DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA
Ministry of Public Administration, Home Affairs,
Provincial Councils and Local Government
Waste Management Authority (Western Province)

THE PROJECT FOR FORMULATION OF WESTERN PROVINCE SOLID WASTE MANAGEMENT MASTER PLAN

Final Report

June 2023

Japan International Cooperation Agency
(JICA)

EX RESEARCH INSTITUTE LTD.
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Source: United Nation

Three districts in Western Province in Sri Lanka

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Abbreviations

AWP	Annual Work Program
AP	Action Plan
BCP	Business Continuity Plan
BOI	Board of Investment
CEA	Central Environmental Authority
C&D Waste	Construction and Demolition Waste
CIDA	Construction Industry Development Authority
CMC	Colombo Municipal Council
C/P	Counterpart
ERD	External Resource Department
IDB	Industrial Development Board
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JOCVs	Japan Overseas Cooperation Volunteers
LA	Local Authority
MC	Municipal Council
MEPA	Marine Environmental Protection Authority
MoH	Ministry of Health
MoI	Ministry of Industries
MoPAHAPCLG	Ministry of Public Administration, Home Affairs, Provincial Councils and Local Government
MoE	Ministry of Environment
MoUD&H	Ministry of Urban Development and Housing
MoFESNP	Ministry of Finance, Economic Stabilization, and National Policies
MP	Master Plan
MSMEs	Micro, Small and Medium Enterprises
NEA	National Environmental Act
NGOs	Non-Governmental Organizations
NPD	Department of National Planning
NSWMSC	National Solid Waste Management Support Centre
OJT	On-the-Job Training
PDM	Project Design Matrix
PO	Plan of Operation
POS	Public Opinion Survey
PP	Pilot Project
PS	Pradeshya Sabha
R/D	Record of Discussions
SATREPS	Science and Technology Research Partnership for Sustainable Development
SEA	Strategic Environmental Assessment
SLLRDC	Sri Lanka Land Reclamation and Development Corporation
SWM	Solid Waste Management
SWML	Scheduled Waste Management License
TOR	Terms of Reference
TRF	Thermal Recovery Facility
UC	Urban Council
UDA	Urban Development Authority
WG	Working Group
WMA	Waste Management Authority
WPC	Western Provincial Council
3Rs	Reduce, Reuse and Recycle

1 Outline of project

1.1 Background

Sri Lanka has been facing a number of environmental problems caused by poor municipal solid waste management, such as lack of effort for waste reduction, lack of success combatting illegal dumping and continuation of unsafe open dumping. The waste volume has been growing due to recent rapid economic growth and population increase, and it is now estimated to be as much as 10,800 tons/day.

Under such circumstances, a collapse at Meethotamulla Waste Disposal Site in April 2017 caused a disaster resulting in the loss of many lives of nearby residents and massive physical damage. In response to this crisis, the Government of Japan provided emergency relief goods and dispatched the Japan Disaster Relief Expert Team, consisting of relevant technical expert members. The expert team suggested that 3Rs activities (reduce, reuse, recycle) and intermediate processing, if properly implemented, would be an effective measure to reduce waste volumes for final disposal. The expert team also recommended that a waste management master plan (MP) for the Western Province should be developed jointly with all stakeholders and that the roles of each stakeholder should be defined clearly in the MP.

Following the recommendations of the Japanese expert team, the Government of Sri Lanka made a request to the Government of Japan to formulate a solid waste management MP for the Western Province in coordination with the Central Government, Provincial Government and Local Authorities (LAs). In response to the request made by the Government of Sri Lanka, the Japan International Cooperation Agency (JICA) conducted a detailed planning survey in May 2018 to formulate a technical cooperation project, and agreed on the framework and content of the Project with the Government of Sri Lanka.

The Project is designed to assist the Western Province in filling the gaps in its management of solid waste by formulating an evidence-based solid waste management MP that encompasses medium- to long-term forecasts and a range of possible solutions to the waste problems.

1.2 Outline

The purpose and outputs of the project agreed between the two countries of Japan and Sri Lanka are described below.

1.2.1 Project title

The Project for Formulation of the Western Province Solid Waste Management Master Plan (hereinafter referred to as “Project”)

1.2.2 Overall goal

Appropriate solid waste management practices in accordance with the Western Province Solid Waste Management Master Plan are undertaken in the Western Province.

1.2.3 Project purpose

Western Province's planning capability on solid waste management is strengthened through the formulation of the Western Province Solid Waste Management MP. "Planning capability" includes the ability to build cooperative structures and coordinate related organizations in accordance with the M/P at the implementation stage.

1.2.4 Expected Output

Output 1. Roles and responsibilities of organizations relevant to solid waste management in Western Province are clarified and institutional arrangements for the formulation of the MP are established.

Output 2. Current situations and challenges of solid waste management in Western Province are clarified.

Output 3. Knowledge and experience which contribute to MP formulation and implementation are acquired through the implementation of pilot projects on appropriate waste management and 3Rs. (Target areas: Colombo Municipality and other LAs).

Output 4. Knowledge and experience which contribute to MP formulation and implementation are acquired through pilot projects for improving planning/ operation of waste management facilities.

Output 5. Collaboration and coordination among relevant organizations in Western Province for the implementation of MP, and formulation and implementation of its related plans (e.g. LA action plans, plans on waste management facilities) are strengthened.

1.2.5 Implementation organization and relevant organization

Solid waste management in the Western Province needs to be carried out by relevant organizations based on a common comprehensive plan. In addition, one or more sub-groups will be directed by the Working Group (WG), which consists of 17 organizations, to formulate the entire plan and individual programs to ensure the validity, reliable effectiveness and efficient operability of the MP. The formulation of subordinate/individual LA action plans and budget plans is supported by the JICA Expert Team to strengthen the effectiveness of the draft MP and the commitment of each agency after completion of the draft MP.

In order to make smooth decisions without project delays, relevant organizations must constantly share information, exchange opinions, form consensus, and smoothly cooperate and coordinate with each other. The relevant organizations of the WG and roles agreed upon in the Record of Discussions (R/D) are shown in the following table and the following figure.

The roles of the WG organizations are as follows, and the activities for the Project Outputs are described in the following table:

- Chairperson of the Joint Coordinating Committee (JCC): Secretary of MoPAHAPCLG (Ministry of Public Administration, Home Affairs, Provincial Councils and Local Government)

- Project director: Director of NSWMSC (National Solid Waste Management Support Centre)
- Project coordinator: Director of WMA (Waste Management Authority)

Table 1-1 Roles of the WG organizations and activities for the project outputs:

	Main Implementer	Co-implementers / Key collaborators
Activities for Output 1	WPC / WMA	Members of WG: 1. General issues (e.g. overall planning and monitoring): MoE, CEA, NPD, and NSWMSC 2. Municipal solid waste: MoE, CEA, CMC, NSWMSC, SLLRDC, SWM Project of MoUD&H, UDA 3. Industrial waste: BOI, MoE, CEA, IDB, SLLRDC, UDA, MoI 4. Construction and demolition (C&D) waste: MoE, CEA, CIDA 5. Infectious and hazardous waste: MoE, CEA, MoH
Activities for Output 2	WPC / WMA	
Activities for Output 3	WPC / WMA, CMC, and target LAs	NSWMSC, MoE, CEA and other institutions depending on the nature of the pilot projects
Activities for Output 4	WPC/WMA, NSWMSC, MoE, CEA, CMC, UDA, SLLRDC, SWM Project of MoUD&H and other institutions depending on the nature of the pilot activities	
Activities for Output 5	WPC / WMA	Members of WG and LAs in Western Province

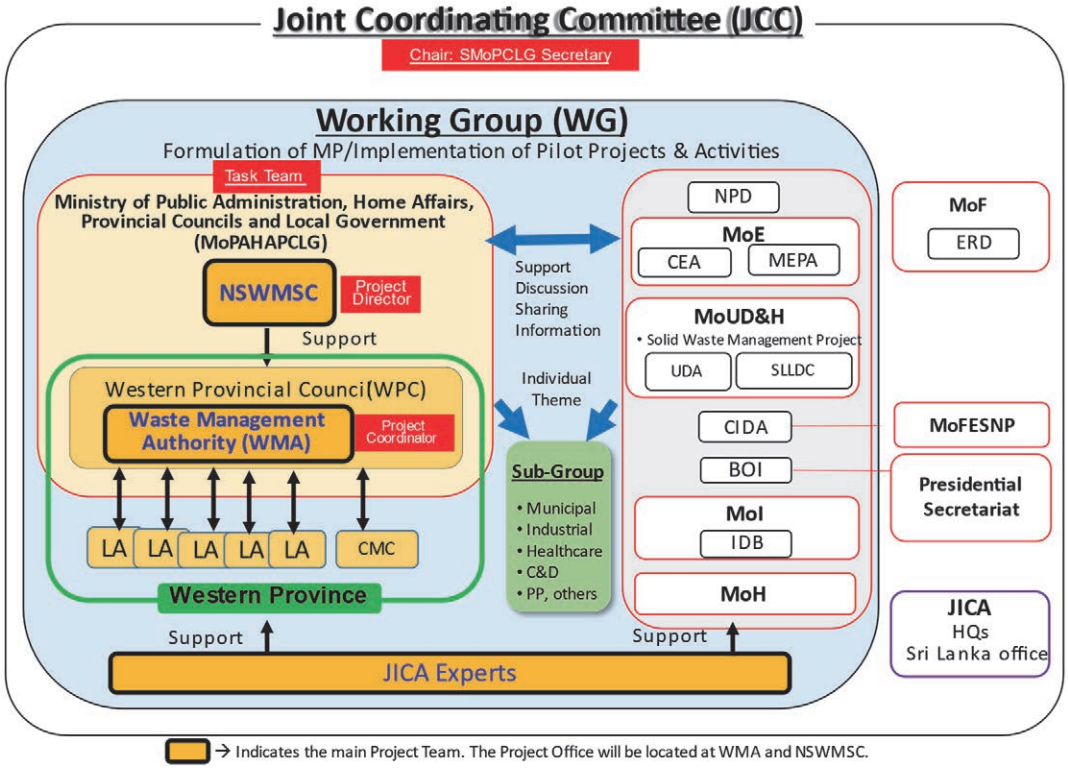


Figure 1-1 Implementation structure among JCC, WG and Sub-groups

1.2.6 Approval of MP

As the approval or disapproval (by the Board of Minister) of the master plan developed by the project is a matter of Sri Lanka's internal administration in which the JICA Expert Team cannot be involved, the JICA Expert Team and the C/P will support the implementation of the approval process by the Government of Sri Lanka, including reporting on the progress of the project to the Head of Secretariat and the Chief Secretary of the Western Provincial Council Government, to ensure that the draft master plan is approved without delay. Once the approval process for the draft Master Plan has started, the progress of the approval process will be monitored by the Working Group. The approval procedures envisaged are as follows.

(1) Approval by Western Province Governor

(2) Submission by NSWMSC, Department of Local Government to Cabinet

(3) Approval by Cabinet as Cabinet decision

1.2.7 Study of current waste amount and composition data for planning

A lot of SWM development projects are being planned or implemented in the Western Province including the Colombo metropolitan area. Those development projects are required to plan the transportation, treatment, disposal, and environmental measures based on future projections of waste volumes and composition generated in the Western Province. The JICA Project has studied and analyzed the waste amount and composition data which are the basis of existing waste-related projects planned and implemented independently by the relevant organizations. In accordance with the results of this analysis, the maintenance of a unified data framework and method for updating this in the future will be finalized by the relevant organizations. In addition, it was confirmed that the implementation schedule of individual projects and the expected budgetary measures to support the projects and reflected the revised plan in the overall MP if it was judged appropriate to revise the plan in consultation with the relevant organizations.

1.2.8 Schedule of JICA project

The project was divided into the following two contract periods: Phase I lasted 20 months from the start of work until the JCC met to discuss the draft master plan, and Phase II extended over the following 33 months.

Phase I : February 2019 - September 2020 (20 months)

Phase II : October 2020 – June 2023 (33 months)

1.3 Project Design Matrix (PDM) and Plan of Operation

Project management is based on joint work with the counterpart and JICA Expert Team in accordance with Project Design Matrix (PDM) and the Plan of Operation (PO).

The PDM and PO are shown below.

Project Design Matrix

Project Title: The Project for Formulation of Western Province Solid Waste Management Master Plan
Implementing Agency: National Solid Waste Management Support Center (NWSMSC), Waste Management Authority (WMA), and relevant organizations
Target Group: Western Province, and organizations relevant to waste management in Western Province
Duration: 2019.2–2023.6
Project Site: Western Province **Version 5**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Appropriate solid waste management practices in accordance with Western Province Solid Waste Management Master Plan (MP) are undertaken in Western Province.	1. All Local Authorities (LAs) prepare/update and implement their solid waste management action plan (LA action plan) in line with the MP within one year after publishing the MP. 2. An inter-organizational coordination body functions to monitor the progress and support the implementation of LA action plan in Western Province.	1. LA's Action Plans 2. Reports on waste management from LAs	
Project Purpose Western Province's planning capacity on solid waste management is strengthened through the formulation of Western Province Solid Waste Management Master Plan (MP).	1. The final draft of the MP is prepared. 2. Western Provincial Council (WPC) and MoPAHAPCLG start the MP approval process. 3. Sub-plans and other related plans (e.g. LA action plans, plans on waste management facilities) in line with the MP are formulated. 4. An inter-organizational coordination body is established to monitor the progress and provide support implementation of the sub-plans and other related plans in Western Province.	1. The final draft of the MP 2. The MP in the process of approval 3. Draft LA's Action Plans/plans on waste management facilities 4. Plan of formulation of execution and monitoring body (e.g. inter-organizational coordination body)	1. National policies regarding waste management do not change significantly 2. Financial resources for the implementation of the MP are secured by LAs.
Outputs 1. Roles and responsibilities of organizations relevant to solid waste management in Western Province are clarified and institutional arrangements for the formulation of the MP are established.	1. Roles and responsibilities of relevant organizations are clarified and documented in the MP and/or other documents. 2. A Working Group for MP formulation is established. 3. Regular meetings are held (at least once in three months) by the Working Group for MP formulation. 4. The process and outputs of activities of the Working Group are shared at the Provincial and Central levels by holding workshops or meetings 6 times. 5. Draft Master Plan is prepared by the Working Group.	1. Documented list of roles and responsibilities 2. List of the Working Group members 3. Minutes of meetings of the Working Group 4. Reports of the workshops or meetings 5. Draft Master Plan	Counterpart (C/P) staff and other staff from relevant organizations continuously engage in the project.

2. Current situation, trend, potentials and challenges of solid waste management in Western Province are clarified.	1. Data on current situations on solid waste management in Western Province are collected. 2. A database using the collected data is created 3. An analysis report on solid waste management in Western Province is prepared.	1. Data on solid waste management in Western Province 2. The database 3. The analysis report on solid waste in Western Province	
3. Knowledge and experience which contribute to MP formulation and implementation are acquired through the implementation of pilot projects on appropriate waste management and 3Rs.	1. Trainings on appropriate waste management and 3Rs for LAs and other relevant organizations are conducted three times. 2. Pilot projects are implemented at one or more than one LA. 3. The results of Capacity Assessment (posttest) for WMA and target LAs improve from those of pretest. 4. Progress of Pilot Projects are monitored by WG for MP formulation.	1.Records of trainings 2.Records of pilot project implementation 3.Reports of Capacity Assessment 4.Reports on pilot projects	
4. Knowledge and experience which contribute to MP formulation and implementation are acquired through pilot projects for improving planning/ operation of waste management facilities.	1. Trainings on planning/ operation of waste management facilities for relevant organizations are conducted more than three times. 2. Pilot projects are implemented at one or more than one waste management facilities. 3. The results of Capacity Assessment (posttest) for relevant organizations of target waste management facilities improve from those of pretest. 4. Progress of pilot projects are monitored by WG for MP formulation.	1.Records of trainings 2.Records of pilot projects implementation 3.Reports of Capacity Assessment 4.Reports on pilot projects	
5. Collaboration and coordination among relevant organizations in Western Province for the implementation of MP, and formulation and implementation of its related plans (e.g. LA action plans, plans on waste management facilities) are strengthened.	1. Meetings for the explanation of the MP are organized for LAs in Western Province and other relevant organizations (including central government organizations) are held more than three times. 2. 11 staff members of WMA and other related organization are given trainings and/or OJT on supporting LAs. 3. Support and guidance for the formulation of sub-plans and other related plans (e.g. LA action plans, plans on waste management facilities) in line with the MP are given to LAs and other relevant organizations. 4. The monitoring system is documented. 5. Budget plans for the implementation of the MP and a guidance for budget plan formulation to implement LAs' action plans are prepared.	1.Records on the meeting for the explanation of the MP 2.Records on training and/ or OJT 3.Records on support and guidance 4.Documented monitoring system 5.Budget plans	

Activities	**Inputs**		
1.1 Roles and responsibilities of relevant organizations relevant to solid waste management in Western Province are clarified by examining policies and legal documents (e.g. national laws, ordinances). 1.2 A Working Group for MP formulation is established. 1.3 Terms of Reference (TOR) of the Working Group for MP formulation are clarified. 1.4 Regular meetings and special meetings or sub-group	[Japanese side] ・Experts - Waste Management - Collection and Transportation - Intermediate Treatment and Final Disposal - 3Rs/ Public Awareness - Financial / Economic Analysis/Institutional plan	[Sri Lankan side] ・C/P ・Personnel cost and operational cost for C/P ・Office space and facilities for Experts at 1. NSWMSC 2. WMA	Large-scale consolidation and/or restructuring of LAs do not occur.

meetings, where necessary, are held. 1.5 Draft Master Plan is prepared through discussions by the Working Group. 1.6 The process and outputs of activities of the Working Group are shared with relevant organizations (including those which authorize the Master Plan) both at the Provincial and Central levels by holding workshops or, meetings. 1.7 An inter-organizational coordination body such as Provincial Solid Waste Management Committee which takes over the work of the Working Group is proposed. 2.1The Working Group for MP formulation decides a. types of waste, b. target year, c. areas and population. 2.2 Organizations in Western Province relevant to solid waste management are investigated and data on solid waste management is collected. 2.3 A database is created using existing data on Western Province's solid waste management. 2.4 Based on the data, current situations and challenges regarding solid waste management are clarified and reported. 3.1 Trainings on appropriate waste management and 3Rs for LAs and other relevant organizations are conducted. 3.2 Target LAs for pilot projects are selected. 3.3 Capacity Assessment (pretest) for WMA and target LAs is conducted. 3.4 The pilot projects on appropriate waste management and 3Rs are planned at the target LAs. 3.5 3.4 is implemented. 3.6 Capacity Assessment (posttest) for WMA and target LAs is conducted. 3.7 3.5 is monitored and its results and knowledge are reported in written form. 4.1 Complaints/ requests made by residents, NGOs and other stakeholders with regard to waste management are studied to identify important issues. 4.2 Target waste management facilities for pilot activities	- Database ・Provision of machinery and equipment - Small scale solid waste transfer station at Kalutara composting facility - Forced aeration system in existing Kalutara composting facility - Equipment for rehabilitating existing compost plant in Karadiyana ・Video Trainings		

are selected. 4.3 Trainings on planning/ operation of waste management facilities are conducted for relevant organizations. 4.4 Capacity Assessment (pretest) for relevant organizations is conducted. 4.5 Pilot projects for seeking optimal technical/ social interventions for improved planning and operation of waste management facilities are planned at the target waste management facilities. 4.6 4.5 is implemented. 4.7 Capacity Assessment (posttest) for relevant organizations is conducted. 4.8 4.6 is monitored and its results and knowledge are reported in written form. 5.1 Meetings for the explanation of the MP are organized for LAs in Western Province and other relevant organizations (including central government organizations) are held. 5.2 The staff of WMA and other relevant organizations enhance their knowledge and skills for supporting LAs and other organizations in their formulation and implementation of the MP, its sub-plans and other related plans (e.g. LA action plans, plans on waste management facilities) through trainings and OJT. 5.3 Support and guidance for the formulation of sub-plans and other related plans (e.g. LA action plans, plans on waste management facilities) in line with MP are given to LAs and other relevant organizations. 5.4 A system to monitor the implementation of sub-plans and other related plans (e.g. LA action plans, plans on waste management facilities) in line with MP is established and documented. 5.5Budget plans for the implementation of the MP and a guidance for budget plan formulation to implement LAs' action plans are prepared.			**Pre-Condition** Staff from relevant organizations in Western Province are assigned for the project.

Plan of Operation

Activity \ year			2019												2020												2021												2022												2023					
			Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
A		Actitivities of entire project																																																					
A1		Formulation of Work Plan																																																					
A2		Establishment and coordination of Joint Coordination Committee (JCC)																																																				
A3		Implementation of monitoring of project progress																																																				
A4		Environmental social consideration																																																				
A5		Preparation of progress report and final report of the project																																																				
A6		Business Continuity Plan for waste management																																																				
A7		Coastal Pollution Waste Management Plan																																																				
Phase I	Phase II	Actitivity	B: Phase I (February 2019-September 2020 : 20 months)																							C:Phase II (October 2020-June 2023: 33 moths)																														
B	C																																																				
B1	C1	【Activities of Output 1】																																																			
B1.1	C1.1	Roles and responsibilities of relevant organizations relevant to solid waste management in Western Province are clarified by examining policies and legal documents.																																																			
B1.2	C1.2	A Working Group for MP formulation is established.																																																			
B1.3	C1.3	Terms of Reference (TOR) of the Working Group for MP formulation are clarified.																																																			
B1.4	C1.4	Regular meetings and special meetings or sub-group meetings, where necessary, are held.																																																			
B1.5	C1.5	Draft Master Plan is prepared through discussions by the Working Group.																																																			
B1.6	C1.6	The process and outputs of activities of the Working Group are shared with relevant organizations (including those which authorize the Master Plan) both at the Provincial and Central levels by holding workshops or, meetings.																																																			
	C1.7	An inter-organizational coordination body such as Provincial Solid Waste Management Committee which takes over the work of the Working Group is proposed.																																																			
B.2	C2	【Activities of Output 2】																																																			
B2.1	C2.1	The Working Group for MP formulation decides a. types of waste, b. target year, c. areas and population.																																																			
B2.2	C2.2	Organizations in Western Province relevant to solid waste management are investigated and data on solid waste management is collected.																																																			
B2.3	C2.3	A database is created using existing data on Western Province's solid waste management.																																																			
B2.4	C2.4	Based on the data, current situations and challenges regarding solid waste management are clarified and reported.																																																			

Figure 1-2 Plan of Operation (Output 1 – Output 2)

Plan of Operation

Activity			2019												2020												2021												2022												2023					
		year	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
B3	C3	【Activities of Output 3】																																																				
B3.1	C3.1	Trainings on appropriate waste management and 3Rs for LAs and other relevant organizations are conducted.																																																				
B3.2	C3.2	Target LAs for pilot projects are selected.																																																			
B3.3	C3.3	Capacity Assessment (pretest) for WMA and target LAs is conducted.																																																			
B3.4	C3.4	The pilot projects on appropriate waste management and 3Rs are planned at the target LAs.																																																			
B3.5	C3.5	3.4 is implemented.																																																			
	C3.6	Capacity Assessment (posttest) for WMA and target LAs is conducted.																																																			
	C3.7	3.5 is monitored and its results and knowledge are reported in written form.																																																			
B4	C4	【Activities of Output 4】																																																			
B4.1	C4.1	Complaints/ requests made by residents, NGOs and other stakeholders with regard to waste management are studied to identify important issues.																																																			
B4.2	C4.2	Target waste management facilities for pilot activities are selected.																																																			
B4.3	C4.3	Trainings on planning/ operation of waste management facilities are conducted for relevant organizations.																																																			
B4.4	C4.4	Capacity Assessment (pretest) for relevant organizations is conducted.																																																			
B4.5	C4.5	Pilot projects for seeking optimal technical/ social interventions for improved planning and operation of waste management facilities are planned at the target waste management facilities.																																																			
B4.6	C4.6	4.5 is implemented.																																																			
	C4.7	Capacity Assessment (posttest) for relevant organizations is conducted.																																																			
	C4.8	4.6 is monitored and its results and knowledge are reported in written form.																																																			
	C.5	【Activities of Output 5】																																																			
	C5.1	Meetings for the explanation of the MP are organized for LAs in Western Province and other relevant organizations (including central government organizations) are held.																																																			
	C5.2	The staff of WMA and other relevant organizations enhance their knowledge and skills for supporting LAs and other organizations in their formulation and implementation of the MP, its sub-plans and other related plans (e.g. LA action plans, plans on waste management facilities) through trainings and OJT.																																																			
	C5.3	Support and guidance for the formulation of sub-plans and other related plans (e.g. LA action plans, plans on waste management facilities) in line with MP are given to LAs and other relevant organizations.																																																			
	C5.4	A system to monitor the implementation of sub-plans and other related plans (e.g. LA action plans, plans on waste management facilities) in line with MP is established and documented.																																																			
	C5.5	Budget plans for the implementation of the MP and a guidance for budget plan formulation to implement LAs' action plans are prepared.																																																			

Figure 1-3 Plan of Operation (Output 3 - Output 5)

1.4 Project site and relevant organization

1.4.1 Project site

Western Province

1.4.2 Implementation body

(1) Main implementation organizations (Task team)

NSWMSC: National Solid Waste Management Support Centre, Ministry of Public Administration, Home Affairs, Provincial Councils and Local Government

WMA: Waste Management Authority, Western Provincial Council

(2) Related organizations

The project is facilitated by a WG comprising the following organizations.

Table 1-2 Composition of the WG

		Abbreviation	Organization
JCC	WG	1 MoPAHAPCLG	• Ministry of Public Administration, Home Affairs, Provincial Councils and Local Government
		2 NSWMSC	• National Solid Waste Management Support Centre
		3 WPC	• Western Provincial Council
		4 WMA	• Waste Management Authority (Western Province)
		5 CMC	• Colombo Municipal Council
		6 MoE	• Ministry of Environment
		7 CEA	• Central Environmental Authority
		8 MEPA	• Marine Environmental Protection Authority
		9 MoUD&H	• Ministry of Urban Development and Housing
		10 UDA	• Urban Development Authority
		11 SLLRDC	• Sri Lanka Land Development Corporation
		12 MoH	• Ministry of Health
		13 BOI	• Board of Investment
		14 MoI	• Ministry of Industry
		15 IDB	• Industrial Development Board
		16 CIDA	• Construction Industry Development Authority
		17 NPD	• Department of National Planning
		18 MoFESNP	• Ministry of Finance, Economic Stabilization & National Policies
		19 ERD	• External Resource Department

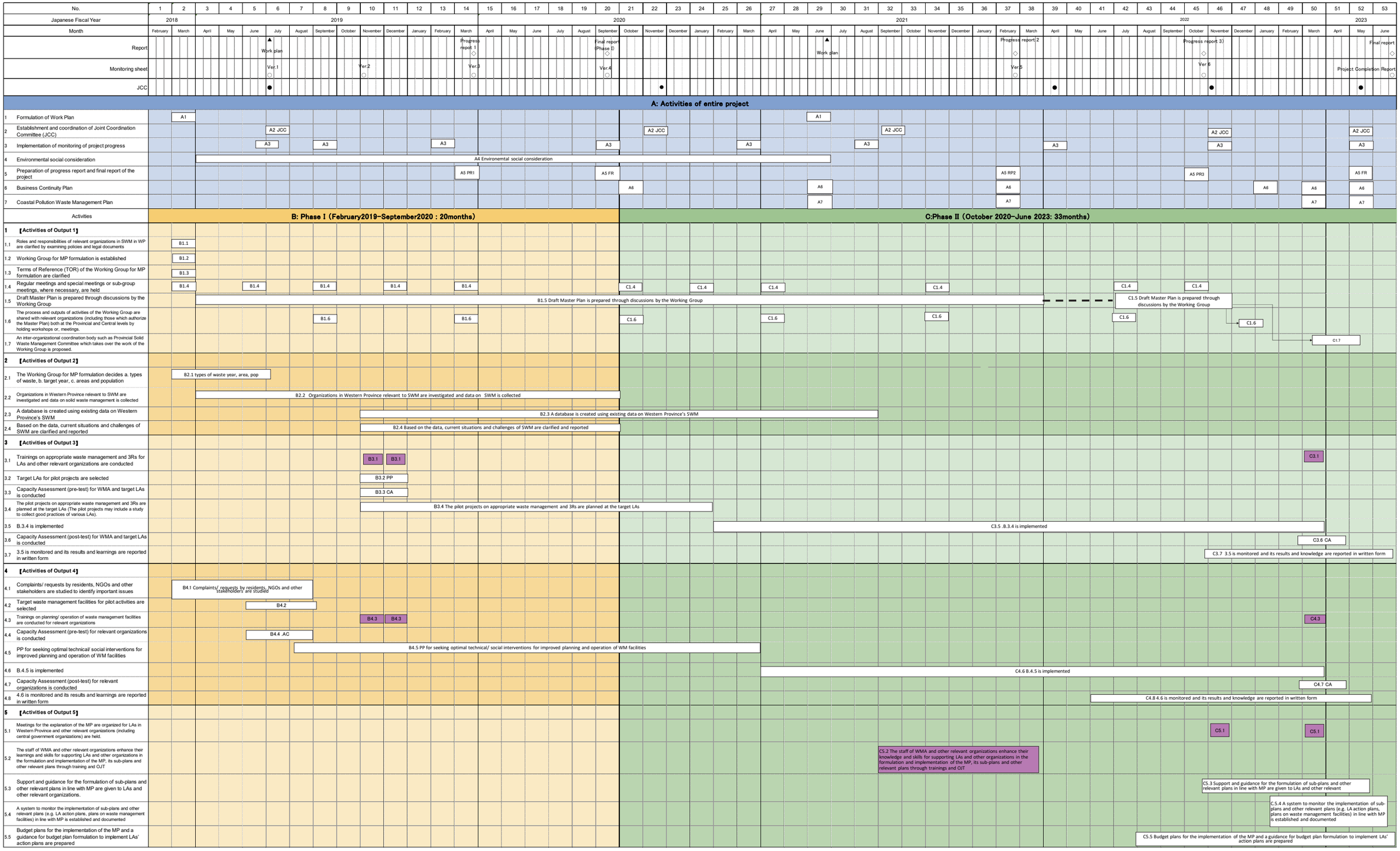


Figure 1-4 Flow chart

1.5 JICA expert team

1.5.1 Team members

The JICA Expert Team is composed of eight members as set out in the following table.

Table 1-3 JICA expert team members

Area of responsibility	Name
1. Team leader / Waste management / Coastal Pollution Waste Treatment and Disposal Plan	Dr. Naofumi Sato (Mr.)
2. Deputy team leader / Waste management / Environmental and social considerations	Dr. Yuko (Aoki) Samuta (Ms.)
3. Intermediate treatment and final disposal / Karadiyana Compost Pilot Project	Eng. Hiroshi Kato (Mr.)
4. Financial and economic analysis / Institutional plan	Hachiro Ida (Mr.)
5. Collection and transportation	Eng. Koji Kusunoki (Mr.)
6. 3Rs / Public awareness 1	Chiaki Nishi (Ms.)
7. 3Rs / Public awareness 2	Rie Kawanishi (Ms.)
8. Database	Akifumi Kanachi (Mr.)
9. Waste Management Business Continuity Plan	Akifumi Kanachi (Mr.)
10. Coastal Pollution Waste Treatment and Disposal Survey	Akifumi Kanachi (Mr.)
11. Equipment procurement support	Akifumi Kanachi (Mr.)

1.5.2 Input of JICA experts

The input of the JICA experts is shown in the following figure:

Table 1-4 Input of JICA Experts

No	Field in charge	Phase 1 (person-months)	Phase 2 (person-months)
1	Team leader/ Waste management/ Coastal Pollution Waste Treatment and Disposal Plan	8.42	14.83
2	Deputy team leader/ Waste management / Environmental social consideration	4.90	5.70
3	Intermediate treatment and final disposal/ Karadiyana Compost Pilot Project	3.25	7.60
4	Financial economic analysis/Institutional plan	5.82	6.25
5	Collection and transportation	3.65	8.10
6	3Rs /Public awareness 1	4.93	6.50
7	3Rs /Public awareness 2	2.60	7.40
8	Database	4.00	2.43
9	Waste Management Business Continuity Plan	-	3.00
10	Coastal Pollution Waste Treatment and Disposal Survey	-	2.00
11	Equipment procurement support	-	0.50

2 Activities through the entire project period

2.1 A.1 Formulation of Work Plan

A draft work plan was prepared based on the activities carried out in Phase I of the project after the documents, materials and information relevant to SWM of Sri Lanka available in Japan were thoroughly reviewed. The draft work plan was modified in accordance with JICA's comments and revised after discussions and exchange of opinions between the JICA Expert Team and relevant Sri Lankan organizations. The final version was submitted to JICA on 30 June 2021.

2.2 A.2 Establishment and coordination of Joint Coordination Committee (JCC)

The establishment, operation and organization of the JCC was supported by the JICA Expert Team. In principle, the JCC is convened at least once a year and agrees on policy changes and PDM revision of the Project. Furthermore, an additional JCC meeting was held to explain the content of the draft MP during its preparation. The JCC chairperson, the secretary of State Ministry of Provincial Councils and Local Government, invites JCC members to JCC meetings. The functions of the JCC are as follows:

- To approve the annual work plans;
- To review the progress of the Project;
- To conduct evaluation of the Project;
- To exchange views and ideas on major challenges that arise during the implementation period of the Project;
- To assess the appropriateness of the PDM in the course of the Project and suggest revision(s), if necessary; and
- To discuss any other related issues.

2.2.1 JCC

The Joint Coordinating Committee (JCC) has held a total of five JCC meetings since the first phase. The following is the agenda of each meeting, and the minutes of the JCC meetings are attached as Appendix 1.

Table 2-1 Date, Time, and Agenda of JCC

	Date	Agenda
1st JCC	9 July 2019	・ Project Briefing ・ Roles and responsibilities of waste management organizations in the Western Province
2nd JCC	26 November 2020	・ Project Progress Report ・ Outline of pilot projects and agreement on the undertakings to be borne by the Government of Sri Lanka and JICA
3rd JCC	21 April 2022	・ Project Progress Report ・ Summary of the Draft Master Plan ・ Revision of PDM ・ Discussion on Tax exemption
4th JCC	4 November 2022	・ Project Progress Report ・ Confirmation of Master Plan approval procedure
5th JCC	18 May 2023	・ Project Completion Report ・ Master Plan approval procedure ・ Project Evaluation

2.3 A.3 Implementation of monitoring of project progress

In this JICA project, regular monitoring was conducted by both the JICA Expert Team and the C/Ps. The monitoring format specified by JICA was used as necessary for substantive discussions at the JCC to confirm the progress of results and resolve the issues of concern.

Monitoring Sheets I & II “Ver.0”, and the drafting policy of Monitoring Sheets I & II “Ver.1” was confirmed with JICA at the pre-departure meeting before the first dispatchment. After the start of the project, it was planned to conduct periodic monitoring (checking the status of PDM achievement, PO progress, and implementation issues) every six months in collaboration with the main implementing agencies, prepare a monitoring sheet, and submit it to the JICA Sri Lanka Office. However, due to the global outbreak of COVID-19 in March 2020 and the impact of overseas travel restrictions, the JICA Expert Team submitted Monitoring Sheets I & II “Ver.1” in November 2020.

The JICA Expert Team submitted Monitoring Sheets “Ver.2” to JICA in September 2019, and “Ver.3” to JICA office in February 2020, which was approved. “Ver.4” was submitted in September 2020 together with the completion report of Phase I, which was approved. “Ver.6” was prepared and submitted to JICA office in November 2022 after confirmation with C/P.

2.4 A.4 Environmental social considerations

Several alternative plans or programs for facilities and equipment to be included in the MP were reviewed during the formulation of the MP in accordance with the strategic environmental assessment (SEA). Specifically, the main items having an environmental and social impact and evaluation method (scoping) were studied at the decision-making stage of the plans and programs. A comparative examination including environmental and social considerations for multiple alternatives was conducted.

CEA published “A SIMPLE GUIDE TO STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)” in September 2019. This guide was created on the premise that the SEA will be enacted (as of April 2023, it has not been enacted). CEA is testing SEA for domestic development plans

prior to enactment. A Strategic Environmental Assessment Unit has been established within CEA, and personnel in charge have been assigned. In this master plan, it was decided to try SEA.

The SEA procedures were carried out according to the tentative procedures prepared by CEA, as shown in the table below. The survey for preparing the SEA report was outsourced to a local consultant.

SEA report is attached as Appendix 2.

Table 2-2 SEA procedure

	Process	Date
1	**CEA received the Master Plan concept proposal and a basic information form duly completed by a Government Institution (WMA)**	July 7, 2021
2	**Screening**	Procedure in CEA
3	**Scoping**	Aug. 13, 2021 Scoping meeting
4	**Preparation & Issuance of ToR**	Sept. 14, 2021
5	**Submission of draft SEA report & draft Master Plan to CEA**	Feb. 17, 2023
6	**Initial appraisal by CEA on compliance with the ToR**	Procedure in CEA
7	**Decision on compliance with the ToR ⇒ If does NOT comply, go back to 5**	
8	Stakeholder consultation	Mar. 2, 2023
9	Technical Expert Committee	Mar. 20, 2023
10	Public consultation	Public consultation was not held
11	Issuance of concerns & recommendations to modify the Master Plan	Apr. 11, 2023
12	Finalizing the draft SEA report & modifications to draft Master Plan	Procedure in WMA
13	Submission of final SEA report & final (modified) draft Master Plan to the CEA	May 4 2023
14	Appraisal of the final SEA report and the final draft Master Plan with modifications	May 19, 2023
15	Submission of observations & recommendations by the CEA to the decision-making entity	TBD
16	Monitoring	by Coordination Committee

The SEA process started with the preparation of a proposal for the master plan concept along with relevant basic information, which was submitted by WMA to CEA. After screening within CEA, it was determined that the project should implement an SEA, and CEA convened relevant organizations to hold a scoping meeting online on 13 August 2021. A scoping TOR was decided at the scoping meeting, and the SEA survey was conducted according to this TOR.

