established collection and disposal systems.

3.6.2. Recycling

a). Central Green Waste Management Facility, Funafuti

The only form of recycling happening in Tuvalu is the conversion of green waste to compost materials. An amount of 255m3 is diverted on a weekly basis with an estimate of 60m3 being shredded and ready for sale. The rest which originates from leaves are piled up and left on-site for some months before they are fully ready as composting materials.

Photo 29: Collected Green Waste being shredded at the Hangar

The collected green waste are shredded into smaller pieces and piled up at the SWAT`s Hangar. These shredded materials mainly come from tree branches including coconut leaves. The other non-woody parts of plants like leaves are disposed of in piles and left at the site until they are completed decomposed.

This government initiative provides the best solution for the management of the high organic waste generated in the country mainly from the green waste. If the recovery rate of the green waste is increased in the future if people make good use of the provided green waste collection services, then the amounts of compost materials will be increased for improvement of gardening in the country. This initiative can be expanded to other outer islands.

The Taiwanese vegetable farm (Happy Garden or Fatoaga Fiafia) at Funafuti is the major client and user of the generated shredded green waste from the Hangar. It has a set target of 100 tonnes of compost to be achieved on an annual basis to support its gardening activities. This will absorb much of the generated shredded materials apart from the households and other businesses who are also collecting bags of composts for their own gardens.

The existence of a similar Taiwan Vegetable Farm and Garden in Vaitupu island makes the expansion of this similar green waste management project to Vaitupu potentially workable. The farm requires the sustainable input of adequate shredded green waste for the production of the needed compost and this will make good use of any generated shredded green waste in Vaitupu.

Photo 30: Collected shredded green waste from the Hangar is put into compost

The collected shredded green waste is put into composting units at the Happy Garden facility for 1-3 months before application on top of the vegetable planting beds. The final compost materials are then applied on the planting beds before planting new seedlings. The use of the compost materials from the green waste is highly required for the successful of the vegetable farm.

Photo 31: Use of the Compost from the Shredded Greenwaste at Happy Garden.

b). Informal Composting / Mulching

These practices of managing the generated green waste is common in Tuvalu and are diverting more than 50% of the generated green waste in Funafuti and more than 90% in the outer islands. While some mulching practices are properly implemented, most are just part of the illegal dumping practices.

Photo 32: Example of green waste illegal dumping

Photo 33: Example of some good green waste management practices

3.6.3. Return

The return of recyclable waste materials to overseas countries for recycling purposes has been put on hold since 2016 due to the combined effect of the low global scrap metals rate overseas and the high shipping cost. With only one shipping company in the country, there are no other shipping options for the existing recycling operation to use. The shipping freight of $2,000 for a 20ft container is too expensive.

Photo 34: Scrap metals have been collected and stored for a year without any shipment

With the low return due to the low global rate of scrap metals overseas, any local processing and shipment of recyclable wastes overseas under the current conditions would operate at a loss. Without any government subsidies to assist recycling operations, the return of waste items overseas for recycling purposes is not economically feasible.

4.0. RECOMMENDATIONS

This section presents key recommendations based on the findings and outcome of this survey under the following waste management aspects.

4.1. WASTE GENERATION CONTROL MEASURES

The outcome of the survey noted the increasing amounts of bulky wastes from End of Life vehicles, motorbikes, white goods (washing machines, refrigerators and others). These are problematic and difficult wastes to deal with in Tuvalu because of the potential hazardous materials embedded in their makeup. While it is very difficult to go against the convenience provided by these equipment to people`s life, there is a need to control their generation because of the limited land spaces to dispose of these equipment when their operating conditions come to an end. There are no appropriate facilities in the country to manage these equipment safely and thus the accidental releases of the embedded hazardous substances to the ground is a disaster for the country`s environment and people. The following provide some options to consider:

4.1.1. Advance Recycling Deposit Fee / Container Deposit Levy

- Need to introduce a deposit fee when these items are imported to the country. The deposited fees by importers will help the government to monitor these goods during their operation lifespan, recover, collect and ship these goods to appropriate overseas destinations. A portion of the deposit fee will be kept by the government for meeting costs incurred as a result of managing these bulky waste items including the shipping overseas.

- The Container Deposit Levy has a similar approach and meaning but mostly applied in other countries for canned and bottled imported products like tinned fish and meat, soft drinks and beer, etc. The deposit levy is very small compared to the Advance Recycling Fee for large items. This levy when deposited will facilitate the recovery, collection and shipping of targeted items to overseas recycling facilities.

4.1.2. Discourage the import of Second Hand Equipment

The analysis of import goods noticed the increasing amounts of used equipment coming into the country. The government must discourage people from importing used equipment. Used equipment and machine only operate for few years and then becoming a hassle for the country in the long term, because of no space and facilities to safely dispose of. Therefore, discouraging people from importing used equipment is better than putting the country`s environment and people at risk. These can be achieved by:

- Setting a permissible import year limit for the equipment depending on the equipment. E.g. Vehicles, motorbikes and refrigerators to 3 years from the date of manufacture; Washing machines to 1year from the date of manufacture, etc.

- If a Recycling Deposit system is in place, a reduced deposit fee must be given to new goods.

The above measures can deter people from purchasing targeted items and at the same time penalizing people who continue to buy these goods through the introduced fees. While it is always hard to introduce these types of measures because of public resistance and political reasons, they are fundamental in promoting the waste producers` duty of care and sense of responsibility in protecting the environment and people`s health. This ensures that the producers of the wastes contribute to the overall management costs of the waste they generate. In developed countries, these types of measures and many other approaches have already been established and these systems are taking care of the entire waste management costs. These help to guide people in their decision making for the sake of the environment and future generations.

4.2. WASTE COLLECTION IMPROVEMENT MEASURES

The collection services have been greatly improved in recent years. The following recommendations aim to further improve the quality and efficiency of the provided services in the future based on the findings of this survey.

4.2.1. Improvement to the Mixed Municipal Solid Waste Service

a). Improvement of Waste Storage by introducing a Prepaid Rubbish Bag.

The introduction of the prepaid rubbish bag should improve areas as highlighted and discussed in this report through:

- **Improving the collection service efficiency**

Using of a standard rubbish bag as a storage system for waste will speed up the collection service and thus reduce collection time and costs. It is easier to pick up and load the rubbish bags on the current collection trailers than the heavy wheelie bins. This addresses some occupational and health safety aspects the workers are currently exposed to as a result of lifting heavy bins on the trailers.

- **Addressing some Health and Environmental Aspects**

This approach solves the problems with the absence of lids for more than 90% of the current bins in Funafuti. It can prevent the waste from rains and thus reduces the waste weight and prevent leachate, flies and bad odour generation. These are some aspects observed during the current collection services implementation, which need to be addressed.

- **Containing of the Waste during collection and final disposal**

In addition to the effectiveness of the rubbish bag in containing the waste at source, its use will help to contain flies, smell and leachate generation at the final disposal site. The blockage effect of plastics that usually affect drainage system can be an advantage for the controlling of leachate seepage at the final disposal site due to the porous nature of the underlying soil. The collected rubbish bags can be packed and levelled in layers before sand cover to control leachate seepage.

This approach does not only improve the above areas, but can assist the government by recovering the costs of collection through the incorporating of the cost in the cost of the

rubbish bag. This system works very well in other Pacific islands like Kiribati with similar conditions to Tuvalu, Vanuatu and New Zealand where this practice is common.

