ANNEX D Results of Solid Waste Management Baseline Survey

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1 SWM Baseline Survey

1.1 Objectives of SWM Baseline Survey

SWM baseline survey was conducted in every state and country of the Project to identify urgent issues technically as well as quantitatively by aiming at formulating state or national SWM strategies. Especially, the waste flows in each area will be a powerful tool to understand the current SWM situation quantitatively. The following are a series of surveys and studies which are essential to draw up the waste flow. Also, the concept of the waste flow is shown in the figure below.

A. Waste Amount and Composition Survey (WACS)
B. Public Opinion Survey on waste discharge manner (POS)
C. Data on population, population of the collection area and the non-collection area
D. Data on recycling (especially volume of recyclables under CDL system)
E. Survey on incoming waste to the disposal site

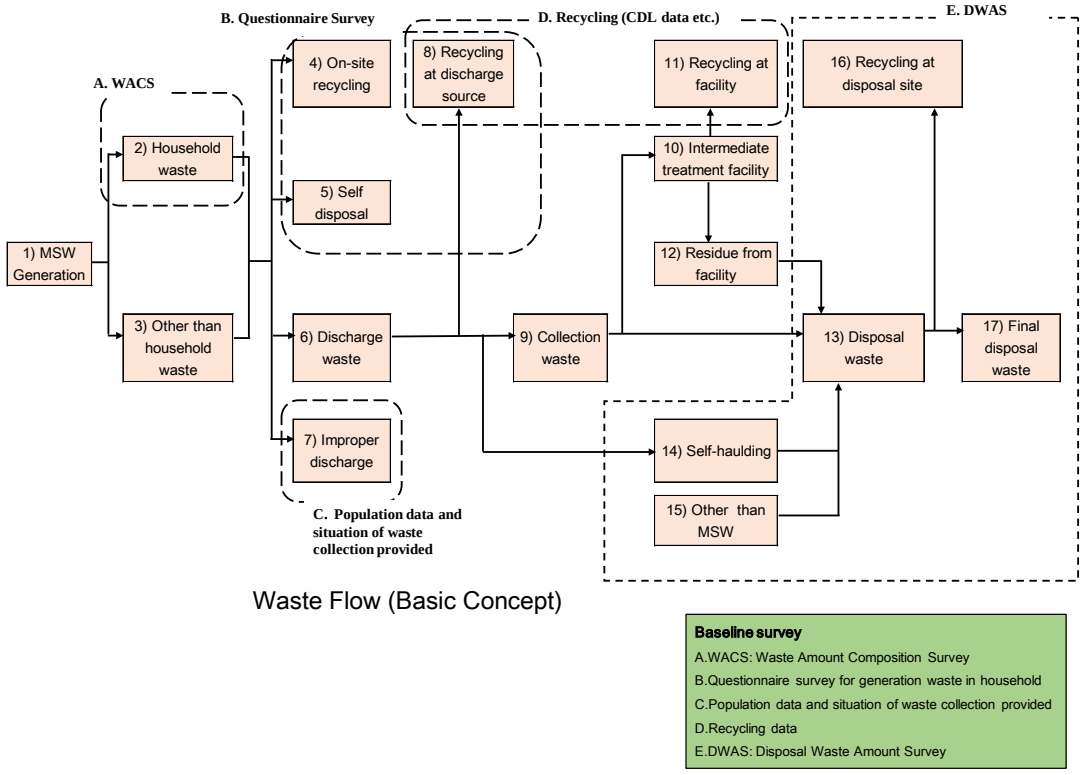


Figure 1: Concept of waste flow with essential SWM studies

1.2 Contents of SWM Baseline Survey

Items examined under each study are shown below.

Table 1: Items examined under SWM Baseline Survey

Survey	Details
WACS	In order to identify amount of waste generated from households and its composition, waste generation amount per person per day as well as its waste composition by weight are surveyed.

	Pohnpei Target: Household waste Duration: One week consecutively Items: i) unit generation rate (g/person/day) ii) Waste composition (weight %) (1) kitchen waste, (2) cardboards, (3) paper, (4) pet bottles for beverages, (5) other plastics, (6) aluminum cans for beverages, (7) cans of canned food, (8) other metals, (9) glass, (10) green waste, (11) textile, (12) leather and lubber, (13) ceramic and stone, (14) disposal diaper, (15) others ***Other areas*** Existing data produced during J-PRISM1 is utilized
Survey on incoming waste to the disposal site	To find out the final disposal amount, surveys on incoming waste to each disposal site were conducted. Site: Public disposal sites in each target area Vehicle: All incoming vehicles Duration: One week consecutively Item: Amount of incoming waste, categories of vehicles (either public collection, direct haulage by households or business), Source (from where), varieties of waste, varieties of vehicle Methodology: ✓ In Palau, portable weigh bridge was used. ✓ In FSM and RMI, measuring volume by sight and converting it to weight
POS on waste discharge manner	Current practices at household level such as on-site recycling, self-disposal and discharge manner were interviewed. Target: Household waste Items: ✓ Discharge manner ✓ Self-disposal (burning, piling up and burying waste within their premises) ✓ On-site recycling (feeding animals, using as fire woods) ✓ Recycling (target items under CDL system)
Population	In order to grasp the amount of generated household waste, the amount of household waste discharged to collection services, and the amount of household waste discharged somewhere, population data such as population of both collection areas and non-collection areas is acquired.
Institutional information	SWM-related laws, organizations and financial mechanisms as well as technical specifications were studied.

Studies carried out in each state and country are as follows.

Table 2: SWM Baseline Survey conducted in each state and country

Country/ State		Palau	FSM				RMI	
			Yap	Chuuk	Pohnpei	Kosrae	Majuro	Ebeye
WACS					○			
Incoming waste amount survey		○*1	○	○	○	○	○*2	○
POS		○	○	○	○	○	○	○
Population		○	○	○	○	○	○	○
SWM Practice	Country	○	−	−	−	−	○	
	State	○	○	○	○	○	−	−
	Local authority	−	○	−	○	○	○	○

*1：M-Dock disposal site

*2：As for waste amount collected by MAWC, the data measured by MAWC itself in 2017 is used.

1.3 Details of SWM Baseline Survey and Schedule

The following are responsible organizations and detailed contents of surveys.

Table 3: Details of SWM Baseline Survey

Survey	Responsible Organizations	Details
Palau		
WACS	-	Utilize the existing data
Incoming waste amount survey	BPW-MPIIC	Site : M-Dock Disposal Site Period : Opening hours of M-Dock Mon. – Fri. (09:00 – 22:00) Sat./ Sun. (13:00 – 19:00)
POS	BPW-MPIIC KSG-SWM	・ Twenty households from Koror ・ Two households each from 10 states in Babeldaob (in total 20 households from Babeldaob)
Population	BPW-MPIIC	State-wide census data and interviews
SWM Practice	BPW-MPIIC/ KSG-SWM/ State governments of Babeldaob	Interview survey to the officers-in-charge at national and state organizations.
FSM Yap		
WACS	-	Utilize the existing data
Incoming waste amount survey	DPW&T	Site : Public disposal site Period : opening hours of the public disposal site (08:00-21:00)
POS	EPA	Twenty households
Population	EPA Municipalities	Municipality-wide census data and interviews
SWM Practice	EPA/ DPW&T	Interview survey to the officers-in-charge

	Municipalities	at state organizations.
FSM Chuuk		
WACS	-	Utilize the existing data
Incoming waste amount survey	DT&PW	Site : Interim disposal site (Marina dump site) Period : opening hours of Marina dump site (08:00-17:00)
POS	EPA	Twenty households
Population	EPA	Area-wide census data and interviews
SWM Practice	EPA/ DT&PW	Interview survey to the officers-in-charge at state organizations.
FSM Pohnpei		
WACS	EPA	Target households ・ Ten households from KITTI Municipality ・ Ten households from Kolonia Town
Incoming waste amount survey	PWMS with support from OT&I	Site : Public disposal site Period : opening hours of the public disposal site (06:00-20:00)
POS	EPA	Twenty households
Population	EPA Municipalities	Municipality-wide census data and interviews
SWM Practice	EPA/ PWMS with support from OT&I	Interview survey to the officers-in-charge at state and municipal organizations.
FSM Kosrae		
WACS	-	Utilize the existing data
Incoming waste amount survey	DT&I	Site : Public disposal site Period : opening hours of the public disposal site ・ Monday to Friday: 08:30 - 15:00 ・ Saturday: 08:00 - 14:30
POS	KIRMA	Forty households (4 municipalities x 10 households)
Population	KIRMA Municipalities	Municipality-wide census data and interviews
SWM Practice	KIRMA、DT&I	Interview survey to the officers-in-charge at state and municipal organizations.
RMI Majuro		
WACS	-	Utilize the existing data
Incoming waste amount survey	MAWC	Site : Public disposal site Period : opening hours of the public disposal site ・ Monday to Saturday: 06:00-20:00
POS	EPA	Forty households in total: 20 from town area and 20 from Laura.
Population	MWAC	Atoll-wide census data and interviews

SWM Practice	MOPW、MWAC	Interview survey to the officers-in-charge at national organizations and MAWC.
RMI Ebeye		
WACS	-	Utilize the existing data
Incoming waste amount survey	KALGOV	Site : Public disposal site Period : opening hours of the public disposal site (07:00-23:00)
POS	EPA	Twenty five households in total: Five households from Gugeegue and 20 households from other parts of Ebeye
Population	KALGOV	Atoll-wide census data and interviews
SWM Practice	KALGOV	Interview survey to the officers-in-charge at KALGOV.

Implementation schedule of SWM baseline survey was as follows.

Table 4: Schedule of SWM Baseline Survey

Country / State		Implementation Period
Palau		June 8th ～ June 18th, 2017
FSM	Yap	June 18th ～ June 28th, 2017
	Chuuk	June 28th ～ July 7th, 2017
	Pohnpei	July 7th ～ July 20th, 2017
	Kosrae	July 17th ～ July 24th, 2017
RMI	Majuro	July 24th ～ July 31st, 2017
	Ebeye	July 31st ～ August 10th, 2017

1.4 Result of SWM Baseline Survey

1.4.1 Republic of Palau

a. Unit Generation Rate (UGR)

As a very first step to understand the current SWM situation, unit generation rate of household waste (UGRHW)[1] as well as unit generation rate of municipal solid waste (UGRMSW)[2], which include waste not only from households but from commercial entities and public organizations, are calculated.

a.1 Unit Generation Rate of Household Waste (UGRHW)

As seen in the table below, URGHW is 673g/person/day, which consists of (i) unit rate of on-site recycling, 98g/person/day, (ii) unit rate of recycling under CDL, 41g/ person/ day, (iii) unit rate of self-disposal, 77g/ person/ day and (iv) unit rate of discharged waste, 457g/ person/ day. In total, approximately 21% of generated waste are recycled at source, and some of the generated waste are disposed at their premises. Only the remaining 68% of the generated waste are discharged.

[1] UGRHW = waste generated from household per person per day (g/ person/day)

[2] UGRMW = (household waste generated per day + waste generated from other than households per day) / person

Table 5: Unit Generation Rate of Household Waste (g/person/day)

Recyclable		Non-recyclable		Waste Generation
On-site recycling	Recyclable for CDL	Self-disposal	Discharged waste	
98	41	77	457[3]	673
14.6%	6.1%	11.4%	67.9%	100%

a.2 Unit Generation Rate of Municipal Solid Waste (UGRMSW)

Municipal solid waste includes not only household waste but also waste from tourism industry, waste from commercial entities and public institutions, etc. Waste generated from other than households are calculated as 1,335 g/person/day through dividing the daily amount of waste from other than households, which is estimated from the waste flow by population. This amount is as twice as large as that of households. As a result, UGRMWS became 2,008 g/person/day.