The preparation of the master plan and the SEA study were carried out in parallel, and on 17 February 2023, WMA submitted the draft of the master plan and the SEA report to CEA. Thereafter, it was examined by Stakeholder Consultation and the Technical Committee, and CEA compiled it. Both documents were amended accordingly and submitted to CEA on 19 May 2023.

A public consultation was not held during this SEA because the SEA is still at the trial stage before its enactment. On the other hand, due to the content of this master plan, CEA convened a Technical Expert Committee separate from the Stakeholder Consultation to examine the master plan and the SEA report in order to evaluate it from a professional perspective.

The pilot projects for the Project do not belong to category B or higher, and therefore do not require environmental and social considerations to be assessed in line with JICA's Guidelines for Environmental and Social Considerations (January 2022). The pilot projects themselves will not have any negative impact on the environment or society, as they constitute an improvement or mitigation measure for the current situation such as offensive odour and scattering of waste at existing waste treatment facilities.

Regarding Kalutara composting plant, one of the pilot projects, WMA has already obtained an Environmental Protection License (EPL) and undergoes on-site inspection by CEA for annual renewal. WMA applied for an Environmental Clearance (EC) for the transfer station, and a site inspection will take place after completion of the installation. As for the Karadiyana landfill, it has been causing pollution problems as open dumpsite for many years. Due to the situation, the removal of all waste from the site and the clearing of the land are required to apply for the EPL. WMA has no choice but to operate the Karadiyana plant without being able to apply for and obtain the EPL.

For the pilot projects of Kalutara composting plant, Kalutara transfer station and Karadiyana composting plant, the draft environmental monitoring and management plan is shown in the table below. It has been formulated based on the results of the environmental checklist of JICA's Guidelines for Environmental and Social Considerations (January 2022).

Table 2-3 Environmental Monitoring and Management Plan

Environmental monitoring management plan for Kalutara (composting plant & transfer station) and Karadiyana composting plant rehabilitation

Item	Mitigation	Monitoring item/indicator, methodology	Monitoring frequency	Implementing agency
Water quality	**Kalutara** ・Leachate is collected and poured into the compost, which prevents the leachate from leaking out of the plant. ・The leachate collection system is equipped with a 17,000-litter capacity of tank to store the leachate for recirculation. ・The storage tank is demanding especially during the rainy season when more leachate and wastewater are generated. ・It is planned to build a small water treatment plant. * CEA and Min. Local Gov. had planned the leachate treatment project but it was not implemented due to the economic crisis.	**Kalutara** ・EPL requires to have the wastewater treatment system when it is installed. CEA carries out an annual inspection when the license is renewed. ・WMA staff at the plant check the condition of the water collection system daily.	・During construction. ・After starting operation. Daily and once a year (CEA). Every 3 months (Monitoring Committee).	WMA CEA Monitoring Committee
	Karadiyana ・No waste treatment system can be installed at Karadiyana as it is an open dumpsite.	**Karadiyana** No monitoring.	N/A	N/A
Scattering of the waste	**Kalutara** ・Some trucks dump the waste on the access road to the open dumpsite, almost in front of the composting plant. WMA staff are watching not to be done. ・During the rainy season, due to heavy rains, (mixed) waste and "soil" from the open dump flow to the road surrounding the composting plant and into the nearby canal as the open dumpsite is higher than the surroundings. This issue is of great concern. ・The planned countermeasure is to operate the transfer station and safely close the open dumpsite. Implementation of the proposed closure plan will stop the waste runoff as the plan/layout takes the slope into account.	**Kalutara** ・EPL requires not to scatter the waste. CEA carries out an annual inspection when the license is renewed. ・WMA staff keep watch to ensure that waste is not dumped outside the open dumpsite.	・During construction. ・After starting operation. Daily and once a year (CEA).	WMA CEA
	Karadiyana	**Karadiyana**	Daily	WMA

	・During the rainy season, due to heavy rains, (mixed) waste and "soil" from the open dump flow to the road surrounding the composting plant and into the nearby canal as the open dumpsite is higher than the surroundings. This issue is of great concern. ・The planned countermeasures consist of improving the operation of the composting plant operation and landfill mining/rehabilitation of the dumpsite to reduce the height of the waste mountain.	・No monitoring except daily on-site inspection by WMA staff.		
Soil contamination	**Kalutara** Same as the above item "Scattering of the waste".	**Kalutara** ・EPL requires not to scatter the waste (which causes soil contamination). CEA carries out an annual inspection when the license is renewed. ・WMA staff are watching not to be done daily.	・During construction. ・After starting operation. Daily and once a year (CEA).	WMA CEA
	Karadiyana Same as the above item "Scattering of the waste".	**Karadiyana** ・No monitoring except daily inspection by WMA staff.	Daily	WMA
Noise/vibration	**Kalutara** ・Basically no significant noise or vibration from the composting plant. Noise may be caused when operating the wheel loader and sieving. No complaints from the neighbourhood so far. ・The transfer station also has no noise concerns. ・EPL has a noise and vibration limit, but the facilities are within the limit.	**Kalutara** ・No need to monitor, except CEA's inspection when renewing the license.	・During construction (Construction company). ・After starting operation. Daily and once a year (CEA).	CEA
	Karadiyana ・Basically no significant noise or vibration from the composting plant. Noise may be caused when operating the wheel loader and sieving. No complaints from the neighbourhood so far.	**Karadiyana** ・No need to monitor.	・N/A	WMA if needed
Offensive odor	**Kalutara** ・To reduce offensive odour, liquid neutralizer is sprayed in the windrows as the initial stage of the composting process (fresh organic waste into windrow) is the main cause of bad odour. ・Processing is only carried out during the day (AM) to avoid the time when most neighbouring residents are at home. ・For the transfer station, offensive odour may be caused when putting the waste into the compaction containers. To minimize odour, a sealed-type container is used.	**Kalutara** ・Public sensor/neighbouring residents. (WMA has a hotline for such inquiries.)	・During the construction. ・After starting operation. Every 3 months (Monitoring Committee) if offensive odour is censored by residents.	Neighbouring residents CEA Monitoring Committee
	Karadiyana ・To reduce offensive odour, liquid neutralizer is sprayed in the windrows as the initial stage of the composting process (fresh organic waste into windrow) is the main cause of bad odour. ・Processing is only carried out during the day (AM) to avoid the time when most neighbouring residents are at home. ・Landfill mining may also cause offensive odour, so operations should be limited to daytime.	**Karadiyana** ・Public sensor/neighbouring residents. (WMA has a hotline for such inquiries.)	Whenever offensive odour is reported by residents.	Neighbouring residents
Living Environment	**Kalutara** ・Neighbouring communities are suffering from offensive odour, polluted water and waste running off from the open dumpsite located next to the composting plant during the rainy season. The pilot projects will contribute to reducing the offensive odour by limiting the exposure of fresh waste. ・A Monitoring Committee was established to monitor the operation of the composting plant and transfer station as well as the safe closure of the dumpsite. Every three months, the committee members and relevant stakeholders including the neighbouring community conduct on-site monitoring, assess the situation and discuss the results. All the information is open to the public.	**Kalutara** ・A Monitoring committee has been established as the activities of Pilot Project for the Project to regularly monitor the condition of the composting plant, transfer station and open dumpsite.	・During construction. ・After starting operation. Every 3 months (Monitoring Committee) if offensive odour is reported by residents.	WMA Monitoring Committee

	Karadiyana ・Karadiyana dumpsite has been a source of pollution for a long time. Neighbouring communities are suffering from offensive odour, polluted water and waste running off from the dumpsite, especially during the rainy season. ・The pilot project contributes to improving the condition of dumpsite, especially by improving the composting plant.	**Karadiyana** ・ Public sensor/neighbouring residents. (WMA has a hotline for such inquiries.)	WMA if offensive odour is reported by residents.	WMA Neighbouring residents
Working environment・Prevention of	・WMA complies with the Factory Ordinance, and an inspector from the Department of Labour visits WMA once a year.	**Kalutara and Karadiyana** ・On-site inspection. ・Following the daily operation and management program.	・During construction.	Construction company
	・WMA subcontracts civil works (when necessary, such as PP) to companies registered as reliable by the government.		After starting operation.	WMA Dept. of Labour (inspector)
	・WMA is developing “Official safety work guidelines” for composting plants and landfill operation, which will be finalized soon. ・The new components, aeration in composting, landfill mining, and transfer station, those activities of PP are needed to be taken into consideration, the guidelines are going to be revised/updated. ・There are committees that have the responsibility to implement/comply with the guidelines. As for Karadiyana, Nalin, Palitha, Madura, Kassun and outsourced personnel who make the document are the members of the committee. They will discuss the revision/update of the guidelines to include these new components. ・For these new components, operator training is needed.		Once a year. Daily.	

Source: Project Team

2.5 A.5 Preparation of progress report

Project progress was compiled jointly with the main C/P into a project progress report and submitted to the C/P organizations, including the working group agencies, upon JICA approval. A total of six project progress monitoring reports have been prepared since the first phase of the project. The submitted reports are shown in the table below.

Table 2-4 Submitted Progress Monitoring Reports

No	Reports	Month of submission
1	1st Progress Report	March 2020
2	Completion Report (Phase I)	September 2020
3	2nd Progress Report	February 2022
4	1st Project Progress Report	March 2022
5	3rd Progress Report	November 2022
6	2nd Project Progress Report	February 2023

2.6 Waste Management Business Continuity Plan

In response to the spread of the new coronavirus on a global scale since January 2020, Sri Lanka issued guidelines for countermeasures against COVID-19 in April 2020, indicating the measures to be taken by waste management companies to prevent infection. Through the formulation of the Business Continuity Plan (BCP), the need for the formulation of a more comprehensive BCP was recognized.

In response, the JICA Expert Team prepared a BCP formulation manual and explained it to WMA. In addition, as a model municipality, JICA supported Mahara PS (Pradeshya Sabha) in developing a BCP. The BCP of Mahara PS is attached as Appendix 3.

2.6.1 Provision of protective equipment to prevent COVID-19 infection

The first and second donation of personal protective equipment for COVID-19 infection prevention was made to LAs and waste management related organizations in the Western Province on October 26, 2020 and June 9, 2021, respectively. The JICA Expert Team also supported the procurement of goods by the JICA office for the third provision of personal protective equipment for all provinces of Sri Lanka (dated April 7, 2022).

(1) 1st supply of personal protective equipment (PPE)

In September 2020, due to the rapid spread of the new coronavirus in Sri Lanka, the Sri Lankan government suspended the acceptance of commercial flights arriving at all international airports in the country, temporarily suspended the issuance of all types of entry visas and suspended the validity of all visas.

In addition, in early October 2020, a large-scale cluster infection occurred at a garment factory in Gampaha, Western Province. As a result, the waste management services of the local government were temporarily suspended or their operation rate has been reduced, resulting in problems such as uncollected garbage and illegal dumping in residential and urban areas.

In response to the rapid spread of the new coronavirus in the western provinces, WMA, which is the C/P agency of this project and has jurisdiction over waste management projects, requested JICA to provide personal protective equipment to reduce the risk of infection among waste management workers. The JICA Expert Team decided to provide the equipment after consultation with the JICA, and agreed with WMA and NSWMSC on the target local authority, type and quantity of equipment to be provided, and provided the equipment on 26 October 2020.

The following is an outline of the first provision of personal protective equipment.

<Outline>

i. Purpose: To contribute to the continuation of stable waste management in the Western Province of Sri Lanka by providing personal protective equipment to essential waste management workers who are at relatively high risk of infection.

ii. Amount of support: Approximately 0.9 million yen

iii. Procurement details:

Table 2-5 First supply of personal protective equipment

Item	Quantity	Unit price (LKR)	Total (LKR)
Surgical masks	17,000	15	255,000
Surgical gloves	3,000	14	42,000
Boots	366	2,200	805,200
Hand sanitizer	325	900	292,500
Personal Protection kits	266	850	226,100
		Total	LKR 1,620,800 ≒JPY 932,430 ※LKR 1 = JPY 0.57 5290

iv. Procurement method: Local procurement

v. Recipient: Western Province Waste Management Authority

vi. Date of donation: 26 October 2020

vii. Publicity: Handover ceremony, press release to local media, Facebook article by JICA Sri Lanka Office

Handover ceremony 1


Handover ceremony 2

Figure 2-1 First handover ceremony

(2) Second supply of PPE

In April 2021, the Delta strain, a variant of the new coronavirus, spread mainly in the Western Province of Sri Lanka, and the operation of the waste management project was again significantly reduced. In response to this, NSWMSC and WMA requested the JICA Expert Team to provide additional infection control equipment. While the infection control equipment distributed during the first supply was mainly for the local authorities in Gampaha district, the additional requests were mainly for the local authorities in Colombo and Kalutara districts that were not covered by the previous distribution.

Considering the situation in the Western Province where the new coronavirus infection was spreading, the JICA experts judged that the request for additional equipment was appropriate.

The outline of the second provision of infection control equipment is shown below.

<Outline>

i. Purpose: Same as the first grant. However, the target was the local authorities which were not covered by the first supply.

ii. Amount of support: Approximately 1.5 million yen

iii. Procurement details:

Table 2-6 Second supply of personal protective equipment

Item	Quantity	Unit price (LKR)	Total (LKR)
Surgical masks	31,700	9	285,300
Surgical gloves	634	1,752	1,110,768
Boots	475	390	185,250
Hand sanitizer	430	750	322,500
Personal Protection kits	9,750	80	780,000
		Total	LKR 2,683,818 ≒JPY 1,498,832 ※LKR 1 = JPY 0.55027

iv. Procurement method: Local procurement

v. Recipient: Western Province Waste Management Authority

vi. Date of donation: 9 June 2021

vii. Publicity: Handover ceremony, press release to local media, Facebook article by JICA Sri Lanka office

Handover ceremony 3

Handover ceremony 4

Figure 2-2 Second Handover ceremony

2.7 Support for planning the treatment and disposal of waste polluting the coast

The coastal areas of the Western Province were extremely contaminated due to the spill of plastic waste and chemical substances caused by the sinking of a Singapore-registered ship in May 2021. After consultation with the relevant ministries and agencies, the JICA agreed with Sri Lanka to conduct a survey on the treatment and disposal of contaminated waste collected from the coastal areas of the Western Province and to support the formulation of a treatment and disposal plan.

However, upon confirmation with MEPA in September 2022, MEPA informed JICA that Singapore had already hired a consultant to formulate the above plan, and that JICA was requested to confirm the formulated plan.

After the treatment and disposal plan submitted by Singapore was shared by MEPA, JICA experts team visited the warehouse where the waste polluting the coast was temporarily stored to collect information, analyzed the plan, and made comments to MEPA.

2.8 Training

It was determined that the training could not be conducted in Japan due to the new coronavirus, and as an alternative measure, videos were made and submitted to WMA. The topics of the videos were as follows:

- Hachioji City, “Hachioji City Initiatives”
- Hachioji City, “Building Good Relationships with Residents”
- Saitama Prefectural Environmental Management Center, “Operation of Final Disposal Sites”

3 Formulation of M/P

3.1 C.1 Activities of Output 1

Output 1 : Roles and responsibilities of organizations relevant to solid waste management in Western Province are clarified and institutional arrangements for the formulation of the MP are established.

3.1.1 C.1.1 Roles and responsibilities of relevant organizations relevant to solid waste management in Western Province are clarified by examining policies and legal documents (e.g. national laws, ordinances)

The roles and responsibilities of relevant organizations – such as those with regulatory and enforcement functions, those responsible for collection and disposal of solid waste, and those providing services such as waste collection, transportation and disposal – were clarified for each type of waste by examining legal and policy documents. The summary of roles and responsibilities of relevant organizations related to municipal solid waste in the Western Province is shown in the table below (Appendix 4).

Local authorities (Municipal Council, Urban Council, Pradeshya Sabha) are responsible for the management (collection, transportation and disposal) of municipal solid waste under the Municipal Councils Ordinance, Urban Councils Ordinance and Pradeshya Sabha Act. The Central Environmental Authority (CEA) is responsible for regulating waste management under the National Environmental Act (NEA).

The Waste Management Authority (WMA) of the Western Province plays two major roles, namely promoting appropriate waste management methods and supporting local authorities' waste management activities. With regard to waste management planning, it is worth noting that there is a possibility of inconsistency between WMA's Western Province waste management plan and local authorities' waste management plans, if each local authority develops its plan according to its own needs and circumstances. Partial optimizations do not guarantee total optimization. Therefore, it is necessary to coordinate the planning processes on provincial and local authority levels by first optimizing provincial planning, then optimizing the plans of local authorities in line with the provincial plan.

There are three districts (Colombo, Gampaha and Kalutara) in the Western Province, and each district has a District Coordinating Committee, for which the Chairperson is appointed from Members of Parliament and the Vice-Chairperson is appointed from Members of Provincial Council. The Committee members are appointed from relevant organizations at the national, provincial and local levels. The committees are in charge of coordination and supervision of all development projects implemented within the respective area.

In the past, the ministry in charge of urban development, including UDA and SLLDC, has been implementing large-scale waste management projects, and the Ministry of Provincial Councils and Local Government (NSWMSC) and the Ministry of Environment (CEA) have been implementing pilot projects and demonstration projects. Although these activities (implementation of waste management projects by these ministries) are not explicitly stipulated

in relevant acts, their initiatives and involvements are required considering the limited technical and financial capabilities at the provincial and local levels. In addition to general functional demarcation among relevant government organizations in municipal solid waste management, when projects are planned and proposed, especially in the Master Plan, not only the responsibilities of the project proponent should be clearly stated and agreed between stakeholders, but also those of the other organizations involved.

With regard to industrial waste, healthcare waste, and construction and demolition waste, proper management is the responsibility of the parties who discharge such waste and is regulated by CEA according to NEA. The line ministries in charge of such industry and services (e.g. Ministry of Industry for industrial waste, Ministry of Health for healthcare waste, Ministry of Urban Development and Housing for construction and demolition waste) are supporting and facilitating the implementation of appropriate waste management. The private sector undertakes part of the waste management where commercially viable, on a fee basis. During the period of this Project, it was planned to identify issues related to non-municipal solid waste in terms of regulations, guidelines, and organizations involved.

Table 3-1 The summary of roles and responsibilities of relevant organizations

Organization	Roles and Responsibility for SWM[1]	Reference (Act, Statute, Gazette, etc.)	Facility Development & Operation (examples)
MoPAHAPCLG	● Policy, strategy development for MSWM ● Facilitation of implementation	● Sectoral oversight functions [2] in Gazette Notification for Ministry's Powers, Duties, Functions, 2015.9.21	
NSWMSC	● Technical support, financial assistance to LAs ● Provision of machinery and infrastructure		● Development of composting plants
MoE	● Development of national policy for SWM ● Coordination, facilitation of implementation	● National Environmental Act, No. 47, 1980 & subsequent Amendments, subsidiary Regulations	
CEA	● Implementation of National Environmental Act ● Publishing technical guidelines (municipal waste, scheduled waste)		● Development of composting plants under Pirisaru (to be operations by LAs)
WPC	● Development of strategies, action plans ● Provision of essential resources to LAs		
WMA	● Management of collection, segregation, transportation, transfer, treatment, disposal of waste in WP	● Western Province Waste Management Statute, No. 1, 2007 (amendment in progress)	● Development and operation of Karadiyana SWM Centre, including WtE by private company
Local authority	● Municipal solid waste management	● Municipal Council Ordinance, Urban Council Ordinance, Pradeshiya Sabha Act	● Development and operation of municipal solid waste management facilities ● Collection and disposal contracts with private companies
MoUD&H	● Urban solid waste management ● Provision of infrastructure facilities	● "Urban solid waste management", Gazette Notification for Ministry's Powers, Duties, Functions, 2015.9.21	● Large scale infrastructure development, Aruwakkalu
UDA/ SLLRDC	● Provision of infrastructure facilities		● Infrastructure development, operation of facilities
MoI	● Development of sectoral policies, R&D, facilitation of implementation	● Sectoral oversight functions of ministries in Gazette Notification for Ministry's Powers, Duties, Functions, 2015.9.21 ● Scheduled waste management in accordance with the regulations under National Environmental Act	
BOI/IDB	● Facilitation of implementation, infrastructure development in Export Processing Zone		● Solid waste treatment (incineration) plant in Seethawaka EPZ by private party (procurement stage)
MoH	● Development of sectoral policies, development of guidelines, facilitation of implementation		● Healthcare waste management facilities developed by MoH and operated by private companies
CIDA	● Development of sectoral policies, development of guidelines, facilitation of implementation		

[1] Extracted from National Waste Management Policy, MoMDE 2019, and from various documents such as annual reports of relevant organizations.
[2] Formulation of policies, programs and projects, monitoring, and evaluation in regard to the subjects.

3.1.2 C.1.2 A Working Group for MP formulation is established

A working group was established to develop the master plan. Prior to the meeting, the main implementing agency and expected member organizations, an overview of the MP to be developed, and the project activity process were shared with the relevant organizations.

3.1.3 C.1.3 Terms of Reference (TOR) of the Working Group for MP formulation are clarified

The role and work of the working group (WG) for the development of the MP is clarified. The WG, which brings together 17 related organizations, is not a place for actual work, but a place for consensus building through the exchange of opinions and coordination after receiving reports on the actual work and progress of a small number of sub-groups that plan and implement the individual activities of the organizations involved. The difference and relationship between the roles of the WG and sub-groups are as follows.

Table 3-2 Comparison between WG and sub-group(s)

	WG	Sub-group(s)
Members	17 related organizations	Set up to take care of activities for each output, if necessary
Frequency	Once every three months	As needed
Role	Review the progress, discuss the content, form consensus, and coordinate as necessary based on the draft MP to be formulated, the roles of each organization, the information and coordination of consultation with the sub-group(s).	• Study the current condition of municipal solid waste, healthcare waste, industrial waste and construction and demolition (C&D) waste. • Formulate and implement the pilot project(s). • Formulate the draft MP. • Support the formulation and implementation of action plans of local authorities. • Report the progress of the Project to WG.

3.1.4 C.1.4 Regular meetings and special meetings or Sub-group meetings, where necessary, are held

Sub-groups were established to plan and implement individual activities with a small number of concerned organizations and provided support for holding and assisting in the facilitation of sub-groups.

Discussions were held on the draft MP and the proposed amendments based on the changes in the investment projects that occurred as described in 4.1.5 below, and the draft MP was finalized.

3.1.5 C.1.5 Draft MP is prepared through discussions by the WG

The master plan formulation incorporates the projects whose implementation has already been decided. However, among the projects considered as decided the following two significant changes occurred in October 2021:

- Regarding Karadiyana TRF, the Government re-appraised the project, including the ability of the concessionaire to implement the project, due to a change in the shareholder

composition. Following the recommendations and observations made by the relevant ministries, the Cabinet decided to cancel the concession agreement.

- Regarding the development of composting plants, etc., it was planned to implement high-priority projects from 2022 with the government's budget. However, due to the financial weakening of the government, the public investment budget was reduced by 38% from the previous year. Due to this government budget constraint, even priority projects could not be implemented in 2022.

In November 2021, the Sri Lankan C/P requested the JICA Expert Team to cancel the originally planned TRF and reschedule other projects' implementation. In response, the C/P and the JICA Expert Team held discussions, made revisions, and finalized the draft MP at the end of January 2023. An SEA report was prepared based on the finalized MP and WMA submitted the draft MP and SEA report to CEA on 17 February 2023. In response, the CEA held an SEA stakeholder meeting on 2 March 2023, followed by a technical committee meeting on 20 March 2023, and SEA comments were submitted to WMA on 11 April 2023. WMA finalized the MP together with the SEA Comment Response Table on the finalized M/P and submitted them o CEA on 7th May 2023. After that, WMA proceeded to the approval process of the M/P in Western Province. The MP is available in English, Sinhala and Tamil.

(1) Western Province Solid Waste Management Master Plan

The structure of the Western Province Solid Waste Management Master Plan is described in detail below.

a. Selection of optimal SWM system

The appropriate SWM Master Plan was selected through the following procedure:

- Projection of future population and future waste amount which constitute preconditions for the formulation of a MP.
- Setting up of alternatives for the SWM system based on a combination of cluster- and individual-based SWM.
- Evaluation of alternatives from a technical, institutional, economical, and environmental point of view.
- Selection of an optimum SWM system for the MP.
- Setting up of short-term, mid-term, and long-term numerical targets for the MP.

a.1. Pre-conditions for developing MP

a.1.1 Planning period

The planning period of the MP is set as follows.

2022: Present
2023-2025 (3 years): Short-term
2026-2030 (5 years): Medium-term
2031-2042 (12 years): Long-term

a.1.2 Future population

The future population of each LA (49 in total) during the target period of the MP has been estimated. The base population for each LA is the 2012 Census population and a population growth rate of 0.78% per year in the Western Province (2012-2018) is evenly applied for the period of the MP. The results are shown in the table below.

Table 3-3 Estimated population growth rate and population projection

Item	Annual Average Growth Rate (%)				Population Projection (1'000)			
		Actual		Projection				
Year	1981 - 2001*	2001 - 2012*	2012 - 2018**	2020 - 2042	2022	2025	2030	2042
Sri Lanka	1.19%	0.73%	1.05%	-				
Western Province	1.65%	0.79%	0.78%	0.78%	6,324	6,474	6,729	7,386
Colombo District	1.46%	0.34%	0.81%		2,511	2,574	2,673	2,934
Gampaha District	2.07%	1.02%	0.74%		2,491	2,551	2,651	2,912
Kalutara District	1.29%	1.25%	0.79%		1,322	1,349	1,405	1,540

Source: * Census 1981, 2001, 2012 Source: JICA Team

** Mid-year Population Estimates

a.1.3 Necessity of transportation to Aruwakkalu Regional Landfill site

22 LAs use their own disposal sites and ten LAs have outsourced waste transportation and disposal to private sites managed by the same companies. These dumpsites have no environmental measures in place and have a negative impact on the surrounding environment, but it is financially and technically difficult to make improvements to individual disposal sites. Therefore, all waste to be disposed of from the Western Province should be transported to the Aruwakkalu Regional Landfill site. In order to establish an efficient and economical transportation system, several primary transfer stations and the Kelaniya TS, a rail transportation hub, will be developed in the Western Province.

Figure 3-1 Location of Aruwakkalu Disposal site

a.2. Prediction of future waste amount

The future waste amount was predicted by following the steps explained below.

- Step 1: Prediction of amount of waste generated without MP

  (Amount of waste generated without MP) = (Future population) × (Future waste generation rate per person per day)

- Step 2: Prediction of amount of waste generated with MP

(Amount of waste generated with MP) = (Future population) × [(Future waste generation rate per person per day) × (Target waste reduction rate)]

- Step 3: Prediction of amount of waste collected

  (Amount of waste collected) = (Amount of waste generated with MP) × (Target waste collection rate)

In addition, the amount of waste generated and collected as a result of future development plans was added to the above projected amount of waste.

a.2.1 Prediction of the amount of waste generated without MP

The prediction of the amount of waste is based on the future population and future waste generation rate per person per day.

The following table presents the results of a study based on a survey on waste amounts and composition conducted by SATREPS[3]. Waste generation rates are shown for 3 different categories of LA, namely Municipal Council (MC), Urban Council (UC), and Pradeshya Sabha[4] (PS). This study is used for the estimation since it is the latest and most reliable study for waste generation rates of both household waste and Municipal Solid Waste (MSW)[5] in Sri Lanka.

Table 3-4 Waste generation rates for households and MSW

Type of LA	Generation rate of household waste	Generation rate of MSW
	g/person/day	g/person/day
MC	350	970
UC	330	630
PS	250	440

Source: JICA Study Team

The waste generation rates per person per day are closely related to economic growth. Therefore, the future waste generation rates are estimated using the following formula:
(Future waste generation rates) = (Present waste generation rates) × [1 + (GDP growth rate per person*) × (Correlation coefficient between waste generation amount and GDP**)]^n

- * GDP growth rate per person = (GDP growth rate) – (Population growth rate (0.78≒0.8))
- ** Correlation coefficient between waste generation amount and GDP growth rate per person: 0.4
- n: Number of years elapsed since 2020 (base year)

* The latest edition of the Central Bank of Sri Lanka Annual Report predicts that the GDP growth rate from 2020 to 2024 will be, per annum, 1.5%, 4.5%, 6.0%, 6.2%, and 6.5%. The subsequent GDP growth rate assumes that an average GDP growth rate of 4.9% for the five

[3] Science and Technology Research Partnership for Sustainable Development
[4] Pradeshya Sabha is a kind of administrative unit. They are the legislative bodies that governs the third-tier municipalities, after the Municipal Council and Urban Council. There are 276 Pradeshya Sabha in Sri Lanka.
[5] Municipal solid waste refers to solid waste generated by municipalities other than industrial waste and consists of household waste and other types of waste including waste from businesses, public areas, schools and hospitals (non-infectious waste).

years will continue until 2042, the final year of the MP.

The GDP growth rate per person is the value obtained by subtracting the population growth rate (0.8%) from the GDP growth rate for each year.

Table 3-5 Actual GDP growth rate and GDP growth rate Projections (%)

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Actual GDP growth rate	5.9	5.4	6.2	7.7	6.8	6.0	3.5	8.0	8.4	9.1	3.4

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Actual GDP growth rate	5.0	5.0	4.5	3.6	3.3	2.3					
GDP growth rate projections							1.5	4.5	6.0	6.2	6.5
							Average GDP growth rate 4.9%/year				

Source: Central Bank of Sri Lanka Annual Report 2019

** Correlation coefficient between waste generation rates and GDP growth rates per person: It is commonly acknowledged that the amount of MSW generated per person per day increases as the GDP growth rate per person increases, but there is little literature that collects and analyzes such data on a global basis. “Estimation of waste generation amount in the world and future forecast, 2020 revised edition”[6] is one of the few references that estimate it. From the viewpoint of the correlation between the GDP growth rate per person and the fluctuation of the MSW generation rate per person, the following approximate formulas are used. The approximate equation is as follows:

$$y = 134.41\ x^{0.3805},\ R^2 = 0.9868$$

- y = MSW generated waste per person (kg/person/year)
- x = GDP growth per person (‘000 US$ /person /year)

Since Sri Lanka’s GDP growth per person in 2020 is approximately USD 4,000, the approximate formula is used to obtain the amount of MSW generated per person, resulting in 624 g per person per day, which is similar to the current amount of MSW generated per person in the Western Province of Sri Lanka.

The GDP per person for 2020 is set at USD 4,000 and the GDP per person through 2042 is determined based on the previously projected GDP growth rate per person. Next, the amount of MSW generated per person and MSW generation growth rate are calculated by using approximate formulas based on these annual GDP per person. As a result, the elastic modulus is determined to be about 0.4.

[6]Press release 21 January 2020, Waste Engineering Research Institute Co., Ltd., http://www.riswme.co.jp/
“Estimation of waste generation amount in the world and future forecast, 2020 revised edition”

Table 3-6 Future waste generation rates without MP (g/ person/day)

Classification		2022	2025	2030	2042
Household waste	MC	362	384	416	506
	UC	342	363	393	478
	PS	259	275	300	364
Municipal solid waste (MSW)	MC	1,004	1,066	1,150	1,406
	UC	652	692	751	913
	PS	456	485	525	683

a.2.2 Prediction of the amount of waste generated with MP

The future amount of waste generated is predicted in consideration of the target waste reduction rates in order to reduce the amount of waste generated estimated in step 1.

The amount of waste generated will increase linearly in accordance with waste generation rates and in line with population growth and economic growth. Since the amount of waste collected and transported, as well as the financial burden for waste treatment and disposal for each LA, will increase, waste generation needs to be reduced in accordance with the following targets for each waste generation source in order to decrease this burden.

Table 3-7 Waste reduction rate

Target year	2022	2025	2030	2042
Waste reduction rate	0%	1%	3%	10%

The future waste generation rate (with MP) is predicted in consideration of the waste reduction rates based on the amount of waste generated predicted in step 1 (without MP).

When comparing the future amounts of waste generated in 2042 with and without waste reduction, the waste reduction amount per person per day is estimated to be approximately 50g per person per day.

Table 3-8 Comparison of future waste generation rates (g/person/day)

Classification		Without MP				With MP			
		2022	2025	2030	2042	2022	2025	2030	2042
Household waste	MC	362	384	416	506	362	380	404	455
	UC	342	363	393	478	342	359	381	430
	PS	259	275	300	364	259	272	291	328
Municipal solid waste (MSW)	MC	1,004	1,066	1,150	1,406	1,004	1,055	1,121	1,265
	UC	652	692	751	913	652	685	728	822
	PS	456	485	525	683	456	480	509	574

a.2.3 Prediction of the amount of waste collected

The future amount of waste collected is predicted using waste collection rates that are based on the amount of waste generated estimated in step 2.

As urbanization progresses, waste collection rates in MC and UC, where the population density is high, have already achieved 65-70%. On the other hand, the waste collection rate in PS, where the population density is low, is less than 30%. MC and UC are aiming for a 95% waste collection rate. However, considering the financial burden on the waste collection of LAs, PSs are aiming for a 60% waste collection rate. LAs (Divulapitiya PS and Kelaniya PS) that have already exceeded a 60% waste collection rate will maintain their current waste collection rates.

Collection coverage has been calculated with the following formula:
[(Amount collected) + (Amount of recyclables at the discharge and collection stage)] / [(Amount generated) + (Amount of recyclables at the generation stage)]

Table 3-9 Waste collection rate targets for each urban category

Classification	2022	2042
MC	65%	95%
UC	72%	95%
PS	32%	60%

The composition of discharged waste is strongly related to the development of urbanization. As urbanization progresses, the ratio of organic waste tends to decrease, while the ratio of recyclables tends to increase.

The targets for the composition of discharged waste have been established as follows.

Table 3-10 Ratio of waste discharged separately by type of LA

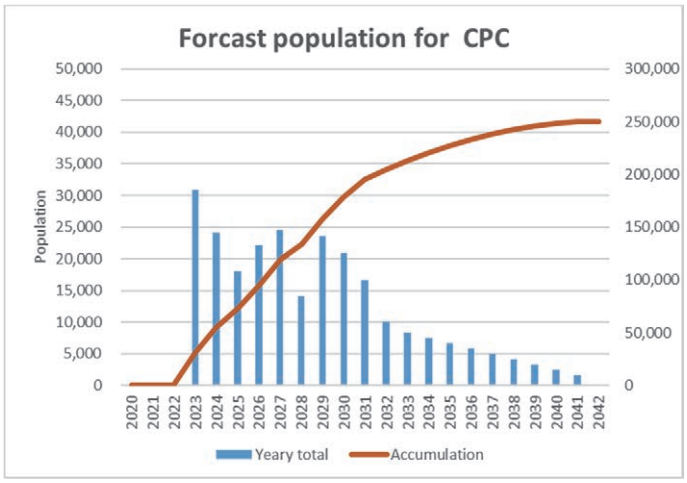
Type of LA	Organic waste	Recyclable			Other waste
		Recycling at discharge/collection	Recycling at recycling yard/SK	Total	
MC	40%	5%	10%	15%	45%
UC	45%	5%	7%	12%	43%
PS	50%	5%	5%	10%	40%

a.2.4 Amount of waste generated based on the development plan

(1) Colombo Port City (CPC)

i. Outline of CPC development

- Chief Ministry/Authority for CPC development: Ministry of Urban Development & Housing
- Development period: 2023-2041 (delay)
- Development population: The resident population and total development population, including commerce and businesses, are assumed to be 70,000 and 250,000 respectively.