The system fairly charges people according to the amounts of waste they produce and it is a very reasonable system compared to a flat rate fee. People are only charged according to the amount of waste they put out for collection and this promotes waste reduction at source. The more the waste the more the bags to buy for packing the waste and this can motivate people to reduce their collection costs. Usually, poor people generate less waste and thus need to buy only one trash bag a week compared to rich people who may need to buy more than one. With a flat rate fee, there is no motivation for waste reduction at source and the poor people subsidize the collection costs for the rich people, which is not fair.

b). Introduction of a Medium Size Rubbish Truck

While the use of tractor and trailer are more appropriate for Tuvalu, the option of using a rubbish truck will improve some areas and aspects of the services with regards to the Occupational and Health Risks encountered by the workers as result of lifting heavy bins above their breast height. This is only applicable if the Department of Waste Management has confirmed the technical and economic feasibility of using such as truck through a pilot project. This type of truck has a low rear loading end set at the workers waist level for easier unloading of the waste.

4.2.2. Improvement for the Bulky Waste Collection

With the low usage by the public of the Bulky Waste Collection Services, this service`s current weekly collection schedule should be revised to save costs. Bulky wastes do not generate on a daily basis and thus the generating volume on a weekly basis is not enough for a collection service to collect. For this reason, the current weekly service may not be needed, but replace with the following measures if possible.

- Establish a Drop-Off Point for people to drop off their wastes similar to the nappies collection system. With the proposed Transfer Station, this can be used for people to bring their items.

- Reduce the collection schedule from a weekly service to a monthly service with the primary focus on large items like refrigerators, washing machines and vehicles.

4.2.3. Improvement of the Green Waste Collection Service.

- The use of the small trailer with no cage for the collection of green waste creates more trips and collection time. In addition, the use of the current dump truck is too high for the workers to lift and unload the waste. This exposes the workers to potential accidents and health risks. For this reason, the same type and size of the trailers currently used for the Kaupule mixed wastes collection service is highly recommended. Some few modifications need to be done for easier loading of the green waste.

- Need to promote the use of this service by the public to increase its coverage at the households` level. The public must be enforced to bring their green waste for collection and the strict monitoring and enforcement of the waste Regulations should deter people from the usual illegal dumping practices.

4.2.4. Improvement of the Nappies Collection

- Install lids on the current nappies collection bins to avoid leachate and flies generation.

- If the prepaid rubbish bag idea is supported, this should avoid any need for a special collection to save running costs in the future. Members of the public should be well informed of the time of the collection service to avoid the dog impact to this waste, which usually happen when taking this waste overnight before the collection.

4.2.5. Improvement of other Wastes Collection

- **Coastal Litter**

A quarterly cleaning up campaign every year involving the communities and public servants on Saturdays will help to promote public awareness and public support for a cleaner Funafuti. A similar arrangement must be made with the outer islands communities to be organized by the Kaupule in collaboration with the islands religious groups and youth groups.

- **Healthcare Waste**

Some training is needed for staff and workers on the management of healthcare waste with special emphasis on the:

- ✓ Promotion of waste segregation at source.
- ✓ Introduction of appropriate storage practices with the use of bins with different colours. This special training must be requested to SPREP for assistance.
- ✓ Operation and Management of the Funafuti Incinerator.

The government must provide supporting funds to the Funafuti Hospital Management for the operation of the special incinerator recently provided and funded by PACWASTE project to ensure its sustainable operation in the future.

- **Used Lubricant Oil**

Containers must be provided to all the sources of oil generation for the safely storage of ULO.

- **Ship Waste**

Proper rubbish bags must be provided on the government ships for the proper storage of wastes on ships. This makes it easier to remove and unload the wastes from the ships as well as unloading from the Funafuti cages for final disposal. This arrangement must be enforced for fishing vessels as well as Government vessels.

4.3. WASTE MINIMIZATION MEASURES

4.3.1. Green Waste Management.

- To improve the landing site of the green waste by levelling it to avoid leachate formation in the area. Side drainages must also be established to drain off any excess water during continuing heavy rains.

- To properly form piles of green waste from incoming leaves that are not shredded and turn over twice or three times a week to promote decomposition of waste and maintain the needed temperature.

Current

Proposed

The proper mounting and piling up of the waste promotes the building up of heat in the waste pile for faster breaking down of the waste.

- To promote home composting through a bonus system in the outer islands in order to get active participation from the communities.

- To expand the green waste management programme to Vaitupu Island with similar arrangement for the use of the produced shredded green waste to support the Taiwan Vegetable Farm.

4.3.2. Recyclable Waste Items

The low global rate of metals overseas makes any local recycling operation uneconomical in Tuvalu without any support including subsidies from the government. In order to ship out recyclable waste items, the introduction of the measures as highlighted in Section 4.1 (4.1.1.) on the following must be considered.

- **Container Deposit Levy / Advance Recycling Fee**

A Regulation is currently being developed with an Action Plan to guide its implementation. The regulation should be flexible to include items from time to time once the system is running smoothly in the future.

A pilot project must be implemented first to be funded by the government to trial the implementation of this initiative before its actual national implementation. This will also allow for the existing waste items to be recovered and collected for shipping overseas before the regulation is enforced. The revenues generated from the pilot project should recover the government invested funds to the pilot project.

The private sector should be involved in the implementation of any system to ensure its sustainability and success in the long run. There are some promising companies who are importing containers of goods throughout the year and their involvement is important in negotiating the shipping costs.

4.4. WASTE DISPOSAL IMPROVEMENT MEASURES

4.4.1. Littering and illegal dumping

- On-going awareness programmes targeting schools and communities with strict monitoring and enforcement of the Waste Regulations.

- The implementation of the proposed Waste Levy Deposit for some goods will address the littering problem. The proposed system will put economic value of about 10cents or 20cents on cans, plastic bottles and others. This will effectively change the mind-set of people and will help in the reduction of littering and illegal dumping.

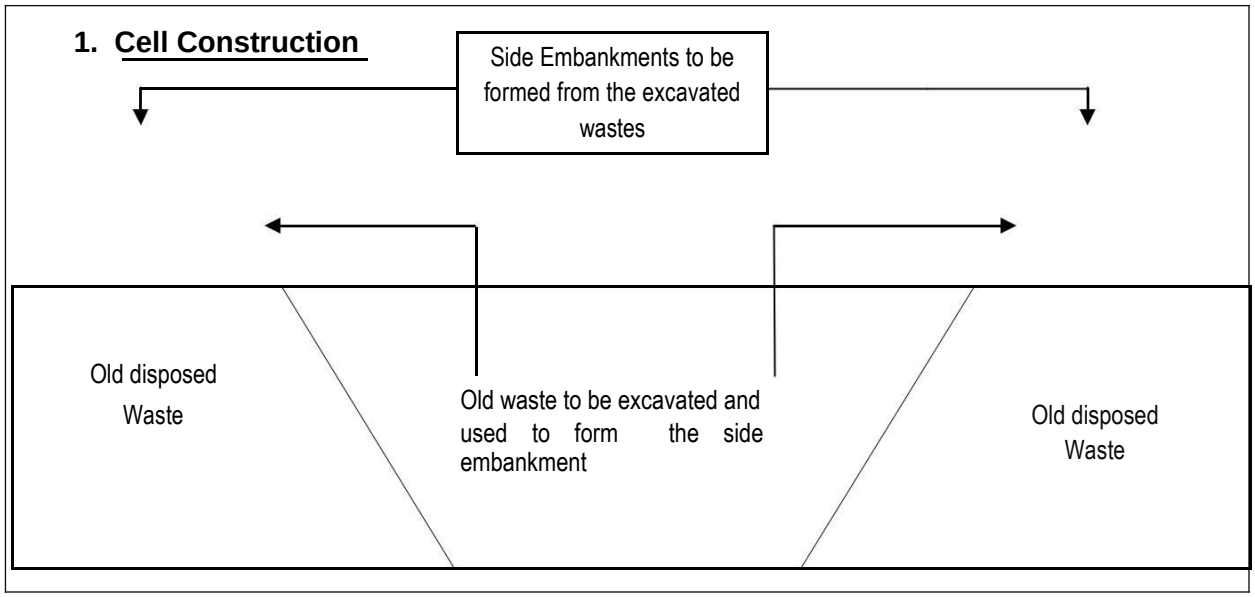
4.4.2. Final Disposal Sites Improvement

Based on the findings of this survey, the following recommendations are made for consideration:

a). Funafuti Dumpsite Improvements

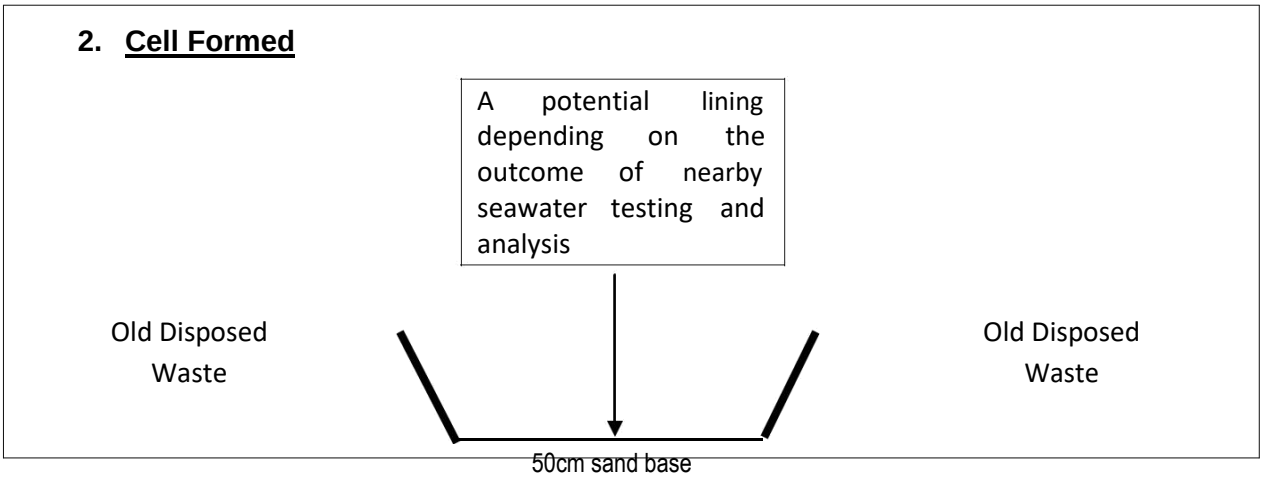
To consider the recommended designs for Funafuti Landfill Options as proposed under the SPREP Technical Assistance through the Tuvalu Waste Baseline Assessment Report (refer Figure 12 below).

Figure 12: Funafuti Cross-Section of the Proposed Rehabilitation Works



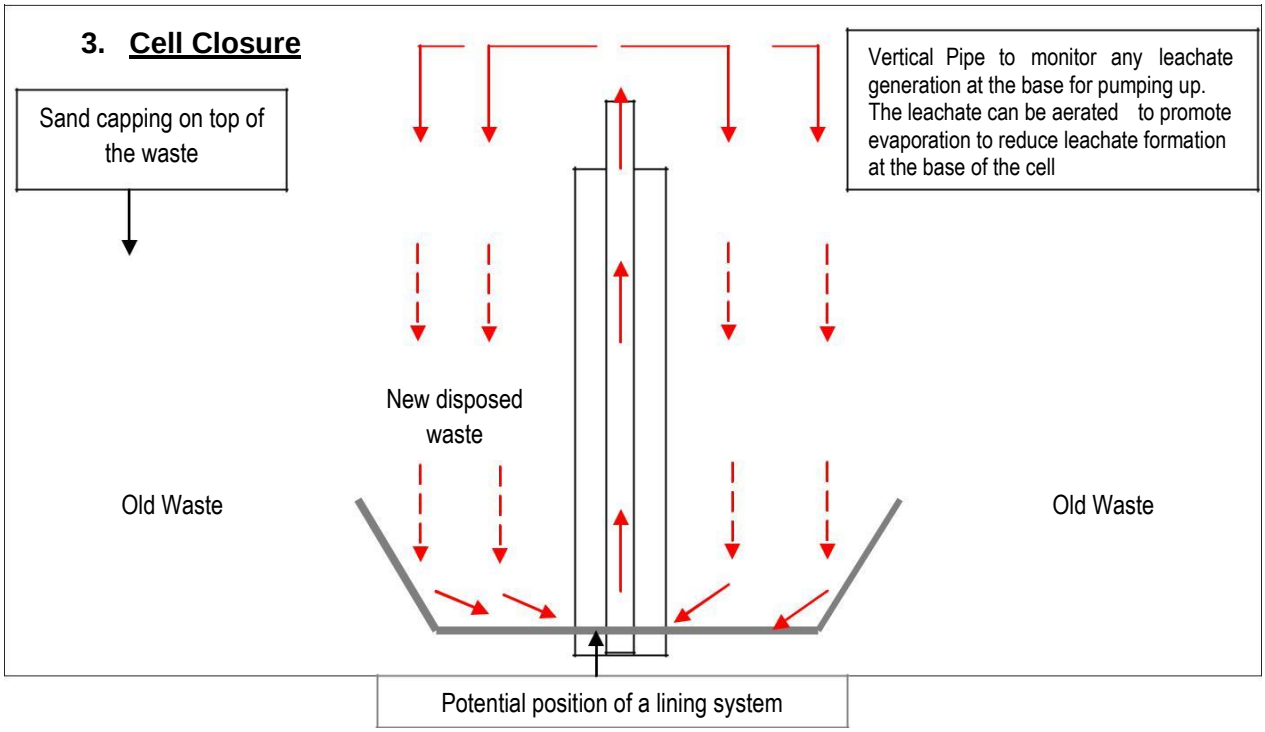
The inner section of the current closed site is excavated about 14m width and 2m to 2.5m deep. The excavated waste is used to form and shape the side embankments with 30cm sand capping on top of the embankment. The space created in the middle during the embankment formation process, becomes the new waste disposal area

Figure 13: Created Disposal Space after excavation of the inner waste



After excavation of the middle area, the new open space is created for the disposal of incoming waste in the middle. The side embankment provides both the horizontal and vertical limits to guide waste disposal operations. The 2.5 to 3m high side embankments also provide some level of resilience during the occurrence of Tidal waves and tsunami event. The sand capping of the side embankment and the created new disposal space prevents the exposed disposed waste from any fire and at the same time improves the visual look of the site. The 50cm sand capping at the base of the new cell reduces direct pollution from the new incoming wastes. Depending on the outcome of the proposed surrounding lagoon areas testing, there is an option of a lining to be placed above the 50cm sand base. The position of this base is determined after testing to estimate the level of the underground water during maximum high tide.

Figure 14: Cross Section of the Cell when it is filled with waste and covered with sand.



The red arrows show the movement of leachate when pumping up from the base. This is important in reducing the leachate at the base of the landfill through evaporation avoiding the leachate rise and seepage from the sides of the embankment. Circulation of the leachate keeps good control of any leachate build up at the base especially during heavy rains. If funding allows, the leachate can be pumped up to a storage plastic or concrete tanks for treatment before realising to the nearby surrounding.