Table 6: Unit Generation Rate of Municipal Solid Waste (g/person/day)

Household waste	Other than household waste	Municipal solid waste
673	1,335	2,008
33.5%	66.5%	100%

b. Incoming Waste to the Final Disposal Site

The number of vehicles and amount of incoming waste to the public disposal site located in Koror, known as M-dock disposal site, were surveyed and the results are shown in the figure below. The average incoming waste amount is 27.05 ton/ day, while the average number of incoming vehicles is 76 per day. The average amount of incoming waste per vehicle is 356kg per vehicle. While 20% of the incoming waste are collected waste by public sector, the remaining 80% are directly brought by households, commercial entities, and so on. Approximately 33% of the waste directly brought are tourism-related waste, such as waste from hotels and restaurants.

[3] This figure is from WACS carried out in 2015.

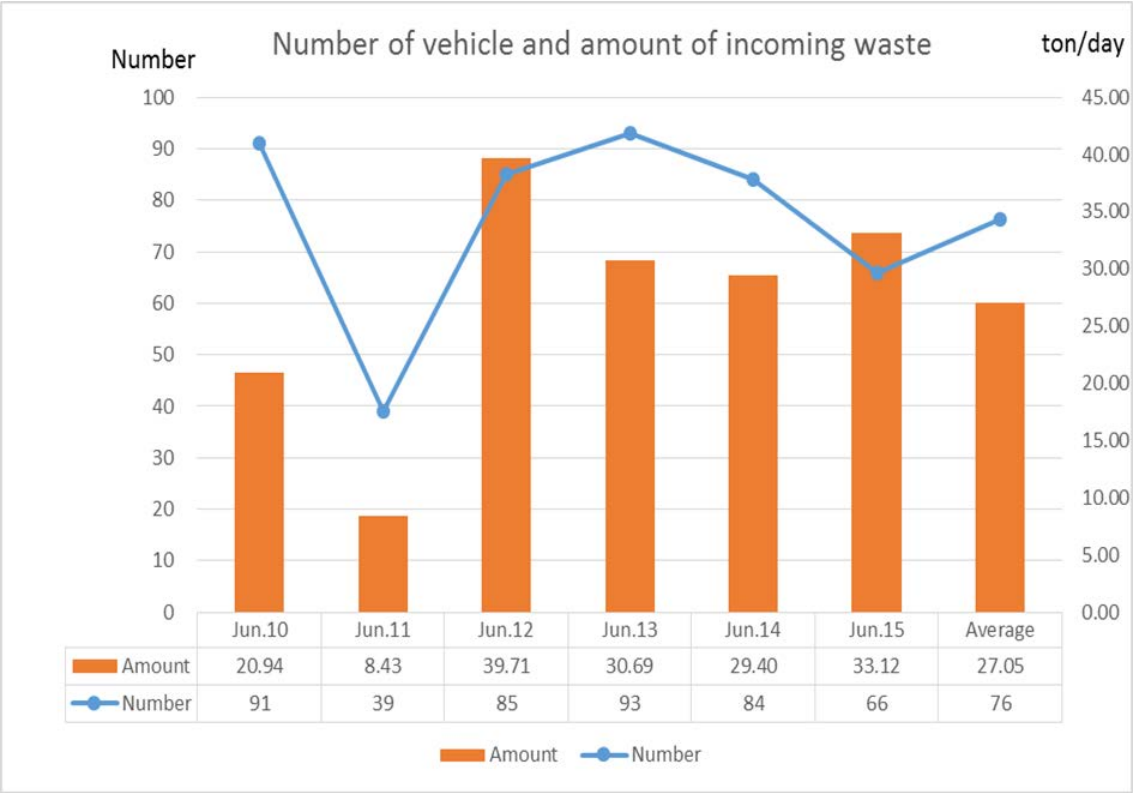


Figure 2: Number of vehicles and amount of incoming waste to M-dock disposal site

c. Current SWM Practice and Issues in Palau

Based on the SWM baseline survey, a waste flow of Palau was drawn up. Current SWM practice and issues detailed below were identified by analyzing the waste flow.

- While 33% of the generated waste are from households, the remaining 64% are from other than households, namely from hotels, restaurants, business entities, public institutions, etc. Waste from other than households generates nearly twice as waste from households.
- While 4.6% of the generated waste are recycled on-site, 5.6% of the generated waste, which is equivalent to 1.9 ton per day are recycled under CDL system. These amounts contribute greatly to prolong life of the final disposal site.
- 24.2% of the generated waste, which is equivalent to 28.2% of the discharged waste are collected through public service. In case of Palau, the major part of the discharged waste, mostly from the tourism-related business entities, are not collected by the public services, but transported directly to the disposal site by themselves. In Palau, the state governments are responsible for collecting waste from residents, and the collection rate is basically 100%.
- 97.6% of the discharged waste, which is equivalent to 83.6% of the generated waste, is properly disposed at the public disposal site.
- While 29% of the incoming waste to the M-dock landfill site is the collected waste, the remaining 71% are directly brought from households, hotels, restaurants, other commercial entities, etc.
- Green waste, cardboard and kitchen waste of some hotels and restaurants are brought into the recycling centre for composting.
- As seen below, there are several recycling activities even at the M-dock landfill site.

- Old tyres are shredded for volume reduction and stored. Used for fuel when demanded.
- Target items under CDL are salvaged from the discharged waste.
- Valuable metals such as aluminium and copper are also salvaged from the piles of scrap accumulated on the corner of the M-dock landfill site.

- Construction of a new landfill site, prolonging life of the M-dock disposal site and development of a system of collection and transportation with introduction of a new landfill site will be strategically important for future SWM in Palau.

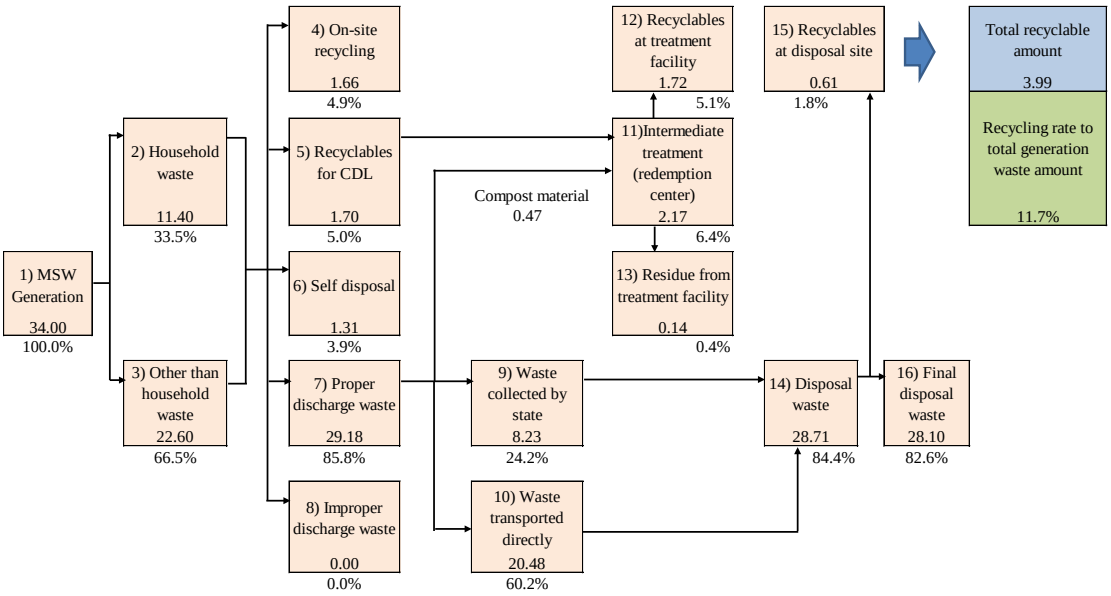


Figure 3: Current Waste Flow of Palau (2017)

1.4.2 FSM

a. Yap

a.1 Unit Generation Rate (UGR)

As a very first step to understand the current SWM situation, unit generation rate of household waste (UGRHW)[4] as well as unit generation rate of municipal solid waste (UGRMSW)[5], which include waste not only from households but from commercial entities and public organizations, are calculated.

A. Unit Generation Rate of Household Waste (UGRHW)

As seen in the table below, URGHW is 834g/person/day, which consists of (i) unit rate of on-site recycling, 266g/person/day, (ii) unit rate of recycling under CDL, 10g/ person/day, (iii) unit rate of self-disposal, 105g/person/day and (iv) unit rate of discharged waste, 453g/ person/day. In total, approximately 33% of generated waste are recycled at source, and some of the generated waste are disposed at their premises. Only the remaining 54% of the generated waste are discharged.

[4] UGRHW = waste generated from household per person per day (g/ person/day)

[5] UGRMW = (household waste generated per day + waste generated from other than households per day) / person

Table 7: Unit Generation Rate of Household Waste (g/person/day)

Recyclable		Non-recyclable		Waste Generation
On-site recycling	Recyclable for CDL	Self-disposal	Discharged waste	
266	10	105	453[6]	834
31.9%	1.2%	12.6%	54.3%	100%

B. Unit Generation Rate of Municipal Solid Waste (UGRMSW)

Municipal solid waste includes not only household waste but also waste from tourism industry, waste from commercial entities and public institutions, etc. Waste generated from other than households are calculated as 458g/person/day through dividing the daily amount of waste from other than households, which is estimated from the waste flow by population. By adding UGRHW to this 458g, UGRMWS became 1,292g/person/day.

Table 8: Unit Generation Rate of Municipal Solid Waste (g/person/day)

Household waste	Other than household waste	Municipal solid waste
834	458	1,292
64.6%	35.4%	100%

a.2 Incoming Waste to the Final Disposal Site

The number of vehicles and amount of incoming waste to the public disposal site were surveyed and the results are shown in the figure below. The average incoming waste amount is 5.63 ton/day, while the average number of incoming vehicles is 44 per day. The average amount of incoming waste per vehicle is 128kg per vehicle. While 23% of the incoming waste are collected waste, the remaining 77% are directly brought by households, commercial entities, and so on. Approximately 43% of the waste directly brought are from households. In sum, many households directly bring small quantity of waste to the public disposal site by themselves.

[6] This figure is from WACS (2015).