Source: Proposed Colombo Port City Development Project December 2015

Figure 3-2 Forecast in the CPC development population

ii. Amount of waste generated after CPC development

- Generation rate
  - ✓ Total generated MSW: 1.5 kg/person/day
  - ✓ Household waste: 0.6 kg/person/day
- Composition of MSW

Table 3-11 Composition of solid waste

Category	Proportion	Remarks
Food waste	45.3%	
Recyclables	15.1%	paper, plastic, glass, metal
Others	39.6%	

Source: Ministry of Urban Development & Housing

Table 3-12 Forecasts of the amount of waste generated based on CPC

Year	Generated Solid Waste (ton/day)								
	Total			Household (HH)			Other than HH		
	Bio - degradable	Recyclables	Others	Bio-degradable	Recyclables	Others	Bio-degradable	Recyclables	Others
2023	21	7	18	8	3	7	13	4	11
2024	37	12	33	15	5	13	22	7	20
2025	50	17	43	20	7	17	30	10	26
2026	65	22	56	26	9	22	39	13	34
2027	81	27	71	33	11	28	48	16	43
2028	91	30	80	36	12	32	55	18	48
2029	107	35	94	43	14	37	64	21	57
2030	120	40	107	48	16	43	72	24	64
2031	132	44	116	53	18	46	79	26	70
2032	139	47	121	56	19	48	83	28	73
2033	145	48	127	58	19	51	87	29	76
2034	150	50	131	60	20	52	90	30	79
2035	155	52	134	62	21	53	93	31	81
2036	158	53	139	63	21	56	95	32	83
2037	162	54	141	65	22	56	97	32	85
2038	165	55	144	66	22	57	99	33	87
2039	168	56	145	67	22	58	101	34	87
2040	168	56	148	67	22	58	101	34	88
2041	170	57	148	68	23	59	102	34	89
2042	170	57	148	68	23	59	102	34	89

Source: JICA Study Team

(2) Marine City (MC)

i. Outline of MC development plan

- Chief Ministry/Authority for MC development: Ministry of Urban Development & Housing
- Development period: 2025-2034

ii. Amount of waste generated for MC development

- Composition of solid waste

Table 3-13 Composition of solid waste

Category	Proportion	Remarks
Food waste	60.0%	
Recyclables	30.0%	paper, plastic
Others	10.0%	

Source: Ministry of Urban Development & Housing

Table 3-14 Forecast of the amount of solid waste generated in MC

Year	Generated SW (ton/day)			
	Total	Bio-degradable	Recyclables	Others
2025	0.5	0	0	0.5
2026	2.5	1	1	0.5
2027	6	3	2	1
2028	11	6	4	1
2029	17.5	10	6	1.5
2030	22	13	7	2
2031	25.5	15	8	2.5
2032	27.5	16	9	2.5
2033	29	17	9	3
2034	30	18	9	3

Source: JICA Study Team

(3)Future amount of waste generated in CM C

Table 3-15 Future waste generation in CMC in 2042 (ton/day)

Forecasted amount of waste generated based on future population	Forecasted amount of waste generated based on development plan			Total
	CPC	MC	Sub-total	
896	375	30	405	1,301

Source: JICA Study Team

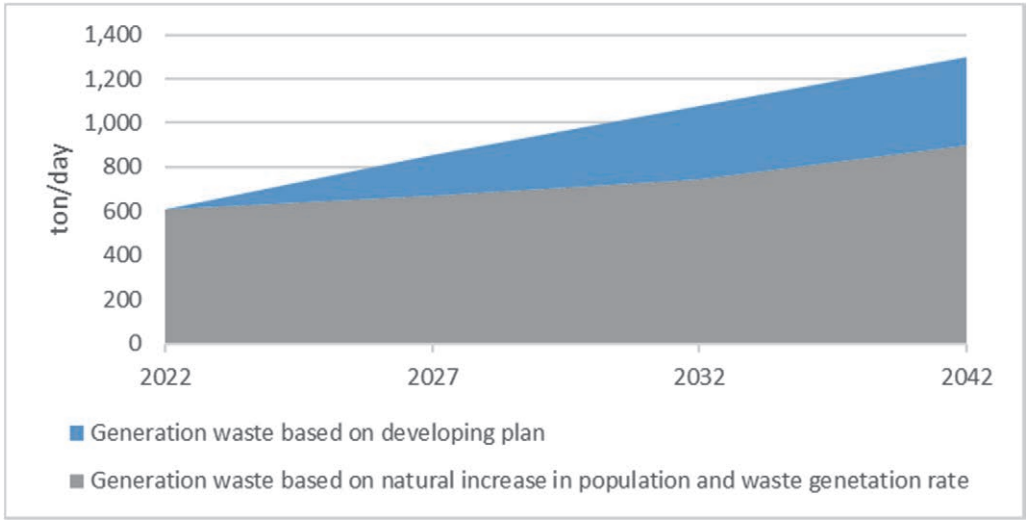


Figure 3-3 Future amount of waste generated in CMC

a.2.5 Waste generation amount

The projected amount of waste that will be generated without the MP and with the MP in consideration of target waste reduction rates are shown below. It is expected that the amount of waste generated with the MP in the Western Province in 2042 will be approximately 6,180 tons per day, which is 1.6 times more than in 2022.

Table 3-16 Future amounts of waste generated (ton/day)

Province/District	Without the MP				With the MP			
	2022	2025	2030	2042	2022	2025	2030	2042
Western Province	3,926	4,272	4,811	6,422	3,926	4,342	4,952	6,181
Colombo District	2,010	2,188	2,465	3,290	2,010	2,278	2,679	3,365
Gampaha District	1,290	1,405	1,580	2,112	1,290	1,390	1,532	1,898
Kalutara District	626	678	766	1,020	626	674	741	918

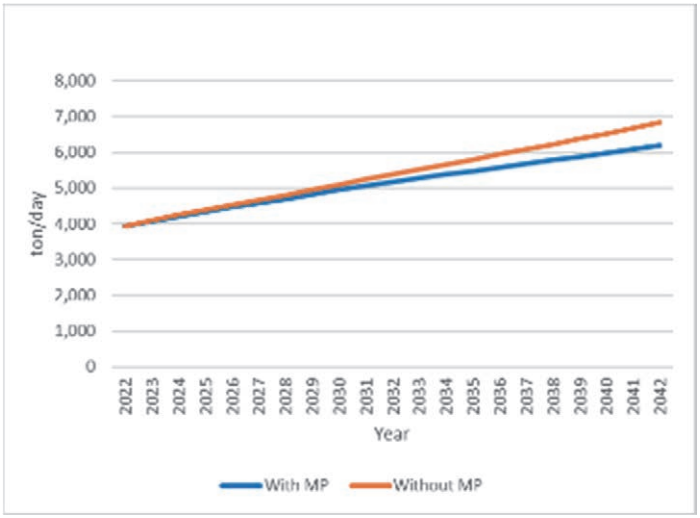


Figure 3-4 Comparison of future generation waste amount between with and without the MP

a.2.6 Collection waste amount

The projected amount of waste collected, with consideration of the target waste collection rates, are shown below.

Table 3-17 Future amount of waste generated and collected (with the MP) (ton/day)

Province/District	Amount of waste generated				Amount of waste collected			
	2022	2025	2030	2042	2022	2025	2030	2042
Western Province	3,926	4,342	4,952	6,181	1,994	2,396	3,093	4,756
Colombo District	2,010	2,278	2,679	3,365	1,274	1,548	2,005	2,937
Gampaha District	1,290	1,326	1,532	1,898	486	577	745	1,258
Kalutara District	626	641	741	918	234	271	343	561

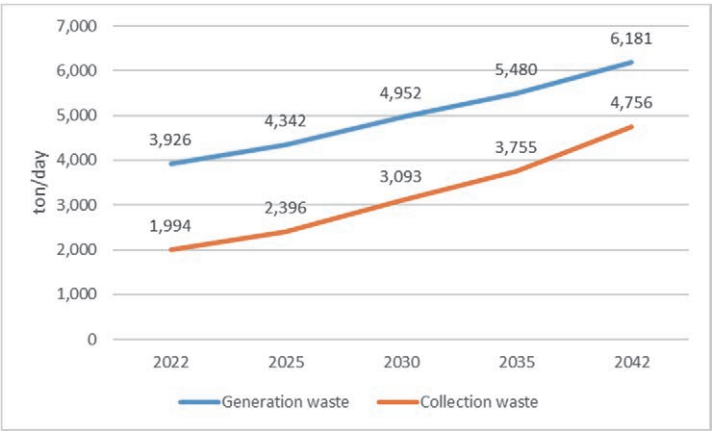


Figure 3-5 Future amount of waste generated and collected with the MP

b. Set up alternatives for the SWM system

b.1. Alternatives for the SWM system

Alternatives for the SWM system are proposed as follows;

- Baseline (Without MP): If the current waste management is continued without considering the reduction of waste generation and the increase in waste collection, the amount of waste improperly discharged will increase. In addition, due to the lack of progress in the development of intermediate treatment facilities, a large amount of collected waste will be delivered to the disposal facility without going through intermediate treatment.

- Alternative A: Consider reducing waste generation and increasing the amount of waste collected by improving the waste collection system. To promote the composting of organic waste, the total intermediate treatment capacity of LAs and cluster-based composting facilities would be increased to 930 tons per day. However, due to insufficient improvement of the other intermediate treatment facilities, much of the collected waste would be sent to landfills without intermediate treatment.

- Alternative B: As in Alternative A, consider the reduction of waste generation and increase in waste collection. Furthermore, the amount of organic waste disposed of would be reduced through the promotion of composting. The total intermediate treatment capacity of the LAs and cluster-based composting facilities would be increased to 930 tons per day and a composting facility with a capacity of 400 tons per day would be constructed at the Waste Park (planned by MoUD&H), raising the total intermediate treatment capacity of composting facilities to 1,330 tons per day. The Waste Park would also have a MRF with a total capacity of 150 tons per day. Approximately 20% of the collected organic waste would be incinerated together with other waste, and the total intermediate treatment capacity of the TRF would be increased to 2,900 tons per day in order to reduce the amount of waste destined for disposal.

- Alternative C: As in Alternatives A and B, the reduction of waste generation and the improvement of waste collection are taken into account. The total intermediate treatment capacity of the LAs and cluster-based composting facilities would be increased to 930 tons per day to reduce the amount of organic waste disposed of to zero, and the total intermediate treatment capacity of the TRF would be increased to

3,300 tons per day to incinerate the organic waste that cannot be treated due to insufficient capacity of composting facilities together with other waste to reduce the amount to be disposed of.

The main components of the alternatives for the SWM system are shown below.

Table 3-18 Main components of the alternatives for the SWM system

Main component of SWM system		Primary transfer station	Composting facilities		Recycling Facilities (MRF)		Thermal recovery facilities	Disposal site
			LAs & cluster based	Waste Park	LAs	Waste Park		
Without MP	Baseline	Primary transfer stations will be constructed to improve collection efficiency	Current capacity 324 ton/day	-	344 ton/day	-	750 ton/day (WPK*)	2,382 ton/day
With MP	Alternative A		930 ton /day	-	421 ton/day	-	750 ton/day (WPK)	3,157 ton/day
	Alternative B		930 ton/day	400 ton/day	421 ton/day	150 ton/day	2,900 ton/day	1,206 ton/day
	Alternative C		930 ton/day	-	421 ton/day	-	3,300 ton/day	1,122 ton/day

* WPK: Western Power at Kerawalapitiya

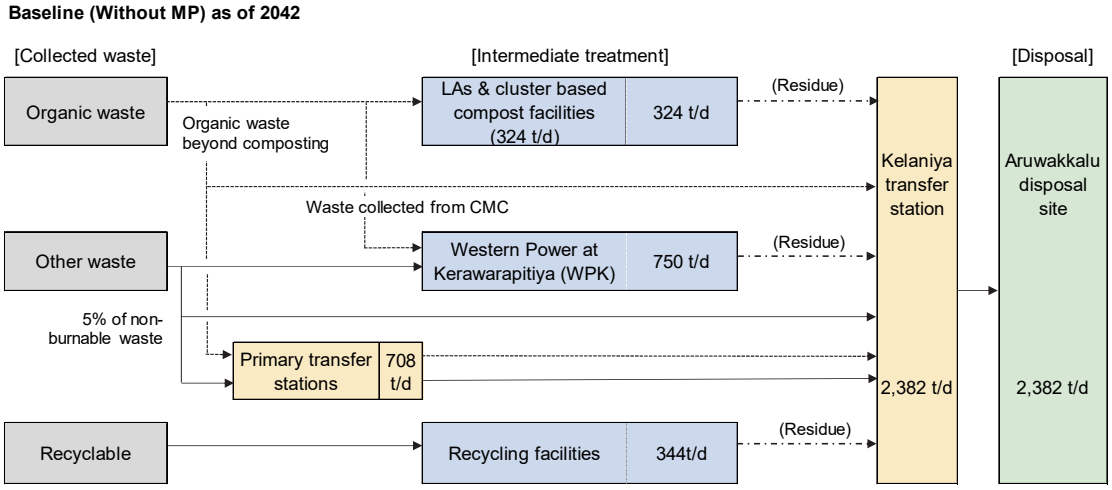


Figure 3-6 Baseline of SWM system

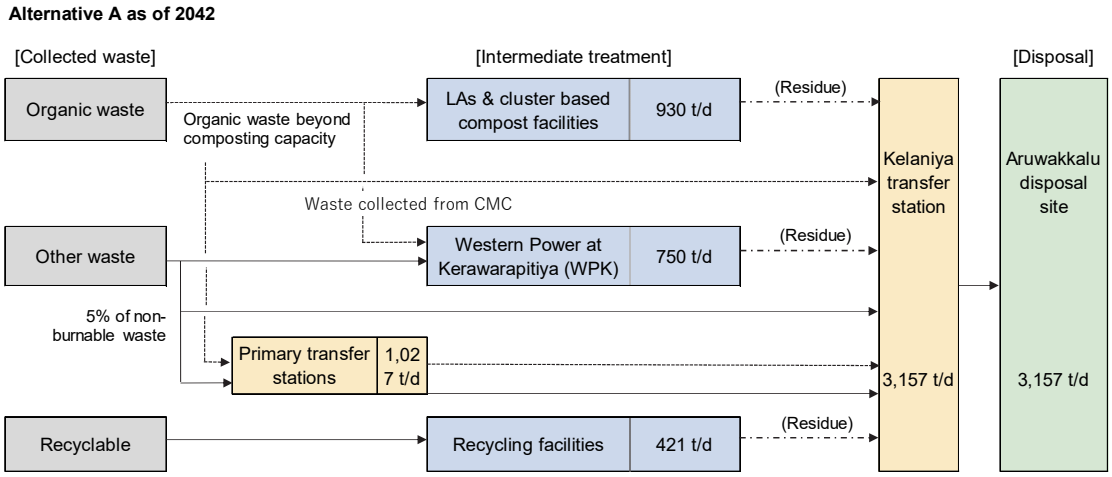


Figure 3-7 Alternative A SWM system

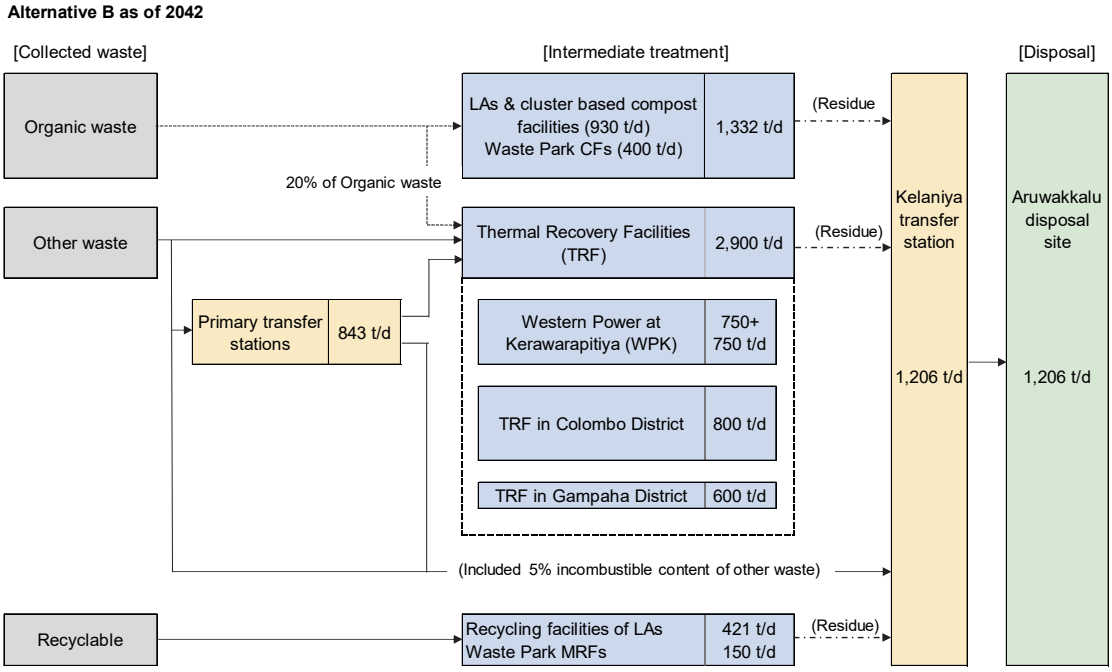


Figure 3-8 Alternative B SWM system

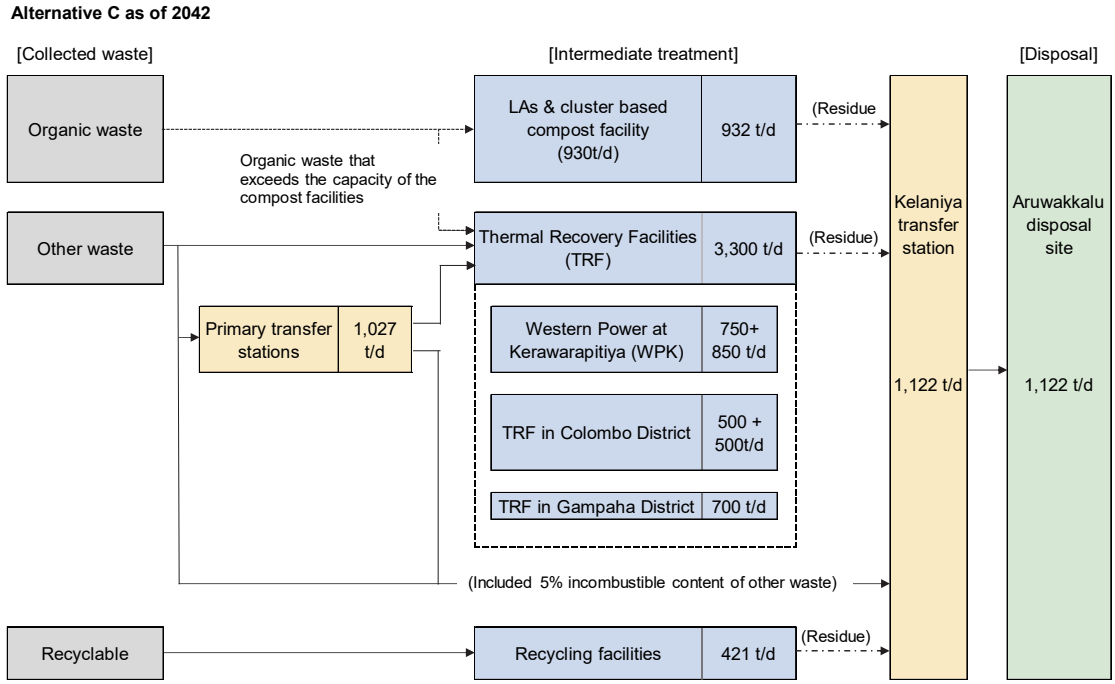


Figure 3-9 Alternative C SWM system

b.2. Evaluation of alternatives for the SWM system

The baseline and alternatives for the SWM system were evaluated in terms of technical, institutional, economic and social considerations, in order to select an optimal plan.

b.2.1 Technical evaluation

The baseline and three alternatives were evaluated for the following technical items that are important to SWM in the Western Province:

- Reduction of improper waste discharge through increased collection coverage and promotion of intermediate treatment.
- Minimization of the amount for final disposal.
- Maximization of organic waste composting

(1) Reduction of improperly discharged waste by improving collection coverage and promoting intermediate treatment

28% of the waste generated is discharged improperly and 56% is discharged for colletion in the baseline scenario On the other hand, in alternatives A, B, and C that include collection improvements, only 8% of the amount generated is discharged improperly and 81% is discharged for collection.

In the baseline scenario, the amount for final disposal accounts for 35% of the waste generated, including residues generated from composting facilities, recycling facilities and thermal recovery facilities. In contrast, the amount for disposal in alternatives A, B, and C are 51%, 20%, and 18%, respectively.

Evaluation of the reduction of improperly discharged waste: Alternative A = Alternative B =

Alternative C > Baseline

Table 3-19 Breakdown of MSW treated and disposed

Waste Flow	Without MP		With MP					
	Baseline		Alternative A		Alternative B		Alternative C	
	Vol. (t/d)	(%)	Vol. (t/d)	(%)	Vol. (t/d)	(%)	Vol. (t/d)	(%)
1. Generation	6,827	*100.0%*	6,181	*100.0%*	6,181	*100.0%*	6,181	*100.0%*
7. Improper discharge	1,913	*28.0%*	515	*8.3%*	515	*8.3%*	515	*8.3%*
5. Discharge	3,805	*55.7%*	4,985	*80.7%*	4,985	*80.7%*	4,985	*80.7%*
8. Informal recycling	290	*4.2%*	229	*3.7%*	229	*6.8%*	229	*3.7%*
11.1 Compost	325	*4.8%*	932	*15.1%*	1,332	*21.5%*	932	*15.1%*
11.3 Recycling	344	*5.0%*	421	*6.8%*	421	*5.4%*	421	*6.8%*
11.4 Thermal recovery	750	*11.0%*	750	*12.1%*	2,874	*46.5%*	3,300	*53.4%*
12. Intermediate untreated waste	2,096	*30.7%*	2,653	*42.9%*	129	*2.1%*	103	*1.7%*
15. Final Disposal	2,383	*34.9%*	3,157	*51.1%*	1,206	*19.5%*	1,122	*18.2%*

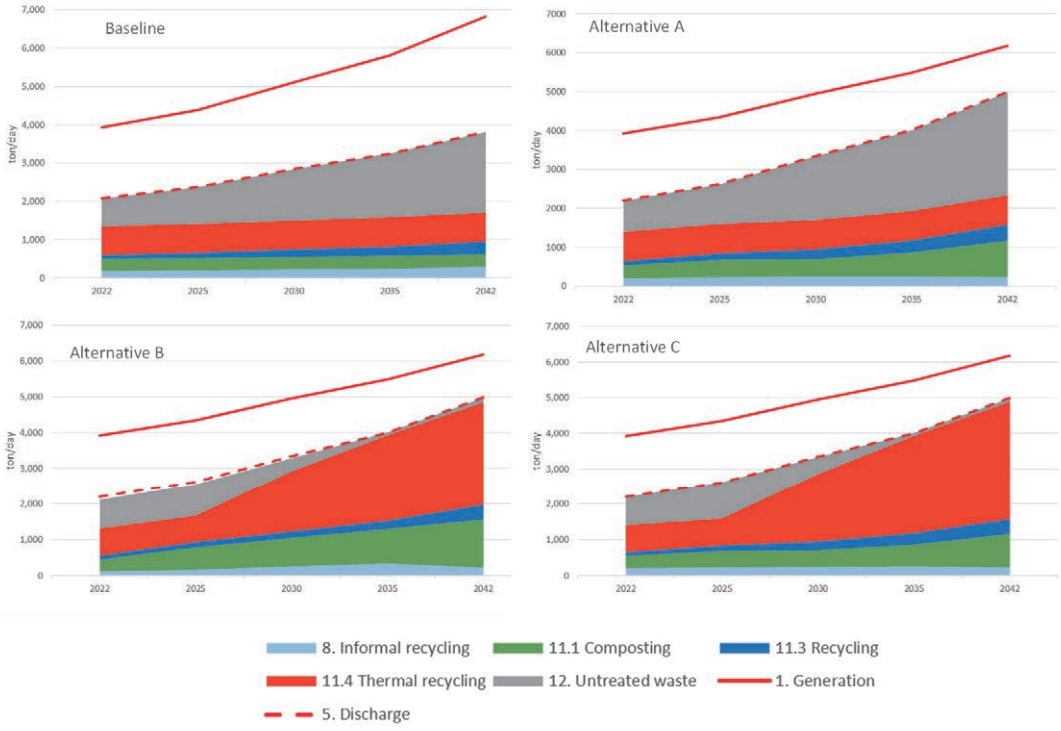


Figure 3-10 Breakdown of MSW treated and disposed

(2) Minimization of amount for final disposal

A comparison of the cumulative amount for final disposal (including 20% soil cover) of the entire Western Province over the 20 years covered by the MP (2023-2042) is shown in the table and figure below.

As a result, the cumulative amount for final disposal of alternative A is the highest. Under

alternative A, a large amount of collected waste is delivered to the final disposal site as it is, without being reduced or recycled, although the waste collection is improved and the capacity of some composting facilities is increased, but without sufficient improvement of intermediate treatment facilities as a whole.

On the other hand, alternatives B and C would increase the capacity of thermal recovery facilities and composting facilities as receivers of the increased amount of collected waste through improved collection, and as a result of waste amount reduction and recycling, and its disposal, succeed in reducing a large amount for final disposal.

While the cumulative amount for final disposal is expected to be 15.4 million m^3 in the baseline, under alternatives A, B, and C this amount is projected to be 127%, 62%, and 60%, respectively, of that of the baseline.

It is planned that, in the future, all landfill waste generated in the Western Province will be transported by rail via the Kelaniya Transfer Station to the Aruwakkalu Final Disposal Site, located approximately 150 km north of Colombo City. Since the initial planned landfill capacity of the Aruwakkalu Final Disposal Site is 5.6 million m^3, it would need to be increased as under alternative A the final disposal amount would be at its largest with 14.0 million m^3, while alternative C would have the smallest final disposal amount of 3.6 million m^3.

Therefore, alternative C is evaluated as the optimal SWM system from the point of view of minimizing the amount for final disposal.

Evaluation of minimization of amount for final disposal : Alternative C > Alternative B > Baseline > Alternative A

Table 3-20 Cumulative amount for final disposal including soil cover (million m^3)

	Baseline	Alternative A	Alternative B	Alternative C
Cumulative amount for final disposal (2023-2042)	15.4	19.6	9.5	9.2
Planned amount for final disposal at Aruwakkalu final disposal site	5.6	5.6	5.6	5.6
Required capacity for final disposal	9.8	14.0	3.9	3.6

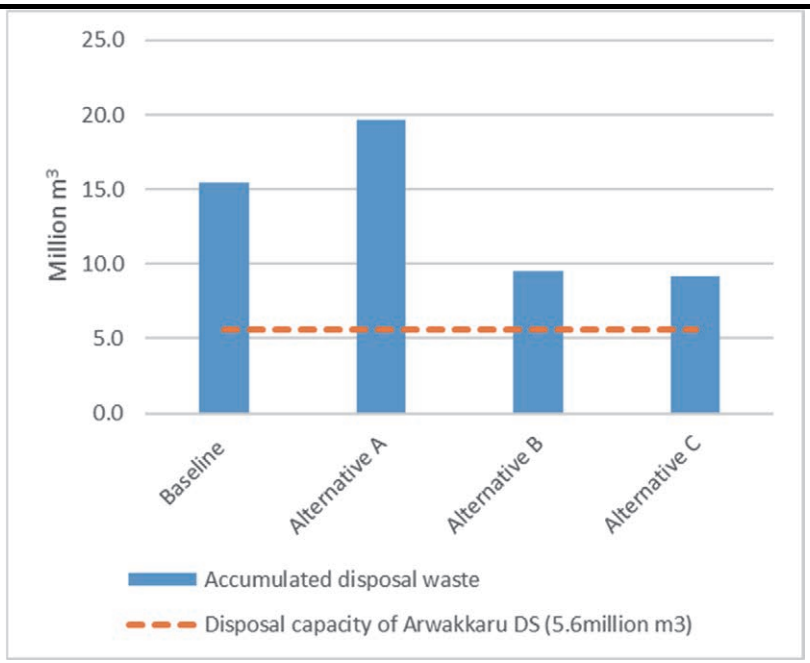


Figure 3-11 Cumulative amount for final disposal (2023-2042) and planned disposal capacity of the Aruwakkalu Final Disposal Site

(3) Maximization of organic waste composting and reduction of final disposal

The amount of organic waste collected and the breakdown of the amount treated and disposed of are shown in the table and figure below.

Since the baseline limits the capacity of the composting facilities and the amount of organic waste brought into the thermal recovery facility, the amount of organic waste that would be disposed of in 2042, the final year of the MP, would exceed 1,000 tons per day. Alternative A would increase the capacity of the composting facilities, but as with the baseline, a large amount of organic waste would finally be disposed of without being reduced in volume nor recycled.

On the other hand, alternatives B and C actively promote thermal recovery, reducing the amount of organic waste that is disposed of at the final disposal site as both other waste and organic waste would be incinerated, in line with the "National Policy on Waste Management 2019" that regulates the final disposal of organic waste. Furthermore, alternative B not only enhances the capacity of the cluster-base composting facilities in LAs but also cooperates with the Waste Park concept promoted by MoUD&H to maximize the use of organic waste that contributes to composting.

Therefore, alternative B is evaluated as the optimal SWM system in terms of final disposal of organic waste.

Evaluation of organic waste composting: Alternative B> Alternative C > Alternative A >Baseline

Table 3-21 Breakdown of organic waste treated / disposed

		2022	2025	2030	2042
Baseline	Organic waste collected	874	1,043	1,327	2,015
	- to composting facilities	325	327	325	325
	✓ to LAs composting facilities	92	92	92	92
	✓ to cluster-based composting facilities	232	232	232	232
	✓ to waste park composting facilities	0	0	0	0
	- to thermal recovery facilities	324	394	448	317
	- to disposal site	225	322	554	1,373
Alternative A	Organic waste collected	896	1,084	1,402	2,226
	- to composting facilities	325	451	514	932
	✓ to LAs composting facilities	92	117	131	136
	✓ to cluster-based composting facilities	232	333	383	794
	✓ to waste park composting facilities	0	0	0	0
	- to thermal recovery facilities	317	349	417	245
	- to disposal site	254	284	473	1,049
Alternative B	Organic waste collected	896	1,084	1,402	2,226
	- to composting facilities	325	611	850	1,332
	✓ to LAs composting facilities	92	117	131	136
	✓ to cluster-based composting facilities	232	333	383	749
	✓ to waste park composting facilities	0	160	400	400
	- to thermal recovery facilities	237	136	552	868
	- to disposal site	334	337	0	0
Alternative C	Organic waste collected	896	1,084	1,402	2,226
	- to composting facilities	325	451	448	932
	✓ to LAs composting facilities	92	117	131	136
	✓ to cluster-based composting facilities	232	333	383	749
	✓ to waste park composting facilities	0	0	0	0
	- to thermal recovery facilities	325	383	835	1,294
	- to disposal site	242	250	55	0

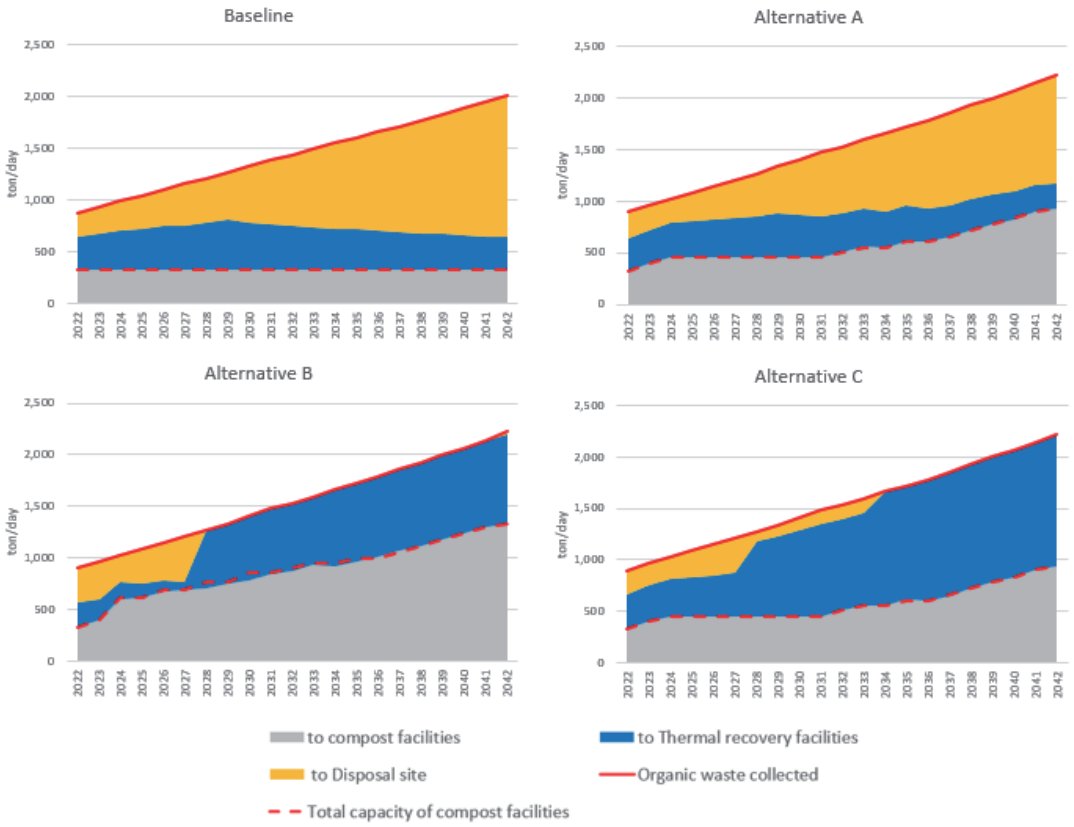


Figure 3-12 Breakdown of organic waste treated and disposed

b.2.2 Financial evaluation

The waste management costs of the baseline and each alternative for the MP period of 20 years (2023-2042) are compared. Cost items and contents of each item used in the calculation for waste management are as follows. The contents were based on hearings from waste service providers and other similar cases.

Table 3-22 Cost items and basis of calculation for waste management (Cost as of 2021)

Item		Unit	Content
1. Collection and transportation	Procurement cost of vehicles	million LKR/unit	- Trailer tractor: 3.5 - 4t compactor: 9.0
	Fuel & maintenance cost	km/liter LKR/liter -	- Fuel consumption: 1.5 - Unit price of fuel: 220 - Maintenance costs per vehicle: 10% of fuel costs
	Labor cost	LKR/month	Monthly salary - Driver: 85,000 - Worker: 34,000
2. Transfer station	Procurement cost of vehicles	million LKR/unit	Vehicle - Roll-on/roll-off truck: 25 - Dump truck (10-ton): 25 Container: 1.0
	Fuel & maintenance cost	km/liter LKR/liter -	- Fuel consumption: 3.0 - Unit price of fuel: 220 - Maintenance costs per vehicle: 10% of fuel costs
	Labor cost	LKR/mon.	Monthly salary - Driver: 85,000 - Worker: 34,000
	O&M cost	LKR/ton	2,000
	Initial cost	million LKR/ton	Primary transfer station: 10.0
3. Intermediate treatment facilities			
3.1 Composting facility	O&M cost	LKR/ton	3,000
	Initial cost	million LKR/ton	- LAs & cluster-based composting facilities: 0.5 - Composting facilities in waste parks: 1.0
3.2 Material recovery facility (MRF)	O&M cost	LKR/ton	2,000
	Initial cost	million LKR	MRFs in waste parks: 400 million LKR/facility with 30-ton capacity
3.3 Thermal recovery facility (TRF)	O&M cost	LKR/ton	7,000
	Initial cost	million LKR/ton	25.0
4. Final disposal	O&M cost	LKR/m^3	4,000
	Initial cost	LKR/m^3	8,000

Currently, collection vehicles mainly consist of compactor trucks in Colombo City, while other municipalities use 4W tractors. The baseline of the waste management system assumes that the current vehicle types will continue to be used in the future, whereas the other alternatives assume that the vehicles will be switched to compactor trucks. In the future, each municipality will need to transport the waste collected to the Kelaniya Relay Station in order to deliver the landfill waste to the Aruwakkalu landfill site. In that context, since the baseline operation using 4W tractors is less efficient in terms of collection and transportation than the other alternatives that involve a switch to compactor trucks, collection costs are higher.

The transportation costs are higher for the baseline and alternative A, under which a large amount of waste is transported from the Kelaniya Transfer Station to the Aruwakkalu Final Disposal Site.

As for intermediate treatment costs, alternatives B and C are higher due to the high construction and maintenance costs related to the large scale of the thermal recovery facilities.

As for final disposal costs, the baseline and alternative A are higher due to the large amount of collected waste that is directly delivered to the final disposal site without going through sufficient intermediate treatment. Furthermore, since the baseline does not consider reducing the amount of waste generated nor improving the collection, the amount of waste collected and subsequently treated and disposed of is lower than in the three alternatives, and thus there was no significant difference in total cost between the baseline and the other alternatives. Therefore, a comparison was made in terms of total cost as well as of cost per ton of waste collected.

As a result, alternative B is the cheapest in terms of total waste management costs and cost per amount of waste collected, and alternative B is evaluated as the optimal SWM system in terms of minimizing waste management costs.

Final disposal cost per ton of waste (1,000 LKR/ton):

Alternative B (17) < Alternative C (18) < Alternative A (20) < Baseline (25)

The 20-year average annual treatment cost of alternative B is projected to be 4.3 billion LKR/year, and the cost per ton of collected waste is projected to be 17,200 LKR per ton.