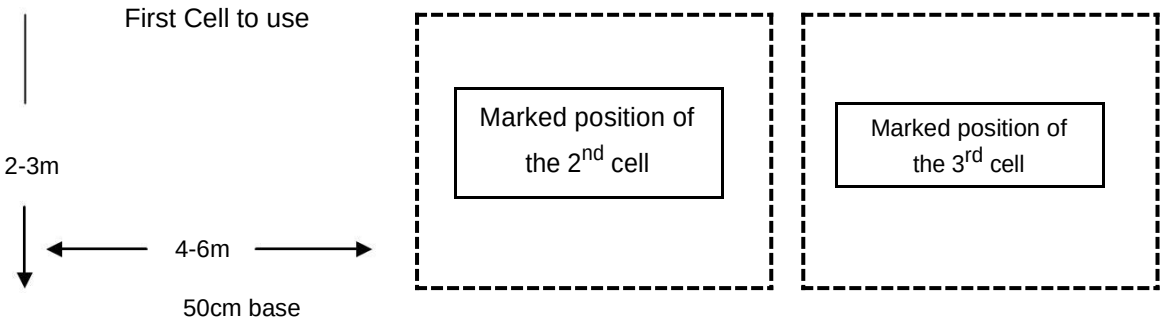
b). Outer Islands Dumpsites Improvements

To consider the following concepts and designs for improvement of disposal sites in the outer islands, a full rehabilitation works as recommended for Funafuti may be difficult because of the unavailability of heavy equipment, trucks and other materials.

Figure 15: Illustration of Improvement Approaches for the Outer Islands

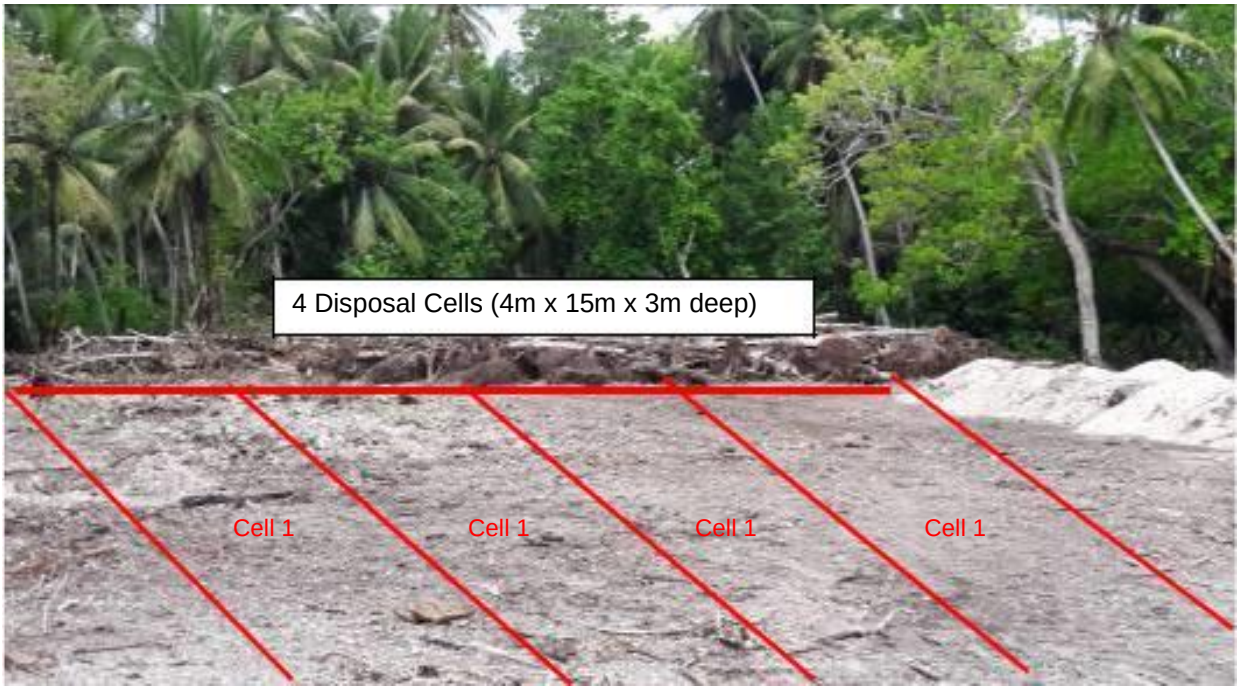
Sandy New Cleared Dumpsite Area

Marking smaller cells (10m – 20m length, 4m-6m width and 2m – 3m depth) on the new areas and excavate one by one when is needed. Smaller cells are recommended for the outer islands for easier control of daily disposal of wastes including sand cover application to keep the waste buried. Having a large cell like Funafuti is too much for the outer islands to manage with limited

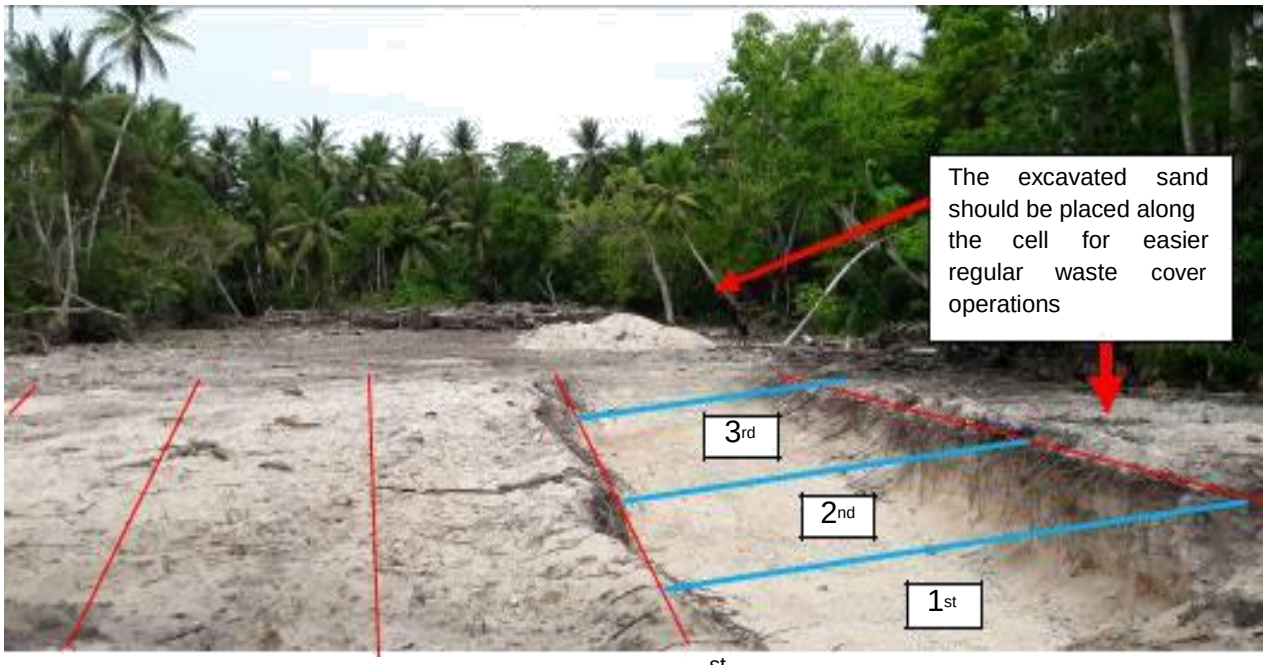


The length of a cell depends on the size of the area but it is good to be around 10-20m. A lining if funds allow can be laid at a different cell for the proper disposal of bulky wastes and other potential hazardous items like electronics. This cell must be different from the normal cell for the disposal of the general wastes. This special cell can also be used to dispose of the collected nappies.