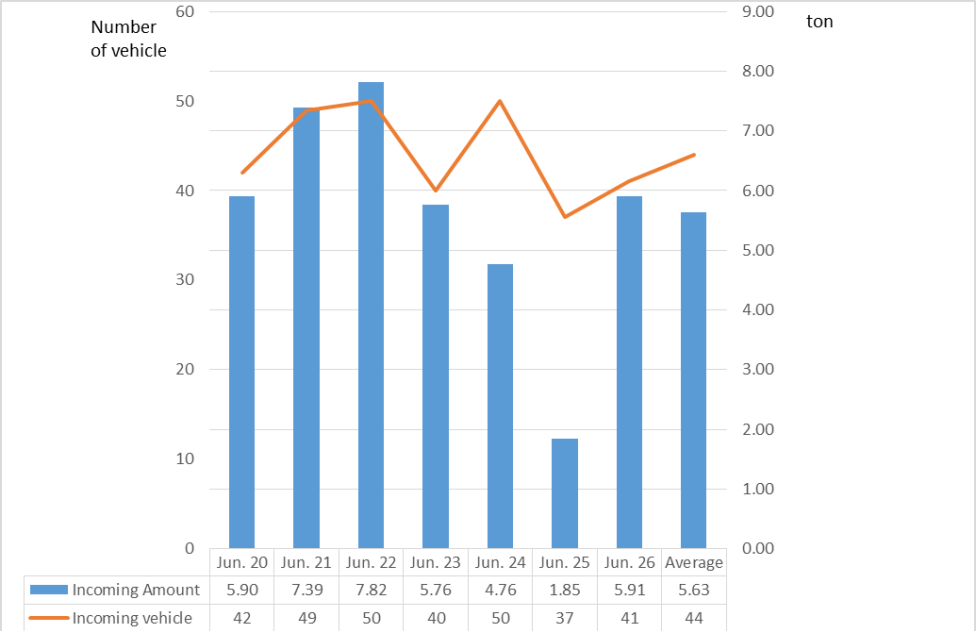


Figure 4: Number of vehicles and amount of incoming waste to the public disposal site

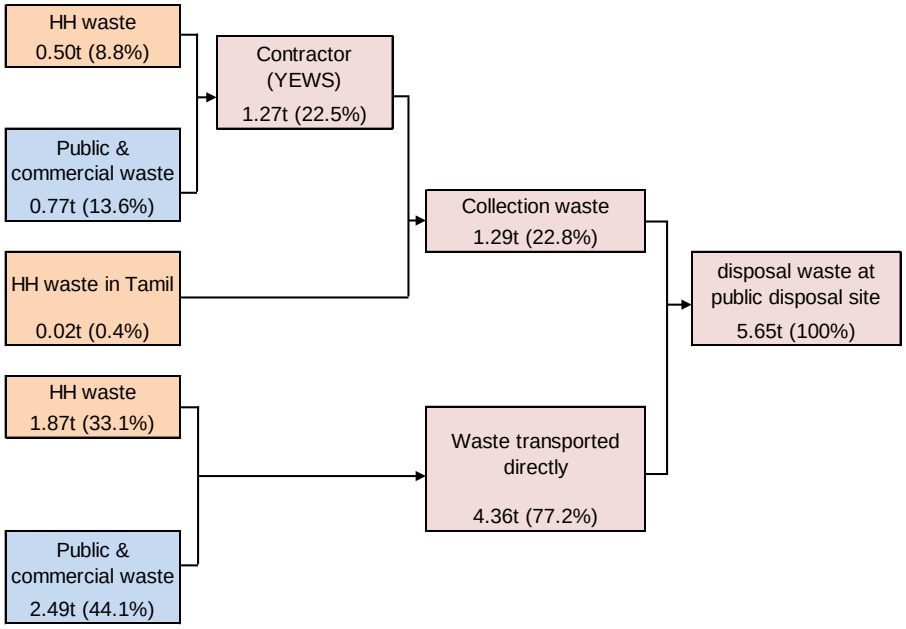


Figure 5: Flow of incoming waste to the public disposal site

a.3 Current SWM Practice and Issues

Based on the SWM baseline survey, a waste flow of Yap was drawn up. Current SWM practice and issues detailed below were identified by analyzing the waste flow.

- While 65% of the generated waste are from households, the remaining 35% are from other than households, namely from business entities, public institutions, etc. The ratio indicates that management of household waste is important in case of Yap.
- As much as 20.6% of the generated waste are recycled on-site. Also, 160kg of target containers are recycled every day under CDL system. Although this is only 1.7% of the

generated waste by weight, it contributes to reduction of littering and extension of life of the public disposal site.

- Only 13.7% of the generated waste, which is equivalent to approximately 20% of the discharged waste are collected through public service. Waste are collected in Yap by the private collection company to whom DPT&T has contracted out collection service in Colonia and by collectors in Tamil where the pilot project of waste collection services has recently started.
- 86% of the discharged waste, which is equivalent to 60% of the generated waste, is properly disposed at the public disposal site. 14% of the discharged waste, which is equivalent to 10% of the generated waste, is disposed at the community dump sites.
- Improvement of collection and transportation, sound management of the community dump sites and pursuit of self-financing SWM system through introduction of collection fee will be strategically important for future SWM in Yap.

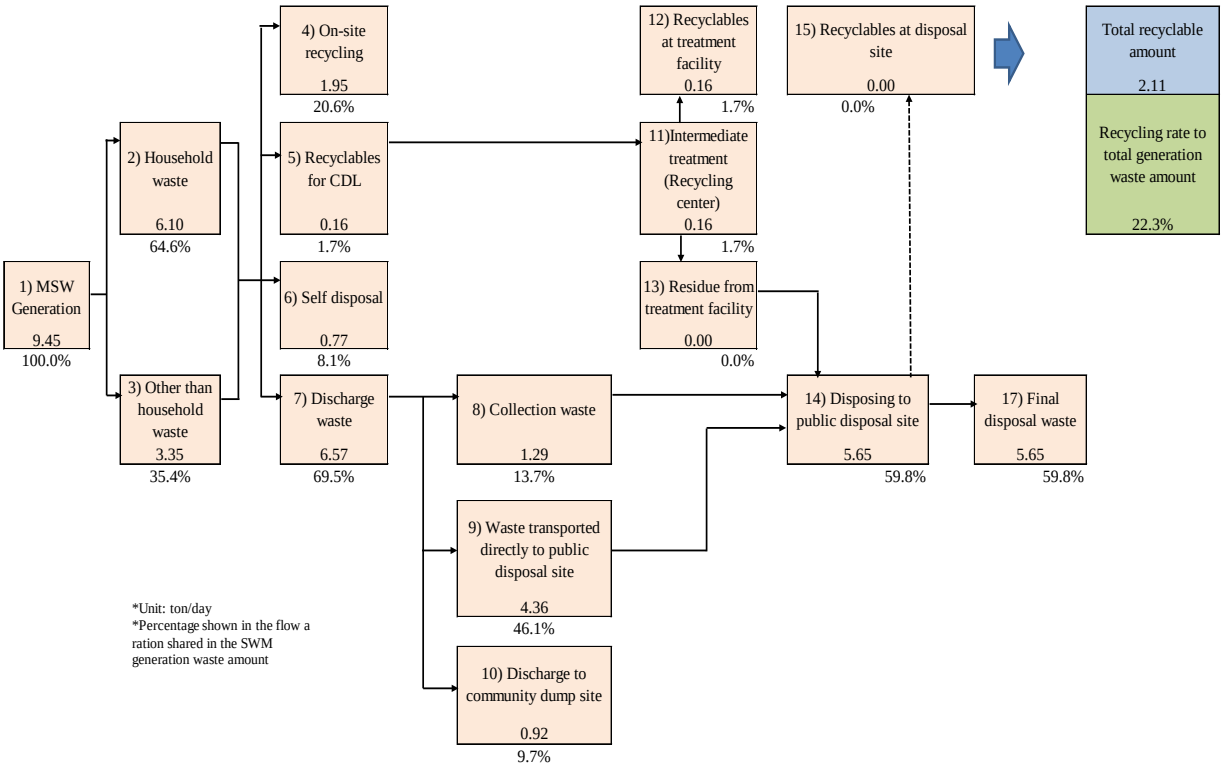


Figure 6: Current Waste Flow of Yap (2017)

b. Chuuk

b.1 Unit Generation Rate (UGR)

As a very first step to understand the current SWM situation, unit generation rate of household waste (UGRHW)[7] as well as unit generation rate of municipal solid waste (UGRMSW)[8], which include waste not only from households but from commercial entities and public organizations, are calculated.

[7] UGRHW = waste generated from household per person per day (g/ person/day)

[8] UGRMW = (household waste generated per day + waste generated from other than households per day) / person

A. Unit Generation Rate of Household Waste (UGRHW)

As seen in the table below, URGHW is 582g/person/day, which consists of (i) unit rate of on-site recycling, 185g/person/day, (ii) unit rate of self-disposal, 36g/ person/ day and (iii) unit rate of discharged waste, 361g/ person/ day. In total, approximately 32% of generated waste are recycled at source, and some of the generated waste are disposed at their premises. Only the remaining 62% of the generated waste are discharged.

Table 9: Unit Generation Rate of Household Waste (g/person/day)

Recyclable		Non-recyclable		Waste Generation
On-site recycling	Recyclable for CDL	Self-disposal	Discharged waste	
185	0	36	361[9]	582
31.8%	0.0%	6.2%	62.0%	100%

B. Unit Generation Rate of Municipal Solid Waste (UGRMSW)

Municipal solid waste includes not only household waste but also waste from tourism industry, waste from commercial entities and public institutions, etc. Waste generated from other than households are calculated as 334g/person/day through dividing the daily amount of waste from other than household, which is estimated from the waste flow by population. By adding UGRHW to this 334g, UGRMWS became 916g/person/day.

Table 10: Unit Generation Rate of Municipal Solid Waste (g/person/day)

Household waste	Other than household waste	Municipal solid waste
582	334	916
63.5%	36.5%	100%

b.2 Incoming Waste to the Final Disposal Site

The number of vehicles and amount of incoming waste to the public disposal site were surveyed and the results are shown in the figure below. The average incoming waste amount is 7.47 ton/ day, while the average number of incoming vehicles is 22 per day. The average amount of incoming waste per vehicle is 340 kg per vehicle. While 48% of the incoming waste are collected waste by DT&PW, the remaining are directly brought mainly by commercial entities such as the biggest supermarket in Weno, hotels, etc. Individual households rarely bring their waste directly to the disposal site, which implies that the residents who receive collection services are satisfied with the service provided by DT&PW.

[9] This figure is from WACS (2015).

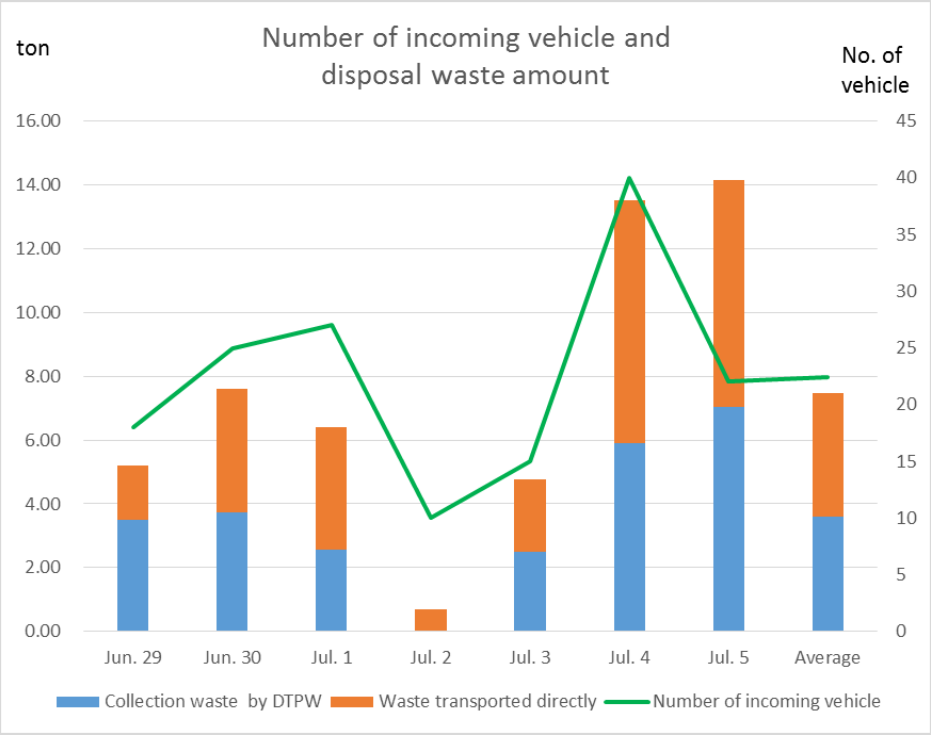


Figure 7: Number of vehicles and amount of incoming waste to the interim disposal site

b.3 Current SWM Practice and Issues

Based on the SWM baseline survey, a waste flow of Chuuk was drawn up. Current SWM practice and issues detailed below were identified by analyzing the waste flow.