Table 3-23 Total amount and unit costs for SWM for 2023-2042

	Unit	Baseline	Alternative A	Alternative B	Alternative C
Collection	million LKR for 2023-2042	167,770	97,213	102,943	106,487
Transfer		100,564	145,975	80,083	87,359
IT *(Compost facilities)		7,100	13,010	20,303	12,997
IT (Material recovery facilities)		3,452	4,164	6,164	4,164
IT (Thermal recovery facilities)		38,320	38,320	149,229	171,643
Final disposal		140,424	190,709	69,337	72,041
Total		457,630	489,391	428,058	454,691
Collected waste	Million ton	18.258	24.873	24.873	24.873
Unit costs for SWM (LKR/ton)	LKR/ton	25,065	19,676	17,210	18,279

* IT: Intermediate Treatment

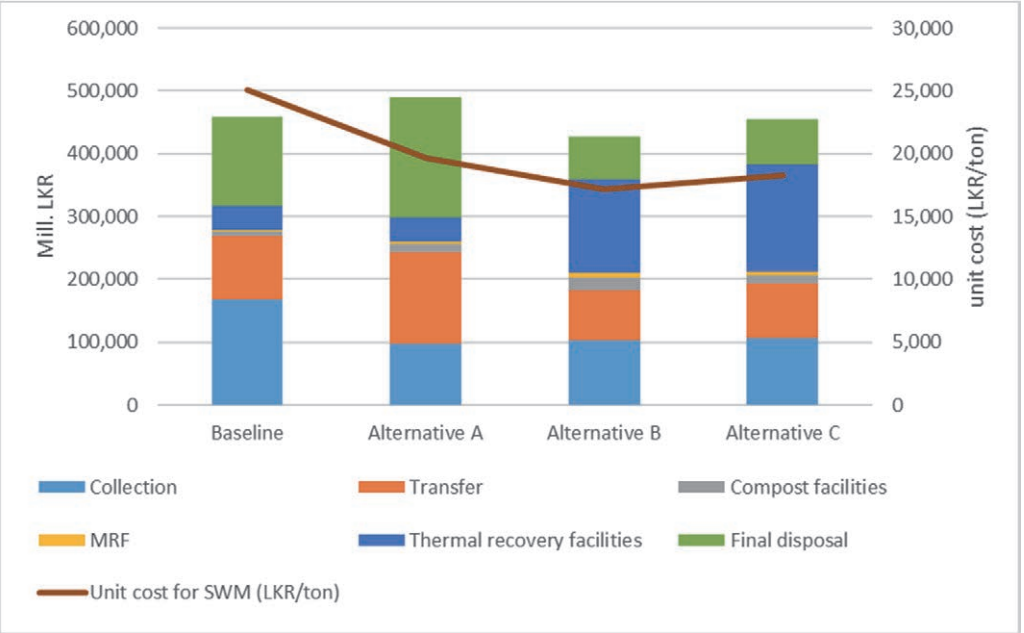


Figure 3-13 Total amount and unit costs for SWM for 2023-2042

b.2.3 Environmental and social considerations

Specifically, the critical environmental and social impact items and evaluation methods (scoping) have been reviewed at the decision-making stage of the plans and programs. A comparative examination including aspects of environmental and social considerations for multiple alternatives have been considered. SEA and MP formulation were conducted in parallel. SEA also includes the formulation of a monitoring plan for environmental and social considerations during MP implementation. The results of the study are summarized in the SEA report (Appendix 2).

b.3. Selection of optimal SWM plan

As a result of evaluating the baseline and the three alternatives for the SWM system, alternatives B and C, which can recover the energy associated with incineration and reduce the volume of waste for final disposal by actively promoting incineration, have been compared with the other options. The amount for disposal is very small, and incnerations are suitable as treatment systems in the Western Province where disposal sites must be sought out of the province. In addition, alternatives A, B and C actively promote the recycling of organic waste through composting, and in particular, alternative B is the system that most favours waste recycling and ensures the composting all the remaining organic waste, except the 20% of the collected organic waste that is incinerated. Economically, alternative B was evaluated as the cheapest system compared to the other plans. Based on the above, alternative B is selected as the optimal SWM system for waste management in the Western Province.

c. Solid Waste Management Master Plan

The SWM targets for the Western Province and each of the three districts are indicated below.

c.1. Numerical targets

Table 3-24 Numerical targets of SWM for the Western Province

Target year		Waste reduction rate	Collection coverage	Recycling rate	Disposal rate
Present	2022	0%	56%	14%	27%
Short term	2025	3%	61%	18%	29%
Middle term	2030	5%	68%	20%	20%
Long term	2042	10%	81%	24%	20%

Table 3-25 Numerical targets of SWM for Colombo District

Target year		Waste reduction rate	Collection coverage	Recycling rate	Disposal rate
Present	2022	0%	70%	14%	27%
Short term	2025	1%	74%	17%	30%
Middle term	2030	3%	80%	18%	18%
Long term	2042	10%	92%	23%	21%

Table 3-26 Numerical targets of SWM for Gampaha District

Target year		Waste reduction rate	Collection coverage	Recycling rate	Disposal rate
Present	2022	0%	43%	16%	26%
Short term	2025	1%	47%	20%	27%
Middle term	2030	3%	54%	23%	29%
Long term	2042	10%	70%	26%	18%

Table 3-27 Numerical targets of SWM for Kalutara District

Target year		Waste reduction rate	Collection coverage	Recycling rate	Disposal rate
Present	2022	0%	41%	13%	28%
Short term	2025	1%	45%	19%	26%
Middle term	2030	3%	51%	20%	12%
Long term	2042	10%	65%	24%	17%

c.2. Future waste amount and waste flow

Future waste amount and waste flow in the Western Province as projected in the MP are shown below.

Table 3-28 Future waste amounts for SWM in the Western Province

Waste Flow	2022		2025		2030		2042	
	Vol. (t/d)	(%)	Vol. (t/d)	(%)	Vol. (t/d)	(%)	Vol. (t/d)	(%)
1. Generation	3,926	100%	4,342	100%	4,952	100%	6,181	100%
7. Improper discharge	821	21%	815	18.60%	748	14.67%	515	7.54%
5. Discharge	2,198	55.99%	2,620	59.79%	3,337	65.43%	4,985	73.02%
8. Informal recycling	118	3.01%	169	3.86%	255	5.00%	229	3.35%
11.1 Composting	325	8.28%	611	13.94%	786	15.41%	1,332	19.51%
11.3 Recycling	110	2.80%	143	3.26%	194	3.80%	421	6.17%
11.4 Thermal recovery	752	19.15%	751	17.14%	1,687	33.08%	2,874	42.10%
12. Intermediate untreated waste	799	20.35%	865	19.74%	365	7.16%	129	1.89%
15. Final Disposal	1,065	27.13%	1,241	28.32%	997	19.55%	1,206	17.67%

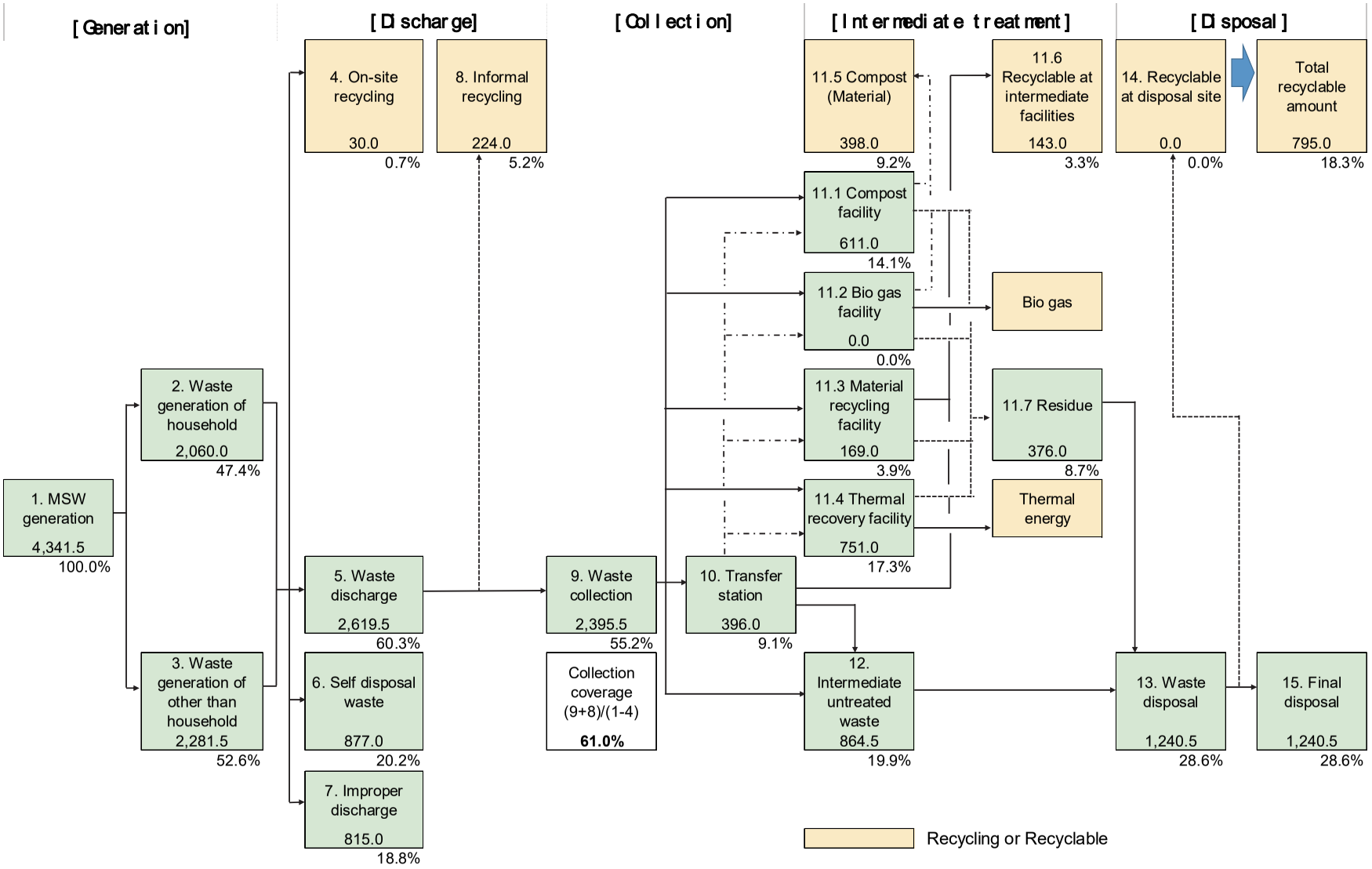


Figure 3-14 Future waste flow in the Western Province by 2025 (Short term)

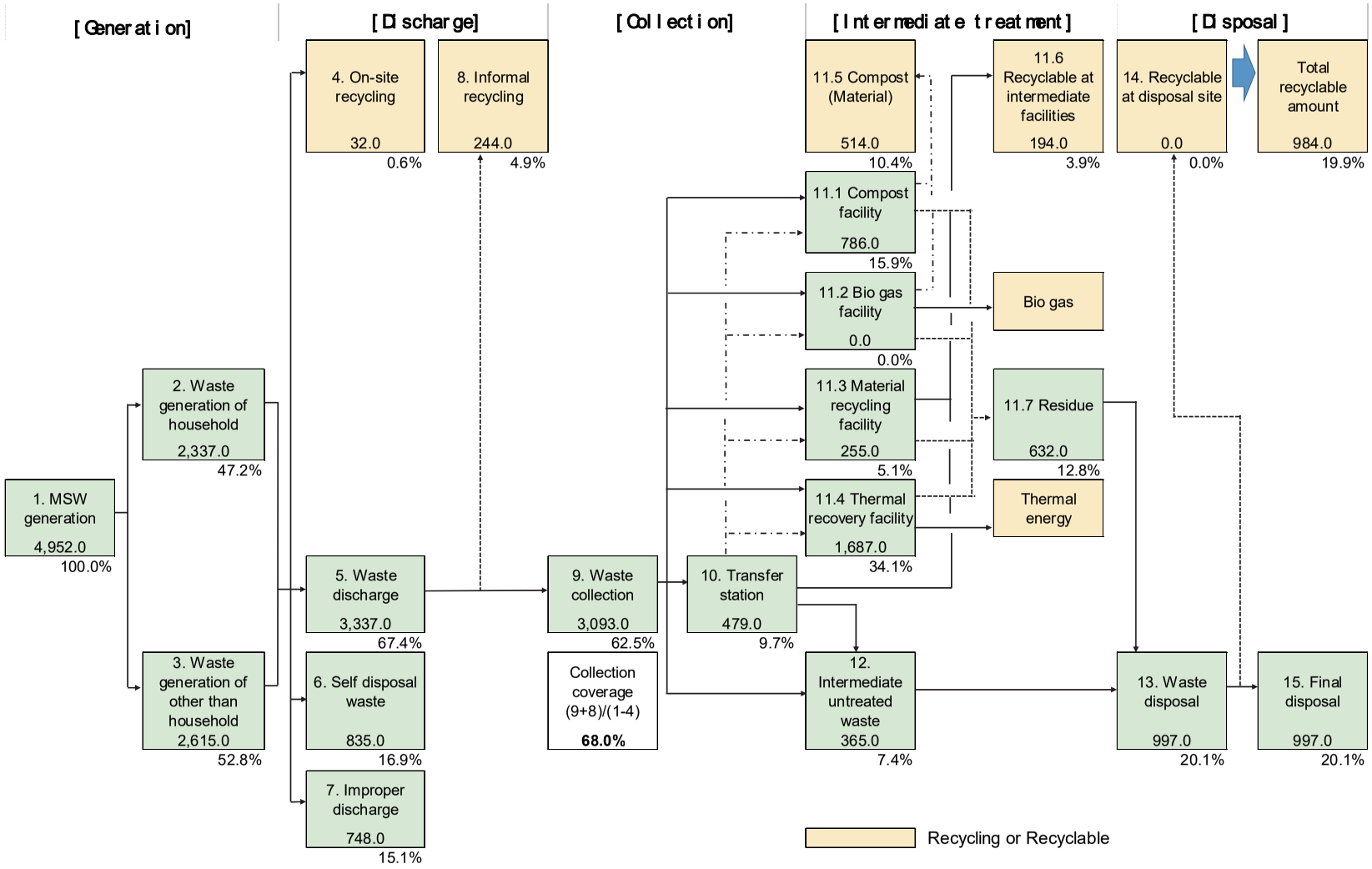


Figure 3-15 Future waste flow in the Western Province by 2030 (Medium term)

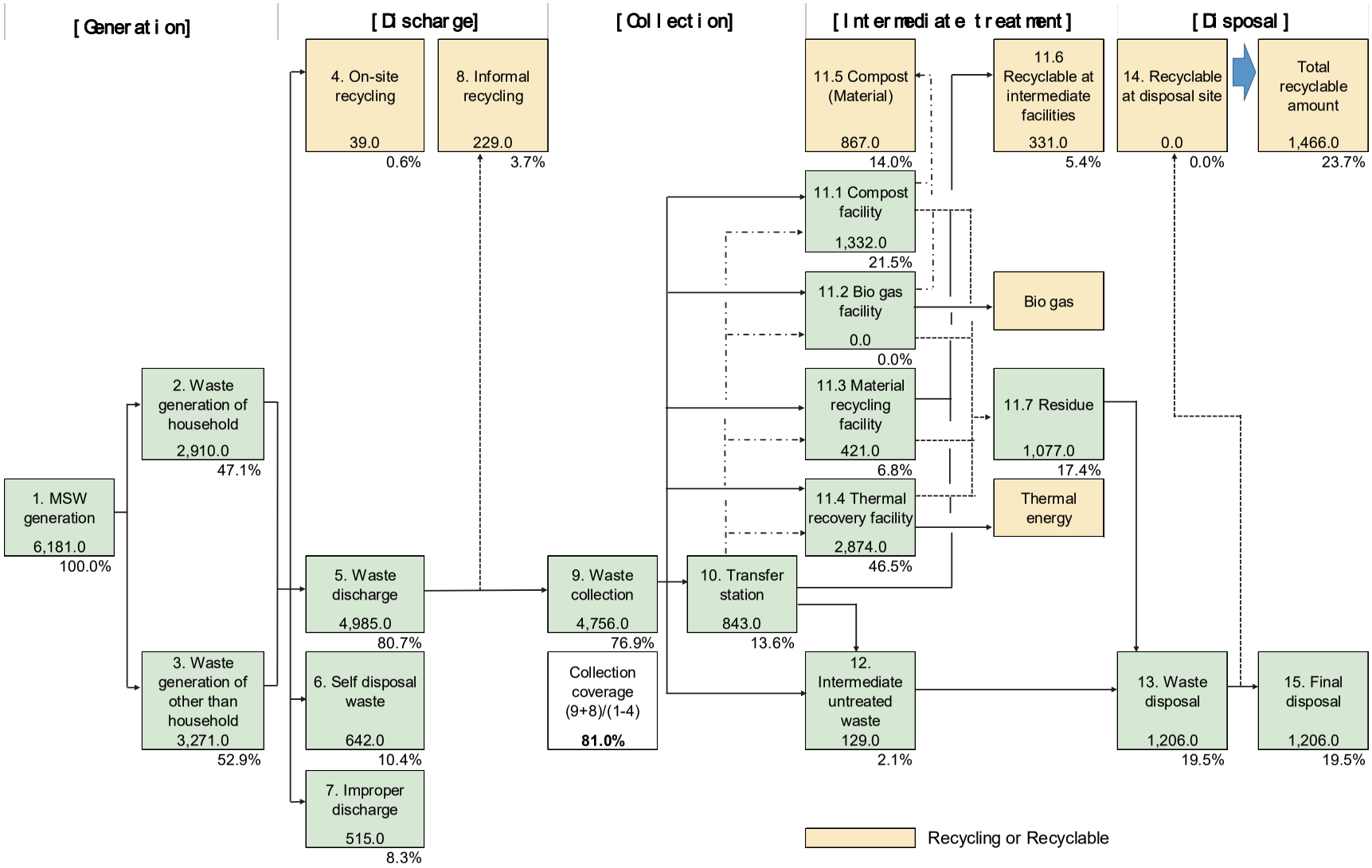


Figure 3-16 Future waste flow in the Western Province by 2042 (Long term)

c.3. Milestones for the MP

The table below shows the milestones for achieving the MP targets during the MP period, i.e. 1) Short term: 2023-2025, 2) Medium term: 2026-2030 and 3) Long term: 2031-2042. The MP will be implemented according to these milestones.

Table 3-29 Milestones for achieving the MP targets

		Short term			Medium term				Long term										
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Reduction of waste generated					1%					3%												10%
Waste separation at source																						
Improvement of collection rate	MC	65%																				95%
	UC	72%																				95%
	PS	32%																				60%
Thermal Recovery Facilities (TRF) (ton/day)																						
WPK WtE facility		750						1,500 (750+750)														
TRF in Colombo District								400						800 (400+400)								
TRF in Gampaha District														600								
Compost facilities (CF) (ton/day)																						
LAs CFs		92			117					131												136
Cluster-bases* CFs		232			333					340												794
Waste Park CFs		0			160					400												400
Material Recovery facilities (MRF) (ton/day)																						
LAs recycling facilities		110			169					255												421
Waste Park MRFs		0			60					150												150
Transfer station (TS) (ton/day)																						
Primary TS					400					490												850
Secondary TS (Kelaniya transfer station)		1,065			1,242					997												1,206
Final disposal (Aruwakkalu DS) (Accumulated volume of waste disposed for 20 years (million m^3))					1.5					4.0												9.5
By-Product																						
Amount of electric power (GWh/year)					74					179												279
Compost (ton/year)					6,700					8,700												14,600
GHG emission reductions from composting of biodegradable waste**(mill.-t CO2/year)		71			156					322												1,273

* Common compost facilities managed by Central Government or Western Province.

** The emission reduction from the project activity is determined as the differences between the GHG emissions of baseline scenario (methane are emitted to atmosphere without recovery) and project scenario (composting biodegradale wastes).

c.4. Action

c.4.1 Outline of SWM system

An overview of the SWM system to be promoted in the MP is shown below.

Table 3-30 Outline of the SWM system

SWM system: Waste reduction at generation source

- Waste reduction is promoted according to the following targets.

Targets for waste reduction rate and amount of waste generated

Year	2022	2025	2030	2042
Targets for waste reduction rate (%)	0%	1%	3%	10%
Waste generated (ton/day)	3,926	4,342	4,952	6,181

SWM system: Segregation of waste discharged

- Segregation of discharged waste, e.g. organic waste, recyclables and other waste, is promoted.

Target rates for the segregation of discharged waste by type of LA

Type of LA	Organic waste	Recyclables			Other waste
		Recycling at discharge/collection stage	Recycling in Recycling yard/SK*	Total	
MC	40%	5%	10%	15%	45%
UC	45%	5%	7%	12%	43%
PS	50%	5%	5%	10%	40%

* SK: Sampath Kendraya

SWM system: Collection system

- Collection area is expanded based on the collection coverage targets by type of LA.

Collection coverage targets by type of LAs

	2022	2042
MC	65%	95%
UC	72%	95%
PS	32%	60%

- Amount of waste collected

Year	2022	2025	2030	2042
Waste collected (ton/day) (* Including recyclables collected by waste collection crews)	1,994 (2,198)	2,396 (2,620)	3,093 (3,337)	4,756 (4,985)

- Type of collection vehicles
  - Organic waste: 4-ton compactor trucks
  - Recyclables: Tractor-trailers (6-7 m^3)
  - Other waste: 4-ton compactor trucks
- Required number of collection vehicles

	2025	2030	2042
Organic waste	99	114	188
Recyclables	94	144	223
Other waste	358	391	569
Total	551	649	980

SWM system: Transfer system

- Primary transfer stations are constructed, operated and managed jointly with the neighbouring LAs.

Primary Transfer Station	Amount of waste transferred (ton/day)		
	2025	2030	2042
Colombo TS	90	90	140
Kalutara West TS	60	90	130
Kalutara East TS	10	40	760
Gampaha West TS	100	130	240
Gampaha East TS	140	170	280
Total	400	490	850

- Secondary transfer station (Kelaniya Transfer Station)
  - Transportation to Aruwakkalu DS by train

	2025	2030	2042
Amount of waste transferred (ton/day)	1,242	997	1,206

Intermediate treatment system

➢ Capacity of Thermal Recovery Facilities (TRF)

	2022	2025	2030	2042
Western Power at Kerawalapitiya (WPK) TRF facility (ton/day)	750	750	1,500	1,500
TRF in Colombo District (ton/day)	-	-	400	800
TRF in Gampaha District (ton/day)	-	-	-	600
Total (ton/day)	750	750	1,900	2,900
Cumulative amount of electric power during 2023-2042 (GWh)	372	372	1,056	4,070

➢ Required capacity of composting facilities (ton/day)

	2022	2025	2030	2042
LAs' composting facilities	92	117	131	136
Cluster-based composting facilities	232	333	340	794
Waste Park composting facilities	0	160	400	400
Total	324	610	850	1,285

➢ Required capacity of recycling facilities (ton/day)

Year	2022	2025	2030	2042
LAs' recycling facilities	116	116	116	270
Waste Park MRF	0	60	150	150

Final disposal system

➢ Waste for disposal generated in the Western Province is disposed of at Aruwakkalu DS.

➢ Volume for disposal ('000 m^3)

Year	2025	2030	2042
✓ Volume of waste for disposal	453	364	440
✓ Soil cover	91	73	88
Total volume for disposal	544	437	528
Cumulative volume for disposal (mill. m^3) from 2023	1.54	4.00	9.51

Cost

Total cost for SWM (million LKR for 2023-2042)

Item	Sub-item	Cost
Collection	Procurement cost of vehicles	7,189
	Fuel & maintenance cost	69,778
	Labor cost	25,976
	sub-total	102,943
Transfer	Procurement cost of vehicles	2,050
	Fuel & maintenance cost	44,556
	Labor cost	1,507
	O&M cost	23,540
	Initial cost	8,430
	Sub-total	80,083
Composting facility	O&M cost	19,638
	Initial cost	665
	Sub-total	20,303
MRF	O&M cost	4,164
	Initial cost	2,000
	Sub-total	6,164
TRF	O&M cost	99,437
	Initial cost	53,748
	Sub-total	153,185
Final disposal	O&M cost	38,046
	Initial cost	31,291
	Sub-total	69,337
Total		432,014

c.4.2 Key strategic actions to improve the SWM system

The following six items have been defined as the priority technical measures to improve the SWM system in the MP. Details of each priority activity are described below.

- ■ Promotion of waste reduction at source of generation
- ✓ Take measures to limit the increase in the amount of waste generated due to population and economic growth.
- ■ Promotion of waste separation and reduction at the discharge stage
- ✓ Ensure waste separation (organic, recyclables, and other waste) and promote the collection of recyclable waste.
- ✓ Promote recycling at generation source and reduce the amount of waste discharged.
- ■ Improved waste collection and transfer system
- ✓ Expand the collection area.
- ✓ Select efficient and hygienic collection vehicles according to the type of waste to be transported.
- ✓ Build primary transfer stations that will be operated and managed jointly by neighboring LAs to improve the collection efficiency of burnable waste (transported to TRFs) and waste for disposal (transported to the Kelaniya TS).
- ■ Promotion of recycling at intermediate treatment facilities
- ✓ Aim for zero disposal of collected organic waste.
- ✓ Recover energy from burnable waste and approximately 20% of collected organic waste.
- ✓ Increase the capacity of composting facilities to maximize the production of compost from the organic waste collected.
- ✓ Promote recycling, increase the capacity of existing LAs' recycling facilities and build MRFs in waste parks.
- ■ Reduction of waste for disposal
- ✓ Reduce the amount of waste for disposal by reducing waste generation, and promoting separate collection and intermediate treatment.
- ✓ Close open dumpsites.
- ■ Establishment of a data management system based on a database
- ✓ Collect and enter the data required for waste management using standard forms.
- ✓ WMA to manage and operate a database of data entered by municipalities and cluster-based facilities.
- ✓ WMA to analyze the data in the database and support LAs for SWM.
- ✓ Implement SWM using the database managed by WMA.

d. Operation of the SWM MP (short and medium term)

The solid waste management projects (SWM projects) that need to be prepared and implemented within eight years (short and medium term) to achieve the MP objectives have been selected and planned.

d.1. SWM projects and implementation schedule

The short and medium (eight years) term SWM projects mainly consist of the following eight projects, and their overall implementation schedule is shown in the table below.

- Project 1: Development of five Primary Transfer Stations (PTS)
- Project 2: Improvement of Kelaniya Transfer Station (KTS)
- Project 3: Development of Cluster-based Waste Treatment Facilities (CWTF)
- Project 4: Improvement of composting facilities
- Project 5: Improvement of recycling facilities for formal recyclables
- Project 6: Procurement of collection and transfer vehicles
- Project 7: Closure of current dumpsites managed by LAs
- Project 8: Encouragement of waste separation

Table 3-31 Schedule of short and medium term SWM Projects

		Short term			Medium term				
	2022	2023	2024	2025	2026	2027	2028	2029	2030
Project 1: Development of five Primary Transfer Stations (PTS)									
Colombo TS: 90 ton/day	Sites selection	Budgeting, Land parches, Environmental process, DD, T/D	Tender, Contract, Construction	Operation					
Kalutara west TS: 90 ton/day				Operation					
Kalutara east TS: 40 ton/day				Operation					
Gampaha west TS: 130 ton/day				Operation					
Gampaha east TS: 170 ton/day				Operation					
Project 2: Improvement of Kelaniya Transfer Station (KTS)									
Amount of waste transferred (ton/day)	1,070	1,240	1,130	1,240	1,320	1,430	920	950	1,000
Compared to 2022 (%)	100%	116%	106%	116%	123%	134%	86%	89%	93%
Project 3: Development of Thermal Recovery Facilities (TRF)									
WPK WtE facility (750 ton/day)	Operation								
Additional WPK WtE facility (750 ton/day)		FS, EIA, Tender, Contract & DD		Construction			Operation		
TRF Colombo District (400 ton/day)		FS, EIA, Tender, Contract & DD		Construction			Operation		
Project 4: Improvement of compost facilities									
Waste Park compost facilities									
Waste Park (ton/day) No.1,2	Sites selection,	Construction	160	160	160	160	160	160	160
Waste Park (ton/day) No.3		Sites selection, Tender, Contract		Construction	80	80	80	80	80
Waste Park (ton/day) No.4				Sites selection, Tender, Contract		Construction	80	80	80
Waste Park (ton/day) No.5						Sites selection, Tender, Contract		Construction	80
Total			160	160	240	240	320	320	400
LAs and cluster-based compost facilities									
Cluster-based facilities (ton/day)	232	300	340	340	340	340	340	340	340
LA's facilities (ton/day)	92	100	110	120	130	130	130	130	130
Total	324	400	450	460	470	470	470	470	470
Project 5: Improvement of recycling facilities for formal recyclables									
Recyclable amount (ton/day)	120	130	150	170	190	200	220	240	260
Waste Park MRF facilities									
Waste Park (ton/day) No.1,2	Sites selection,	Construction	60	60	60	60	60	60	60
Waste Park (ton/day) No.3		Sites selection, Tender, Contract		Construction	30	30	30	30	30
Waste Park (ton/day) No.4				Sites selection, Tender, Contract		Construction	30	30	30
Waste Park (ton/day) No.5						Sites selection, Tender, Contract		Construction	30
Total			60	60	90	90	120	120	150
Project 6: Procurement of collection and transfer vehicles									
Compactor truck for organic waste		Subsidies and support systems	Procurement plan, approval, budgeting	99	101	108	108	111	114
Compactor truck for other waste				358	378	407	360	373	391
Tractor trailer for recyclable				94	105	115	126	137	144
Project 7: Closure of current dump sites operated by LA									
Preparation of Guideline for closing dump sites	Guideline								
Technical guidance and budgeting secured for closure		Guidance Budgeting							
Implementation of closure			Implementation						
Project 8: Development of waste separation promotion program									
Development of waste separation guidelines	Guideline								
Seminar for LAs on understanding the guideline.		Seminar							
Preparation and implementation of promotion program		Preparation							
Implementation of separate collection of waste			Implementation						

(2) Economic and financial analysis of the master plan

In the previous sections, the formulation and selection of the Master Plan alternatives were discussed mainly from a technical viewpoint. Three alternatives have been formulated through (i) estimation of waste generation, (ii) estimation of waste treatment volumes based on collection and waste composition targets for each local authority, (iii) creation of alternatives by combinations of waste treatment method and waste volume. The Working Group selected Alternative B as the best from a technical, socio-environmental, and total financial cost perspective.

In terms of economic and financial assessment of the selected alternative, the analysis focuses on the following two aspects:

- Cost-effectiveness: Confirmation that the selected method is the least expensive among the technically and environmentally feasible alternatives.
- Financial sustainability: Confirm that the relevant authorities have sufficient financial capacity to bear the cost.

(a) Cost-effectiveness

Various factors affect the total cost of waste management, such as the amount of waste, the type of waste, the intermediate treatment method, the means of transportation, and the transportation distance. The conditions differ depending on the local authorities. The comparable average cost (levelized cost per ton of waste taking into account the lifetime of the facilities) of the following three methods is estimated to evaluate the cost-effectiveness among the alternatives.

Table 3-32 Conditions of intermediate treatment and final disposal

	(1) Composting	(2) Thermal Recovery	(3) Direct Disposal
Input	Organic waste only	Mixed waste (organic waste and recyclable waste can be included)	Any municipal waste
Process Output Disposal	From 1 ton of organic waste, 100 kg of compost are produced. 250 kg of residues remain and are transported to Aruwakkalu DS for disposal. The compost is sold in the market at LKR 10/kg.	Through incineration with energy recovery, 274 kWh of electricity are generated from 1 ton of mixed waste. 250 kg of residues remain and are transported to Aruwakkalu DS for disposal. The concessionaire sells electricity to CEB and the economic value of the electricity (LKR 19.0/kWh) is counted as revenue.	Waste is transported without intermediate treatment from the Kelaniya Transfer Station to Aruwakkalu DS for disposal.

Source: JICA Expert Team

The comparison between the alternatives is made by estimating the total SWM cost per ton of waste for each treatment option. For all of the above intermediate treatment options, the collection and transportation costs to the transfer station are assumed to be the same and are thus not included in the calculation. In the calculation of future costs and benefits, the general methodology is followed and inflation is not taken into account. The cost estimates are as follows:

i. Composting

CAPEX: Unit capacity construction cost LKR 500,000/ton
Facility lifetime: 20 years; Interest rate: 4% => Annual capital recovery factor: 7.4% => Annualized capital cost LKR 37,000/ton/year
Per-ton construction cost LKR 100
Operation: Per-ton operation cost for composting LKR 3,000
Transportation & Disposal: Residues (250 kg from 1 ton of organic waste) transportation & disposal, based on (iii) below: LKR 17,400 × 0.25 LKR 4,400
Revenue: 100 kg of compost from 1 ton of organic waste @LKR 10/kg LKR 1,000

ii. Thermal Recovery Facility (TRF)

CAPEX: Unit capacity construction cost LKR 25,000,000/ton
Facility lifetime: 20 years; Interest rate: 4% => Annual capital recovery factor: 7.4% => Annualized capital cost LKR 1,850,000/ton/year
Per-ton construction cost LKR 5,100
Operation: Per-ton operation cost for TRF + 10% Overhead LKR 7,700
Transportation & Disposal: Residues (250 kg from 1 ton of organic waste) transportation & disposal, based on (iii) below: LKR 17,400 × 0.25 LKR 4,400
Revenue: 274 kWh from 1 ton of waste; Avoidable cost for CEB: LKR 19.0 kWh (from CEB Long-term Generation Expansion Plan 2022-2041) LKR 5,200

iii. Direct Disposal

CAPEX: Construction cost of Aruwakkalu DS LKR 8,000
OPEX: Operation cost of Aruwakkalu DS LKR 4,000
Transportation: From Kelaniya TS to Aruwakkalu DS LKR 5,400

Table 3-33 Levelized costs of waste treatment and disposal per ton

(LKR/ton)

	(1) Composting	(2) Thermal Recovery	(3) Direct Disposal
Capital cost (CAPEX)	100	5,100	8,000
Operation cost	3,000	7,700	4,000
Transportation	4,400	4,400	5,400
Revenue (-)	- 1,000	- 5,200	
TOTAL	**6,500**	**12,000**	**17,400**

Source: JICA Expert Team

As a result of the above cost-effectiveness analysis, the least expensive treatment method is (1) Composting of organic waste, which costs LKR 6,500 per ton, followed by (2) Thermal recovery (LKR 12,000), while the most expensive option is (3) Direct disposal (LKR 17,400).

- (1) Composting cost is 63% lower than (3) Direct disposal cost. (2) Thermal recovery cost is 31% lower than (3) Direct disposal cost. Thus, both (1) Composting and (2) Thermal recovery are more cost-effective than (3) Direct disposal.
- Since (1) Composting and (2) Thermal recovery are treatment methods for different types of waste, they are not mutually exclusive alternatives. Thus, both are to be implemented insofar as technical and environmental conditions allow. Composting has a relative advantage in term of economic efficiency in case of financial resource constraints.
- The ranking by cost-effectiveness of the alternatives is consistent with the waste management hierarchy. (1) Composting (recycling), (2) Thermal (energy) recovery, and (3) Disposal. Acting according to cost-effectiveness is at the same time proceeding according to the waste management hierarchy.

(b) Financial sustainability

Financial sustainability analysis confirms that concerned authorities have sufficient financial capacity to bear the cost. This is critical from the following two considerations:

- It is assumed from past practice that the recurrent cost is financed by the local authorities, while the central government bears the capital investment cost. The capital cost is very low compared to the government's total capital budget. Therefore, the financial capacity of the government should not be an issue.
- In 2020, the own revenues of the LAs of the Western Province only covered one quarter of their total expenditure. The remaining three quarters have been transferred from the government. In this context, LAs do not have the freedom to allocate a budget to their priority areas. Waste management currently receives 20% of the total recurrent expenditure, the highest among all expenditure heads. It is unlikely that the percentage allocated to waste management will increase significantly.

Alternative B, considered the best from a technical, environmental, and economic perspective, is assessed from the financial sustainability viewpoint.

The table below summarizes the waste management costs during the MP period (20 years from 2023 to 2042) by management process, separated for capital investment costs (30%) and operating costs (net of revenue 70%). A comparison of the process activities shows that collection costs account for 29% and transportation costs for 23%, which means that transportation-related costs account for more than half. This is followed by thermal recovery (incineration with power generation), final disposal, and composting.

Table 3-34 Costs for the Master Plan (Total of 20 years)

(million LKR)

Waste Management Process	Costs		Benefits (-)	**Total Net Costs**	%
	Capital	Operation			
Collection	7,513	95,754	0	**103,267**	29%
Transfer/Transportation	10,417	69,601	0	**80,018**	23%
Composting	503	19,638	- 6,546	**13,595**	4%
Recycling	2,000	4,164	0	**6,164**	2%
Thermal Recovery	53,748	99,437	- 73,953	**79,232**	23%
Final Disposal	31,291	38,046	0	**69,337**	20%
Total	**105,472**	**326,640**	**80,499**	**351,613**	**100%**
%	30%	93%	-23%	**100%**	

Source: JICA Expert Team

For the financial sustainability analysis, it is essential to confirm the total budget envelop of the respective organization. Since the capital budget fluctuates from year to year and depends on the central government, the comparison is made on the recurrent budget of 2020. The budget per person of the central government is LKR 116,000, that of the Western Provincial Council is LKR 12,000 (1/10th of the central government) and that of the 49 local authorities is LKR 4,000 (1/30th of the central government, 1/3 of WPC).

Table 3-35 Recurrent Budget of the central government, Western Provincial Council, and LAs (2020)

		Central Government	Western Provincial Council	Local authorities in the Western Province		
				49 LAs (Total)	CMC	48 LAs (excl. CMC)
Recurrent Budget	(LKR Mil)	2,548,359	73,774	22,533	10,895	11,638
Population	('000)	21,919	6,226	6,226	597	5,629
Recurrent budget per person	(LKR/ person)	128,036	11,849	3,619	18,250	2,068

Source: Budget Estimates 2020, Financial Statement (2020) Western Provincial Council, LA's Budget Data from Finance Commission

The table below shows the share of the budget allocated to waste management in 42 LAs in the Western Province (data is not available for 7 LAs). The average is 20%, the median is also 20%, and the most frequent range is 20%-30%.

Table 3-36 Share of budget allocated to waste management in LAs (2021)

	0% - 10%	10% - 20%	20% - 30%	30% - 40%	40% - 50%
No. of LA	9	12	15	5	1

It can be noted that waste management is currently one of the most significant items of expenditure in the budget of local authorities. When the master plan is implemented and the level of services improves, the allocation for waste management will have to be increased accordingly. LAs may then face difficulties finding resources for such allocations.

The first step is to estimate the total recurrent budget of LAs to analyze financial sustainability. It has been estimated assuming a 5% per annum increase in real terms.

Table 3-37 Projection of total recurrent budget in the 49 LAs of the Western Province (2022-2042)

(million LKR)

	2022	2023	2027	2032	2037	2042	2023-2042 Total
Recurrent Budget	26,426	29,135	35,413	45,197	57,685	73,622	963,365

Source: JICA Expert Team

Then, the costs estimated in the MP for each activity of the waste management process are broken down into annual allocation, as shown below. These figures do not include the capital expenditure, which is supposed to be covered by the budget of the central government.