Figure 16: Illustration using the Nanumea New Area



Marking of smaller cells on the cleared area



The disposal of waste must start from one end (indicated 1st) and gradually filling up to the top of the cell. Once 1st section is filled up, then sand cover follows, while moving to 2nd section and continues to 3 rd until the excavated cell is filled up. The entire disposed waste should have been covered with sand if the proposed approaches are followed. **The blue line indicates the order of disposing waste and soil cover from 1st to 3rd sections.**

A typical manageable disposal cell has been constructed at the Nanumea Waste Landfill to dispose of the incoming waste. Once this cell is filled up, the excavated sand is used to cover the disposed waste, while at the same time creating a new adjoining disposal cell for the continuation of waste disposal operations. This can continue until the entire area is covered. This approach provides some control by limiting the area for disposal from time to time to avoid waste being disposed all over the area. It is also easier to cover a small area with sand than a larger area. Such type of approach is suitable for the rest of the outer islands. During the financial year 2017, about 4 disposal sites in the outer islands are planned for improvement works including the installation of security fences. These are important proposed developments to ensure these sites are properly managed in the future.

Figure 17: Imagined Cross Section of Nanumea Waste Landfill Disposal Cells

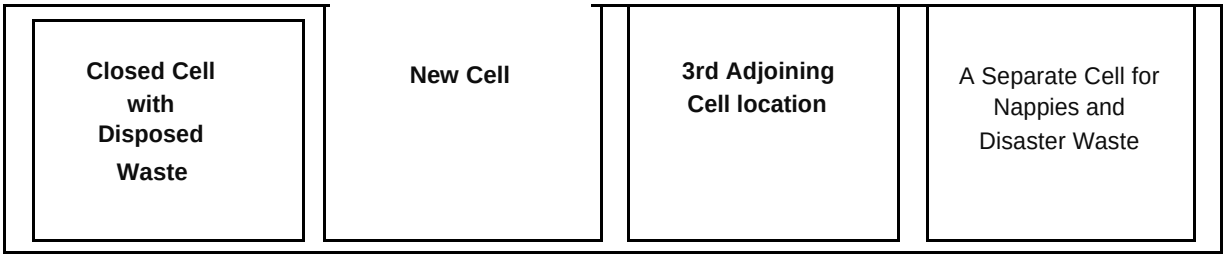


Figure 17 illustrates an ideal cross section of the Nanumea Waste Landfill with marked positions of disposal cells for the disposal of waste. Cell 1 shows a filled cell with the disposed waste being covered. Cell 2 is a new excavated cell for use and the next unexcavated areas are for the next cells.

During the consultant visit to the outer islands, lots of bulky wastes with potential hazardous nature were observed being disposed of along the coast line under current illegal dumping practices. These can be disposed of properly using a lined separate cell as indicated if funding allows. This approach can be used for the development of the other islands disposal sites.

The proposed improvement for Funafuti is special as it handles more than 50% of the total generated wastes in the entire country based on the survey findings. The methodologies proposed are also practical in Funafuti where heavy equipment, materials and electricity is available.

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6.0. ANNEX SECTION

ANNEX 1: WASTE AMOUNT & COMPOSITION SURVEY PROCEDURES

Also known as the Waste Characterization Study or Generation and Composition Survey, this survey assesses the nature of the generated solid waste in an area – a community, village, town, municipality, business or organization. The generated information from this survey is considered the starting point of any waste management planning.

a). Unit Waste Generation

Known as the daily amount (kg or lb) of waste generated by one person at a particular location or area. This DGR is largely influenced by environmental, social and economic conditions of an area and thus it can be different from community to community, town to town, business to business, organization to organization and country to country. The assessment of DGR is the easiest part of a Waste Audit when implementing in the field and can be done easily when required.

DGR = $\frac{\text{Total Weight on Day 1 (TWD1) + TWD2 + TWD3.….+ TWD7}}{\text{7 Days of the survey duration}}$

= Daily Waste (DW)

= $\frac{\text{DW}}{\text{N (No. of People in the Surveyed Households or Businesses}}$

= Kg of waste per person per day

Simple Steps to Follow based on Waste Audit Implemented in the Pacific Islands

1. Select a target area for the survey implementation.

2. Randomly select a number of households within the target area (for domestic waste) or businesses (for commercial waste). Refer to WHO Waste Guide (1996) for further readings. The sampling size for an urban population should range between 20 to 25 or more for each particular income level area. If there are three different income level areas within an urban population, then the total sampling population size will be within the range of 80 to 100 or more. For a peri-urban or rural setting, there are no income level areas as most income level groups are residing within a particular location or area, thus a sampling size of 20 to 25 per area is relevant to provide a good representation of the total population.

3. Design a simple questionnaire (refer Annex 7) for the survey and use it to gather other information from the selected households or businesses. Key information to include in a questionnaire:

4. Visit the selected household and discuss the purpose of the survey. Advise all selected households to keep their waste at home for the survey team to pick up during the period

of the survey. Failing to do this can affect the survey if some households` wastes are picked up by the existing collection service in the survey area. Also inform them not to put waste from the past days including waste already disposed at backyards but the new waste generated within 24 hours from the scheduled first survey collection. Strongly emphasize to use the provided survey bags to put their new waste and place at the front of their houses before going to work if no one stays home.

Visiting to the Households to discuss the Survey and ask for support and participation

5. Give 8 trash bags to all the selected households_for the survey. Label the bags to distinguish different households (E.g. H1 corresponds to Household No.1, etc.) to avoid mixing during later assessments and analysis. Giving all the trash bags during the first visit is recommended if requested by the households especially for working families. Otherwise, give one bag each to all the selected survey households during the first visit, with the other seven to be given when collecting the bags.

Marking of Selected Households and Distribution of Marked Rubbish Bags in Funafuti

6. Collect the trash bags for eight consecutive days using an open truck on a set time already made known to the selected households or businesses. The first day collected trash bags must not be considered as they may consist wastes from the past days. (WHO Waste Guide Book, 1996).

Collection of Rubbish Bag from the Selected Households in Funafuti for the seven consecutive days

7. Collected bags are weighed using a hanging scale as shown in the photo.

Weighing of the collected Trash bags for the seven consecutive days

Table 1: Example of a Simple Daily Recording Sheet for Waste Audit Survey

	HOUSEHOLDS WASTE RECORDING SHEET								
	STARTING DATE:				LAST DATE:				
Household No.	No. of People	1st (kg)	2nd (kg)	3rd (kg)	4th (kg)	5th (kg)	6th (kg)	7th (kg)	Weekly Individual Waste (WIW)
1	9	16	12	11.5	9.7	8.5	10	13	**80.7**
2	7	11	9.8	10	7.5	10.5	11	9	**68.8**
3	8	9	8	6	7	7	9	10	**56**
4	7	7	8	7	6	7	6	9	**50**
5	6	8	8	9	6	7	7	8	**53**
	37	**51**	**45.8**	**43.5**	**36.2**	**40**	**43**	**49**	**308.5 (TW)**

N.B. This is just an example for illustration purposes.

8. To calculate the Average Daily Waste (ADW)

$$= \frac{\text{Total Waste (TW)}}{7 \text{ Days}}$$

$$= \frac{308{,}5\text{kg}}{7}$$

$$= \mathbf{44kg}$$

9. To calculate the Daily Waste per Person
   = Average Daily Waste

   = 44kg
     37people
   = **1.1kg per person per day**

BOX 1: CALCULATION OF THE WASTE DAILY GENERATION RATE

The following information and data were extracted from surveys implemented in urban areas of Samoa:

a). Apia Western Urban Area Waste Generation and Composition Survey (2007)

TW = 1,750kg
ADW = 1,750kg / 7days
= 250kg
No. of people in the surveyed 50 households = 400
= 250kg / 400 people
= 0.63 kg / person / day

b). Waste Density

Known as the amount of waste (kg) in one cubic meter (m3) of space. From past experiences in the Pacific islands, the assessment of the Waste Density must go together with the Waste Generation Assessment as discussed above. The weighed bags used for the measurement of the daily waste generation can be used straight away to measure the density of the collected waste.