- While 63.5% of the generated waste are from households, the remaining 36.5% are from other than households, namely from business entities, public institutions, etc. The ratio indicates that management of household waste is important in case of Chuuk.
- As much as 20.2% of the generated waste are recycled on-site. However, other recycling such as CDL do not exist currently in Chuuk. Introduction of CDL is worth considering since it greatly contributes to reduction of littering and extension of life of the disposal site.
- About 28% of the generated waste, which is equivalent to approximately 37% of the discharged waste are collected directly by DT&PW. These percentages may look low, but this is mainly due to lack of access road in some areas in Weno. In most areas where there is an access road, DT&PW provides collection services and basically the residents in the collection area are satisfied with the service.
- As much as 76.8% of the discharged waste, which is equivalent to 58.3% of the generated waste, is properly disposed at the interim disposal site. The rate of on-site recycling, which is 20.2% of the generated waste, is substantially high.
- Construction of a new final disposal site, proper management of the current interim dump site to use it until the new disposal site is ready, and introduction of CDL will be strategically important for future SWM in Chuuk.

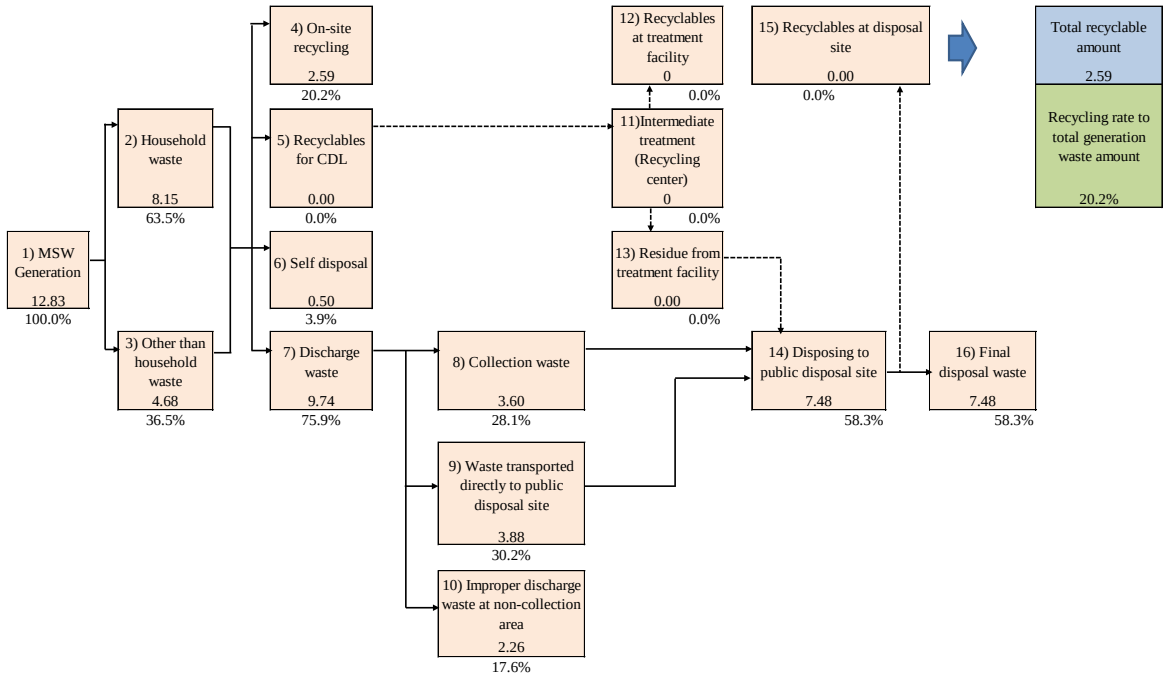


Figure 8: Current Waste Flow of Chuuk (2017)

c. Pohnpei

c.1 Unit Generation Rate (UGR)

As a very first step to understand the current SWM situation, unit generation rate of household waste (UGRHW)[10] as well as unit generation rate of municipal solid waste (UGRMSW)[11], which include waste not only from households but from commercial entities and public organizations, are calculated.

A. Unit Generation Rate of Household Waste (UGRHW)

As seen in the table below, URGHW is 743g/person/day, which consists of (i) unit rate of on-site recycling, 289g/person/day, (ii) unit rate of recycling under CDL, 5g/ person/ day, (iii) unit rate of self-disposal, 93g/ person/ day and (iv) unit rate of discharged waste, 356g/ person/ day. In total, approximately 40% of generated waste are recycled at source, and some of the generated waste are disposed at their premises. Only the remaining 48% of the generated waste is discharged.

Table 11: Unit Generation Rate of Household Waste (g/person/day)

Recyclable		Non-recyclable		Generation waste
On-site recycling	Recyclable for CDL	Self-disposal	Discharge waste	

[10] UGRHW = waste generated from household per person per day (g/ person/day)

[11] UGRMW = (household waste generated per day + waste generated from other than households per day) / person

289	5	93	356[12]	743
38.9%	0.7%	12.5%	47.9%	100%

B. Unit Generation Rate of Municipal Solid Waste (UGRMSW)

Municipal solid waste includes not only household waste but also waste from tourism industry, waste from commercial entities and public institutions, etc. Waste generated from other than households are calculated as 404g/person/day through dividing the daily amount of waste from other than households, which is estimated from the waste flow by population. By adding UGRHW to this 404g, UGRMWS became 1,147g/person/day.

Table 12: Unit Generation Rate of Municipal Solid Waste (g/person/day)

Household waste	Other than household waste	Municipal solid waste
743	404	1,147
64.8%	35.2%	100%

c.2 Waste Amount and Composition Survey (WACS)

In Pohnpei, WACS was carried out to know unit discharge rate of household waste (g/ person/ day) as well as the composition of discharged waste.

A. Amount of Discharged Waste

Unit discharge rate of household waste is 356g/person/day, which consists of 75g of kitchen waste per person per day and 281g of non-kitchen waste per person per day.

Table 13: Unit Discharge Rate of Household Waste (g/person/day)

Kitchen Waste	Non-kitchen Waste	Total
75	281	356

B. Waste Composition

Despite the fact that on-site recycling of kitchen waste as feed to animals is commonly practiced, WACS shows that the kitchen waste comprises 29.4% of the discharged household waste. This implies that the ratio of kitchen waste in generated household waste is much larger. Other noticeable items are other plastic which accounts for 14.5% and diaper which accounts for 10.1%. By volume, other plastic comprises as much as approximately 40%.

Table 14: Composition of Discharged Household Waste

Composition	Percentage (%)

[12] This figure is from WACS (2015).

	Weight %	Volume %
1. Kitchen waste	29.4%	8.5%
2. Cardboard	7.7%	15.6%
3. Other paper	2.5%	4.6%
4. PET bottle	1.3%	3.9%
5. Other plastic	14.5%	39.7%
6. Aluminum can	1.5%	3.3%
7. Tin can	2.4%	2.8%
8. Other metal	4.2%	3.3%
9. Glass	1.9%	2.4%
10. Grass/Wood	5.5%	7.2%
11. Textile	3.6%	1.3%
12. Rubber/Leather	2.1%	0.9%
13. Ceramic/Stone	0.7%	0.2%
14. Diaper	10.1%	3.5%
15. Others	12.6%	3.0%
Total	100.0%	100.0%
Apparent Specific Gravity（ ASG)	0.10	

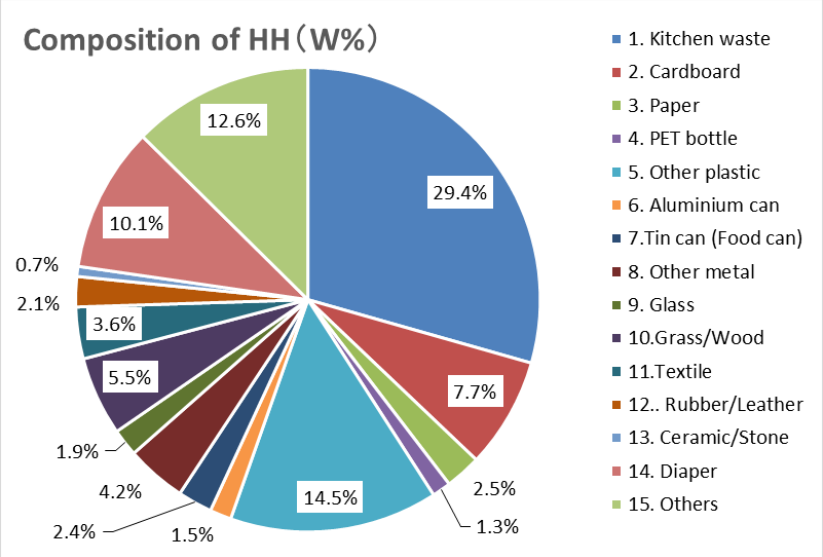


Figure 9: Waste Composition of Household Waste (% in weight)

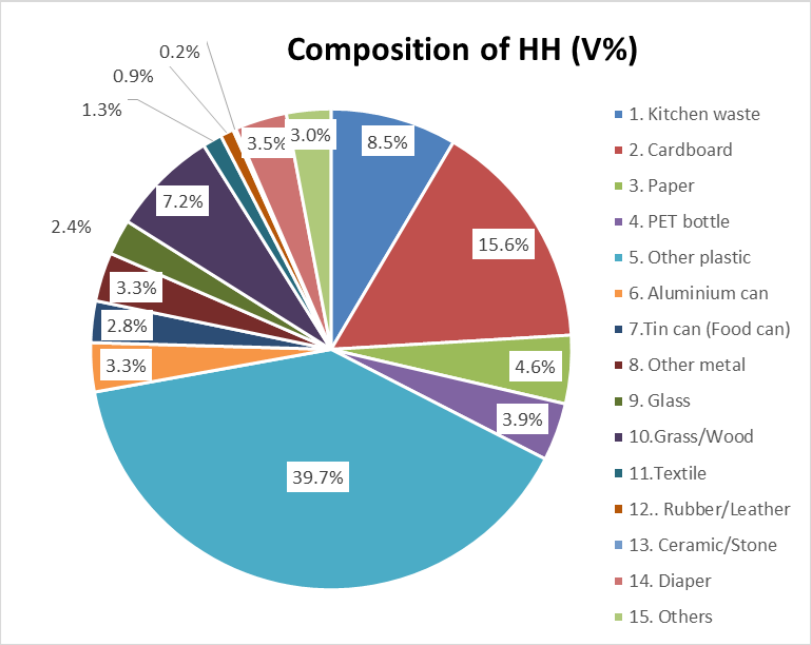
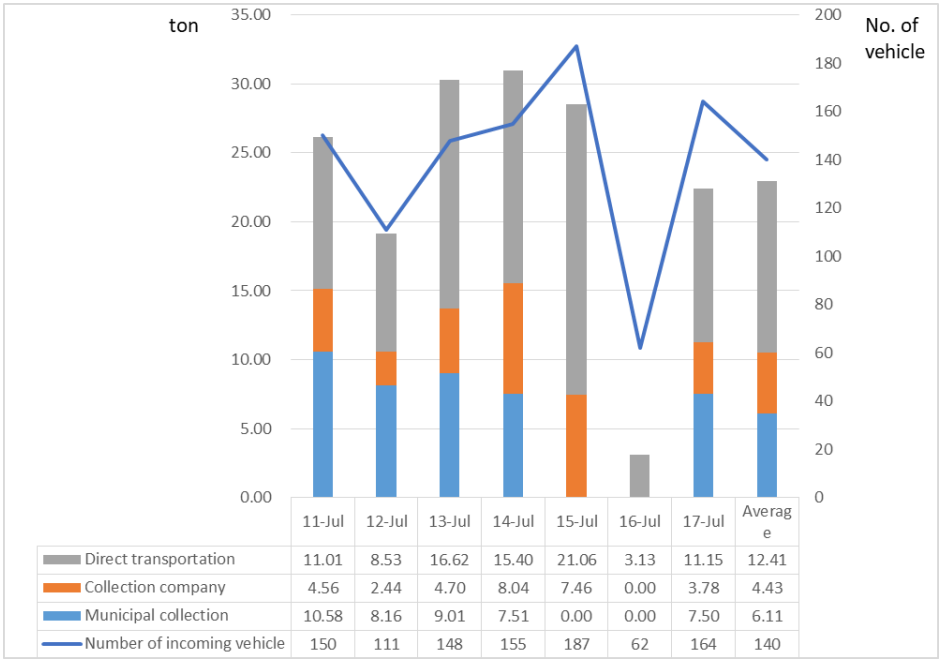