Table 3-38 Estimated operation cost of waste management (2022-2042) - Case 1

(million LKR)

Waste Management Process	2023	2027	2032	2037	2042	2023-2042
Collection	3,376	3,802	4,687	5,564	6,501	95,746
Transfer/Transportation	3,065	4,033	3,379	3,310	4,066	68,701
Composting	437	756	958	1,161	1,456	19,638
Recycling	96	147	208	258	307	4,164
Thermal Recovery	625	765	1,181	1,661	1,882	25,485
Final Disposal	2,010	2,513	1,895	1,751	2,113	38,056
Total	**9,610**	**12,015**	**12,308**	**13,705**	**16,325**	**251,790**
% of Recurrent Budget	**33%**	**34%**	**27%**	**24%**	**22%**	**26%**

Source: JICA Expert Team

The percentage of 33% in 2023 and peak of 34% in 2027 are 1.7 times the current level (20%).

The sharp increase during this period is caused by the large volume of untreated waste transported to and disposed of in Aruwakkalu DS due to the lack of intermediate treatment facilities. The percentage then gradually lowers as intermediate treatment facilities develop and the amount of waste disposed of without treatment decreases.

Table 3-39 Estimated operation cost of waste management - Case 2

(million LKR)

Waste Management Process	2023	2027	2032	2037	2042	2023-2042
Collection	3,376	3,802	4,687	5,564	6,501	95,746
Transfer/Transportation	3,065	4,033	3,379	3,310	4,066	68,701
Composting	437	756	958	1,161	1,456	19,638
Recycling	96	147	208	258	307	4,164
Thermal Recovery	2,403	2,939	4,539	6,381	7,232	97,932
Final Disposal	2,010	2,513	1,895	1,751	2,113	38,056
Total	11,388	14,190	15,666	18,426	21,675	324,238
% of Recurrent Budget	39%	40%	35%	32%	29%	34%

Source: JICA Expert Team

The Case 1 scenario assumes that the capital expenditure is borne by the central government. Accordingly, the capital cost of thermal recovery is excluded from the table. However, at the operation stage, payment in the form of a tipping fee is made to the TRF concessionaire for the waste it receives. In this case, both capital cost and operation cost are included in this fee. (This is the case of the first thermal recovery facility in Kerawalapitiya, where the investor is paid LKR 23.1/kWh for electricity by CEB and the balance (LKR 13.1/kWh) is covered by the Treasury as a special arrangement to take into account the urgency and the limited capacity of the LA.) When part of the capital expenditure is included in the tipping fee, the share of waste management in the recurrent expenditure increases significantly, as shown in the table above (Case 2).

The share of waste management in LAs' budget is indicated on the last line. The highest percentage of 40% is reached in 2027 and gradually declines to 29% in 2042, which is 6%-8% higher than in Case 1. This is unbearably high. To avoid this unrealistic figure, the capital component should be removed from LAs' burden, either by financing the capital cost, e.g. through viability gap funding (VGF) by the central government at the initial stage, or by subsidizing the capital portion through annual fund transfers from the Treasury to the concessionaire. It is essential that the central government, Provincial Council, and local authorities discuss and agree on this matter when formulating the project .

To alleviate these difficulties faced by LAs, it is essential to decide on a policy consisting either of continuous support from the central government not only for capital expenditure but also for recurrent expenditure, or, as a short-term contingency measure, to allow controlled open dumping (less costly compared to disposal in Aruwakkalu DS) in a nearby area.

Table 3-40 The share of waste management in LAs budget

	0% - 10%	10% - 20%	20% - 30%	30% - 40%	40% - 50%
No. of LA	9	12	15	5	1

Source: JICA expert team

3.1.6 C.1.6 The process and outputs of activities of the WG are shared with relevant organizations (including those which authorize the MP) both at the Provincial and Central levels by holding workshops or meetings

The approval procedure for MPs is as follows: State government department/WMA → State government Chief Secretary → State government Chief Minister → State government Board of Ministers. Since the comprehension of the Chief Secretary of the State government, who is the highest administrative official, is the most important for the approval of the MP, meetings are held approximately once every six months to share the WG's activity process and results with the Chief Secretary of the State government. After approval by the provincial government, the process of obtaining Cabinet approval will be initiated.

3.1.7 C.1.7 An inter-organizational coordination body such as Provincial Solid Waste Management Committee which takes over the work of the Working Group is proposed

The Working Group was the main forum for discussing the Draft Master Plan. To take over the work of the WG, "Coordination Committee on Waste Management in Western Province" described below was proposed and agreed upon at the JCC meeting on 4 November 2022. In order to formalize the establishment of the committee, the creation of the committee will also be proposed and approved when the Provincial Council and the Cabinet of Ministers approve the MP.

(1) Purpose and Functions

The objective is to facilitate the implementation of waste management development projects and operations in the Western Province through inter-organizational coordination.

- Develop a 3-year action plan in line with MP.
- Recommend major infrastructure development projects.
- Monitor progress and support the implementation of ongoing development projects.
- Monitor waste management performance at the central government and LA levels.

(2) Organization

- The Committee consists of undersecretaries and heads of organizations. Meetings are held twice a year.
- The Working Committee consists of project managers. Meetings are held quarterly.

(3) Committee Members

- Ministry of Public Administration, Home Affairs, Provincial Councils and Local Government, and NSWMSC
- Ministry of Environment and CEA
- Ministry of Urban Development and Housing, SLLDC
- Western Province and WMA
- In addition to the above members, organizations such as the National Planning Department, Local Authorities, JICA, and other relevant organizations will be present as Invitees.

(4) Responsibility

- Ministry of Public Administration, Home Affairs, Provincial Councils and Local Government, and NSWMSC: coordinating the committees and secretariat functions
- WMA: Develop a draft 3-year action plan for waste management in the Western Province and report on the status of waste management in the Western Province.
- Each organization: Implement projects in line with Committee decisions and report on progress.

3.2 C.2 Activities of Output 2

Output 2: Current situations and challenges of solid waste management in Western Province are clarified.

3.2.1 C.2.1 The Working Group for MP formulation decides a. types of waste, b. target year, c. areas and population

Types of waste, target years, area of local authority and population in the MP will be determined based on discussions according to the following principles proposed by the JICA Expert Team.

a. The types of waste considered in this MP for the short-, medium- and long-term periods are mainly municipal solid waste generated by households, institutes, shops, restaurants, offices, hospitals, factories, etc. The present status of industrial waste, medical waste, and construction and demolition waste included in municipal solid waste and scheduled waste are to be studied and summarized using available secondary data.

b. The duration of the MP is tentatively 20 years from 2020 to 2040. Target years for the long-term plan, medium-term plan and short-term plan are set at 2040, 2030 and 2025 respectively as per previous discussions with the Sri Lankan government. The WG shall finalize the duration and terms of the MP.

c. The boundaries, areas, population, number of households, etc. of the target 49 LAs in the Western Province are to be defined by the WG.

For item c) above, the future population of the 49 LAs in the Western Province has been projected for the MP period (2020-2040). The most recent census (2012) was used as the basis for these estimates. The population growth rate of 0.78% per annum, which was derived from the population growth rate of 2012-2018 in the Western Province, was uniformly applied to all LAs for the entire 20-year period. The results are shown in the table below.

Table 3-41 Population growth in the Western Province (1981-2018) and future projection

Item	Annual Average Growth Rate (%)			Population Projection ('000)		
Year	1981 - 2001*	2001 - 2012*	2012 - 2018**	2020	2030	2040
Sri Lanka	1.19%	0.73%	1.05%			
Western Province	1.65%	0.79%	0.78%	6,226	6,729	7,273
Colombo District	1.46%	0.34%	0.81%	2,473	2,673	2,889
Gampaha District	2.07%	1.02%	0.74%	2,453	2,651	2,865
Kalutara District	1.29%	1.25%	0.79%	1,300	1,405	1,519

Source: * Census 1981, 2001, 2012

** Mid-year Population Estimates

Source: JICA Expert Team

3.2.2 C.2.2 Organizations in Western Province relevant to solid waste management are investigated and data on solid waste management is collected

(1) Municipal solid waste

a. Objectives of collecting, analyzing and utilizing SWM data

The objectives are as follows:

i. SWM data of LAs are collected and analyzed in order to understand the present situation and issues quantitatively.
ii. Based on the identified SWM situation and issues, a quantitative SWM Master Plan (MP) for Western Province is formulated. In addition, action plans (AP) for LAs in line with the MP are developed.
iii. The capacity of LAs and WMA staff to collect, analyze and use SWM data is improved.
iv. A series of activities for collecting, analyzing, and utilizing waste management data in the Western Province will support the development of the national level database system that CEA and NSWMSC are aiming for.

b. Collection of SWM data for LAs

The procedure for collecting, analyzing and utilizing SWM data is as follows:

i. Discussion with relevant C/P organizations.
Discussions were held with relevant C/P organizations on the purpose of data collection, data to be collected, procedure for data collection, analysis and use of collected data, etc.
ii. Completion of a draft questionnaire for collecting SWM data
Following intermittent discussions with WMA, NSWMSC, and CEA, a draft questionnaire for collecting SWM data was finalized. The survey items are shown below.

Table 3-42 List of items on SWM data questionnaire

Item	Sub- item	Details
1. Basic data	Contact information	Address, telephone, and e-mail of head office and sub-offices.
	Population	—
	Number of households	—
	Administrative area	—
	Information of GN and Word	Number and list of GN and Word.
2. Laws and regulations	Regulations/ordinances on SWM	Exist or do not exist. If exist, name of regulation, etc.
3. SWM Plan	SWM Action Plan	Formulated or not formulated. If formulated, the year of formulation.
	Other plan(s) on SWM	Formulated or not formulated. If formulated, the name of the plan and year of formulation.
4. Organization for SWM	Name of the SWM organization	—
	Skills of officers engaged in SWM	Position, Status, Education, Qualifications.
	Skills of workers for each field of SWM	Position, Status, Education, Qualifications.
5. Reduction in waste discharge	Home composting	No. of composting bins distributed.
	Parisara pola	Number of many times it has been held. Average amount of recyclables collected.
6. Collection and transportation	Collection coverage	Total length of collection routes and population covered by the collection service.
	Separate waste collection	Separating or not separating. If separating, list of categories.
	Provider(s) of collection service	LA, Private contractor, Both private and LA
	Collection method	Door-to-door, Kerbside collection, Bell collection, Container collection, Other.
	Inventory of collection vehicles	Vehicle type, Registration number, Capacity, Production year, Brand, Condition, Ownership.
	Information on collection operations	Collection schedule, No. of trips, Type of waste collected, Facilities where the waste collected is transported
	Collection fee	Charging system exists or not. Which sector is charged?
	Separation of recyclables	Recyclable items when recyclables are collected separately.
	Recycling during collection by collectors	Recyclable items.
7. Transfer station/place	Transfer station	Operating or not operating. If operating, location and transfer system.
	Transfer trucks	Type, Loading capacity, Number.
	Recycling at transfer station	Type of collectors, Number of collectors, Recycling items and amount for each item, Market and/or buyers of recyclables.
8. Intermediate treatment	Composting facility	Operating or not operating. If operating, capacity, location, composting method, and system of operation.
	Biogas facility	Operating or not operating. If operating, capacity and system of operation.
	Recycling facility	Operating or not operating. If operating, capacity, recycling charge, and types of recyclables.
	Thermal recovery facility	Operating or not operating. If operating, capacity, charge, and targeted waste.
9. Final disposal	Final disposal	If LA has own site: location, type of disposal site (open dumping, controlled dumping, sanitary disposal site), and system of operation. Disposal in cluster disposal site: location (LA) and name of disposal site.
	Recycling at disposal site	Type of collectors, Number of collectors, Recycling items and amount for each item, Market and/or buyers of recyclables.
	Tipping fee	Collection fee system, and Payment and fee collection method.
	Illegal dumping	Regulations on illegal dumping prevention.
10. Financial situation	Total budget and expenditure of LA	—
	Expenditure for SWM	Cost of labour, collection, transportation, disposal, drain cleaning, awareness activities, etc.
11. Environmental education and awareness-raising activities	Name, implementing body and outline of activities	
12. Waste amount and composition	Household waste, other than household waste	Implementing or not implementing.

iii. Training of trainers for WMA staffs

Training of trainers for WMA staff, mainly three district managers and seven zonal managers, were held i) to correctly understand the content of the questionnaire and ii) to be able to correctly explain to LA staff how to fill in the questionnaire.

iv. Data collection workshops

Data collection workshops were conducted according to the following schedule by WMA staff using the questionnaire.

Table 3-43 Schedule of data collection workshops conducted by each district and/or zone

District	Zone	Number of LA	Date	Venue
Colombo	Kotte	CMC and 6 districts in CMC	30 July 2019	CMC District office
Colombo	Kotte	5	25 July 2019	Western provincial council building
Colombo	Dehiwala	7		
Gampaha	Negambo	6	22 July 2019	Negombo MC
Gampaha	Gampaha	7	1 August 2019	Gampaha MC
Gampaha	Kelaniya	6		
Kalutara	Horana	8	23 July 2019	Panadura UC
Kalutara	Kalutara	9		

i. Collection and examination of questionnaires

WMA staff collected the questionnaires from the LAs, requested data to unanswered questions, and checked unclear data. Emphasis was placed on collecting missing data and checking unclear data relevant to waste flow analysis.

ii. Waste collection survey in LAs

For LAs that did not measure the amount of waste collected with a weighbridge, this was estimated based on the information such as the type of collection vehicle, loading capacity, type of target waste, and operation schedule, etc. If the information provided by the LAs was unclear, WMA staff visited those LAs to confirm the above information. The number of LAs visited and confirmed was 25, which is half of the 49 LAs in the Western Province.

iii. Analysis of the current SWM situation

The current situation and issues of SWM were clarified based on the analysis of the collected data. The SWM Survey Report for the Western Province was prepared based on the clarified current situation and issues.

Furthermore, based on the present SWM situation and issues identified, MP and action plans for specific improvements in waste management have been formulated.

c. Waste flow analysis

i. Objectives of waste flow analysis

The objectives of waste flow analysis are as follows:

- Quantitatively understand the current situation of SWM in the Western Province,

- Set one or more quantitative goal(s) for the SWM Master Plan in the Western Province, and
- Quantitatively monitor progress toward the goal(s).

Based on the data collected from the LAs, a waste flow analysis was conducted for each LA, each zone, each district, and the entire Western Province.

ii. Definition of municipal solid waste (MSW)

Municipal solid waste ncludes garbage, refuse or a variety of solid material that is in excess of, or is discarded or rejected as useless or unwanted, from human and animal activities that originates from households, commercial establishments and community actions, and shall not include:

- Waste material prescribed as Scheduled Waste by Regulation published in Gazette Extraordinary No.1534/18 of 1 February 2008; and
- Waste or discharges of any industrial process, agricultural and sewage and source separated recyclables.

iii. Concept of waste flow

The conceptual diagram of the waste flow is shown in the figure below.

The total amount of municipal solid waste (MSW generation) (No.1) generated by households (No.2) and generated at locations other than households such as business entities (No.3) is discharged (No.5) to collection services in a collection area. Waste generated in areas that are not covered by collection services is self-disposed at the source of generation (No.6). Part of the waste generated (No.1) is discharged improperly by littering or illegal dumping (No.7).

Waste discharged in collection areas is collected (No.9) and transported to an intermediate treatment facility (No.11-1, 2, 3, 4) or directly to a disposal site (No.12). To improve transport efficiency, some LAs have one or more transfer station(s) (No.10), where the waste collected is transferred to large-capacity vehicles and transported to an intermediate treatment facility(s) and/or disposal site(s).

Waste recycling occurs at each stage, i.e. generation (No.4), discharge/collection (No.8), intermediate facility (No.11-5, No.11-6) and final disposal (No.14).

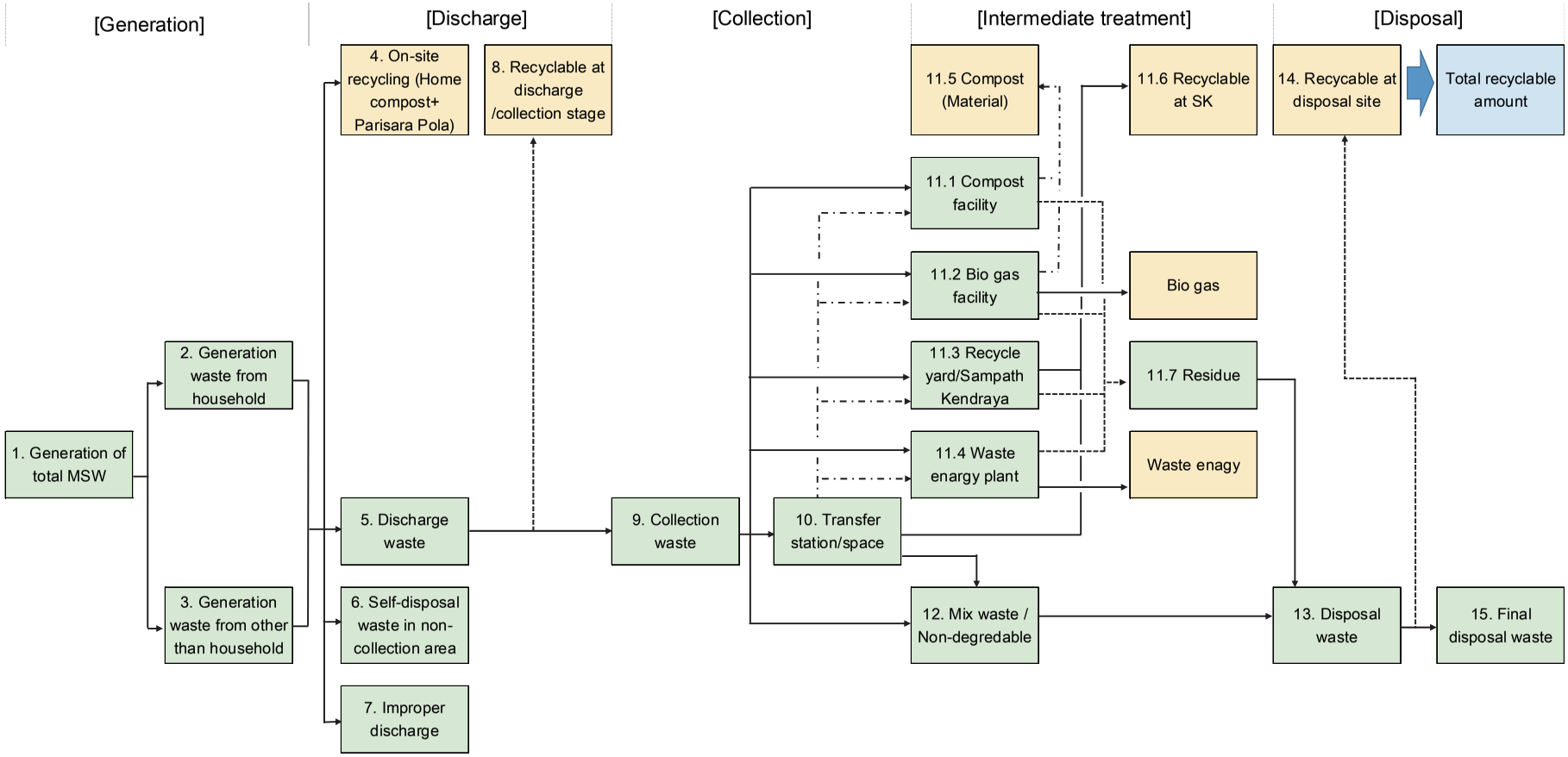


Figure 3-17 Conceptual diagram of the waste flow

Based on the above-mentioned definition of MSW, the terms used in the waste flow analysis are defined below:

- Total MSW generated (No.1) is the total amount of waste generated by households (No.2) and at locations other than households (No.3).
- On-site recycling (No.4) mainly refers to composting of organic waste in residential premises and recycling activities such as Parisara pola.
- Discharged waste (No.5) refers to waste discharged to regular collection services provided directly by an LA and/or private sector company(ies) contracted by the LA.
- Self-disposal (No.6) refers to the disposal of waste generated in areas not covered by collection services and eliminated at source, mainly by burial, burning and stockpiling.
- Improper discharge (No.7) refers to littering or illegal dumping.
- Recycling at discharge/collection stage (No.8) refers to the recycling of recyclable materials collected mainly by collection crews.
- Collected waste (No.9) refers to waste collected by regular collection services.
- Transferred waste (No.10) refers to waste collected by small-capacity collection vehicles that is then transferred to larger collection vehicles to improve transportation efficiency and reduce collection cost.
- Treated waste (No.11-1, 2, 3, 4) refers to waste transported to intermediate treatment facilities, such as composting facility, biogas facility, recycling centre including Sampath Kendraya and energy recovery plant, where it is treated.
- Composting material (No.11-5) refers to organic waste used for compost production.
- Recyclable at intermediate facility (No.11-7) refers to waste remaining after recycling, composting and treating at intermediate facility (No.11-1.2.3.4).
- Residues generated at intermediate treatment facilities (No.11-7) refers to the waste remaining after recycling, composting and treatment in intermediate facilities.
- Mixed and other waste (No.12) refers to waste collected and transported either directly, or via a transfer station, to a disposal site.
- Disposed waste (No.13) refers to waste disposed of at a final disposal site and includes the residues generated at intermediate treatment facilities.
- Recycling at disposal site (No.14) refers to the recycling of recyclable materials recovered at the disposal site, mainly by waste pickers.
- Waste for final disposal (No.15) refers to all the waste disposed of at a final disposal site, except the recyclables recovered at the disposal site (No.14).

iv. Data used for waste flow analysis and calculation method

The following data has been used for the waste flow analysis:

- Data on waste generation rates (gram/person/day) obtained from the waste amount and composition survey conducted by SATREPS in 2014.

- Waste amount data measured by weighbridge installed at waste management facilities. The facilities where a weighbridge is installed are the Karadiyana disposal site, the Muturajawela disposal site, the Kalutara composting plant, and the Dickovita composting plant.
- WMA monthly reports that are compiled as part of SWM data for LAs.

3.2.3 C.2.3 A database is created using existing data on Western Province's solid waste management

(1) Background

In Sri Lanka, data on the daily collection, transportation, intermediate treatment, and final disposal of municipal solid waste is not readily available. The reasons are as follows:

i. Daily data on municipal solid waste management is not easily available.
ii. There is no standardized data collection method.
iii. There is no data monitoring system between LAs and provincial and central governments.

To address these issues, it was decided to develop a waste management database system for the 49 LAs in the Western Province of Sri Lanka using the data collected in this project.

(2) Objectives and expected outcome

The purpose of developing a waste management database is for WMA to collect, organize, and analyze the data necessary for waste management in the 49 LAs of the Western Province, and to use the data for the formulation of MPs and action plans. In addition, the following outcomes are expected from the development of the waste management database:

i. Easy access to the collected waste management data
ii. Establishment of a standardized data collection method
iii. Establishment of a monitoring system
iv. Utilization of the accumulated data for planning and decision-making

(3) Database establishment

The project created a database on municipal solid waste in the Western Province. It should be noted that industrial waste, medical waste, and construction and demolition waste are NOT included in the database.

The purpose of developing the database is for WMA to collect, manage, and analyze the waste management data necessary for the formulation of MPs and LA action plans in the Western Province, ensuring that the data used in these plans is kept up to date. The database will mainly be shared by MoPAHAPCLG and CEA.

In addition, advice will be given on the development of the national waste management database planned by NSWMSC and CEA based on lessons learned from the previous experiences.

The database is composed of the following five modules and works through an agile development process.

Module 1: Administration, database setting

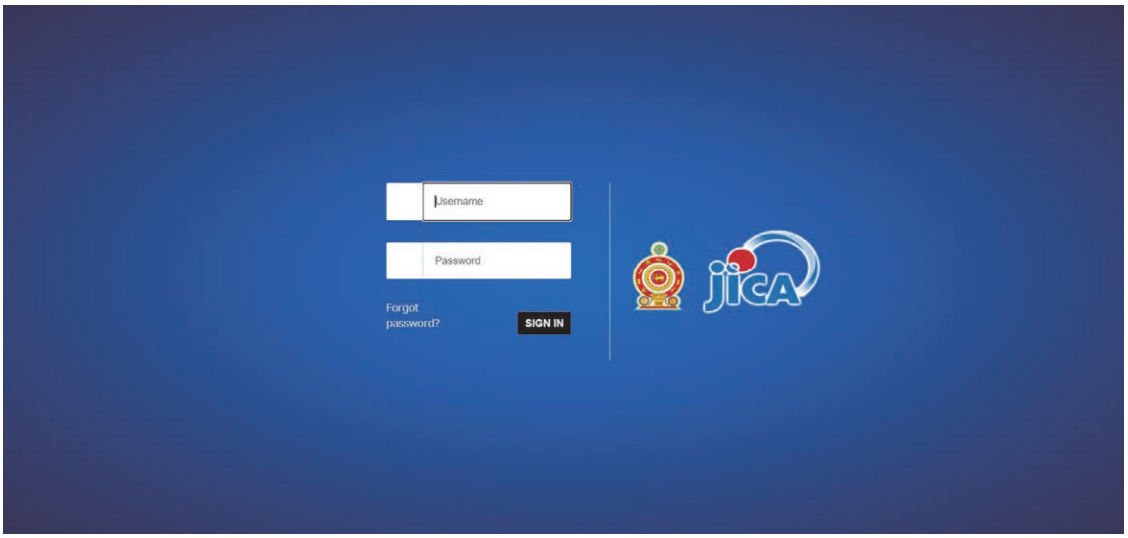
Module 2: Input of general data on waste management

Module 3: Waste collection database

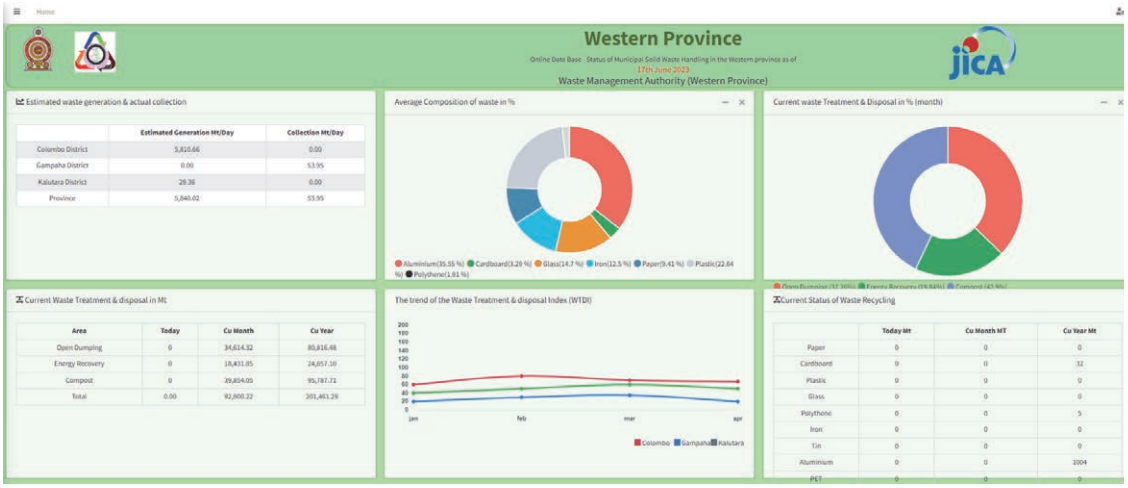
Module 4: Data analysis

Module 5: Data publication

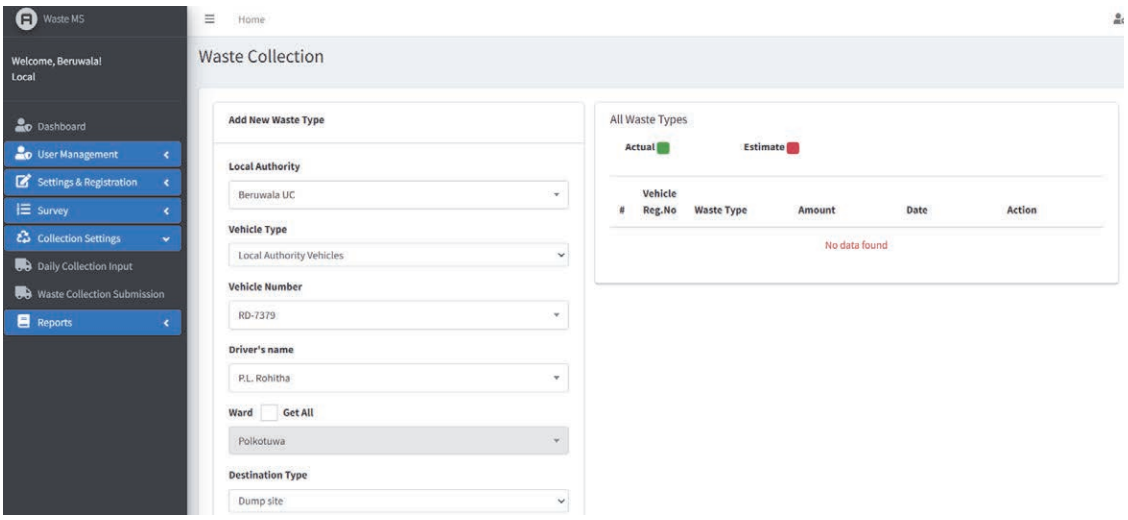
Modules 1 and 2 were completed in early January 2020 and tested for operation. Then, the development of Module 3 was completed in March 2020, and that of Module 4 and Module 5 in March 2021. For modules 3 to 5, operational tests were conducted with WMA staff and LAs staff. The development of the dashboard was completed in October 2022 and the database was transferred to the cloud space of the Western Province.



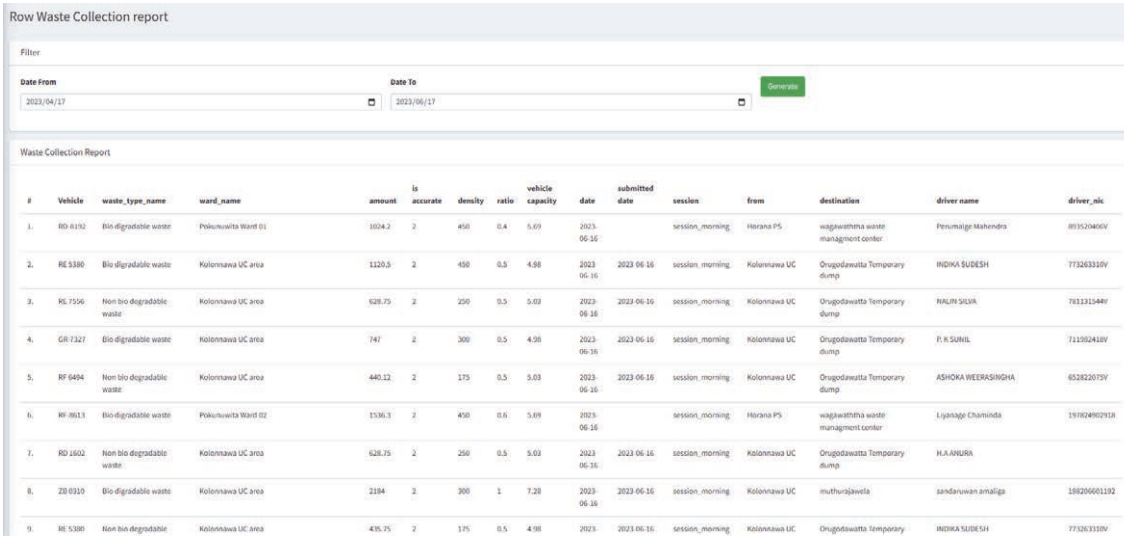
Log in page



Dashboard



Module 2 & 3: Data entry page



Module 4 & 5: Report generation

Figure 3-18 Database Main Modules

(4) Input and Output items

Local authorities (LAs) can input collection data on a daily basis, as well as register waste management facilities to input data on the amount of waste delivered to each facility. The entered data will be stored and compiled in the cloud space.

The users of the database, including higher-level organizations (NSWMSC and WMA), will be able to view all data. The data can also be downloaded in Excel/CSV format. The dashboard displays the analysis data in the form of graphs and tables created using the aggregated data.

The main input/output items of this database are listed below.

Table 3-44 Input item

No	Input items	Input frequency
1	General information on municipal waste management	Annually
2	Waste collection vehicles	At any time
3	Broken waste collection vehicles	At any time
4	Waste collection vehicle drivers	At any time
5	Data on waste collected	Daily
6	Waste intake data for waste transfer stations	Daily
7	Waste intake data for recycling facilities	Daily
8	Waste intake data to composting facilities	Daily
9	Data on waste delivered to final disposal sites	Daily
10	Data on waste delivered to thermal recovery facilities	Daily
11	Waste composition ratio	At any time

Table 3-45 Output item

No	Output items	Output format	Page
1	Waste collection data	Excel/CSV	Reporting page
2	Amount of waste collected in the Province/District	Table	Dashboard
3	Waste composition	Graph	Dashboard
4	Percentage of waste treated and disposed of	Graph	Dashboard
5	Amount of waste treated and disposed of	Table	Dashboard
6	Amount recycled	Table	Dashboard
7	Amount of compost produced	Table	Dashboard
8	Production efficiency of composting facilities	Table	Dashboard
9	Waste collection and final disposal volume	Graph	Dashboard
10	Ranking of LAs for final and intermediate disposal	Table	Dashboard
11	Visualization of LAs with no data entry	Table	Dashboard

(5) Operational structure

The operational structure of this database is as follows: the LAs enter the data, WMA manages, monitors, and provides feedback, and NSWMSC oversees the entire database system.

Initially, it was planned to transfer this database to the cloud space of MoPAHAPCLG for nationwide expansion, but due to lack of availability of personnel to manage the database, it was decided to transfer it to the cloud space of the Western Province. WMA, with the assistance of the Western Province IT department, operates the database system.

The following represents the operational structure of the database.

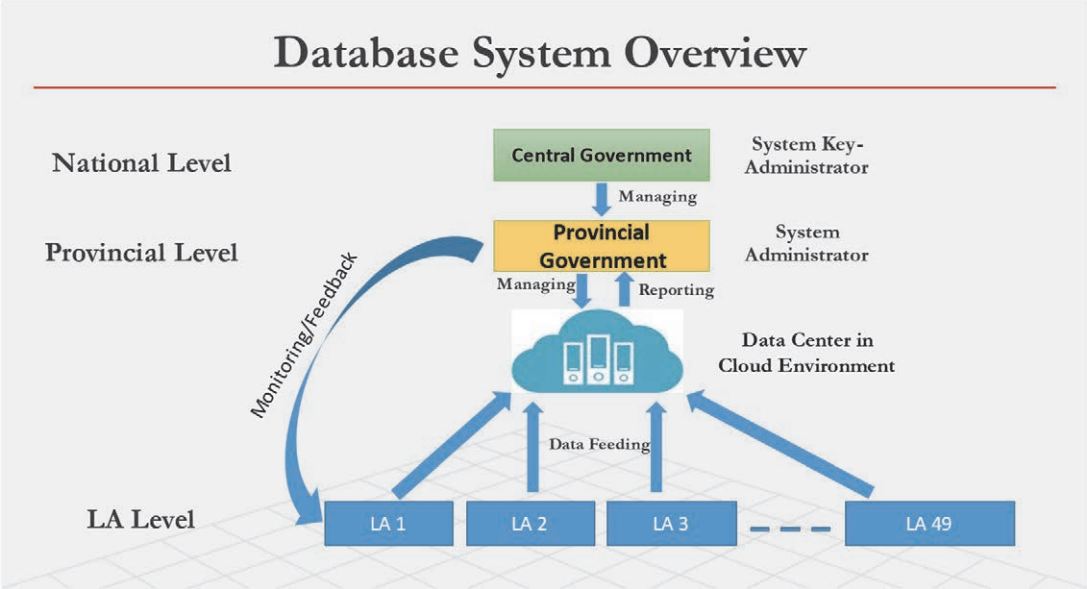


Figure 3-19 Database operational structure

(6) Operation and Maintenance Cost

The cost items associated with the operation and maintenance of the database are as follows. Since this is a government server, there is no charge for the use of cloud space.

- Personnel costs to manage the database: (zero currently as WMA has no IT personnel)
- Database maintenance costs: 124,000 LKR / year

3.2.4 C.2.4 Based on the data, current situations and challenges of solid waste management are clarified and reported

Although interviews with municipalities and hospitals were not conducted due to the spread of the new coronavirus with regard to the medical waste survey and the industrial waste survey, the Western Province Waste Survey Report was completed, reflecting only the surveyed results.

4 Activities of Pilot Projects

In order to gain knowledge and experience that will contribute to the development and implementation of the MP, this project launched six pilot projects in Output 3 and Output 4. The pilot projects were implemented on a trial basis in selected locations and on specific topics in order to identify the key points and evaluate the effects of the implementation of the plans envisaged in the MP.

The pilot projects are outlined in the table below.

Table 4-1 Pilot Projects in Output 3

No.	Project name	Outline	Expected outcomes
1	Development of a mobile application on the 3Rs	Through the development and introduction of a mobile application on the 3Rs, LAs will share information and educate residents about waste separation and collection.	● The amount of organic waste and valuable waste sorted will increase. ● The use of the 3Rs mobile application will increase the segregation and collection of organic waste and valuable waste at source and contribute to the promotion of recycling as described in the MP.
2	Small-scale waste transfer station	A small-scale waste transfer station will be constructed to improve the efficiency of transport and its operations, reduce the environmental impact through maintenance, and increase the operational capacity of the station. Since the existing open dumping site will no longer be needed when the transfer station is put into service, technical support for the closure of the site (planning of the closure) will be provided. However, the C/P will bear the construction costs for the closure.	● Approximately 15 tons/day of mixed waste disposed of at Kalutara final disposal site will be transferred to the TRF. ● A closure plan for the Kalutara landfill will be developed. ● One of the five small-scale waste transfer stations listed in the MP is established and becomes a model transfer station.
3	Collection and analysis of good practices in waste management	Collect and analyze information on a wide range of lessons learned and good practices from waste management stakeholders in the Western Province and share and disseminate this information to stakeholders.	● Lessons learned and good practices in waste management will be shared with waste management agencies and municipalities in the Western Province.