Simple Steps to Do (following the assessment of Daily Waste Generation)

This assessment looks at estimating how much space the generated waste would fill.

1. After weighing the collected bags for determining waste generation, empty the contents of the bags in a container (60L, 80L, 100L or 120L plastic bucket) or place the rubbish bags in the container and firmly press down. Fill the bin until it is full . There are many plastic containers available in different sizes which can be used as long as the size is known. Using more containers of the same size would speed up this assessment. Continue emptying the bags into the containers until all the collected bags are completed.

Measuring the Density of the Waste by Transferring all the Collected Waste into a Bin.

When emptying the waste into the bin, waste has to be pushed down firmly to avoid space created until it is filled up. The number of full bins is recorded on a daily basis during the seven days period (as required for the DGR calculation) and WD calculation is then calculated as:

Waste Volume (m3) = Number of Full Bins on Day1 (NFBD1) + NFBD2 ….NFBD7
= Number of Full Bins (Day 1- Day 7) x Size of the Bin used

Example:

= 9 bins + 7 bins + 10 bins + 6 bins + 7 bins + 10 bins + 8 bins
= 57 bins x 120Litres
= 6,840 Litres
= 6.84m3 (1m3 = 1,000Litres)

Waste Weight (Kg) **=** Refer to the recorded weight measurements from Day1 to Day 7 to obtain the Total Weight of the Waste (TW)

Note: An alternative option is to randomly select bags for this exercise. For this particular option, the weight of the randomly selected bags must be used. The total weight of selected bags is divided by the total number of full bins filled by these selected bags. This is highly recommended for a large survey, which may take time to go through the entire collected waste (refer further readings – WHO Waste Guide, 1996).

BOX 2: CALCULATION OF THE WASTE DENSITY

E.g. Considering the Samoa`s Waste Audit result for example:

Then Waste Density = 1,750kg / 6.84m3
= **255.84kg per m3**

c). Waste Composition

Known as the breakdown (composition) of the generated waste into different types of waste. This is the most challenging and difficult part of a Waste Audit as it requires the daily separation of the collected waste into different types (primary composition). Depending on the purpose of a Waste Audit, additional classification can be made (secondary composition) to study in details the generated types of waste under different categories.

Primary	Secondary
1. Organic:	Green waste & Kitchen Waste including Food scraps
2. Plastics:	PET bottles,PE bottles, Other hard plastics, shopping & packing bags, etc.
3. Papers:	All types of papers and cardboards.
4. Metals	Aluminum cans, Steel cans, old small utensils, etc.
5. Glasses	Vine glasses, Breweries glasses, window glasses, etc.
6. Textiles	Old and worn clothes, bags, socks, gloves, etc.
7. Others	Mixed Waste (Nappies, etc.), Cables, Hazardous waste (radio batteries, etc.)

While *Primary Composition* provides some information for exploring opportunities for waste minimization, it is the *Secondary Composition* Data that provides the more detailed information for proper planning of any waste minimization initiatives like recycling, composting and regulatory measures targeting specific waste items (E.g. Plastic bags ban, Container Deposit Levy for some canned and bottled goods.).

Simple Steps to Do a Primary Composition Assessment

1. Spread a tarpaulin (4m x 4m) flat on a leveled ground to be used for this assessment exercise.

Tarpaulin being placed for easier assessment of the waste

2. Segregate waste into different types (organics, plastics, papers, metals, glasses, textiles and others for the rest of the waste). It is easier to segregate and remove first the waste items with less presence leaving the dominant ones in the middle to do

last. Use different containers if available or bags to separate different segregated items.

Separation of waste into the primary categories – organics, papers, plastics, metals, glasses and others

3. Collect the different categories being segregated one by one in a trash bag and measure their weights.

Weighing of the different segregated waste

4. To calculate the composition of different categories, the weight of different categories are divided by the total weight of all categories and multiply by 100%

$$\text{E.g. Organic \%} = \frac{\text{Total Weight of Organic Waste}}{\text{Total Weight of all Categories}} \times 100\%$$

$$= \frac{893\text{kg}}{1{,}750\text{kg}} \times 100\%$$

$$= 51\%$$

Table 1: Example of Waste Composition Calculation

BOX 3: CALCULATION OF WASTE COMPOSITION

Organics:	110kg + 150kg + 132kg + 115kg + 122kg + 150kg + 104kg	= 893kg (51%)
Plastics:	36kg + 41 + 38kg + 46kg + 41kg + 51kg + 35kg	= 298kg (17%)
Papers:	28kg + 21kg + 15kg + 19k + 23kg + 13kg + 16kg	= 145kg (8.2%)
Metals:	20kg + 17kg + 14kg + 16kg + 14kg + 12kg + 13kg	= 116kg (6.6%)
Textiles:	12kg + 11kg + 9kg + 8kg + 11kg + 6kg + 5kg	= 68kg (3.8%)
Others:	38kg + 30kg + 42kg + 31kg + 33kg + 43kg + 3kg	= 230kg (13.1%)
		= 1,750 kg (100%)

Simple Steps to Do for a Secondary Waste Composition Assessment

When planning some waste minimization initiatives - recycling, composting and introduction of relevant regulations targeting specific types of waste, further assessment of the constituents of different waste categories is needed. For instance, when assessing the feasibility of a recycling facility, further detailed assessment of the metals waste category is needed.

1. From the bags of different waste categories being measured and discussed above, let's use the Metal Category for example.

2. Empty all the metals waste bags on a tarpaulin and segregate the waste metals into aluminum cans, steel cans, aluminum foils, small size utensils and scrap metals.

3. Weigh separately the different metal items – aluminum cans, steel cans, aluminum foil, small size utensils and scrap metals.

4. Continue the same process for the rest of the segregated waste categories to get a clear snap shot of the different waste categories constituents.

ANNEX 2: DETAILED COMPOSITION OF THE GENERATED HOUSEHOLDS WASTES ON THE ISLANDS

Waste Data from survey team who have conducted the survey in the Outer Islands									
	Nmea	Nmaga	NTO	Nui	VTP	Nkfetau	F/Futi	Nklaelae	TOTAL
1. Organic Waste									
Food Waste	0.375	0	0.245	0.445	0	0	4.055	0	**5.12**
Green waste	227.66	218.143	142.025	197.945	465.005	317.585	437.15	351.555	**2357.068**
2. Papers									
Papers	7.96	6.035	5.695	6.97	5.095	1.865	35	5.525	**74.145**
Cardboards	2.77	11.965	3.51	16.655	9.125	8.065	69.58	6.94	**128.61**
3. Metals									
Aluminium Cans	1.82	0.492	0.185	0.235	1.56	0.75	19.95	0.655	**25.647**
Steel Cans	10.995	7.54	5.21	21.95	10.245	12.02	21	3.515	**92.475**
Others	0.955	8.98	4.935	0.92	5.035	2.49	20.53	5.845	**49.69**
4. Plastics									
PET/PE	7.74	4.108	2.21	3.105	4.165	2.135	68.53	4.56	**96.553**
Plastic bags	12.11	11.995	9.095	12.045	7.115	7.045	122.92	9.52	**191.845**
Other hard plastics	10.935	15.825	6.08	2.98	5.045	8.1	43.75	6.3	**99.015**
5. Glasses									
Glasses bottles	12.28	12.525	5.315	12.365	19.775	6.67	19.53	18.507	**106.967**
Other glasses	5.94	3.102	1.47	0	1.27	0	17.85	0.89	**30.522**
6. Textiles									
Clothes, socks, etc	6.6	9.63	3.305	3.275	5.965	1.525	39.34	18.695	**88.335**
7. Others									
Nappies	21.34	36.77	66.55	81.375	65.74	14.005	273.42	34.36	**593.56**
Styrofoams	0.6	1.495	0.205	0.265	3.39	0.405	0.28	1.25	**7.89**
TOTAL	**330.08**	**348.605**	**256.035**	**360.53**	**608.53**	**382.66**	**1192.885**	**468.117**	**3947.442**