Figure 10: Waste Composition of Household Waste (% in volume)

c.3 Incoming Waste to the Final Disposal Site

The number of vehicles and amount of incoming waste to the public disposal site were surveyed and the results are shown in the next figure. The average incoming waste amount is 22.95 ton/ day, while the average number of incoming vehicles is 140 per day. The average amount of incoming waste per vehicle is 164 kg per vehicle. While direct haulage comprises 54.1% of the incoming waste, 26.6% of the incoming waste is collected waste by municipalities and 19.3% of that is collected waste by the private collectors. Also, as seen in Figure 4-12, household waste comprises approximately 30% of disposed waste at the final disposal site, while the remaining 70% are from other than households. In sum, the fact that many households directly bring small quantities of waste to the public disposal site by themselves indicates municipalities in Pohnpei fail to provide satisfactory collection services to the residents.



	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	Average
Direct transportation	11.01	8.53	16.62	15.40	21.06	3.13	11.15	12.41
Collection company	4.56	2.44	4.70	8.04	7.46	0.00	3.78	4.43
Municipal collection	10.58	8.16	9.01	7.51	0.00	0.00	7.50	6.11
Number of incoming vehicle	150	111	148	155	187	62	164	140

Figure 11: Number of vehicles and amount of incoming waste to the final disposal site

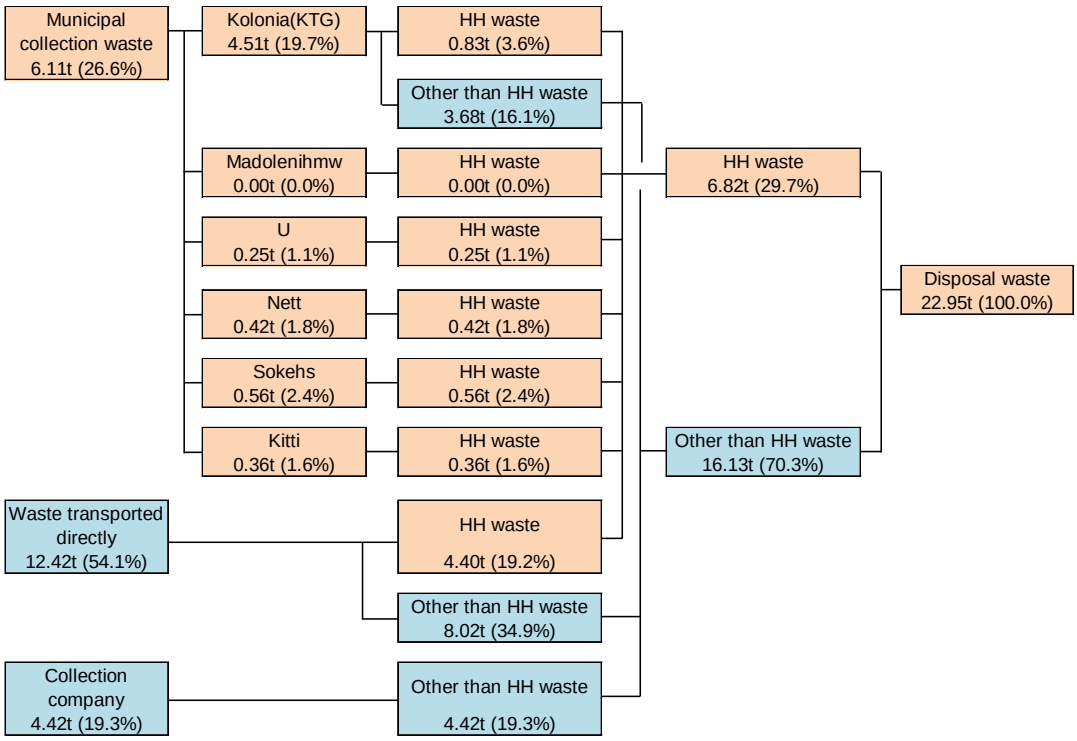


Figure 12: Flow of incoming waste to the final disposal site

c.4 Current SWM Practice and Issues

Based on the SWM baseline survey, a waste flow of Pohnpei was drawn up. Current SWM practice and issues detailed below were identified by analyzing the waste flow.

- While 65% of the generated waste are from households, the remaining 35% are from other than households, namely from business entities, public institutions, etc. The ratio indicates that management of household waste is important in case of Pohnpei.
- As much as 25.2% of the generated waste are recycled on-site. Also, 200kg of beverage containers, which is equivalent to 1.7% of the generated waste by weight are supposed to be recycled per day under CDL system. These CDL-related figures estimated through household surveys must be collated with the data from the CDL operator, EPA in case of Pohnpei[13]. Also, by considering the current operation, i.e. limited target items, in fact only aluminium cans, and infrequent purchase of cans at redemption centres, the system needs to be improved substantially.
- Only 13.3% of the generated waste, which is equivalent to approximately 20% of the discharged waste are collected through public service. This low figure is attributed to the inability of local governments who are primarily responsible for waste collection in Pohnpei to provide satisfactory collection services to the residents.
- 75.5% of the discharged waste, which is equivalent to 50% of the generated waste, is properly disposed at the public disposal site.
- Improvement of collection system, improvement of CDL system and pursuit of self-financing SWM system through introduction of collection fee could be strategically important for future SWM in Pohnpei.

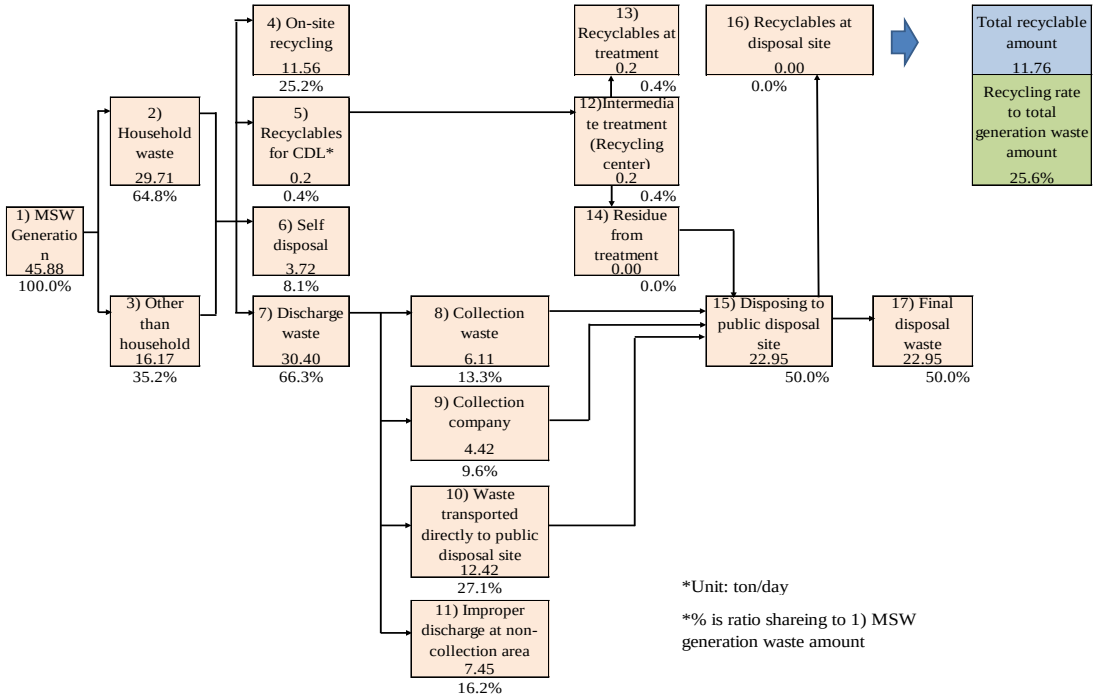


Figure 13: Current Waste Flow of Pohnpei (2017)

d. Kosrae

d.1 Unit Generation Rate (UGR)

As a very first step to understand the current SWM situation, unit generation rate of household waste (UGRHW)[14] as well as unit generation rate of municipal solid waste

[13] Data has been requested for long, but have not been provided yet.

[14] UGRHW = waste generated from household per person per day (g/ person/day)

(UGRMSW)[15], which include waste not only from households but from commercial entities and public organizations, are calculated.

A. Unit Generation Rate of Household Waste (UGRHW)

As seen in the table below, URGHW is 773g/person/day, which consists of (i) unit rate of on-site recycling, 262g/person/day, (ii) unit rate of recycling under CDL, 25g/ person/ day, (iii) unit rate of self-disposal, 99g/ person/ day and (iv) unit rate of discharged waste, 387g/ person/ day. In total, approximately 37% of generated waste are recycled at source, and some of the generated waste are disposed at their premises. Only the remaining 50% of the generated waste are discharged.

Table 15: Unit Generation Rate of Household Waste (g/person/day)

Recyclable		Non-recyclable		Waste Generation
On-site recycling	Recyclable for CDL	Self-disposal	Discharged waste	
262	25	99	387[16]	773
33.9%	3.2%	12.8%	50.1%	100%

B. Unit Generation Rate of Municipal Solid Waste (UGRMSW)

Municipal solid waste includes not only household waste but also waste from tourism industry, waste from commercial entities and public institutions, etc. Waste generated from other than households are calculated as 355g/person/day through dividing the daily amount of waste from other than households, which is estimated from the waste flow by population. By adding UGRHW to this 355g, UGRMWS became 1,128g/person/day.

Table 16: Unit Generation Rate of Municipal Solid Waste (g/person/day)

Household waste	Other than household waste	Municipal solid waste
773	355	1,128
68.5%	31.5%	100%

d.2 Incoming Waste to the Final Disposal Site

The number of vehicles and amount of incoming waste to the public disposal site were surveyed and the results are shown in the next figure. The average incoming waste amount is 4.18 ton/ day, while the average number of incoming vehicles is 19 per day. The average amount of incoming waste is 220 kg per vehicle. While 29% of the incoming waste is collected waste by municipalities, the remaining 71% of the incoming waste are brought

[15] UGRMW = (household waste generated per day + waste generated from other than households per day) / person

[16] This figure is from WACS (2015).

directly by households, business entities and so on.