Table 4-2 Pilot Projects in Output 4

No.	Project name	Outline	Expected outcomes
4	A-1. Capacity improvement and reduction of environmental impact (Small and medium scale)	Technical interventions aimed at improving operational procedures, facilitating aeration, improving water content ratio management, odour control, leachate control, etc. of small and medium scale composting plants.	● It is demonstrated that the introduction of aeration technology in a medium-scale composting plant can reduce composting duration by more than 40%. ● It becomes an improvement model for the 20+ small and medium scale composting plants listed in the MP.
	A-2. Capacity improvement and reduction of environmental impact (Large scale)	Technical interventions aimed at improving the operational procedures of a large-scale composting plant and rehabilitation of the existing final disposal site.	● The treatment capacity of the large-scale composting plant is increased from 20 tons/day to 200 tons/day. ● One of the two large-scale composting plants listed in the MP is rehabilitated and serves as model for the rehabilitation of the other one.
	B. Complaint/request surveys (e.g. stakeholder analysis and construction and socioeconomic surveys at the pilot sites of A above)	Consensus building to analyze the impact on residents, commercial facilities, and other stakeholders at the pilot project sites of A above, for use in the pilot projects A above, and to develop and implement measures to respond to complaints and requests.	● The number of complaints from residents about waste management facilities decreases. ● The intermediate treatment facility described in the MP is accepted by the surrounding community and can continue to operate properly.

4.1 C.3 Activities of Output 3

Output 3: Knowledge and experience that contribute to MP formulation and implementation are acquired through the implementation of pilot projects on appropriate waste management and 3Rs. (Target areas: Colombo Municipality and other LAs)

4.1.1 C.3.1 Training on appropriate waste management and 3Rs for LAs and other relevant organizations are conducted

(1) Training on appropriate waste management and 3Rs

The seminar for which the main topic is appropriate waste management and 3Rs, was held on 7th November 2019 for all 49 local authorities in Western Province. The number of participants was approximately 150 persons. One important part of this seminar was the introducing of solid waste management practices of Shibushi City in Kagoshima, Japan presented by a municipal officer of Shibushi City.

Table 4-3 Agenda of seminar for appropriate waste management and 3Rs

Time	Activity	Presenter
8.30 - 9.00	Registration of participants	
9.00 -9.15	Welcome and opening remarks	Director, NSWMSC
9.15 - 9.20	Speech by JICA Sri Lanka Office	Secretary, MoLG of WP
9.20-9.30	Speech by the Secretary	Representative of JICA office
9.30- 9.45	Keynote Speech	WPC
9.45 -10.15	Outline of "West Waste MAP" project	JICA consultant
10.15- 10.30	Outline of Western Province SWM Database	Director NSWMSC
10.30- 10.45	Tea break	
10.45-12.15	Shibushi City Waste Management Practices	Shibushi city officer
12.15-12.45	Kuliyapitiya UC Waste Management Practices	KUC Chairman
12.45-1.15	Social Aspect of SWM	Prof Mallika Pinnawela
1.15 - 2.15	Lunch break	
2.15-3.15	Discussion on Implementation of Waste Management	Legal Officer, Local Government
	Rule No. 1 of 2008 & relevant issues	Department of WP
3.15-3.45	Discussion	
3.45-4.00	Closing remarks	Director, WMA
4.00-4.15	Tea	

An officer of Shibushi City with 20 WMA staff visited to the pilot project sites of The project for pollution control and reduction of environmental burden in solid waste management (ReEB Waste) (2017-2019) after the seminar for appropriate waste management and 3Rs.


Presentation by Shibushi City officer


Separate discharging at guesthouse at Kataragama PS

Final disposal site at Kataragama PS

MRF at Rathnapura MC

Figure 4-1 Visiting to the ReEB Waste pilot project sites by an officer of Shibushi City with 20 WMA staff

(2) Training on planning/ operation of waste management facilities are conducted

The seminar for which the main topic is the planning/ operation of waste management facilities was held on 17th December 2019 for all 49 local authorities in Western Province. The number of participants was approximately 170 persons. One important part of this seminar was the introducing of rehabilitation of current disposal sites in Sri Lanka based on the SATREPS (2011-2017) presented by Professor Ken Kawamoto of Saitama University in Japan.

Table 4-4 Agenda of seminar for planning/ operation of waste management facilities

Time	Activity	
8.30 - 9.30	Registration of participants	
9.30 - 9.40	Welcome and opening remarks	
9.40 - 9.50	Speech by JICA Sri Lanka office	JICA representative
9.50 -10.00	Keynote speech	
10.00 -11.00	Rehabilitation of final disposal sites based on SATREPPS guide	Prof. Ken Kawamoto
11.00 -11.20	Morning tea	
11.20 - 11.50	Calculation of Waste Generation Rates	Prof. Ken Kawamoto
11.50 -12.30	Waste Amount & Composition Survey	JICA consultant
12.30 - 1.00	Sampling techniques for analysis	Dr A K Karunarathne
1.00 - 2.00	Lunch break	
2.00 - 2.30	Western Province SWM Database	Director, WMA
2.30 - 3.30	Financial Analysis in terms of SWM	JICA Consultant
3.30 - 3.50	Discussion	
3.50 - 4.00	Closing remarks	
4.00- 4.15	Tea	

Professor Kawamoto visited to the pilot project sites of ReEB Waste project (2017-2019) after the seminar for planning/ operation of waste management facilities.


Presentation by Prof. Kawamoto


Compost plant at Kurunegala MC


Courtesy call to Kataragama PS Chairman


Final disposal site at Kataragama PS


Final disposal site at Kataragama PS


Compost plant at Kataragama PS

Figure 4-2 Visiting to the ReEB Waste pilot project sites by Prof. Kawamoto

Seminar was held on 17 December, 2019 for WMA, which plans and operates waste-related facilities, MoUD&H, SLLRDC, CMC and 49 local authorities in the Western Province. At the same seminar, Professor Kawamoto of Saitama university who engaged in SATREPS "Establishment of Pollution Prevention and Restoration Technology Utilizing Regional Characteristics at Sri Lanka Waste Disposal Site" (April 2011-March 2016) was invited as a guest speaker to introduce the low-cost and low-maintenance pollution control technology that utilizes materials procured in Sri Lanka studied in the program. The contents of the seminar are as follows.

i. Rehabilitation of existing final disposal site
ii. Waste generation amount survey method
iii. Waste survey method
iv. Database utilization method
v. Appropriate financial management of waste managment

(3) Training on appropriate waste management

The following results were explained during the Western Province Local Government Stakeholders Workshop held on 14 March 2023.

i. Database

ii. Mobile Application

iii. Transfer station

iv. Aeration Project 4

v. Karadiyana PP 5

vi. Consensus Building

(4) Training on promotion of 3Rs

Of the four tasks in the “Waste Dictionary” activity , the final task iv. is still being carried out by WMA’s Zonal Managers.

i. Decide on the waste category for each waste item (seven categories have been agreed upon, namely bio-degradable waste, recyclable waste, e-waste, bulky waste, hazardous waste, burnable waste, and residual waste).

ii. List up the waste items that should be included in the dictionary.

iii. Separate the waste items listed up in ii. into the seven categories and add instructions on how to discharge them.

iv. Describe the current treatment of each item after separate collection. (This task was conducted simultaneously with iii.

After the draft with “the said task completed” was submitted by WMA to JICA Expert Team in May 2022, many items were found with separation categories that did not match with the final disposal method (e.g. an item whose final disposal method is “incineration” was categorized as “subject to recyclable waste collection”). Therefore, all the items that seemed to require corrections were highlighted and specific explanations were provided during web meetings so that the necessary revisions could be made.

4.1.2 C.3.2 Target LAs for pilot projects are selected

For the pilot project related to a small-scale waste transfer station, the Kalutara composting plant was selected as the target site in the first phase.

The pilot project related to 3Rs promotion was to be implemented in the cities of Colombo, Maharagama, and Kolonnawa, but the pilot project site was changed as described in 4.1.4 (2) below. In the case of Kolonnawa PS, the COVID-19 pandemic made it difficult to introduce a new project on top of normal operations. As for Colombo, CMC decided to decline the pilot project because it plans to duplicate the pilot project after the exchange. Discussions with the

Maharagama MC resulted in its declining the project because it did not align with the city's priorities.

As new target municipalities, the Sri Jayawarudanapure Kotte and Dehiwala were considered because the collection activities need to be stable in order to utilize the above-mentioned mobile application, and because they are close to the Western Provincial Council and can be easily monitored by the COVID-19. An agreement has been reached with Sri Jayawarudanapure Kotte MC and a pilot project is being implemented. Discussions were held with Dehiwala MC. The mobile application was explained to them and they showed willingness to implement it. It is expected that WMA will follow up with Dehiwala MC to realize the implementation.

4.1.3 C.3.3 Capacity Assessment (pre-test) for WMA and target LAs is conducted

With reference to the three perspectives of capacity described in the "JICA Capacity Assessment Handbook" (September 2008), a document was created to give an overview of the capacity required for each pilot project, and a capacity assessment was conducted. For the capacity assessment, interviews and questionnaire surveys were conducted with the C/P in charge of each pilot project and the JICA experts in charge, related information was collected, and an evaluation form was filled out. This form integrates pre-test and post-test results. It is shown in 4.1.6 as capacity assessment result.

4.1.4 C.3.4 Pilot projects on appropriate waste management and 3Rs are planned at the target LAs

(1) Pilot project on appropriate waste management

A small-scale waste transfer station was constructed on the site of the Kalutara composting plant operated by WMA to improve the efficiency of transport and transfer operations, reduce environmental impact through basic maintenance and improve the operational capacity of the station. The plan was to transfer non-organic waste (excluding recyclable waste) delivered to the composting plant and residues generated from the composting plant treatment process into transport containers for transport to the TRF located in Colombo district, Western Province, or the Aruwakkalu Regional Landfill in the North Western Province. It was planned to use haulage containers. The transport containers will help prevent odour, waste scattering, sewage collection and landscape degradation during transshipment and transport of the waste. WMA agreed to properly close the existing open dumping disposal site according to the plan as soon as the budgetary means are available.

(a) Outline

The efficiency of solid waste transfer and transportation is improved, the negative environmental impacts are mitigated, and the operational capacity of transfer is increased by the small-scale solid waste transfer station.

(b) Pilot Project site

- Address: Premises of Kalutara composting plant owned by Kalutara UC within Kalutara PS boundary.
- Owner of Kalutara composting plant: Kalutara UC
- Operating body of Kalutara composting plant: Waste Management Authority (WMA)

(c) Current condition and issues

The total amount of waste collected in Kalutara UC and Kalutara PS is approximately 34 tons/day, of which around 27 tons/day is segregated biodegradable waste. The segregated biodegradable waste is treated at the Kalutara composting plant operated by WMA. The sum of waste collected and residues screened during the biodegradable waste treatment process is approximately 16 tons/day, and all the residues have been improperly discharged in the open dumpsite behind the Kalutara composting plant for many years. Environmental issues, such as offensive odour, stray dogs, pests, leachate generated from the open dumpsite have negatively impacted the surrounding area of the Kalutara composting facility even though Kalutara UC covers the open dumpsite with soil several times a year.

(d) Content of the Pilot Project

A waste transfer station will be constructed on the site of the composting plant, and non-organic waste (excluding recyclable waste) and residues generated from the composting process will be transferred into shipping containers and transported to a designated TRF in the Colombo district (Western Province), or to the Aruwakkalu Regional Landfill located in the North Western Province. Using shipping containers will help prevent odour, scattering, collection of sewage, and landscape deterioration during waste transportation. The existing open dumpsite will be closed with the technical support of the JICA Expert Team and the budget of the C/P. The details of the pilot project are as follows:

- Formulation of the basic plan and detailed design of the small-scale solid waste transfer station
- Construction of the facility and procurement of equipment
- Operation of the small-scale solid waste transfer station
- Closure of the current open dumpsite
- Monitoring

The details of the facility and equipment of the small-scale solid waste transfer station are given below. The required number of waste containers is two because one of the containers should continuously stay at the transfer station, while the other is transported to the final destination.

Table 4-5 Details of the facility and equipment of the small-scale solid waste transfer station

No.	Item	Specifications	Qty	Details
1	Static compactor with input hopper	Loading capacity: 20 tons/day	1 unit	It consists of the static compactor loading the waste from the hopper to the container, the driving system and the hopper.
2	Waste container	Capacity: 26 m^3	2 units	It stores the residues with leachate for transportation to the TRF in Colombo district or Aruwakkalu final disposal site.
3	Container hauler trailer vehicle with hook system	GVW higher than 15 tons	1 unit	Its purpose is to haul the waste containers.

(e) Contribution and necessity of small-scale solid waste transfer station to the MP

The pilot project of small-scale solid waste transfer station contributes to acquiring knowhow on the following points and will serve as a good practice for the future establishment of the other small-scale solid waste transfer stations planned in the MP:

- Site selection for the establishment of a solid waste transfer station
- Environmental considerations
- Plan and design of a solid waste transfer station
- Technical aspect of waste transfer
- Operation of a solid waste transfer station
- Monitoring

(f) Design specifications

The design specifications are described below:

- Processing capacity: 20 tons/day
- Waste density before compaction: 0.3-0.4 ton/m^3
- Waste density after compaction: 0.4 ton/m^3
- Container capacity: 26 m^3 × 0.4 ton/m^3 = 10.4 tons
- Required number of trips: 20 tons ÷ 10.4 tons = 1.9 round trip/day
- Transportation distance: 60 km
- Speed: 30 km/h
- Time required for a round trip: (60 km ÷ 30 km/h) × 1 round trip = 4.0 hours/round trip
- Number of working hours: 10 hours/day
- Number of round trips per day: 10 hours/day ÷ 4.0 hours/round trip = 2.5

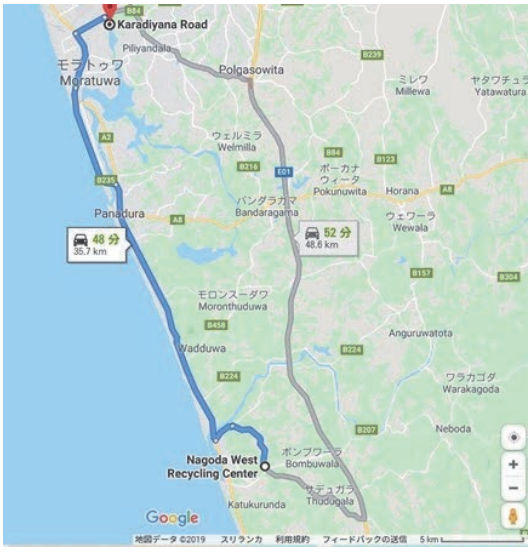


Figure 4-3 Route from the transfer station to the final destination

round trips → 2.0 round trips

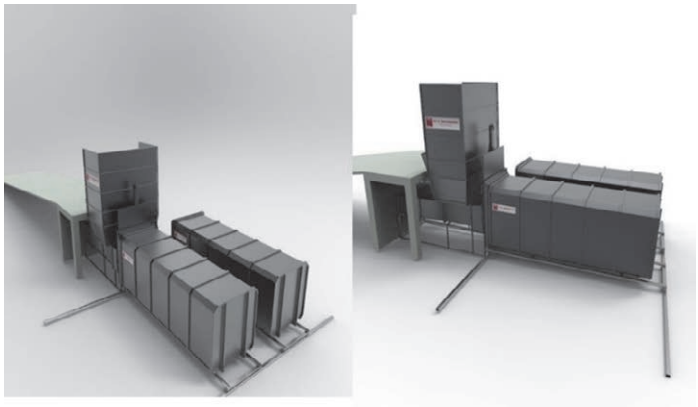


Figure 4-4 Image of a container hauler trailer vehicle with hook system

(g) Environmental and social considerations on the development of the small-scale solid waste transfer station

The establishment of the waste transfer station will result in changes in traffic volume due to the arrival and departure of vehicles transporting refilled waste. In addition to the traffic volume, noise and odour from non-organic waste are expected to be generated.

- Changes in traffic volume: The frequency of vehicles transporting transshipped waste entering and exiting the facility should be about twice a day.
- Noise control: The vehicles transporting transshipped waste must comply with the noise standards. The waste transfer facility shall be equipped with a hydraulic system to reduce noise generation.
- Vibration control: The noise level of the current composting plant should not exceed the noise standards.
- Odour control: The waste will be transshipped in sealed-type containers.
- Wastewater control: A collection system should be incorporated to prevent sewage from being discharged outside the composting plant site.

At the end of September 2022, JICA Expert Team and a contractor signed a contract for the design and construction of the small-scale waste transfer station. During construction, which was scheduled to start in November 2022, and after the start of service, environmental and social considerations were to be monitored in accordance with the above-mentioned items. According to the laws and regulations of Sri Lanka, no EIA is required for the establishment of a waste transfer station.

(2) Pilot project on 3Rs promotion

(a) Change in the content of the pilot projects

The pilot projects for promoting the 3Rs in high-rise apartments were initiated in Phase I but encountered serious difficulties in implementing the activities in the communities due to the

COVID-19 pandemic. At the same time, daily collection in each LA began to be disrupted. Consequently, following discussions with the C/P, these pilot projects were abandoned and a new project that could be carried out even under the COVID-19 pandemic was devised.

From November 2020, the development of a "Waste dictionary" started in order to promote separation at source in the Western Province, and in parallel discussions began on its development as a mobile application.

The purpose of the Waste Dictionary is "to make it easy to know which waste to sort into which category" and as a mobile application that takes over this purpose, examples of mobile applications used by Japanese local authorities have been gathered. This was proposed in response to the findings of the surveys conducted in Phase I which revealed that the waste sorting rules were not clear for residents.

A few LAs of the Western Province had tried to introduce such mobile applications in the past. These were all intended to notify users "when the collection vehicle would be coming" and to provide information on the location of collection vehicles. However, they had accumulated complaints such as the vehicle location not displaying correctly, or the collection service not actually reaching their houses despite location information indicating the vehicle was approaching. They did not help improve solid waste management itself, and the provision of the mobile application service was also not sustainable.

These aspects were considered during a series of discussions with WMA, and it was decided to develop an application that would have the following features:

i. Waste Dictionary (to be able to look up the waste category of each item).
ii. Waste collection schedule of respective local authorities (to be able to know which waste category would be collected on which day of the week).
iii. Notice board for information from WMA and LAs (to notify residents about sudden changes to the collection schedule, or inform in advance of the schedule of special collections and events).

(b) Change in local authorities to conduct pilot projects for 3Rs promotion

The pilot projects planned in Phase I were to be implemented in Colombo Municipality, Maharagama Urban Council and Kolonnawa Urban Council. However, it had become difficult for Kolonnawa UC to introduce a new activity in addition to its daily work due to the COVID-19 pandemic. Colombo MC had withdrawn because the content of the new pilot project would overlap with its own project. Kotte Municipality was nominated as a replacement, considering that a stable provision of waste collection services is required for using the mobile application, and that the geographical proximity to the WMA office would allow for relatively easily monitoring despite the pandemic. Kotte MC, the capital of Sri Lanka with a population of about 110,000[7] and where there is a mix of high-rise apartments and densely populated residential areas,

[7] According to the 2012 census in, the population of Kotte is 107,508 (Department of Census and Statistics)

faces challenges in raising awareness and promoting the 3Rs. A letter was sent to Kotte MC to explain the content of the above-mentioned pilot project and to inquire their intention to participate in the project, and the MC readily agreed to participate.

Based on discussions with Kotte MC, collection routes in the Rajagiriya area were selected as the target for the pilot project.

4.1.5 C.3.5 C.3.4 is implemented

(1) Pilot project on appropriate waste management

The local contractor (KENT ENGINEERS (PVT) LTD) for the small-scale waste transfer station pilot project procured materials and manufactured transport containers and compaction units at the factory of the vehicle manufacturer “Ashok Leyland”.


Transport container


Compaction unit


Hydraulic jack unit

Figure 4-5 Manufactured transport containers and compaction units at the factory

After the equipment was manufactured, it was transported to the project site for installation and the small-scall waste transfer station was handed over after a completion inspection on 7th June 2023.


Feeding residue to hopper


Loading residue to container


Hauling container to trailer

Figure 4-6 Entire view of small-scale transfer station

The implementation schedule for the construction of the small-scale waste transfer station is shown below.

The small-scale waste transfer station pilot project has started to develop a manual describing how to establish and operate a waste transfer station was made (Appendix 5).

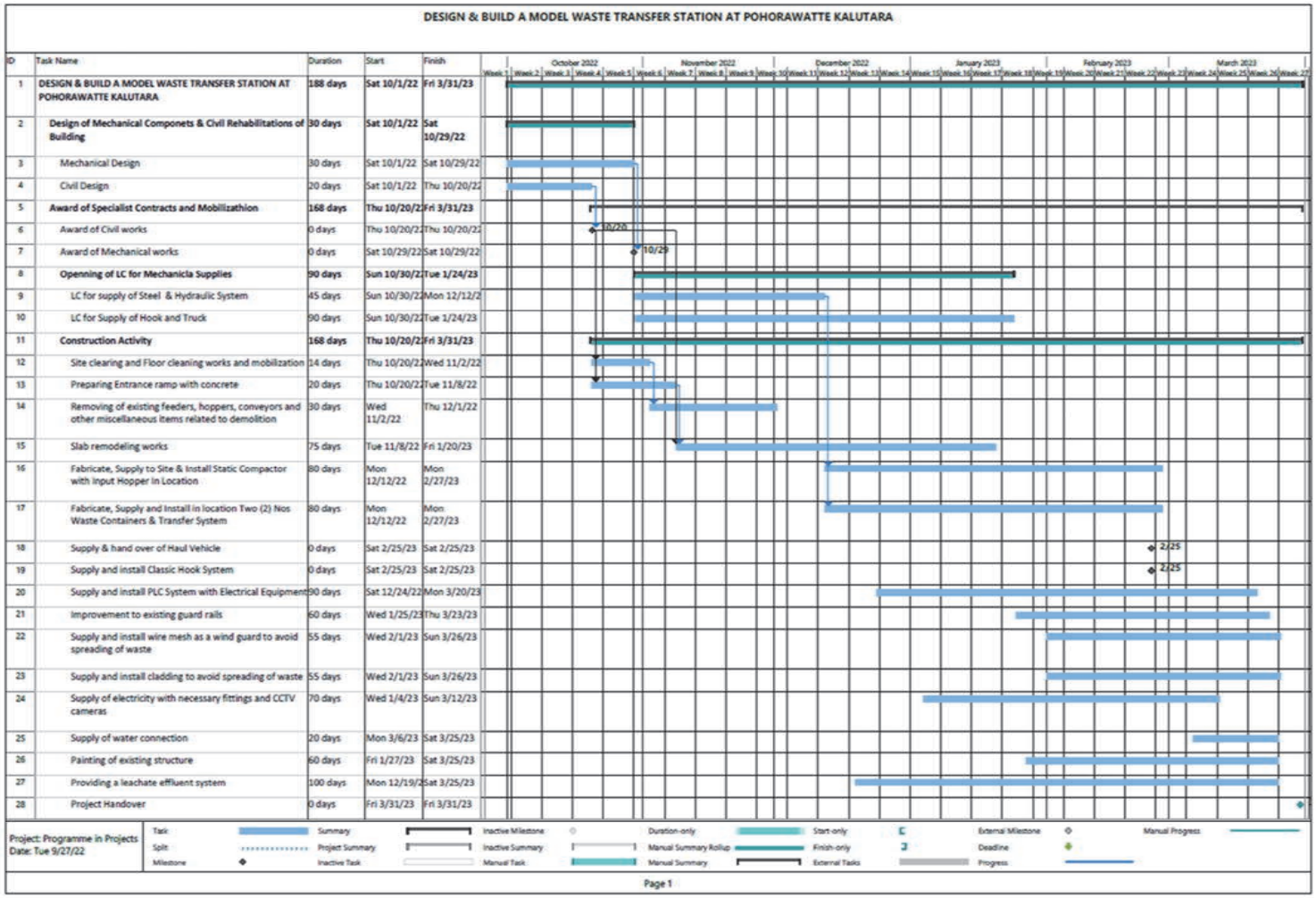


Figure 4-7 Project diagram

Prior to the establishment of the small-scale waste transfer station, a closure plan for the waste open dumpsite at the rear of the site was drawn up based on the survey results, and the final plan was created and mapped out. Using this final plan, a rainwater drainage plan for the final plan, the layout of the gas venting facilities were studied, and the necessary drawings, quantities and construction period were examined. It is planned to close the open dumpsite after the small-scale waste transfer station is operational, and in May 2023 WMA prepared a grant application to the Department of Local Government and NSWMSC for the closure works (see 4.2.5(3) for further details).

(2) Pilot project on 3Rs promotion

In the pilot project for the promotion of the 3Rs, as described in C.3.4, a mobile application for 3Rs promotion was developed. The Waste Dictionary, which is one of the main components of the application, was developed in English in cooperation with WMA staff, and the preparation of the waste collection route maps and collection schedule for uploading to the application was done by the municipality of Kotte (hereinafter "Kotte MC") with the support of WMA staff.

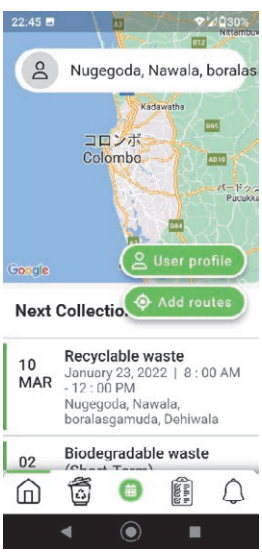
Kotte MC first tested the application for a week in the Rajagiriya area to eliminate possible bugs in the application's system. For this trial, the staff of the Health division of Kotte MC conducted awareness-raising activities for the residents of the area to explain the application and the purpose of the trial. The application prepared for full operation after bug fixes were handed over to WMA.

It is expected that the data of the remaining areas of Kotte MC will be uploaded to the system by the application developer in coordination with WMA so that Kotte MC will be able to launch the application officially across the whole city.

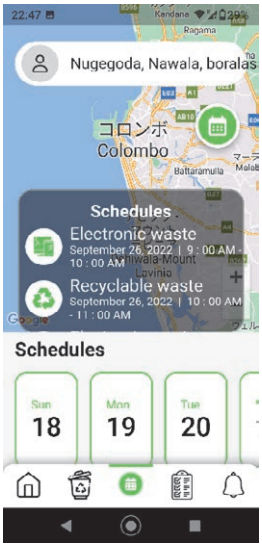
(a) Functions of the application that residents can use

In the figure "Mobile app user flow for residents" shown on the next page, the functions indicated in the red box are those related to waste separation and collection (the functions shown in the upper part are for registration). Residents can use the following functions: 1) Information on the collection day for each waste category in the user's neighbourhood, 2) Information on the sorting category of each waste item, 3) Reporting of problems with waste collection services and waste in the neighbourhood, 4) Request for a collection of waste in bulk or gully, and 5) Reception of notices from LAs.

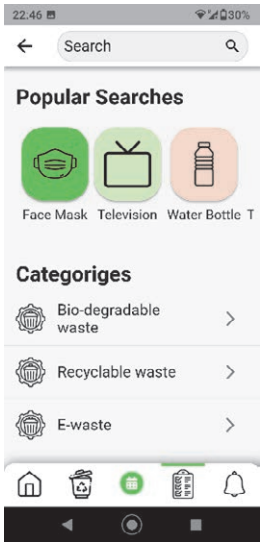
Screenshots of the application (User Interface, or UI) below shows the functions 1), 2) and 4). The form used for 3) is similar to that for 4).



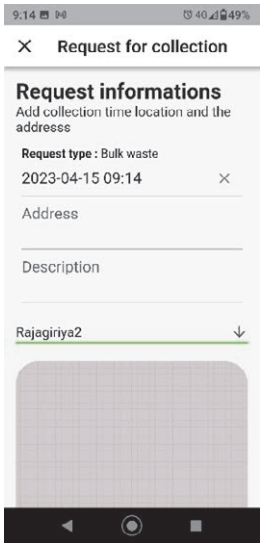
1) Indication of the waste collection route relevant to the user. The waste collection schedule related to the route is indicated at the bottom of the screen.



1) By clicking on a date at the bottom of the screen, the waste categories that will be collected on that day are displayed.



2) In the Waste Dictionary interface, the user can search for the appropriate sorting category of an item by typing the item name in the "search" bar at the top of the screen.



4) Form for requesting bulky waste collection.
The space at the bottom will show the map with the location for collection.

Figure 4-8 UI of the waste separation mobile application

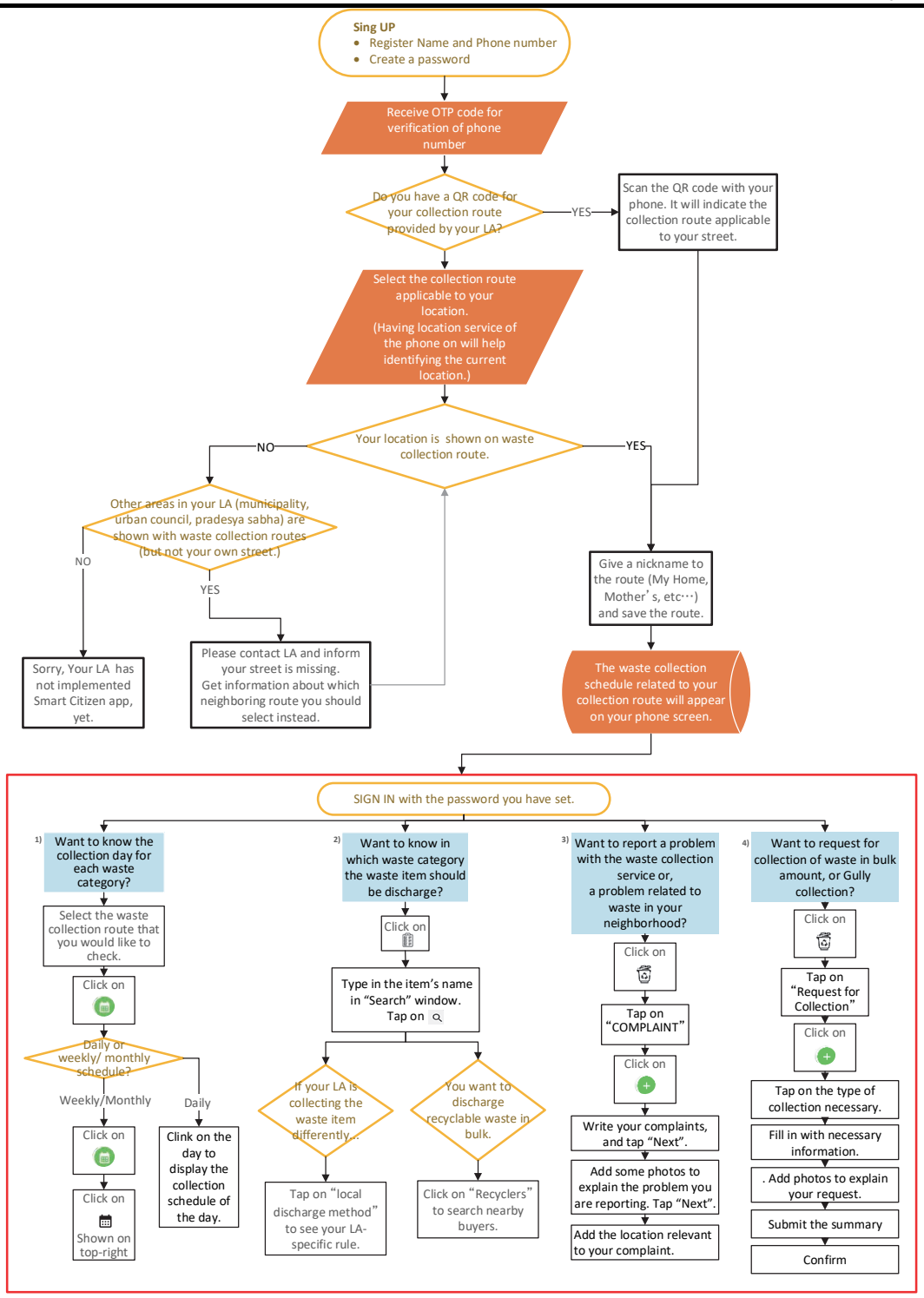


Figure 4-9 Mobile app user flow for residents

In the sections below, the functions of 1) and 2) are explained, along with the work required for preparing the data needed for the respective function.

1) Information on the collection day for each waste category in the user's neighbourhood

i. Function

Each LA carries out its own waste collection, based on its own schedule, and allocates days of the week for the collection of designated waste categories in each collection area where a

specific waste collection vehicle will operate. (For example, Vehicle A will collect organic waste in Area 1 on Monday, Wednesday, and Friday, and in Area 2 on Tuesday, Thursday, and Saturday, etc.) If these days are not fully known to local residents, the waste that the LA expects to collect will not be discharged on the desired day. From the residents' point of view, it could be frustrating that the waste they have spent time preparing for collection are left uncollected on the day they discharged it. Another problematic case is waste collection during public holidays, when the waste collection is not provided according to the regular schedule and the alternative collection days have not been notified in advance to the residents. In order to avoid such problems, this mobile application indicates the waste collection schedule for each waste category that applies to the waste collection route in the user's residence area (and/or other desired places for waste collection), once the waste collection routes have been registered on the application.

Data on waste collection routes is prepared by the LA and uploaded to the application's database before the application is launched in the LA. The waste collection route corresponding to each of the user's locations is then displayed on the interface after the user registers by scanning a QR code provided by his/her LA or selecting a location on the map.

ii. Preparation of the necessary data

In order to upload the data for the waste collection route map of an LA, the LA needs to develop a map data of all the waste collection routes and provide it to the application developer. Currently most of the LAs only have hand-drawn waste collection route maps that indicate the collection routes along the main roads. The application is expected to indicate the precise route even to a resident living on a secondary road. To this end, each LA must draw up a route map for each collection route with a GPS.

In Kotte MC, WMA and JICA Expert Team lent their GPS devices to the municipality and designated staff started to record thoroughly all collection routes in the ten waste collection wards. As of 10 April 2023, eight wards have completed this work. (Out of the eight wards, the data of only one ward has been uploaded to the application's database so far. This is the trial area, and the data of the other wards will be uploaded step by step by the application developer after the trial.)

2) Information on the sorting category of each waste item

i. Function

Once a user registers the location of his/her residence (or other desired location such as "my parents' home"), the Waste Dictionary loads the waste categorization implemented by the LA relevant to his/her location. If the LA uses an incinerator, the waste dictionary that includes the category "burnable waste" will be loaded, and if not the dictionary without the "burnable waste" category will be loaded.

For example, if a user in an LA with an incinerator would like to discharge "a kettle", and

hesitates whether it should be discharged as “burnable waste” or “recyclable waste”, he/she can look up in the application for the appropriate category, and discharge it properly.

ii. Preparation of necessary data

The Waste Dictionary was first developed in English in Excel format in cooperation with WMA staff. With this tool, an improvement in the quality of the waste discharged as “organic waste (composting material)” as well as an increase in the recycling rate are expected, as it allows people to correctly sort their waste according to the actual recycling rules in place in Sri Lanka or in the Western Province, whereas people currently judge whether an item should be discharged as “recyclable waste” or “composting waste” based on their individual understanding.

Through the development of this Waste Dictionary, WMA staff also realized that there are items that cannot be recycled currently in Sri Lanka or in the Western Province although they are commonly perceived as recyclable. Furthermore, they also become aware that the same waste item should be classified into different waste categories depending on the respective LAs disposal methods (e.g. with and without the use of an incinerator, with and without provision of regular collection services for hazardous waste or electrical appliances, etc.)

Table 4-6 Excerpt from the Waste Dictionary

Items	Discharge Category (7 streams)	Discharge Category (4 streams)	3 streams without burnable	Discharge Instructions	Treatment after Collection
AC adapter	E-waste	Special waste	Special waste	Bring in on the day of e-waste collection or Parisara Pola.	Available dealers to be connected
Accordion curtains	Bulky waste	Burnable waste	Residual waste	Cut into 12" pieces and handover to LA on the designated collection day	Incineration
Activated carbon	Residual waste	Residual waste	Residual waste		Landfill
Ads (flyers)	Burnable waste	Burnable waste	Residual waste		Incineration
Agriculture waste (organic)	Bio-degradable waste	Bio-degradable waste	Bio-degradable waste	If it is not exceeding 5 kg, discharge with biodegradable waste. In case of large quantity, call the special collection service.	Composting
Air (bed) mattresses	Burnable waste	Burnable waste	Residual waste	Cut into 12" pieces and handover to LA on the designated collection day	Incineration
Air conditioner indoor unit	E-waste	Special waste	Special waste	Bring in on the day of e-waste collection or Parisara Pola.	Available dealers to be connected
Air conditioners	E-waste	Special waste	Special waste	Bring in on the day of e-waste collection or Parisara Pola.	Available dealers to be connected
Air freshener container (glass)	Recyclable waste	Recyclable waste	Recyclable waste		Sold to recyclers (factory, middleman)

The English version of the Waste Dictionary has been translated into Sinhalese and Tamil and the three language versions have been uploaded to the application's database.