ANNEX 3: ILLUSTRATION OF WASTE ESTIMATION USING THE GENERATION PER CAPITA & DENSITY

Data	F/futi	N/Mea	N/Maga	N/tao	Nui	V/tupu	N/Fetau	N/laelae
1).Population (2012 Est)	6,194	556	481	606	541	1,565	540	324
2).Generation Rate kg/person/day	0.40	0.34	0.42	0.31	0.39	0.46	0.54	0.47
3).Density of the Generated Waste	176	163	92.96	199	203	173	176	164.25
4).Daily Amount of Waste on each island (kg)	2,478	189	202	188	211	720	292	152
5). Annual Amount of the waste on each island (tonnes)	904	69	74	69	77	263	106	55
6).Estimated Annual Volume of the generated waste on each island (m3).	5,138	423	793	345	379	1,519	605	337
7). Estimate Number of Full Trailer Loads (4m3) per annum	604	106	198	86	95	380	151	84
8). Expected No. of Monthly Loads	50	9	17	7	8	32	13	7
9). Expected No. of Weekly Loads	13	2	4	2	2	8	3	2

Row 4 Data = Row 1 x Row 2
Row 5 Data = Row 4 data x 365 days
Row 6 Data = Row 5 data x 1000 (1 tons = 1000kg) then divide by Row 3 (Density)
Row 7 Data= Row 6 data divide by size of collection vehicles in the islands (i.e. 4m3 for outer islands, 8.5m3 for Funafuti).
Row 8 Data = Row 7 data divide by 12 months
Row 9 Data = Row 8 data divide by 4 weeks

ANNEX 4: WASTE SURVEY QUESTIONNAIRE

Area or Island Name: ..... Date:.....

Weather ..... (Sunny/Windy/Rainning)

1. **CONTACT INFORMATION**

   Name of Household / Household No:.....

   Location of the House.....

   House Type .....

   House Ownership .....

2. **NATURE OF THE WASTE GENERATED**

   Daily Diet: Preference 1 .....P or Buy

   .Preference 2.....P or Buy

   .Preference 3.....P or Buy

   Weekly number of soft drink cans consumed .....

   Weekly number of water bottle consumed .....

   Weekly Expense on Groceries.....

   Weekly Expense on Transportation.....

   Weekly Expense on Electricity .....

3. **MEASURE OF INCOME**

   Source of Income .....

   No of Employed People in the Family.....

   Estimate Monthly Income.....

4. **WASTE MANAGEMENT**

   (See if the family has a bin) .....How many bins.....

   How do you dispose of your waste (you can see around the house)

   Green waste.....

   General waste .....

   Bulky waste .....

   Nappies .....

(Any bulky waste around).....

What is the waste level in your bin when the collection comes.....

Do you burn any waste .....

Do you take your bin or rubbish along the road or they collect from your house.....

5 AWARENESS LEVEL

Are you aware of the waste collection services available (how many)

Did you get any information about the collection services .....

How did you get or hear it .....

Do you have a radio.....

6. APPRECIATION OF THE COLLECTION SERVICE.....

For a point system of 1 to 10, what do you think of the collection services, what is your score.....

What is your reason for your score .....

Any suggestions you want to make for improvement .....

7. WILLINGNESS TO PAY FOR THE SERVICE

How much you are willing to pay if the waste collection is charged (monthly).....

Do you support an idea of introducing a rubbish bag for people to put in their waste like in NZ, Australia, Kiribati and Vanuatu.....

These rubbish bags cost between 20cent to 1dollar, how much you can afford if we sell the rubbish bag.....

8. CDL & RECYCLING

In order for cans, plastic bottles, and bulky waste to be recycled and send overseas, we need to support the cost by introducing a waste levy like other countries. E.g. 10cent for soft drinks, 100dollar for import cars, 50dollars for washing machines and refrigerators.

Do you support this plan .....

ANNEX 5: DATA AND RECORDING FORMS

1. VOLUME SUMMARY FORM

(Fill from the Volume Daily Records)

DAY	NUMBER OF FULL BINS	
	TALLY COUNT	TOTAL
Day 1	1 + 1 +1 + 1	4
Day 2	1+ 1 + 1 + 1	4
Day 3	1 + 1 +1 + 1 + 1	5
Day 4	1 + 1 +1+ 1 + 0.5	4.5
Day 5	1 + 1 +1 + 1	4
Day 6	1 + 1 +1 + 1	4
Day 7	1 + 1 +1 + 0.5	3.5
TOTAL NUMBER OF FULL BINS FOR 7 DAYS		**29**

N.B: SIZE OF THE BIN = 75Litres

2. COMPOSITION SUMMARY FORM

(Fill from the Daily Composition Records)

Day 1	**Waste Composition Assessment**		
	Primary	**Secondary**	**Kg**
	1. Organic	Food Scrap	-
		Green Waste	35.85
		Total of Organic Waste	**35.85**
	2. Papers	Cardboard	0.67
		Paper	0.13
		Total of Papers	**0.80**
	3. Plastics	Plastic bottles	0.19
		Bags, papers, films	0.52
		Hard plastics – pvc pipe, toys, etc	0.84
		Total of Plastics	**1.55**
	4. Metals	Soft drinks	0.04
		Canned food	2.75
		Others	0.34
		Total of Metals	**3.13**
	5. Glasses	Bottles	0.85
		Others – louvers, plates, cups, etc	-
		Total of Glasses	**0.85**
	6. Textiles	Clothes, socks, rubbers, carpets, etc	-
		Total of Textiles	-
	7. Others	Nappies	5.87
		Styrofoams	0.19
		Total of Others	**6.06**
	OVERALL TOTAL OF ALL WASTE CATEGORIES - 48.24		

Day 2	Waste Composition Assessment		
	Primary	**Secondary**	**Kg**
	1. Organic	Food Scrap	-
		Green Waste	46.605
		Total of Organic Waste	**46.605**
	2. Papers	Cardboard	0.94
		Paper	0.12
		Total of Papers	**1.06**
	3. Plastics	Plastic bottles	0.27
		Bags, papers, films	0.84
		Hard plastics – pvc pipe, toys, etc	1.08
		Total of Plastics	**2.19**
	4. Metals	Soft drinks	0.065
		Canned food	2.45
		Others	0.12
		Total of Metals	**1.635**
	5. Glasses	Bottles	0.325
		Others – louvers, plates, cups, etc	-
		Total of Glasses	**0.325**
	6. Textiles	Clothes, socks, rubbers, carpets, etc	0.18
		Total of Textiles	**0.18**
	7. Others	Nappies	1.53
		Styrofoams	0.015
		Total of Others	**1.545**
	OVERALL TOTAL OF ALL WASTE CATEGORIES – 54.54		

Day 3	Waste Composition Assessment		
	Primary	**Secondary**	**Kg**
	1. Organic	Food Scrap	-
		Green Waste	63.215
		Total of Organic Waste	**63.215**
	2. Papers	Cardboard	2.52
		Paper	0.9
		Total of Papers	**2.72**
	3. Plastics	Plastic bottles	0.685
		Bags, papers, films	1.01
		Hard plastics – pvc pipe, toys, etc	0.705
		Total of Plastics	**2.4**
	4. Metals	Soft drinks	.08
		Canned food	0.775
		Others	0.225
		Total of Metals	**1.08**
	5. Glasses	Bottles	2.5
		Others – louvers, plates, cups, etc	-
		Total of Glasses	**2.5**
	6. Textiles	Clothes, socks, rubbers, carpets, etc	0.18
		Total of Textiles	**0.18**