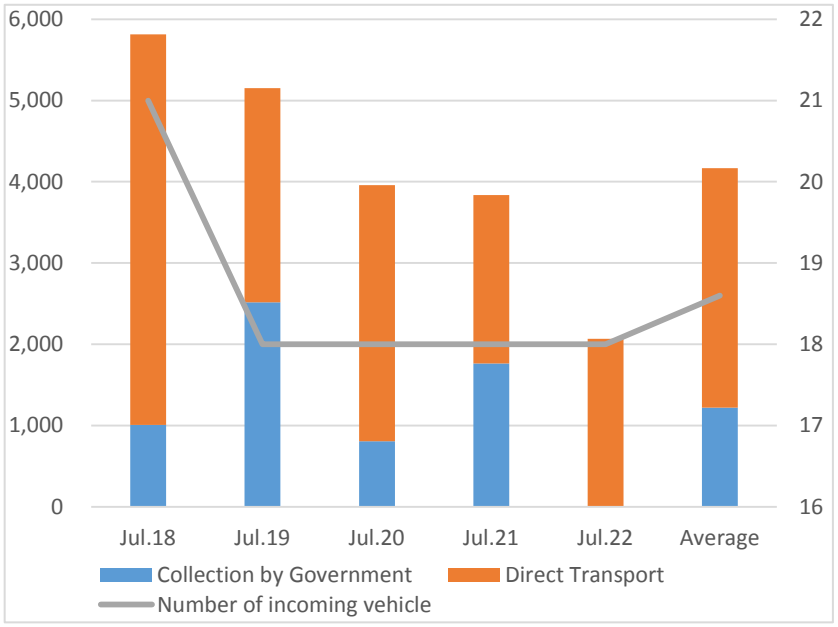


Figure 14: Number of vehicles and amount of incoming waste to the final disposal site

d.3 Current SWM Practice and Issues

Based on the SWM baseline survey, a waste flow of Kosrae was drawn up. Current SWM practice and issues detailed below were identified by analyzing the waste flow.

- While 68.5% of the generated waste are from households, the remaining 31.5% are from other than households, namely from business entities, public institutions, etc. The ratio indicates that management of household waste is important in case of Kosrae.
- As much as 23.2% of the generated waste are recycled on-site. Also, 240 kg of beverage containers such as aluminium cans, pet bottles and glass bottles are recycled every day under CDL system. This is equivalent to 3.2% of he generated waste by weight, and it contributes to reduction of littering and extension of life of the public disposal site.
- Only 16.3% of the generated waste, which is equivalent to 29.2% of the discharged waste are collected through public service. This low figure is attributed to the inability of local governments who are primarily responsible for waste collection in Kosrae to provide collection services to the residents.
- 86.3% of the discharged waste, which is equivalent to 56.1% of the generated waste, is properly disposed at the public disposal site.
- Improvement of collection and transportation and pursuit of self-financing SWM system through introduction of collection fee will be strategically important for future SWM in Kosrae.

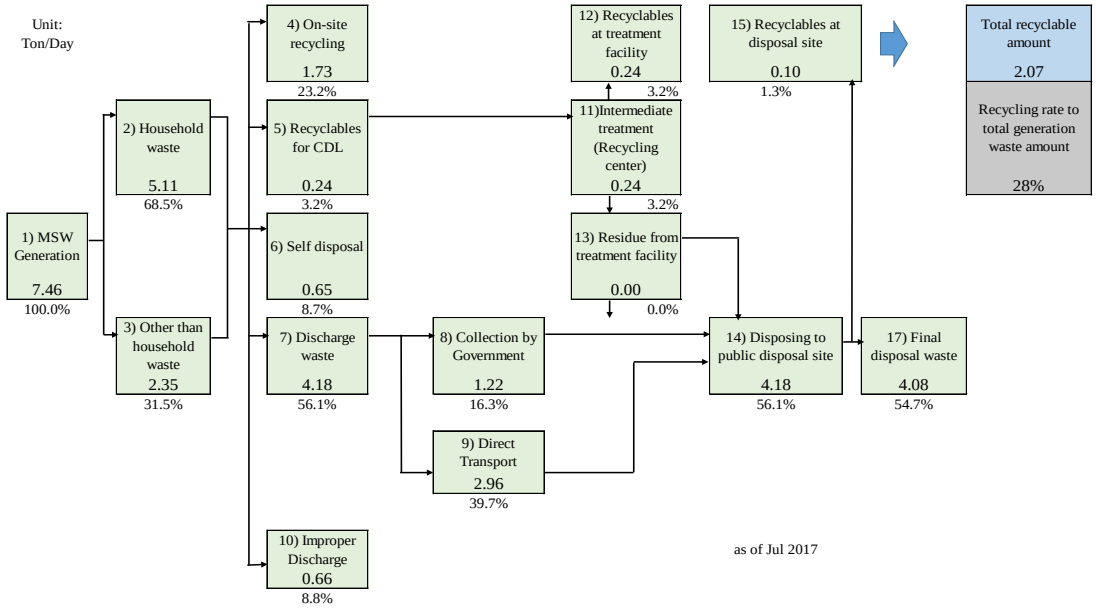


Figure 15: Current Waste Flow of Kosrae (2017)

1.4.3 RMI

a. Majuro

a.1 Unit Generation Rate (UGR)

As a very first step to understand the current SWM situation, unit generation rate of household waste (UGRHW)[17] as well as unit generation rate of municipal solid waste (UGRMSW)[18], which include waste not only from households but from commercial entities and public organizations, are calculated.

A. Unit Generation Rate of Household Waste (UGRHW)

As seen in the table below, URGHW is 868g/person/day, which consists of (i) unit rate of on-site recycling, 118g/person/day, (ii) unit rate of recycling under CDL, 3g/ person/ day, (iii) unit rate of self-disposal, 18g/ person/ day and (iv) unit rate of discharged waste, 728g/ person/ day. In total, approximately 14% of generated waste are recycled at source, and some of the generated waste are disposed at their premises. The remaining 84% of the generated waste are discharged

Table 17: Unit Generation Rate of Household Waste (g/person/day)

Recyclable		Non-recyclable		Waste Generation
On-site recycling	Recyclable for CDL	Self-disposal	Discharged waste	

[17] UGRHW = waste generated from household per person per day (g/ person/day)

[18] UGRMW = (household waste generated per day + waste generated from other than households per day) / person

118	3	18	728	868
13.4%	0.3%	2.1%	84.2%	100%

B. Unit Generation Rate of Municipal Solid Waste (UGRMSW)

Municipal solid waste includes not only household waste but also waste from tourism industry, waste from commercial entities and public institutions, etc. Waste generated from other than households are calculated as 546g/person/day through dividing the daily amount of waste from other than households, which is estimated from the waste flow by population. By adding UGRHW to this 546g, UGRMWS became 1,413g/person/day.

Table 18: Unit Generation Rate of Municipal Solid Waste (g/person/day)

Household waste	Other than household waste	Municipal solid waste
868	546	1,413
61.4%	38.6%	100%

a.2 Incoming Waste to the Final Disposal Site

The number of vehicles and amount of incoming waste to the public disposal site were surveyed and the results are shown in the next figure. The average incoming waste amount is 34.8 ton/ day, while the average number of incoming vehicles is 50 per day. The average amount of incoming waste is 696 kg per vehicle. While 63% of the incoming waste is collected waste by MAWC, the remaining 37% of the incoming waste are brought directly by households, business entities and so on. Also, as seen in Figure 4-17, household waste comprises approximately 52% of disposed waste at the final disposal site which is equivalent to 22 ton per day, while the remaining 48%, which is equivalent to 12.8 ton per day are from other than households. Incoming wastes such as general waste, scrap metals, wood and green wastes are deposed in each designated area.

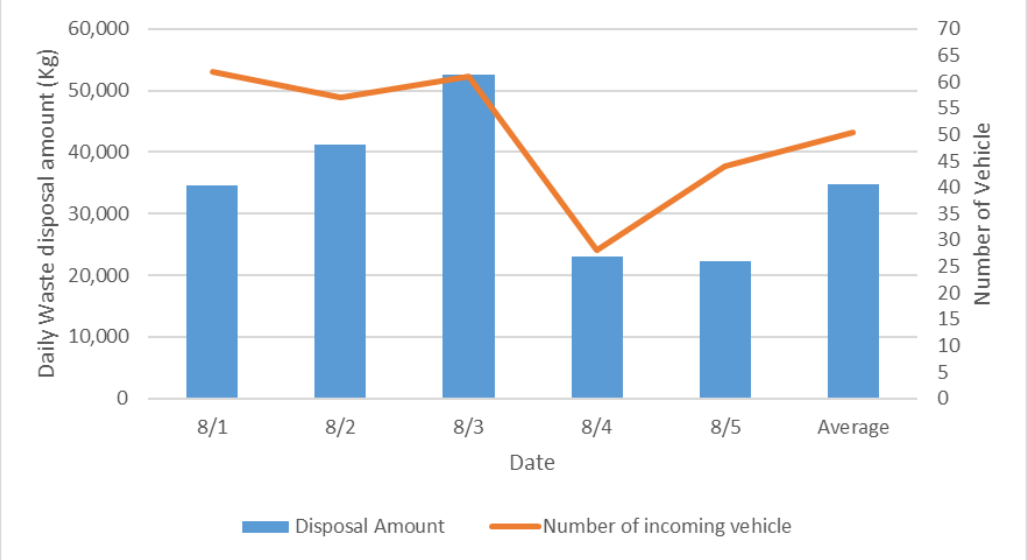


Figure 16: Number of vehicles and amount of incoming waste to the final disposal site

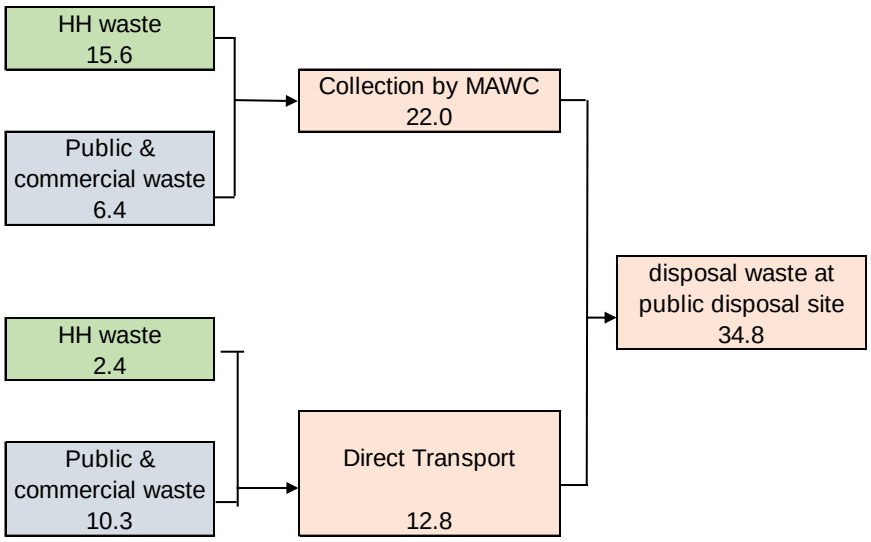


Figure 17: Flow of incoming waste to the final disposal site

a.3 Current SWM Practice and Issues

Based on the SWM baseline survey, a waste flow of Majuro was drawn up. Current SWM practice and issues detailed below were identified by analyzing the waste flow.

- While 61.3% of the generated waste are from households, the remaining 38.7% are from other than households, namely from business entities, public institutions, etc. The ratio indicates that management of household waste is important in case of Majuro.
- Only 8.4% of the generated waste, which is much lower than that of four states of FSM, is recycled on-site. Although CDL system has not been in place yet, MAWC purchases aluminium cans at the disposal site.

- At the final disposal site, a container-type portable incinerator has been placed[19], and MAWC tries to reduce the amount of waste piling up in the site through incinerating general waste using waste wood as fuel. As of August 2017, it contributes to 2% reduction.
- As much as 50.8% of the generated waste, which is equivalent to 63.2% of the discharged waste, is collected waste by MAWC. MAWC collects waste from residents of major areas of Majuro except two remote communities, namely Laura and Ajertake.
- 89% of the discharged waste, which is equivalent to 80.2% of the generated waste, is properly disposed at the public disposal site.
- Construction of a new landfill site, prolonging life of the current disposal site and introduction of CDL system will be strategically important for future SWM in Majuro.