2. Backend functions that require preparatory works by WMA, LAs and the application developer

The development of this application has been carried out collaboratively by WMA and the JICA Expert Team. After the initial launch, the main manager of the application will be WMA, and after signing an agreement with any interested LA of the Western Province, the two parties will run the application together. When a new LA decides to introduce the application in its territory, the developer will have to help uploading the necessary data sets. Therefore, WMA and the application developer have signed a service agreement.

To maintain its Google Play Store and Apple Store accounts, WMA will incur an annual expense of approximately LKR 10,000 per account. In addition, LAs that wish to use the service in the future will incur an annual fee of approximately LKR 2,000 per year to ensure access to the map functionality.

The figure on the next page shows the roles and responsibilities of the three parties, following the process of the application implementation in an LA.

WMA will promote the implementation of the application in other LAs based on the experience of the pilot project in Kotte MC. A manual for this purpose has been prepared and is attached in the Appendix 6

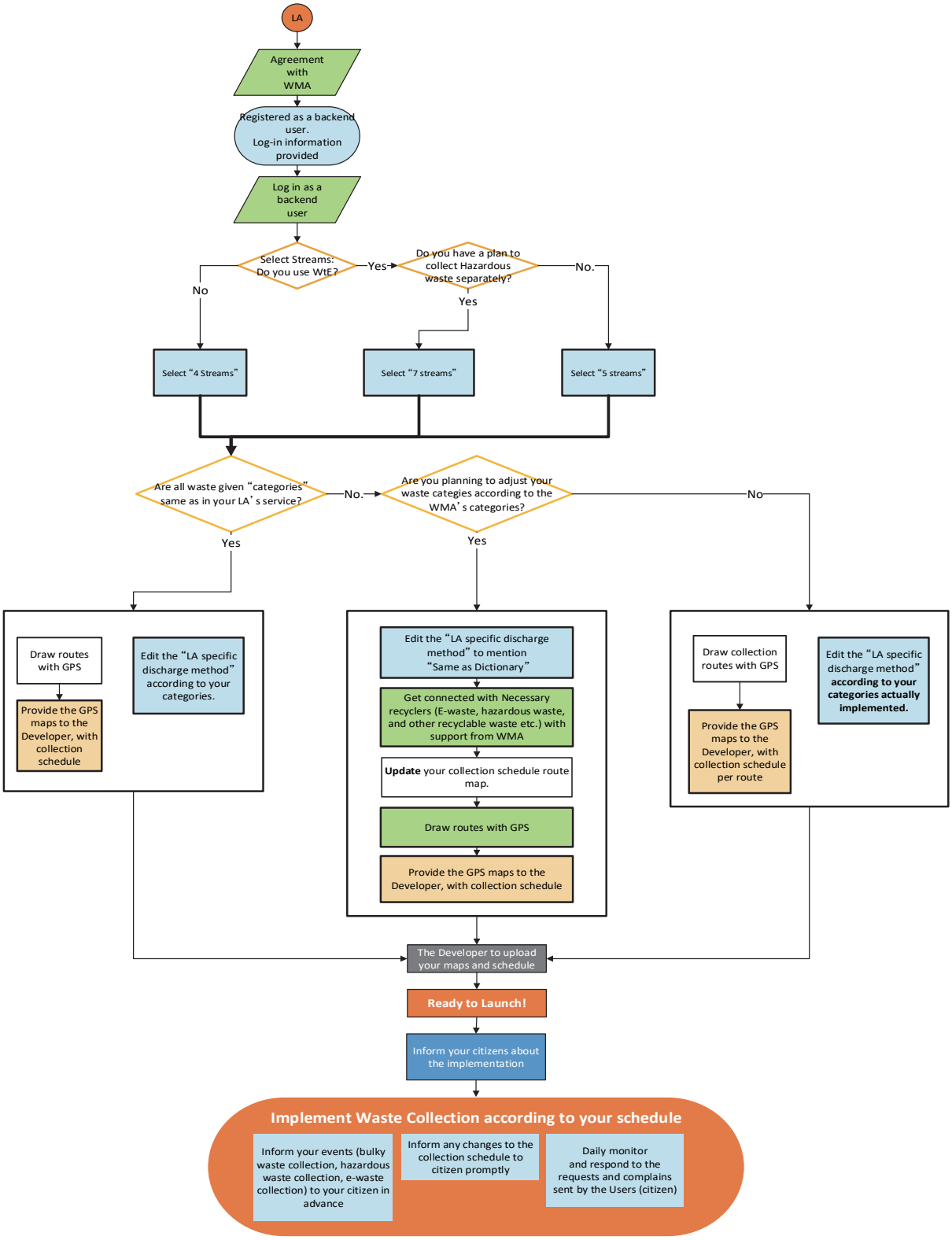


Figure 4-10 Responsibilities of WMA, LA and the Developer for the implementation of the application in a LA.

(3) Pilot Project: Collecting Good Practice on Waste Management in Western Province

a. Definition and target of good practice

Good practice is defined as cases that contribute to improved waste management in terms of environmental, economic, efficiency, safety and hygiene. The good practices cover activities related to municipal waste management in Western Province.

b. Objective of good practice

The objective is to spread activities to improve municipal waste management by selecting good practices and introducing them widely to relevant organizations.

c. Methodology of collecting good practice

The following procedures were used to collect and analyze good practices.

i. Preparation of compiling form
ii. Collection of good practices by WMA staff
iii. scrutinizing the content of the collected good practices
iv. Carrying out additional investigations if necessary
v. Compiling of the good practices according to the categories
vi. Selection of good practices
vii. Compilation and distribution of good practice for SWM

d. Summary of Good Practice

Eight good practices were collected through the above procedure. The table below summarizes the selected good practices. A detailed description of the good practices is attached as Appendix 7.

Table 4-7 Summary of Good Practice

No	Title	Local Authority	Feature
1	Eco Bricks concept for polithene waste management	Homagama PS	Recycle a single waste material "polithene" at source. Eco Bricks are made by filling plastic bottles with polithene, and the Eco Bricks are exchanged for flowerpots recycled from the Eco Bricks at various events and programs. This is a good practice that is easy to participate in and contributes significantly to raising recycling awareness and reducing waste at the source.
2	Promotion of waste segregation through awareness and instruction of collection workers	Moratuwa MC	Organic waste segregation is encouraged due to the instruction and awareness-raising of residents by collection workers. Selected areas where organic waste is not being separated based on Weigh bridge data and focused awareness-raising activities. This is a good practice of promoting waste segregation at the source.
3	Management of collection & transportation vehicles by utilizing GPS	Colombo MC	All collection vehicles are installed with GPS to control the collection route and collection time. If a collection vehicle breaks down, another vehicle takes over the collection using GPS. This is a good practice of providing reliable waste collection and transportation.
4	Management of small-scale compost plan	Seethawaka PS	The board that the date of intake, turning and the times of turning is recorded on are set above each compost piles. This is a good practice of how careful management produces good quality compost.
5	Management of medium-scale compost plant	Ja-Ela PS	The good degree of segregation of organic waste is due to the awareness of residents and the guidance and instruction provided by the collection crews during collection. Compost plant is large enough to manage and mature the composting by taking enough time. This is a good practice of the production of good-quality compost.
6	Segregation of recyclable during collection work and at recycling facilit	Seethawakapure UC	Five categories are segregated at the source. Further separation is carried out in the collection process, and the final 17 categories of recyclables are sorted at the recycling center. This is a good practice of the comprehensive promotion of recycling at the stages of generation, collection and treatment.
7	Animal Feeding	Seethawakapure UC	This is a good practice of how fresh organic waste can be separated and recycled as animal feed. Sorting animal feed from organic waste takes the role of removing contamination from organic waste as pre-sorting and it improves the quality of compost production.
8	Thermal recycle of Organic waste by Biogas	Kaduwela MC	This LA has its own biogas plant and its intake is 7t/d. Generated electricity used for the compost plant activity. The LA is giving priority to manage their waste by using the waste as a resource.

4.1.6 C.3.6 Capacity Assessment (post-test) for WMA and target LAs is conducted

Capacity Assessment was conducted with reference to the three perspectives for grasping capacity of the “JICA Capacity Assessment Handbook” (September 2008), and a document (see

table below) was created to give an overview of the capacity required for each pilot project.

The structure of the table is as follows. For each pilot project, the objective of the pilot project is "Performance (P0)", the other outcomes are P1, P2, etc., and the goal to be achieved by accumulating Performance (P) is "Impact (I)". "Capacity (C)" includes technical capacity (specific skills and knowledge, tacit knowledge), core capacity (management ability to proactively solve problems using technical capacity, intention/attitude, leadership, etc.). These capacities are developed on the "Environmental Base", such as formal and informal social institutions and social infrastructure, and are influenced by "External Conditions" and "Resources"[8].

For each pilot project, the JICA Expert Team provided technical assistance to the C/Ps who play a central role as an effort to strengthen their individual technical capacity. It is expected that this approach will reach both the C/P department and WMA as the affiliated organization, and that performance and impact will increase through strengthening the technical and core capacities of individuals and organizations.

In order to assess the capacity strengthened by the pilot projects, information and records related to the results of the activities such as prepared materials, interviews with C/Ps, and interviews with experts in charge were recorded and collected. According to this data, the intended technical capacity was strengthened through the pilot projects, and the changes before and after the implementation were shown in a 5-grade evaluation with the reasons described in the section "Technical capacity".

Below are the results of the capacity assessment of the Kalutara Transfer Station Pilot Project and the 3Rs Promotion Pilot Project.

[8] JICA (2008) p.17

Table 4-8 Kalutara Transfer Station Pilot Project

Kalutara Transfer Station PP

Impact	The experience gained from the PP serves as a reference for developing other candidate sites for a transfer station.		External Conditions and Resources ・Temporal budget to operate the machine for estimation of the operation cost is secured. ・After estimating the operating cost, the budget request will be submitted to WMA's board. ・Application for EC (Environmental Clearance) was submitted to CEA. CEA will inspect the transfer station at the start of operation and will issue the EC.
Performance 1	Train other staff of WMA by showing/demonstrating to disseminate knowledge and experience. WMA is developing "Safety work guidelines" for the operation of composting plants and landfills. The outcome of the PPs will be incorporated in these guidelines.		
Performance 0	The efficiency of solid waste transfer and transportation is increased in Kalutara.		
Capacity	Core Capacity	**Technical Capacity**	
	① Palitha Udayanga, ② Project Manager of Mihisaru Resource Management Center (Kalutara)	＜Input as PP activities/expected capacity＞ 0 (as baseline). Mr. Palitha (C/P) has 18 years of experience in composting plant operation, and joined WMA in 2011 as composting plant manager. **① Basic operation of the machine ＜Score:0→4＞** ①- 1 C/P understands how to unload the waste from the collection vehicles, compact it properly, and transfer it to the containers. ①-2 C/P learned how to efficiently transport the waste by transferring it to a large vehicle. The efficiency of waste transfer and evaluation of long-distance transportation were examined from the viewpoint of operating costs. After the start of operation, Mr. Palitha, as plant manager, will estimate the tipping fee based on the actual operating costs. It can be judged that the C/P understands the mechanism of the machine and has the ability to continue to operate it. **② Safety guidelines ＜Score: 0→4＞** ②-1 C/P understands the emergency response procedure of the compaction units when transporting waste. ②-2 C/P understands how to handle large trailers when transporting waste. C/P understands the workflow of transfer and transport of the waste. It is expected that regular training will be conducted for machine safety management. Safety guidelines will be issued by PP. An operation manual has been created by the construction company.	
Environmental base			
Policy, institutional environment, organization and other general environment			

Table 4-9 3R Pilot Project

3Rs PP

Impact	・The experience gained from the PP serves to encourage waste separation at source by the residents by using the app.	External conditions/ resources ・WMA secured the budget to maintain the mobile application.
Performance 1	・Through the development of the waste dictionary, WMA staff clarified the classification of the waste they handle, and waste categorized as “unknown” was sorted. (because there is a difference in ・Since the collection route is necessary to create a GPS map, Kotte MC decided to formalize the collection routes when creating the map for the application. This contributed to the improvement/increased efficiency of waste collection in Kotte MC.	
Performance 0	・Lessons learned by conducting trial/Pilot Project of the 3Rs App’s functions shown below. i. Waste Dictionary (to be able to look up the waste category of each item). ii. Waste collection schedule of designated LA (to be able to know which waste category will be collected on which day of the week). iii. Notice board for information from WMA and LAs (to notify citizens about sudden changes in the collection schedule, or inform in advance about the schedule of special collections and events).	

Capacity	Core Capacity	**Technical Capacity**
	① **Samudrika** ② District manager of Colombo ③ Development of Waste Dictionary, coordination with Kotte MC and Maharagama UC, technical input of WMA when necessary, documentation of procedure: 1. Creation of an account for WMA to upload the App on Apple store and Google Play store; 2. Drafting of MOU for WMA-LA on the use of the App.; 3. Drafting of MOU for WMA-Developer on service agreement ① **Ganga** ② Zonal manager of Kotte zone ③ Central person for the development of the Waste Dictionary, coordinated with Kotte MC to support the development of the GPS route map. ① **Kasun** ② Zonal manager of Dehiwala zone ③ Waste Dictionary development, took over the roles of Ganga while she was on maternity leave, creation of a user manual for LAs and WMA, to support LAs in the development of GPS route maps and in the dissemination of information about the App. to local communities. ① **Sanjey** ② Zonal manager of Gampaha zone ③ Waste Dictionary development, creation of a user manual for LAs and WMA to support LAs in the development of GPS route maps, and in the dissemination of information about the App. to local	＜Input as PP activities/expected capacity＞ **A (Capacity): Principal knowledge and understanding of the functions of the 3Rs App.** ① **Understand the concept of the Waste Dictionary and able to manage it.** **①-1 The Waste Dictionary was revised several times during the development period with inputs made by WMA’s zonal managers. <Score 3→4>** -Their inputs have become increasingly relevant and valid over time. It is therefore considered that their ability to update the Waste Dictionary has been well developed. However, the actual update work on the Smart Citizen app system could not be carried out with them, and only the Developer’s demonstration of how to do it was recorded on video and documented in a manual. **①-2 Adapt the separation categories of the dictionary with the actual sorting rules of the LAs through coordination with the LAs. <Score 3→3>** Actual implementation has been conducted only with Kotte MC and the trial period did not provide a chance to compare Kotte MC’s actual situation with the Waste Dictionary. ② **Support the development of Collection Route GPS Maps in designated LAs**. ③ **-1 Technical support to LAs by lending a GPS logger for drawing up the maps. <Score 3→5>** - The zonal Managers were trained by the JICA Expert Team with the actual device and provided face-to-face instruction to Kotte MC staff when developing their route maps. The ability of WMA staff was well developed considering that Kotte MC could develop valid route maps. **②-2 Check if the route map with LA’s waste categories and collection schedule are coordinated to develop “Schedule by route” and “Schedule by category”. <Score 3→4>** - Zonal Managers need to closely coordinate with LAs’ officials and supervisors to be able to monitor the validity of the routes and schedules provided on the App. The activities that have been completed during the project could only help WMA staff to understand how entries are made in the system. ③ **Manage the Notice Board for information from WMA and LAs. <Score 3→4>** - Demonstration of how to enter the necessary information for “Push Notifications” on Smart Citizen app was shared through a video clip as well as in the manual. Kotte MC has tested the function. ④ **Support LAs to start using the App. (how to select the applicable set of waste categories, how to update their collection schedule and route, how to make announcement through the App., etc.) <Score 3→4>** - The training to Kotte MC was the first and only training conducted during the project period. By referring to the video and manual, WMA should be

communities. (Also involved in Mahara PS Action Plan and BCP of Mahara PS.) Note: All zonal managers were involved in the development of the Waste Dictionary.	able to teach LA staff the basic use of the App. **B (Capacity): Coordination and communication with the LAs to conduct the above. <Score 3→4>** - WMA staff now know when and for which aspects their support is needed by LAs. They still need more experience to be able to provide assistance with a full understanding.

Environmental base
Policy, institutional environment, organization and other general environment

4.1.7 C.3.7 C.3.5 is monitored and its results and knowledge are reported in written form

(1) Pilot project on appropriate waste management

The waste transfer stations generally come in three types: open dump type, drum type, and compaction type. For this project, the compaction type was selected as it has the fewest environmental and social issues, and was manufactured and installed by a Sri Lankan domestic contractor.

The results of the pilot project for the construction and operation of the waste transfer station and the findings obtained through these activities are as follows:

(a) Construction aspects

- Local contractor designed and constructed with technical assistance from Kawashima Co., LTD, which has experience installing composting plants in Sri Lanka.
- The transfer station in this case was manufactured by a local Sri Lankan contractor, but the hydraulic jacks, which are not manufactured in Sri Lanka, were imported from China, and the thick-walled steel plates were procured in Sri Lanka. The locally manufacturing was performed at the manufacturing plant of Ashock Layland, an Indian vehicle manufacturer, with no particular problems with steel plate cutting, assembly, or welding techniques.
- The local contractor in Sri Lanka successfully designed and built the entire facility, including leachate collection methods, in addition to designing and manufacturing the compaction units, containers, and hook-lift trailers.

The initial cost would be approximately USD 1 million, including the building, compaction unit, and trailer vehicle.

(b) Operational aspects

- It was confirmed that a total of three personnel is required to operate the small-scale transfer station: one heavy equipment operator to supply waste to the hopper, one person in charge of the operation panel, and one person in charge of the trailer.
- The small-scale waste transfer station in this case is designed to transfer residues generated from the composting plant and non-organic materials sorted at the source, such as households, but the properties of each are different. Problems such as partial collapse occurred when transferring waste from the compaction unit to containers, but these problems were remedied

by improving the timing of opening and closing the slide gate and by covering the gate with a tent sheet.

- The cost breakpoint for the amount of waste to be loaded into containers is 14 tons per trip; above 15 tons per trip, the Gross Vehicle Weight (GVW) of the vehicle increases by one rank, resulting in relatively high initial and per-ton operating costs.

Although the distance from the Kalutara Transfer Station to the Kerawalapitiya WtE facility is about 49 km, the waste transfer saves about 1,000 KR/ton. Operation costs with and without the small transfer station are listed below.

- Without small-scale transfer station: approx. 2,422 LKR/ton~6.5 USD/ton
- With small-scale transfer station: approx. 1,392 LKR/ton ~3.5 USD/ton

The introduction of a small transfer station would save approximately 7,300,000 LKR per year in operating costs.

(c) Knowledge

In addition to the small-scale waste transfer station established in this pilot project, four other sites need to be established in the entire Western Province, and the construction and operational experience gained from this project will be useful in establishing the four sites.

- Since it is difficult for the municipality to cover the construction cost of approximately 1 million USD, budgetary action by the Western Province or the central government is required.
- Support by the Western Province is also needed, as the operating costs of a small-scale transfer station may be insufficient to cover the cost of bringing in fees from the local authority.
- It is necessary to consider in advance how to handle residuals and sorted non-organic materials during periods of operational shutdown due to extended power outages or repairs. Measures include bringing the materials directly to the TRF by waste collection truck volume or renting large trucks and heavy equipment for alternative transportation.
- The transferred waste is expected to be brought to the TRF, but during the maintenance period of the TRF, it will be considered bringing the waste to the cement kiln and limiting the waste collection.
- A facility such as this one will take a year or two years before it can be properly operated, so a warranty contract should be signed by the contractor to handle the project.
- When establishing the other four small-scale waste transfer stations, the policy should be to improve existing transfer stations rather than to establish them at completely new sites to avoid creating social problems.

(2) Pilot Project on 3Rs promotion

Regarding the development and its implementation, the knowledges acquired through the development process was summarized in the manual, which includes the following contents;

i. Overall Objectives of the Application
ii. Purpose of the Application
iii. Benefits of the Application
iv. Functions of the Application Development
    - ➢ Development of Waste Dictionary by WMA
    - ➢ Development of Collection Route Map in Respective LAs
v. Responsibility of Local Authorities and WMA
vi. How to create GPS-based “collection routes maps”
vii. Data Entries from Backend by Local Authorities

The following documents are presented as attachments.

- Flow of Implementing the Smart Citizen App by LA and Responsibilities of WMA, LAs, and Ceytech, which is the outsourced IT developer.
- Flow of Using the Smart Citizen App by a Citizen User

4.2 Activities of Output 4

Output 4: Knowledge and experience that contribute to MP formulation and implementation are acquired through pilot projects for improving planning/ operation of waste management facilities

4.2.1 C.4.1 Complaints/ requests made by residents, NGOs and other stakeholders with regard to waste management are studied to identify important issues

(1) Survey plan on complaints and requests from residents

Currently there are complaints from local residents about odour at the target composting plant. Therefore, a pilot project on technical interventions to improve the planning and operation of waste management facilities was considered in order to reduce odour. Prior to the implementation of the pilot project on technical interventions, a survey on complaints and requests received from the communities neighbouring the pilot site was carried out. The survey on complaints and requests was sub-contracted locally to a professor from Peradeniya University who had conducted social surveys on final disposal sites for SATREPS.

Table 4-10 Outline of the survey on complaints and requests

Survey Item	Objectives	Survey Method
Focus Group Discussion	• Examine the actions to be proposed to each stakeholder.	• Literature review • Focus group discussion • Interviews
Socio-economic survey	• Opinion survey of residents, commercial facilities, industries (including dischargers, neighbouring residents and landowners) regarding the planning, monitoring, and evaluation of facilities.	• Questionnaire survey for 250 HH

(2) Implementation of surveys

(a) Focus Group Discussion

Stakeholders were divided into the following eight groups to hear their views from different perspectives. Odour concerns were raised in particular with regard to the composting plant and the open dumpsite.

Table 4-11 Eight groups for focus group discussion

Group 1:	Officials directly connected to Mihisaru Compost (Director of Waste Management Authority, Assistant Director, Zonal manager, Project manager, with Coordinator of JICA project)
Group 2:	Office staff and field staff of Mihisaru Compost (2 management assistants, 1 supervisor, 4 laborers)
Group 3:	Community leaders and members **(**Chief Priest & 5 monks of the Buddhist temple near Mihisaru Compost and five community members who are living very close to the composting plant and the open dumping site
Group 4:	Employees of two nearby institutions **(**Principal of the school serving the community, 4 teachers of the school, 1 doctor of the hospital)
Group 5:	Villagers (Residents of the Alubogahalanda GN divisions where the open dumping site and composting plant are located)
Group 6:	Business owners in the neighbourhood (2 owners of eateries, 2 grocery shop owners and 1 small hardware shop owner)
Group 7:	Students (Grade 1, 3, 5 / Grade 7, 8, 9 / Grade 10, 11). Three separate discussions.
Group 8:	High-level administrative officers and holders of political office **(**District Secretary of Kalutara, Assistant Secretary, UC Chairman, PC Chairman, Director Planning). Separate discussions in the form of Key Informant Interviews.

Focus Group Discussion (Group 1)

Focus Group Discussion (Group 1)

Focus Group Discussion (Group 7)

Focus Group Discussion (Group 7)

Figure 4-11 Focus Group Meetings

(b) Socio-economic survey

The socio-economic survey was conducted among 250 households in the neighbourhood. The results of the survey are as follows:

First, in terms of environmental impact, odour was found to be the main issue for both the

composting plant and the open dumpsite. The increased number of animals such as dogs and flies has also been identified as an issue for the two facilities.

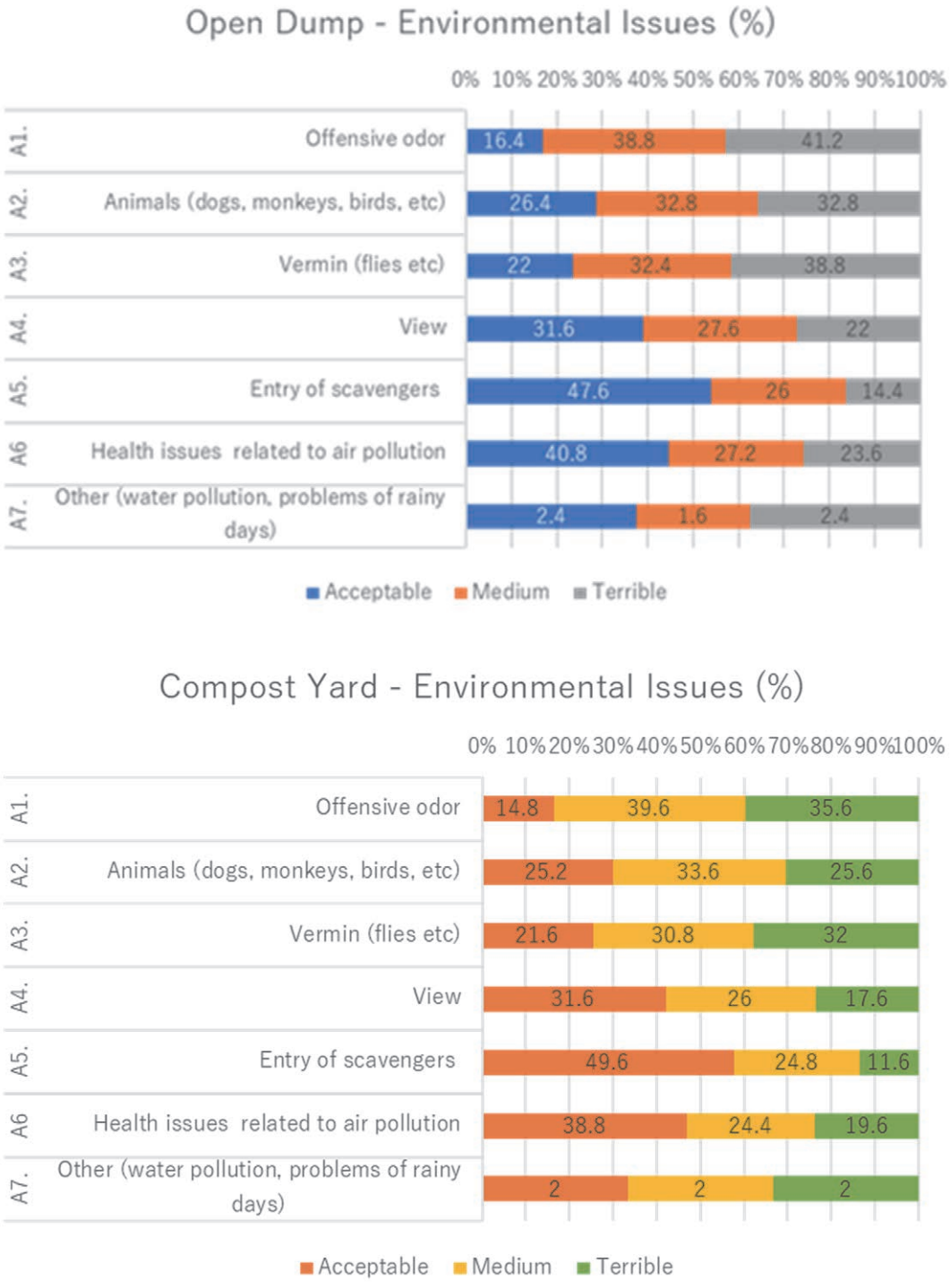
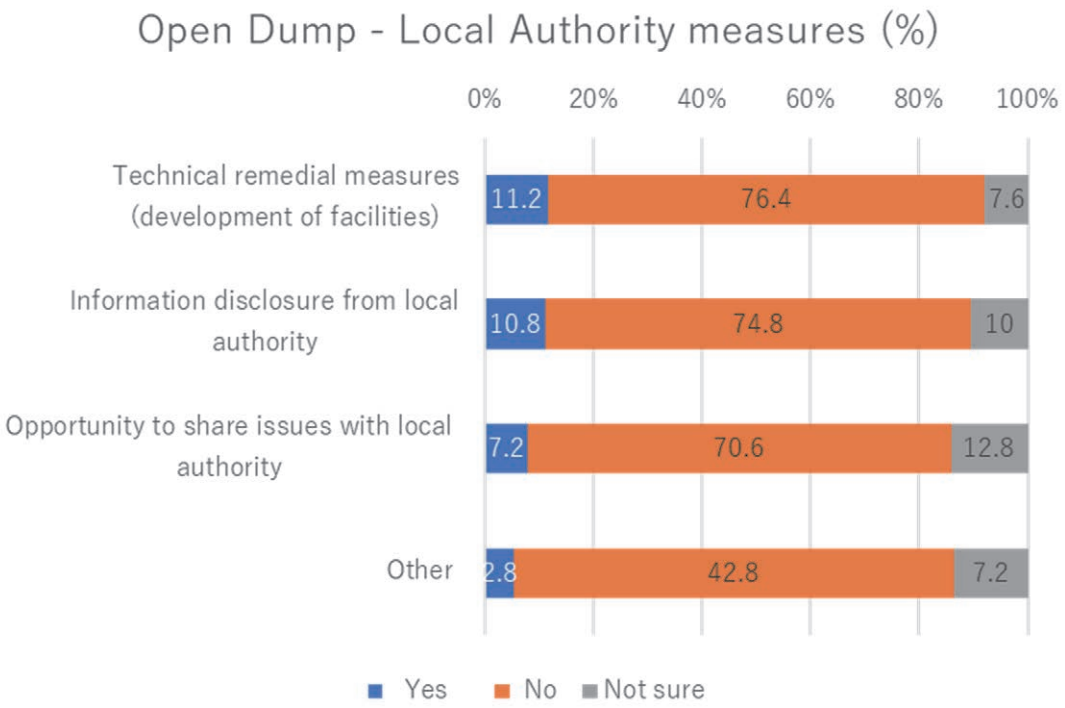


Figure 4-12 Environmental issues of open dumping and compost yard

And from the survey, it was found that residents perceive that no measure has been taken by the local authorities to address environmental challenges.



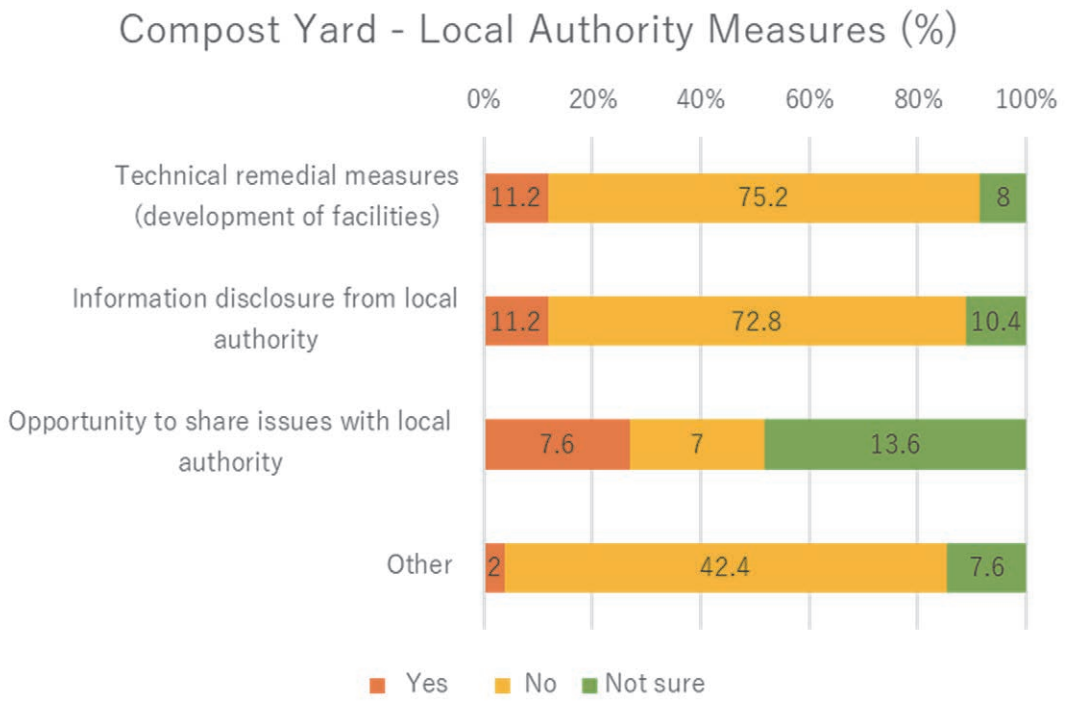


Figure 4-13 Result of Interview survey (Local Authority measures)

It was also found that residents want the local authorities to provide technical explanations (education), disclose information on environmental impacts, exchange views with the community, and explain construction schedule, progress and decisions regarding facility improvements.

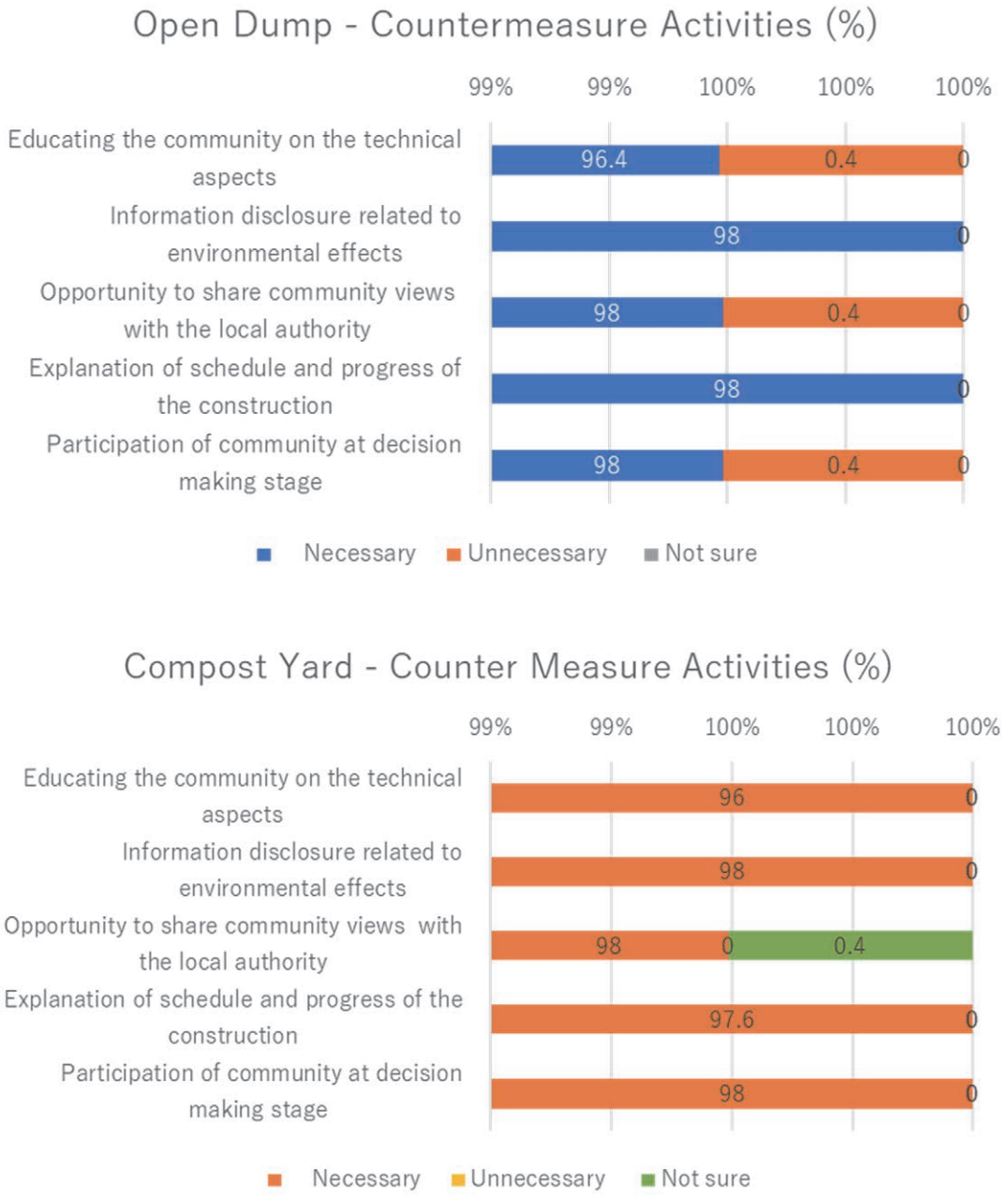
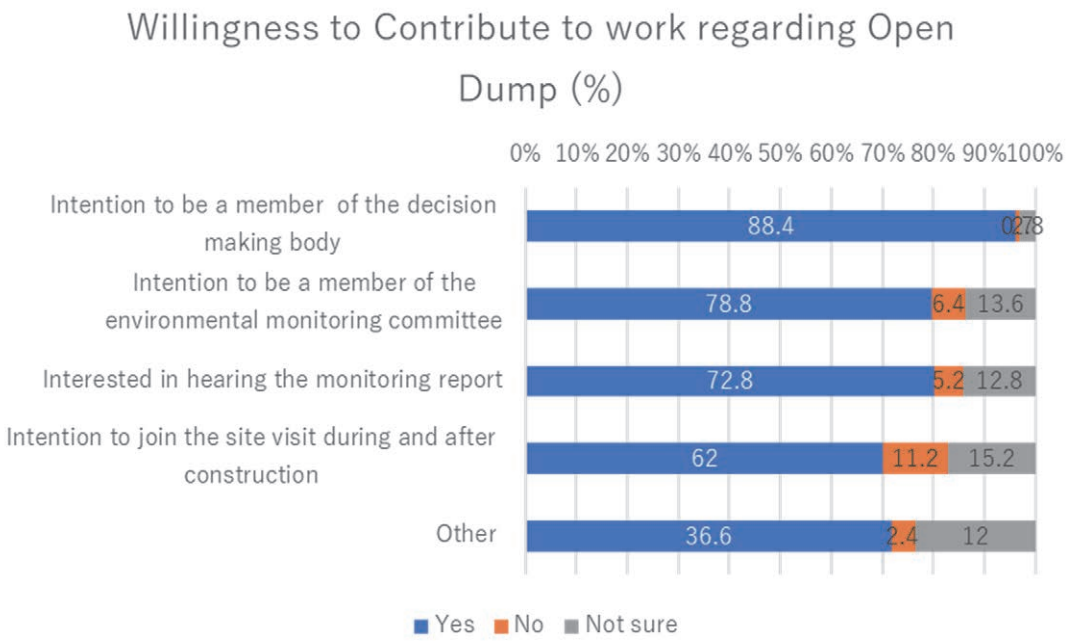


Figure 4-14 Results of interview survey (Countermeasure activities)

Furthermore, nearly 80% of the residents expressed a high level of interest in improving both facilities, carrying out environmental monitoring and monitoring reports.