	7. Others	Nappies	3.515
		Styrofoams	-
		Total of Others	**3.515**
	OVERALL TOTAL OF ALL WASTE CATEGORIES – 76.31		

Day 4	**Waste Composition Assessment**		
	Primary	**Secondary**	**Kg**
	1. Organic	Food Scrap	-
		Green Waste	48.805
		Total of Organic Waste	**48.805**
	2. Papers	Cardboard	2.675
		Paper	0.13
		Total of Papers	**1.805**
	3. Plastics	Plastic bottles	0.265
		Bags, papers, films	2.645
		Hard plastics – pvc pipe, toys, etc	0.48
		Total of Plastics	**2.39**
	4. Metals	Soft drinks	0.055
		Canned food	3.455
		Others	0.055
		Total of Metals	**1.565**
	5. Glasses	Bottles	0.29
		Others – louvers, plates, cups, etc	-
		Total of Glasses	**0.29**
	6. Textiles	Clothes, socks, rubbers, carpets, etc	0.165
		Total of Textiles	**0.165**
	7. Others	Nappies	0.755
		Styrofoams	0.095
		Total of Others	**0.85**
	OVERALL TOTAL OF ALL WASTE CATEGORIES – 59.87		

Day 5	**Waste Composition Assessment**		
	Primary	**Secondary**	**Kg**
	1. Organic	Food Scrap	-
		Green Waste	45.72
		Total of Organic Waste	**45.72**
	2. Papers	Cardboard	0.415
		Paper	0.145
		Total of Papers	**0.56**
	3. Plastics	Plastic bottles	0.48
		Bags, papers, films	0.75
		Hard plastics – pvc pipe, toys, etc	2.42
		Total of Plastics	**2.65**
	4. Metals	Soft drinks	0.045
		Canned food	0.99
		Others	0.905
		Total of Metals	**1.24**
	5. Glasses	Bottles	0.865
		Others – louvers, plates, cups, etc	-
		Total of Glasses	**0.865**
	6. Textiles	Clothes, socks, rubbers, carpets, etc	0.445

	Total of Textiles		**0.445**
	7. Others	Nappies	0.415
		Styrofoams	0.105
	Total of Others		**0.52**
	OVERALL TOTAL OF ALL WASTE CATEGORIES – 53.7		

Day 6	**Waste Composition Assessment**		
	Primary	**Secondary**	**Kg**
	1. Organic	Food Scrap	-
		Green Waste	44.2
	Total of Organic Waste		**44.2**
	2. Papers	Cardboard	0.695
		Paper	0.29
	Total of Papers		**0.985**
	3. Plastics	Plastic bottles	0.065
		Bags, papers, films	0.45
		Hard plastics – pvc pipe, toys, etc	0.95
	Total of Plastics		**1.465**
	4. Metals	Soft drinks	0.04
		Canned food	0.685
		Others	0.175
	Total of Metals		**0.90**
	5. Glasses	Bottles	-
		Others – louvers, plates, cups, etc	-
	Total of Glasses		-
	6. Textiles	Clothes, socks, rubbers, carpets, etc	0.485
	Total of Textiles		**0.485**
	7. Others	Nappies	1.37
		Styrofoams	-
	Total of Others		**1.37**
	OVERALL TOTAL OF ALL WASTE CATEGORIES – 49.405		

Day 7	**Waste Composition Assessment**		
	Primary	**Secondary**	**Kg**
	1. Organic	Food Scrap	-
		Green Waste	33.19
	Total of Organic Waste		**33.19**
	2. Papers	Cardboard	0.15
		Paper	0.15
	Total of Papers		**0.30**
	3. Plastics	Plastic bottles	0.18
		Bags, papers, films	0.83
		Hard plastics – pvc pipe, toys, etc	1.625
	Total of Plastics		**2.635**
	4. Metals	Soft drinks	0.425
		Canned food	0.915
		Others	0.67
	Total of Metals		**2.01**
	5. Glasses	Bottles	1.84
		Others – louvers, plates, cups, etc	-
	Total of Glasses		**1.84**
	6. Textiles	Clothes, socks,	0.07

	rubbers, carpets, etc	
	Total of Textiles	**0.07**
7. Others	Nappies	0.55
	Styrofoams	-
	Total of Others	**0.55**
OVERALL TOTAL OF ALL WASTE CATEGORIES – 40.595		

4.. INVENTORY OF AVAILABLE WHEELIE BINS IN THE ISLANDS

Island Name: Nukufetau

Number of bins: 125 household bins & 3 community bins

Bins with lids and wheels: 123

Bins without lids: 3

Bins without wheels: 2

Bins without both lids and wheels: none

Bins with cracks or holes in the frame: none

- **Households without bins:** 10 households

Daily Waste Generation Assessment

- Daily Generation Rate = Total Weight D1+TWD2+TWD3+TWD4+TWD5+TWD6+TWD7 7

DAYS of the survey duration

= 48.64+54.285+76.35+59.631+53.735+49.405+40.595

7

= 382.636

7

= 54.662kg (Daily Waste)

= 54.662

102 (Total of people in the surveyed household)

= 0.540kg of waste per person per day

Waste Density Assessment

- Waste Density=(No Full Bin D1+NFBD2+NFBD3+NFBD4+NFBD5+NFBD6+NFBD7)x Size of bin

= (4bins+4bins+5bins+4.5bins+4bins+4bins+3.5bins) x 75Litres

= 29 x 75Litres

= 2175Litres

= 2.175m³

Waste Density = 382.636/2.175m³

= 175.92kg per m³

Waste Composition Assessment

Organics: 35.85kg + 46.605kg + 63.215kg + 48.805kg + 45.72kg + 44.20kg + 33.19kg = 317.58kg (83%)

Papers: 0.80kg + 1.06 + 3.42kg + 2.805kg + 0.56kg + 0.985kg + 0.30kg = 9.925kg (2.6%)

Plastics: 1.55kg + 2.19kg + 2.4kg + 3.39kg + 3.65kg + 1.465kg + 2.635kg = 17.275kg (4.5%)

Metals: 3.13kg + 2.635 + 1.08kg + 3.565kg + 1.94kg + 0.90kg + 2.01kg = 15.26kg (4%)

Glasses: 0.85kg + 0.325kg + 2.5kg + 0.29kg + 0.865kg + 1.84kg = 6.67kg (1.7%)

Textiles: 0.18kg + 0.18kg + 0.165kg + 0.445kg + 0.485kg + 0.07kg = 1.525kg (0.4%)

Others: 6.06kg + 1.545kg + 3.515kg + 0.85kg + 0.52kg + 1.37kg + 0.55kg = 14.405kg (3.8%)

382.64kg (100%)

5 COLLECTION SERVICE TIME AND MOTION ASSESSMENT EXAMPLE

Date ..3/5/17.....

Trip No. … 1

Tractor leaves the Hangar (time)..... **8.00am**.....

First Stop at the first waste pickup point or station (time) ..... **8.10am**.....

Record how many pickup points or stations the tractor stops and picks up waste including the first stop above. uring every stop, record the number of households using the same pickup point or station.

Station No.	No. of Households
1	3
2	3
3	3
40	3

Last Stop to pick up waste, when the trailer is full (time)……**10.10am……**

Stop at the Disposal Site (time) ……**10.40m**……

Unloading the Load (time) …… **10.41am**……..

Finish Unloading (time) …… **10.46am**……

Total Collection Time : 8am to 10.46am (2hours 46mins)

Average Pickup Time per Station

= Time taken for the collection of stations

= 120minutes (2hours)

= 120 / 40 stops

= 3mins / 3 households (average households per stop)
=1m (60seconds)

Average pickup time per households is 60seconds.

Unloading Time: 10.41am – 10.46am = 5mins