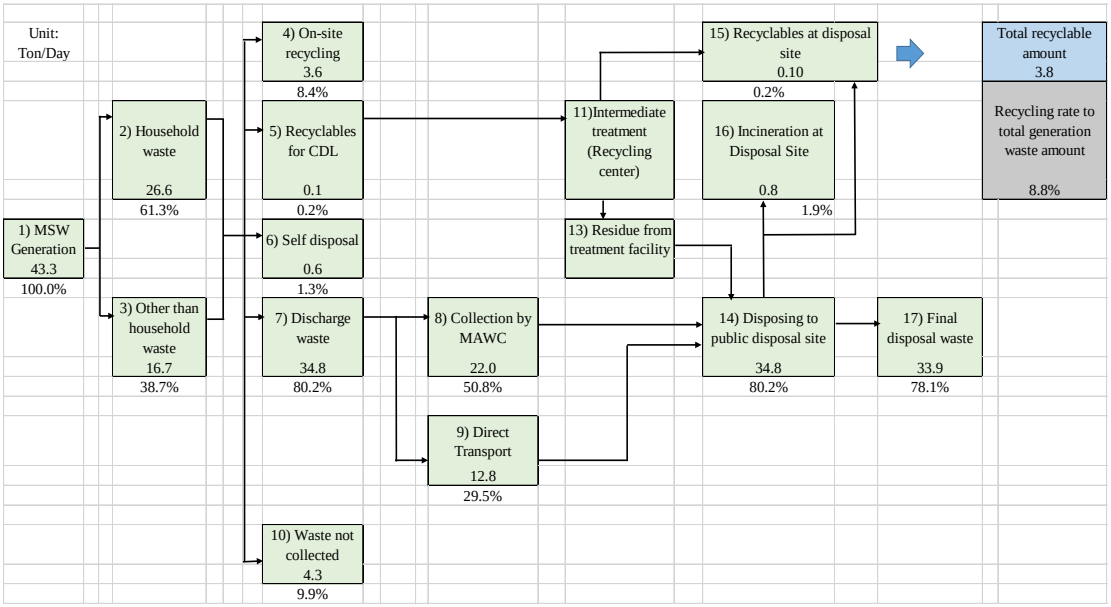


Figure 18: Current Waste Flow of Majuro (2017)

b. Ebeye

b.1 Unit Generation Rate (UGR)

As a very first step to understand the current SWM situation, unit generation rate of household waste (UGRHW)[20] as well as unit generation rate of municipal solid waste (UGRMSW)[21], which include waste not only from households but from commercial entities and public organizations, are calculated.

A. Unit Generation Rate of Household Waste (UGRHW)

As seen in the table below, URGHW is 868g/person/day, which consists of (i) unit rate of on-site recycling, 89g/person/day, (ii) unit rate of recycling under CDL, 0g/ person/ day, (iii) unit rate of self-disposal, 89g/ person/ day and (iv) unit rate of discharged waste, 683g/

[19] The portable incinerator is made by Air Burners. For more information of the product, please see www.airburners.com

[20] UGRHW = waste generated from household per person per day (g/ person/day)

[21] UGRMW = (household waste generated per day + waste generated from other than households per day) / person

person/ day. In total, approximately 11% of generated waste are recycled at source, and some of the generated waste are disposed at their premises. The remaining 78% of the generated waste are discharged.

Table 19: Unit Generation Rate of Household Waste (g/person/day)

Recyclable		Non-recyclable		Waste Generation
On-site recycling	Recyclable for CDL	Self-disposal	Discharged waste	
96	0	89	683[22]	868
11.1%	0.0%	10.3%	78.0%	100%

B. Unit Generation Rate of Municipal Solid Waste (UGRMSW)

Municipal solid waste includes not only household waste but also waste from tourism industry, waste from commercial entities and public institutions, etc. Waste generated from other than households are calculated as 355g/person/day through dividing the daily amount of waste from other than households, which is estimated from the waste flow by population. By adding UGRHW to this 355g, UGRMWS became 1,223g/person/day.

Table 20: Unit Generation Rate of Municipal Solid Waste (g/person/day)

Household waste	Other than household waste	Municipal solid waste
868	355	1,223
71.0%	29.0%	100%

b.2 Incoming Waste to the Final Disposal Site

The number of vehicles and amount of incoming waste to the public disposal site were surveyed and the results are shown in the next figure. The average incoming waste amount is 11.2 ton/ day, while the average number of incoming vehicles is 23 per day. The average amount of incoming waste is 487 kg per vehicle. While 68% of the incoming waste is collected waste by KALGOV, the remaining 32% of the incoming waste are brought directly by households, business entities and so on. Also, household waste comprises approximately 68% of disposed waste at the final disposal site, which is equivalent to 7.6 ton per day, while the remaining 32%, which is equivalent to 3.6 ton per day, are from other than households.

[22] Time & Motion survey in 2017

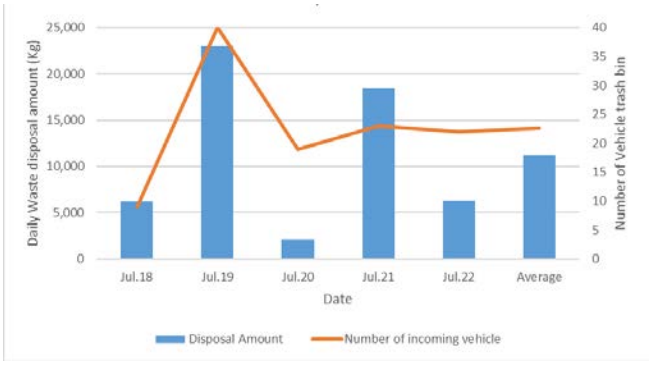


Figure 19: Number of vehicles and amount of incoming waste to the final disposal site

b.3 Current SWM Practice and Issues

Based on the SWM baseline survey, a waste flow of Ebeye was drawn up. Current SWM practice and issues detailed below were identified by analyzing the waste flow.

- While 70.9% of the generated waste are from households, the remaining 29.1% are from other than households, namely from business entities, public institutions, etc. The ratio indicates that management of household waste is important in case of Ebeye.
- Only 7.8% of the generated waste, which is much lower than that of four states of FSM, is recycled on-site.
- As many as 60.8% of the generated waste, which is equivalent to 67.8% of the discharged waste, is collected waste by KALGOV. KALGOV collects waste from residents of all areas of Ebeye, and therefore the collection rate is 100%.
- All the discharged waste is properly disposed at the public disposal site.
- Formulation of the solid waste management plan for KALGOV, which includes the investment plan for equipment and facilities, and introduction of CDL system will be important future activities for Ebeye.

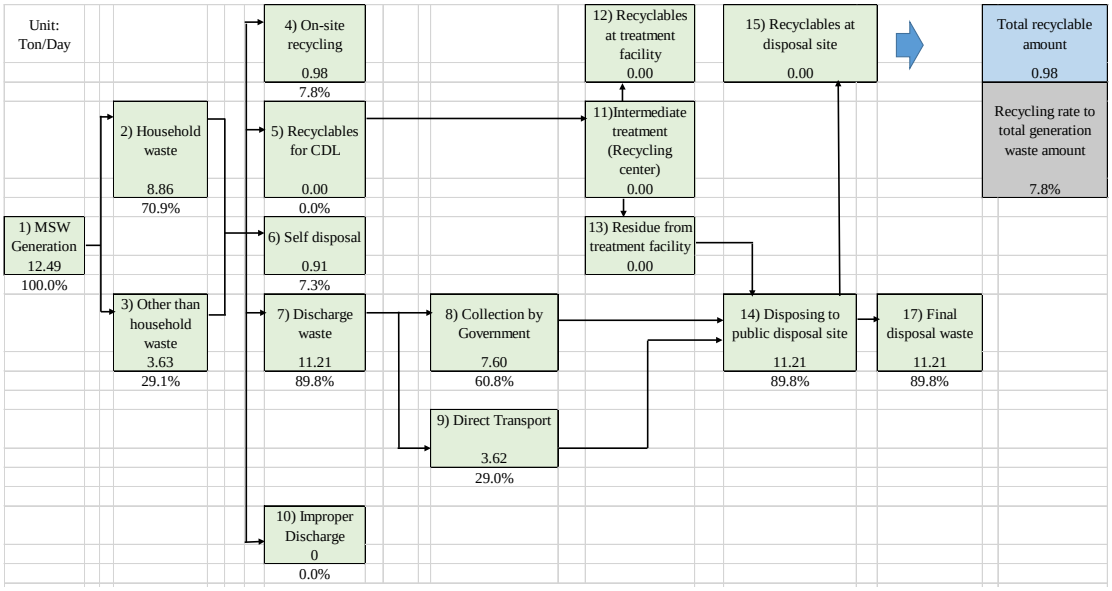


Figure 20: Current Waste Flow of Ebeye (2017)

1.5 Comparative Review of SWM Situations in Three Micronesian Countries

1.5.1 Indicators Used for Comparative Review

The following indicators which became available through formulation of waste flows are used to compare SWM situations in three Micronesian countries. The details are indicated in the following figure.

- Indicator 1: Generation rates

  Both unit generation rate of household waste (UGRHW) and unit generation rate of municipal solid waste (UGRMSW)

- Indicator 2: Discharge

  First, define the waste deposed at the public disposal site out of discharge waste as the properly discharged waste, and the remaining waste out of discharge waste as the improperly discharged waste. Then two ratios, namely a ratio of properly discharged waste to generated waste and a ratio of improperly discharged waste to generated waste are compared.

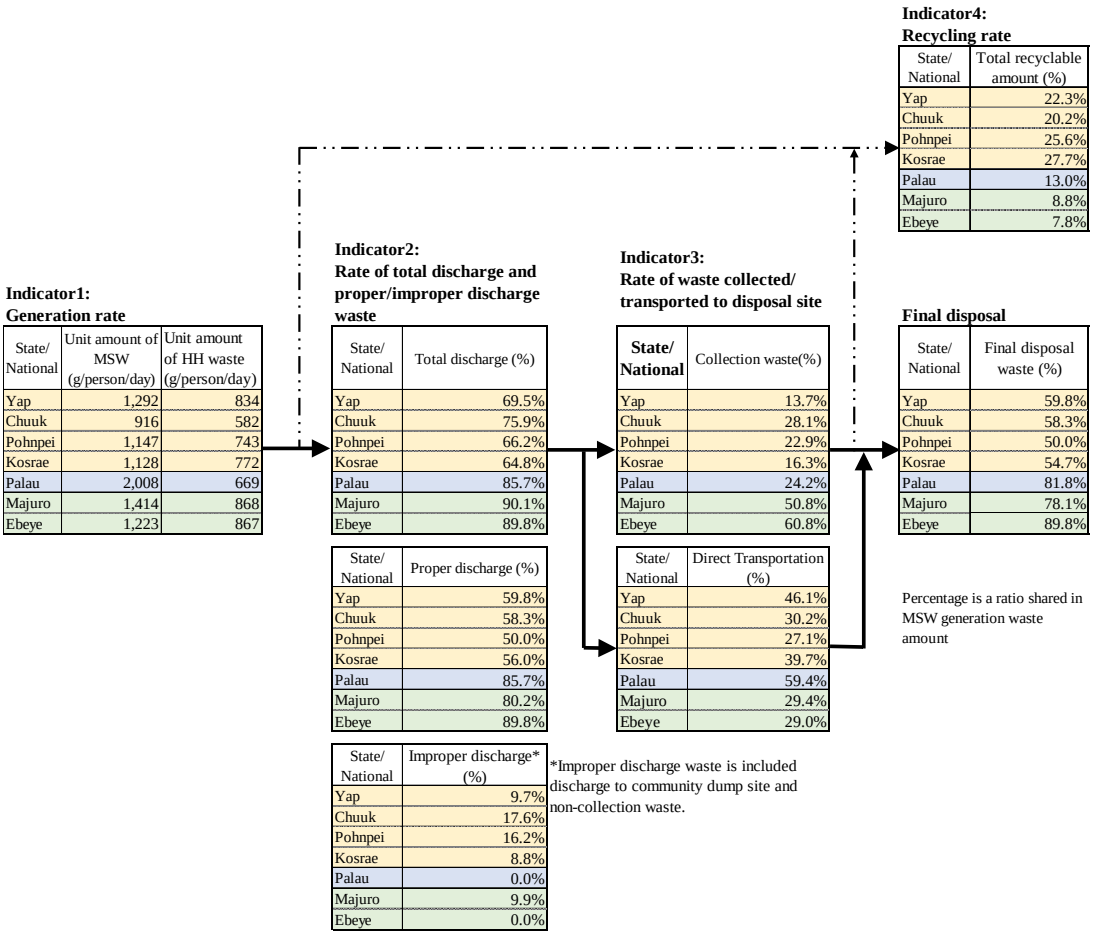
- Indicator 3: Disposal

  A ratio of waste collected by certain services to waste directly brought by residents, business entities, etc., among the waste disposed at the final disposal site.

- Indicator 4: Recycling

  A ratio of recycled waste to generated waste. Recycled waste consists of waste recycled on-site, waste recycled under CDL and waste salvaged at the final disposal site.

- Indicator 5: Organizational and financial situations



State/ National	Unit amount of MSW (g/person/day)	Unit amount of HH waste (g/person/day)
Yap	1,292	834
Chuuk	916	582
Pohnpei	1,147	743
Kosrae	1,128	772
Palau	2,008	669
Majuro	1,414	868
Ebeye	1,223	867

State/ National	Total discharge (%)
Yap	69.5%
Chuuk	75.9%
Pohnpei	66.2%
Kosrae	64.8%
Palau	85.7%
Majuro	90.1%
Ebeye	89.8%

State/ National	Proper discharge (%)
Yap	59.8%
Chuuk	58.3%
Pohnpei	50.0%
Kosrae	56.0%
Palau	85.7%
Majuro	80.2%
Ebeye	89.8%

State/ National	Improper discharge* (%)
Yap	9.7%
Chuuk	17.6%
Pohnpei	16.2%
Kosrae	8.8%
Palau	0.0%
Majuro	9.9%
Ebeye	0.0%

State/ National	Collection waste(%)
Yap	13.7%
Chuuk	28.1%
Pohnpei	22.9%
Kosrae	16.3%
Palau	24.2%
Majuro	50.8%
Ebeye	60.8%

State/ National	Direct Transportation (%)
Yap	46.1%
Chuuk	30.2%
Pohnpei	27.1%
Kosrae	39.7%
Palau	59.4%
Majuro	29.4%
Ebeye	29.0%

State/ National	Total recyclable amount (%)
Yap	22.3%
Chuuk	20.2%
Pohnpei	25.6%
Kosrae	27.7%
Palau	13.0%
Majuro	8.8%
Ebeye	7.8%

State/ National	Final disposal waste (%)
Yap	59.8%
Chuuk	58.3%
Pohnpei	50.0%
Kosrae	54.7%
Palau	81.8%
Majuro	78.1%
Ebeye	89.8%

Figure 21: Comparative Review of SWM Situations

1.5.2 Findings from Comparison

a. Indicator 1: Generation

UGRMSW in Palau is over 2,000g per person per day. This is mainly because unit generation rate of non-household waste is much bigger than other islands, while UGRHW is approximately the same. The large amount of tourism-related waste such as waste from restaurants and hotels is a distinctive characteristic of Palau. As for other islands under the Project, namely four states of FSM and two cities of RMI, there is not much differences in both UGRHW and UGRMSW.

Table 21: Comparison of three kinds of unit generation rates (g/ person/ day)

National / State		UGRMSW	UGRHW	UGR of non-HH Waste
Palau		2,008	669	1,339
FSM	Yap	1,292	834	458
	Chuuk	916	582	334

	Pohnpei	1,147	743	404
	Kosrae	1,128	772	356
FMI	Majuro	1,414	868	546
	Ebeye	1,223	867	356

b. Indicator 2: Discharge

In the four states of FSM, the ratio of discharged waste to generated waste is very low, and this is mainly because on-site recycling is active in this region. However, the rate of improper discharge in four states FSM is rather high compared with Palau and RMI. The reasons for widespread practices of improper discharge differ from state to state. For example, in case of Yap, this is mainly because the public collection service is provided only in the central part of the state. In both Pohnpei and Kosrae, municipalities, the prime agency to provide collection services, are too weak financially to provide satisfactory services without introduction of fee collection. In Chuuk, DT&PW, the prime responsible agency to provide collection service, is unable to run collection trucks in certain areas where there is no access road.

In case of Palau and RMI, basically the public sector provides collection services to all the residents, and therefore collection rates in these areas can be considered as 100%.

Table 22: Rate of Proper and Improper Discharge

National / State		Total discharge waste	Proper discharge	Improper discharge	Discharge place of improper waste discharge
Palau		85.7%	85.7%	0.0%	States provide 100% collection service to household.
FSM	Yap	69.5%	59.8%	9.7%	Disposal to community dumpsites is currently considered as proper.
	Chuuk	75.9%	58.3%	17.6%	Improper discharge means mainly discharge to nearby open spaces in an improper manner.
	Pohnpei	66.2%	50.0%	16.2%	The same as Chuuk State.
	Kosrae	64.8%	56.0%	8.8%	Illegal dumpsites that existed along roadside have been closed. Improper discharge to nearby open spaces continues.
RMI	Majuro	90.1%	80.2%	9.9%	There are some non-collection areas at remote areas such as Laura and Ajertake.
	Ebeye	89.8%	89.8%	0.0%	KALGOV provides 100% collection service to households.

c. Indicator 3: Disposal

Among the waste properly disposed at the public disposal site, (i) a proportion of waste collected by certain services and (ii) a proportion of waste directly brought by residents, business entities, etc, are compared across the three countries. The rate of waste directly transported to the disposal site is high in Palau because the direct transportation by hotels and restaurants is common practice. The same rate is also high in Yap and Kosrae of FSM because collection service by the public sector is rather limited, and therefore residents must bring their waste to the disposal site by themselves in these states. On the other hand, the public collection service is well provided both in Majuro and Ebeye in RMI, and residents do not have to bring their waste to the disposal site by themselves. Thus, this rate is very low.

Table 23: Rate of waste directly transported to the disposal site

National / State		Waste collected	Waste directly transported	Issues on waste collection and transportation
Palau		24.2%	59.4%	The rate of waste directly transported to the M-dock disposal site is shown here. In Koror and Babeldaob, the entire household waste is collected by state governments (collection rate is 100%), and disposed at the M-dock disposal site. About twice as large as the quantity of collected household waste is directly transported to the M-dock disposal site by the tourism related business entities, such as hotels, restaurants and shops.
FSM	Yap	13.7%	46.1%	Main responsible actor for waste collection service is DPW&T. Some households in Colonia make contracts with private entities individually. Most other households transport their wastes directly to the disposal site. Also, there are a few community dumpsites.
	Chuuk	28.1%	30.2%	Due to the non-availability of roads, some areas are accessible. DT&PW does major SWM activities, but do not have budgets except personnel costs.
	Pohnpei	22.9%	27.1%	Each municipality has collection vehicle donated by donors, but the collection rate is low in each municipality.
	Kosrae	16.3%	39.7%	Each municipality owns vehicles for collection. No collection services in inaccessible areas.
RMI	Majuro	50.8%	29.4%	Waste collection services are provided to all the HH except a few remote areas. Collection frequency is once a week.

	Ebeye	60.8%	29.0%	Waste collection services are provided to all the HH. Collection frequency is 4 times a week in main area.

d. Indicator 4: Recycling

Recycling rate, which is defined as a ratio of recycled waste to generated waste, is compared among three countries. In four states of FSM, this figure is well over 20% mainly because on-site recycling, which is deeply rooted in their life style, e.g. feeding kitchen waste to animals and using dried coconut shell as substitute fuel, are commonly practiced.

Also, CDL contributes, too, in islands where CDL system functions well. Especially in Palau, the recycling rate under CDL is high because CDL-target beverage containers consumed by tourists are also collected and recycled by the private business entities. In addition, shredding used tires and shipping-out of scrap metals have been tried at the M-dock landfill site.

Table 24:Recycling Rate

National / State		On-site recycling	Recyclable for CDL	Recyclable at disposal site	Total recyclable
Palau		3.5%	6.3%[23]	2.0%	11.8%
FSM	Yap	20.6%	1.7%	0.0%	22.3%
	Chuuk	20.2%	0.0%	0.0%	20.2%
	Pohnpei	25.2%	0.4%	0.0%	25.6%
	Kosrae	23.2%	3.2%	1.3%	27.7%
RMI	Majuro	8.4%	0.2%	0.2%	8.8%
	Ebeye	7.8%	0.0%	0.0%	7.8%

e. Indicator 5: Organizational and financial situations

Organizational settings as well as financial situations of each country are summarized in the table below.

Table 25: Organizational and Financial Situations

National / State	Issues on organization for SWM	SWM cost
Palau	In Koror, collection service is provided by the state government, and the collection rate is 100%. Also, the Koror state government works hard at recycling through CDL and composting. In Babeldaob, state	98US$ /ton

[23] This rate includes recycling of green waste by composting.

		governments of 10 states provide collection services to the residents, and the collection rate is considered as 100%. Basically, each state has a designated disposal site, although not sanitary landfilling. In case of Palau, prolonging life of the M-dock disposal site till the inauguration of a new landfill site is an urgent remaining issue.	
FSM	Yap	Waste collection & haulage is mainly managed by the state (DPW&T). Some households make contracts with private collection companies in Colonia area. Many households transport their wastes to the public disposal site directly. Municipalities (communities) do not have their own budget. To improve the SWM situation, expansion of waste collection, introduction of waste collection fee and tipping fee, and proper management of community dump sites shall be considered.	24US$ /ton
	Chuuk	DT&PW is providing SWM services from waste collection to disposal. Waste collection service is well provided in the area where collection vehicles are accessible. However, some areas do not receive collection services because of the road condition in Weno Island. As DT&PW does not have the specialized budget for SWM, sometimes collection work has stopped due to lack of fuel of collection vehicle.	13US$ /ton
	Pohnpei	Six municipalities are responsible for waste collection in Pohnpei. The collection coverage is very low because of the financial situation of each municipality. T&I manages and supervises the contract with Pohnpei Waste Management Services (PWMS), which is the organization managing the disposal site. EPA is responsible agency for CDL (operated by Kolonia/ Madolenihmw municipality). However, as frequency to redeem CDL recyclable is limited, it affects to recycling effect.	36US$ /ton
	Kosrae	Four municipalities are responsible for waste collection in Kosrae. The collection coverage is very low mainly because of financial situation.	15US$ /ton
RMI	Majuro	The secretary of MWIU chairs the board of MAWC. MWIU also supplies equipment to MAWC. EPA is the lead agency for CDL. MAWC is playing a major role on waste collection, recycling and waste disposal. Organization of MAWC needs to be strengthened.	71$/ton
	Ebeye	Department of Public Works of KALGOV is responsible for SWM in Kwajalein Atoll. KALGOV can access to a variety of funds to improve the environment and sanitation conditions in Ebeye. Therefore, comprehensive SWM plan including investment plan will ease the application for funding.	22$/ton