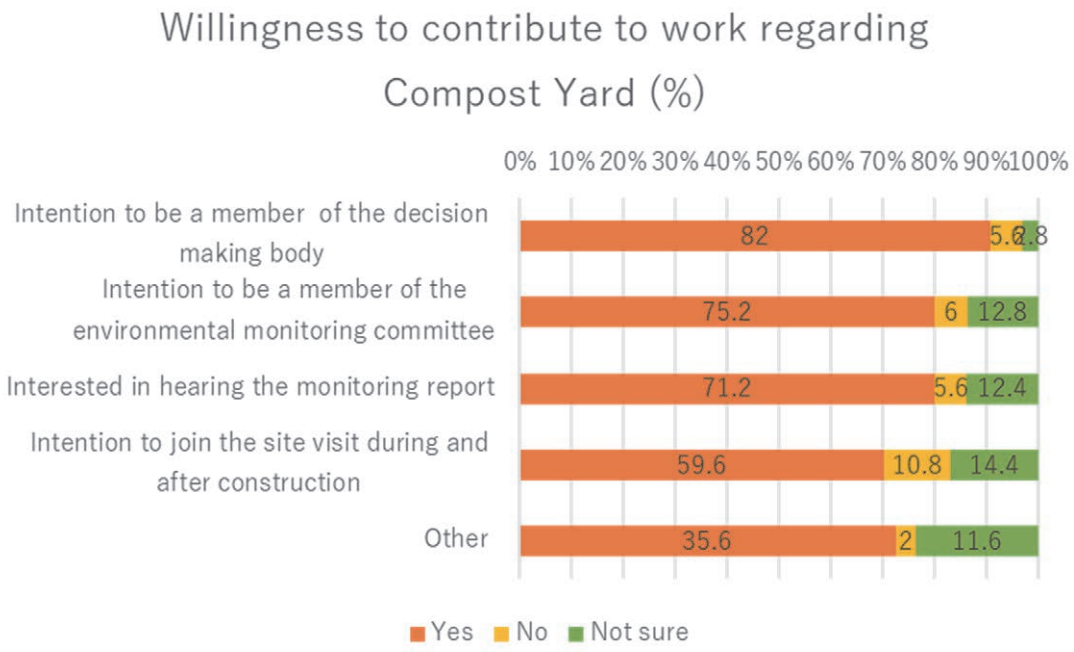


Figure 4-15 Willingness to contribute to work regarding open dump and compost yard

Interviewer training

Socio-economic survey with a resident

A resident took the surveyors to the landfill in backyard of his house

Interview survey at the temple located in front of the composting plant

Figure 4-16 Interview Survey

4.2.2 C.4.2 Target waste management facilities for pilot activities are selected

The target waste management facility for the pilot project was an existing regional final disposal site or an intermediate treatment facility, and the Karadiyana composting plant was selected as the pilot project site during the first phase.

In June 2020, WMA, which operates the Karadiyana final disposal site, requested assistance from JICA and the JICA Expert Team for the improvement of the Karadiyana composting plant and equipment procurement since the closure of the final disposal site and disposal of all organic waste were urgent issues. After consultation with counterpart organizations (CEA, NSWMSC, WMA, and UDA), the need for improvement support was confirmed, and a draft Karadiyana Compost Improvement Plan was prepared in July 2021. With this background, Karadiyana Compost Improvement Plan was added as new pilot project of Output 4.

4.2.3 C.4.3 Training on planning/ operation of waste management facilities are conducted for relevant organizations

As seminars and workshops were restricted in Sri Lanka due to the spread of the new coronavirus, training was conducted individually at each C/P institution as an alternative.

(1) Ministry of Local Government, NSWMSC

The following training was conducted on waste-related facility planning and operations.

- 1 September 2022: Waste Management Overview (1)
- 13 October 2022: Waste Management Overview (2)
- 6 October 2022: Master Plan Approach
- 20 October 2022: Various Survey Methods

4.2.4 C.4.4 Capacity Assessment (pre-test) for relevant organizations is conducted

With reference to the three perspectives of capacity described in the "JICA Capacity Assessment Handbook" (September 2008), a document was created to give an overview of the capacity required for each pilot project, and a capacity assessment was conducted. For the capacity assessment, interviews and questionnaire surveys were conducted with the C/P in charge of each pilot project and the Japanese experts in charge, related information was collected, and an evaluation form was filled out. This form integrates pre-test and post-test results. It is shown in 5.2.7. as capacity assessment result.

4.2.5 C.4.5 Pilot projects for seeking optimal technical/ social interventions for improved planning and operation of waste management facilities are planned at the target waste management facilities

(1) Kalutara Compost Improvement

The objectives and content of the pilot project for the improvement of the medium-scale composting plant are as follows.

(a) Outline

Improvements are being made to the operation of the current medium-scale composting plant. A leachate treatment system and an aeration system of the composting plant are developed to mitigate offensive odour.

(b) Pilot Project site

- Address: Premises of Kalutara composting plant owned by Kalutara UC within Kalutara PS boundary.
- Owner of the composting plant: Kalutara UC
- Operating body of Kalutara composting plant: Waste Management Authority (WMA)

(c) Current Condition and Issues

The total amount of waste collected in Kalutara UC and Kalutara PS is approximately 34 tons/day, of which around 27 tons/day is segregated biodegradable waste. The segregated biodegradable waste is treated at the Kalutara composting plant operated by WMA. The unfavourable aerobic condition of the composting plant causes environmental issues, such as offensive odour, and social issues.

(d) Content of Pilot Project

The construction, equipment, and operation of the current composting plant are developed to promote aerobic conditions, maintain proper moisture content and mitigate offensive odour. The development plan refers to the aeration system of "KAWASHIMA COMPOST" and "MATSUYAMA Recycling Centre in Kagoshima". The pilot project consists of the following activities:

- Basic plan and details of the facility
- Construction of the facility and procurement of equipment
- Operation of the upgraded composting plant
- Monitoring

The details of the facility and equipment of the upgraded composting plant are shown below.

Table 4-12 Details of the facility and equipment of the upgraded composting plant

No.	Item	Specifications	Qty	Details
1	Development of the composting plant (Modification of the aeration system)	Treatment capacity: 20 tons/day	1 unit	Installation of a blower and an aeration pipe. Modification of the slab floor to accelerate aerobic conditions.
2	Design and construction supervision for the development of the composting plant		1 unit	Conclusion of a contract with a local consultant to conduct the detailed design, bid and construction supervision for the development of the aforementioned composting plant.

(e) Contribution and necessity of small-scale solid waste transfer stations to the MP

The Western Province Solid Waste Management Master Plan provides for the improvement of the operation of more than 20 existing medium- and large-scale composting plants in the province, including increased processing capacity and reduced environmental impact. These improvements in terms of the capacity reduced the environmental impact. The experience gained from this project will serve as a reference for improving the other medium- and large-scale composting facilities. Specific items for reference are as follows:

- Obtention of Environmental Protection License
- Planning and design of medium-scale composting plants
- Technical transfer
- Operation of middle-scale composting plants
- Monitoring

In Phase I, three aeration acceleration systems were installed, and the speed of the composting process was increased, and odour was improved, confirming that the introduction of these systems was effective. In Phase II, it was planned to install the remaining seven units, but due to budget

constraints, it was decided to install only three units and continue to observe the overall operation of the composting plant.

(f) Design Specification

- Processing capacity: 20 tons/day
- Waste density before compaction: 0.3-0.4 ton/m^3
- Air supply method: Forced aeration system with air supply method
- Maximum static pressure: more than 3.0 kPa
- Maximum air flow: 40 m^3/min.
- Number of blowers: Changed from a total of 10 units to 3 units due to the need for technical improvements.

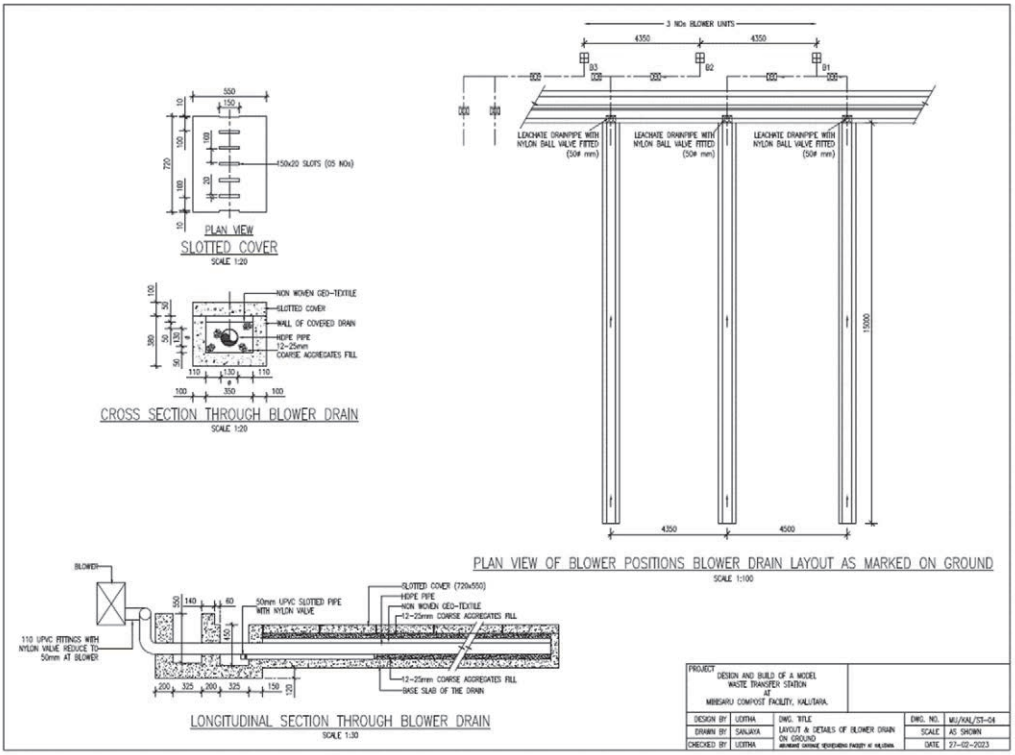


Figure 4-17 Structural drawing of aeration system

PVC perforated pipe | Perforated pipe and gravel stone | Installation of geo-textile | Installation of RC rid

Figure 4-18 Construction procedure of aeration system

(g) Environmental and social considerations for the development of Kalutara composting plant

At the Kalutara composting plant, which is one of the target waste management facilities of the pilot project, local residents were complaining about the offensive odour. The purpose of this pilot project is to reduce odour through technical improvements to the plant. The offensive odour also comes from the residues of the compost generation process, as the residues is currently dumped at an adjacent disposal site. At the small-scale transfer station described above, the residues will be loaded to be transferred, for example to a final disposal site, instead of being dumped on nearby land. This will also reduce the offensive odour. This pilot project is a technical countermeasure against the odour problem in the vicinity of the composting plant, which has been identified as an "environmental and social problem". No adverse environmental and social impacts are expected to result from the implementation of this pilot project.

(2) Consensus-building pilot project for the improvement of operations

Based on the analysis results of the surveys on the complaints and requests related to waste management (focus group discussions and socio-economic baseline surveys), the following activities were planned for the Consensus-Building Pilot Project:

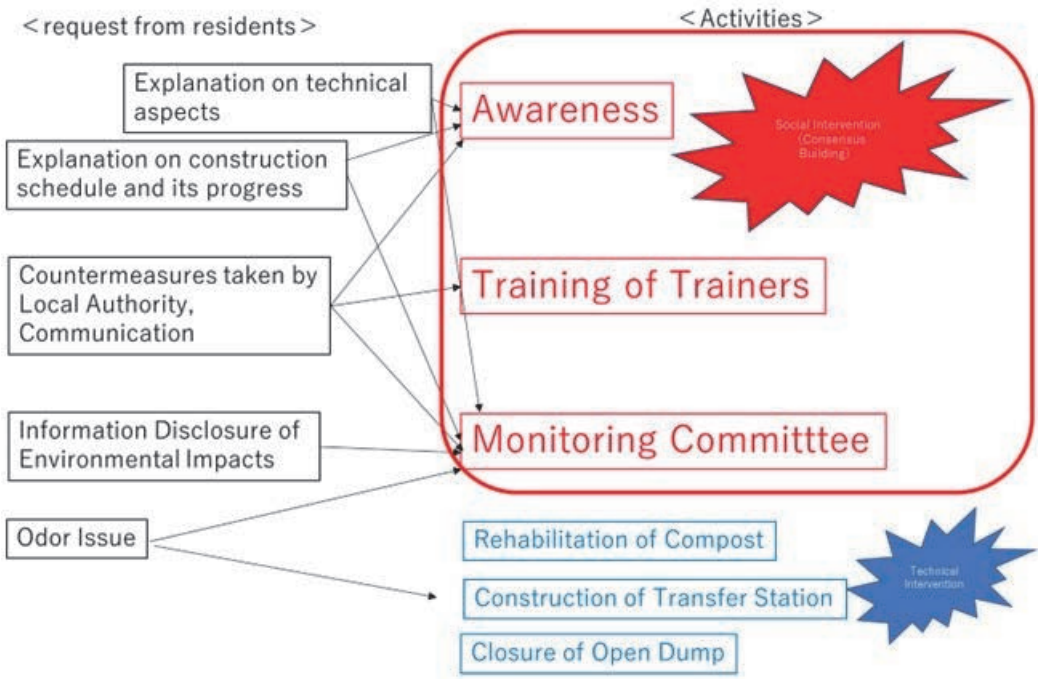


Figure 4-19 Survey results and plan of pilot activities

Table 4-13 Plan of activities on consensus building

Activities	Objectives	Method
Social Awareness	• Increased social awareness of the people affected by the waste management facilities. • Improved communication between the management of the waste management facilities and the neighbouring residents.	• Stakeholder meeting • Awareness
Training of Trainers	• Enhanced communication skills	• Lecture
Monitoring Committee	• Explanation on the technical development of the composting plant to the residents by the implementation body of the pilot project. • Monitoring of the composting plant, open dumpsite and transfer station.	• Monitoring

(3) Closure plan of Kaluthara Final Disposal site

(a) Current conditions of the proposed project site

The proposed site is located to the west of the Kalutara composting facility and is an open dumping site that has been in use for a very long time and has no covering soil. In addition, there is no daily management of the site, although bulldozer operations irregularly pile up the scattered waste. This pilot activity provides for the safe closure of this inadequate disposal site.

Figure 4-20 Current condition of the project site (Google Earth)

During the development of the plan, a topographical survey of the target site was carried out in November 2022 to determine the current topography of the area. The results showed that the elevation is about 1.5 m near the river boundary on the west side of site and that the slope of the waste layer is 2-3 m. The elevation near the edge of the composting facility on the east side of the site is approximately 5 m, and the highest part of the waste layer has an elevation of about 7.5 m. The survey results are presented below.

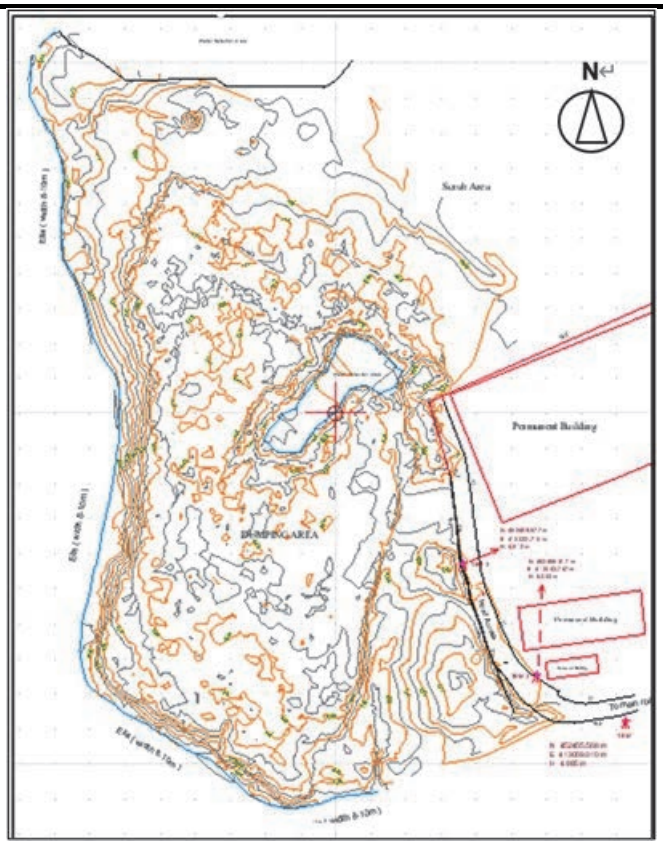


Figure 4-21 Topographic survey results for the open dumping site (November 2022)..

(b) Current condition of cross section

Based on the survey results, cross sections were made every 20 m in the longitudinal direction, and slopes were formed with a slope of 1:1 to 1:3 from the water surface of the river on the west side. The centre of the cross section is relatively flat but interspersed with small hills.

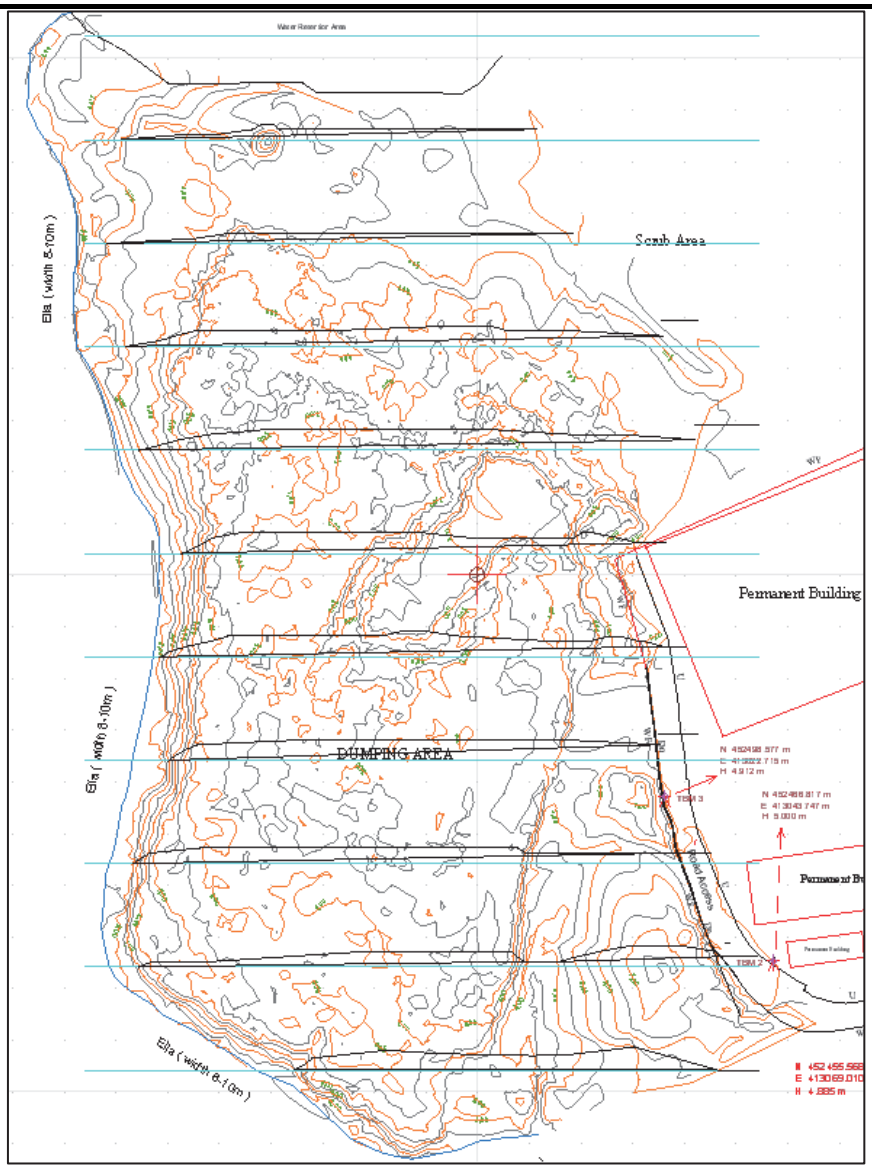


Figure 4-22 Undulation condition diagram

(c) Setting the base surface

To develop a closure plan, it is necessary to set the base surface. Following the analysis of the current topography, the base surface on the west side of the site was set at 3.0 m because the slope is generally stable at an elevation of 3.0 m. On the other hand, the base surface on the east side was set at 5 m because the slope is stable at a height of 5 m near the boundary with the composting facility. The base surface on the south side was set at an elevation of 3.0 m. The south side of the site is a sloping line connecting the west side (elevation 3 m) and the east side (elevation 5 m).

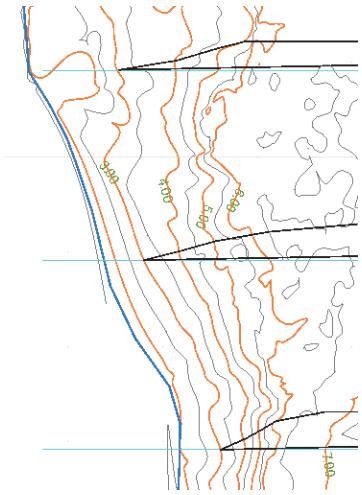
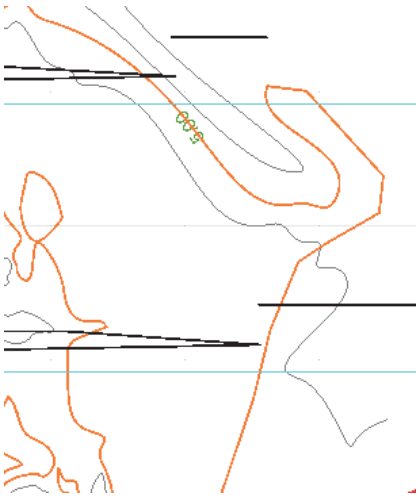
The condition of the west side	The condition of the east side
	

Figure 4-23 Current slope edge and ground conditions

(d) Planning the cross section

The waste that is currently scattered will be collected, compacted, and shaped using bulldozers and other heavy equipment, and then covered with a final soil cover. Before these operations, the planned cross-sectional profile is established based on the landscaping plan and design.

CEA's "Technical Guidelines on Solid Waste Management in Sri Lanka" (9.2.10 Closure design) provides the following:

a.	The design of landfill lift above ground, especially the height of the lift, must consider the scenery of the facility, the stability, and the safety in the operation.
b.	The final side slope design, side slopes of above-ground disposal units shall not be steeper than 3 horizontal to 1 vertical and have the drainage system to control erosion of the final cover.
c.	Final cover design The final cover shall be a minimum 60 cm soil layer with maximum hydraulic conductivity of 1 x 10-5 cm/sec

The plan is based on this regulation, but it does not specify a numerical value for the height of one lift. Therefore, assuming that one lift is 5 m, which has been applied in many cases in Japan, a small step of 2 m wide is provided for each lift. The following is a standard cross section taking these considerations into account.

The thickness of the final cover shall be 60 cm as indicated in the guidelines.

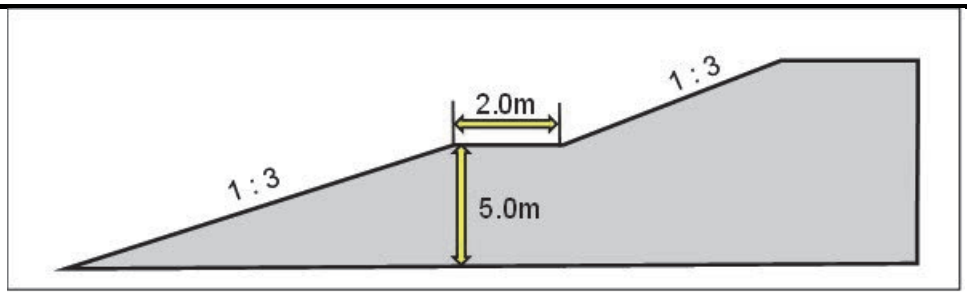


Figure 4-24 Standard cross section of slope area

(e) Estimated amount of landfilled waste

The volume for each elevation is estimated by measuring the flat area of each contour line using CAD, considering an elevation of 3 m as the bottom. A margin of 20% was assumed for the volume because the condition of the bottom of the waste landfill site was unknown. The results are shown below.

Table 4-14 Estimated amount of landfilled waste

Level (m)	H (m)	Area (m^2)	Average (m^2)	Volume (m^3)
3	-	14,616	-	-
4	1	10,969	12792.5	12,793
5	1	14,282	12625.5	12,626
6	1	9,626	11954	11,954
6.5	0.5	11,745	10685.5	5,343
7	0.5	687	6216	3,108
Sub-total				42,715
		Contingency	20%	8,543
Sub-total				51,258
		Cover soil	20%	10,252
Total				61,509

Based on the above, a landfill shape capable of holding approximately 62,000 m^3 is considered, assuming that a 5 m wide perimeter road is constructed for post-closure maintenance.

(f) Setting of landfill shape

When setting the shape of the landfill, a 5 m wide perimeter road was added for post-closure maintenance. Assuming a landfill height of 5 m and a slope of 1:3, the volume that could be contained was calculated to be approximately 45,000 m^3. On the other hand, as described above, the required volume is about 62,000 m^3, which represents a shortfall of almost one third. Therefore, a second tier was considered to compensate for the shortfall, and the results showed that a second tier with a height of 3 m and a slope of 1:3 could hold a volume of approximately 18,000 m^3. According to the above, approximately 63,000 m^3 could be secured in two tiers, so the planning proceeded with this form.

Table 4-15 Estimated volume that can be secured with the assumed shape

Position	1st step	2nd step
	Area (m2)	Area (m2)
Bottom	14,181	7,766
Top	8,612	4,329
Average	11,397	6,048
Hight(m)	4.0	3.0
Volume(m^3)	45,586	18,143
Total Volume(m^3)	63,729	

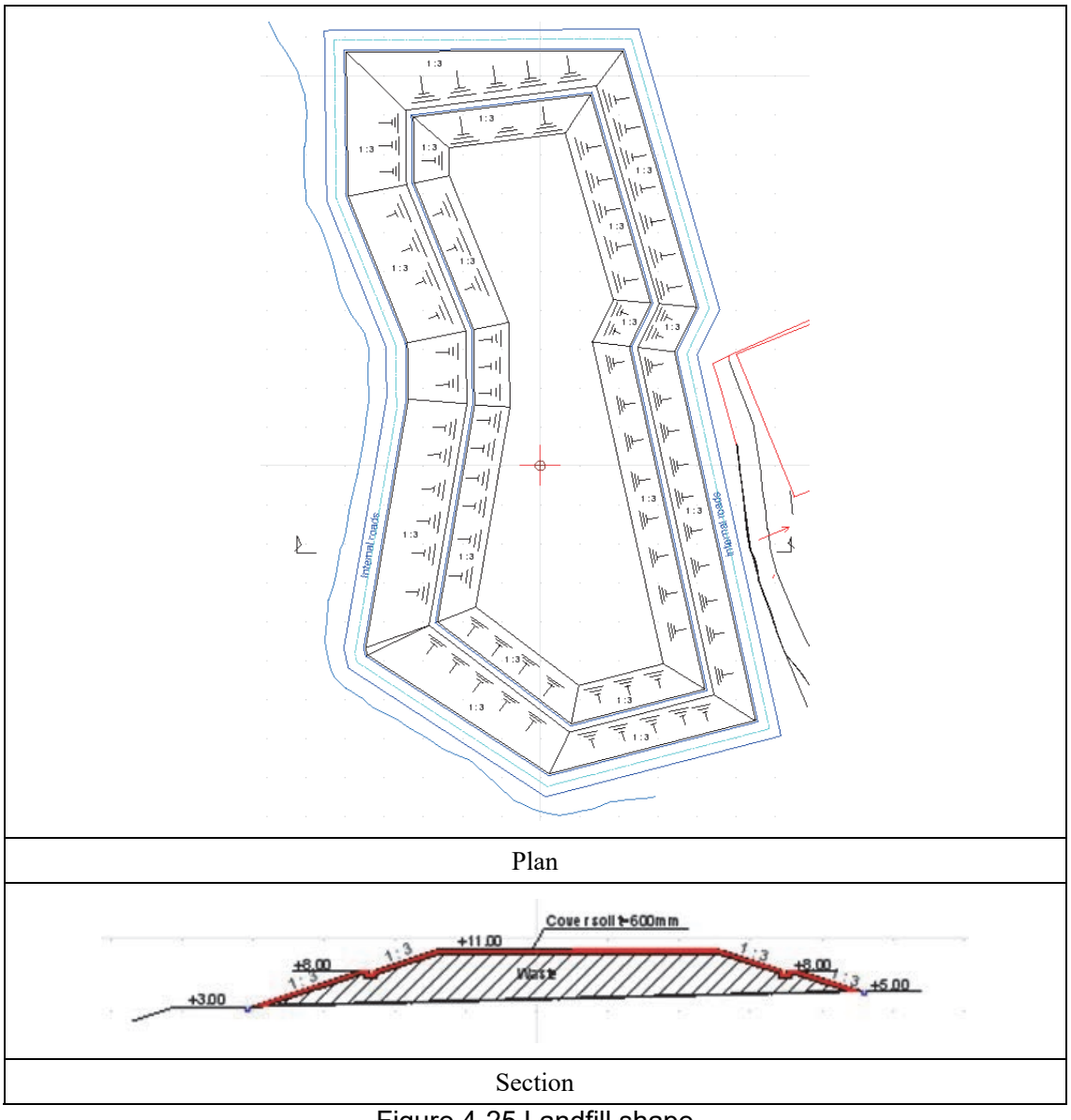


Figure 4-25 Landfill shape

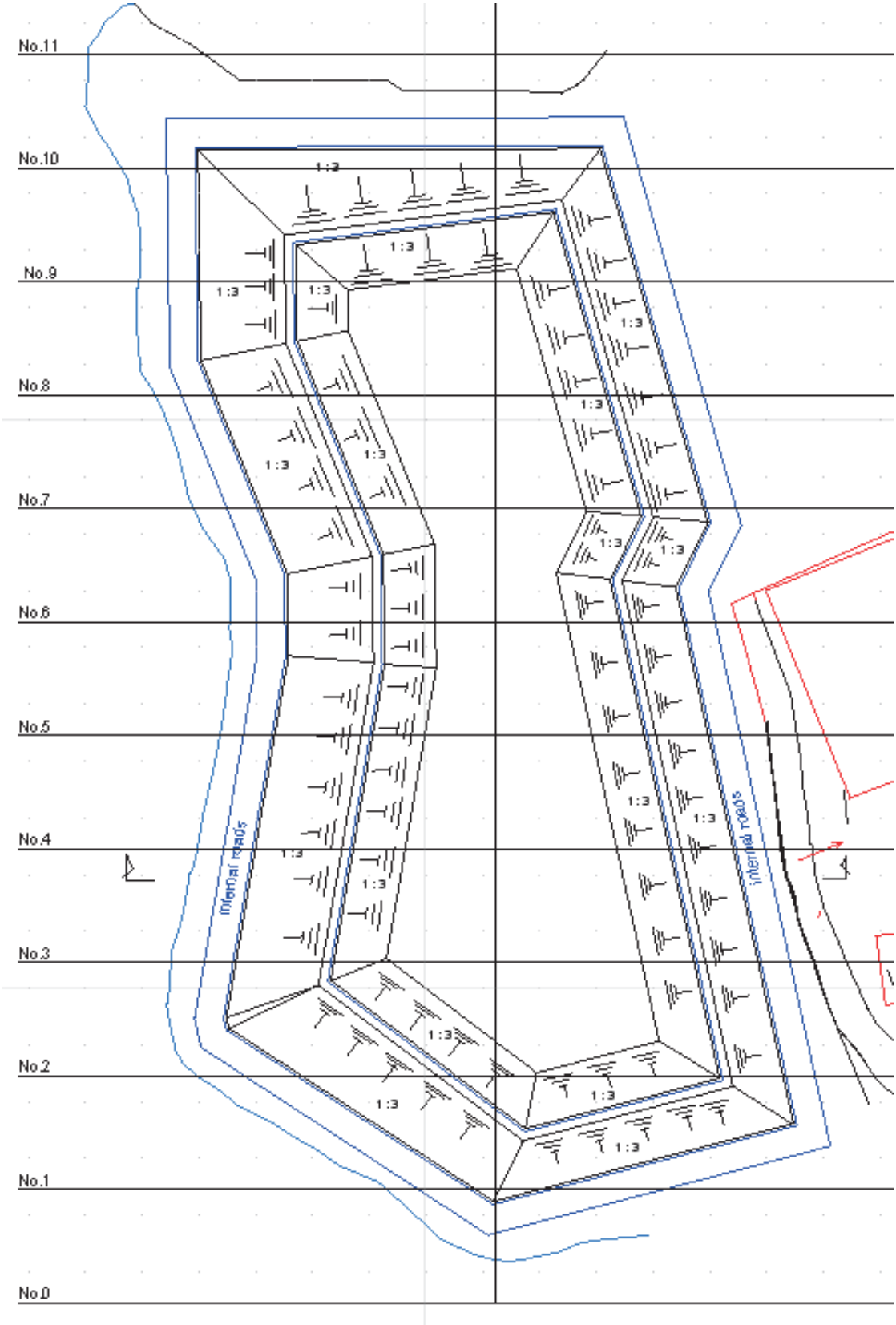


Figure 4-26 Plan view with measurement lines

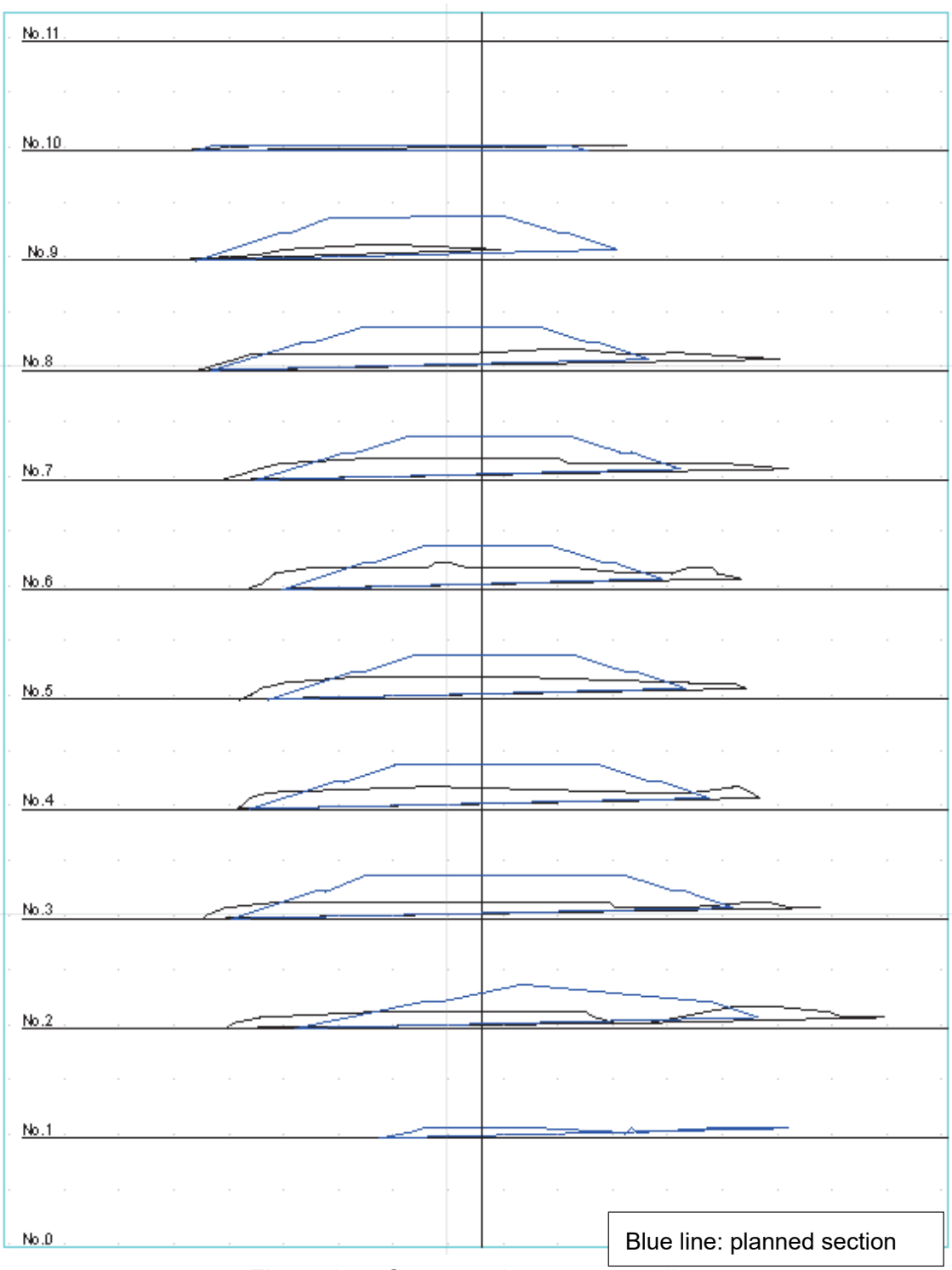


Figure 4-27 Cross section per survey line

(g) Landscaping method

In order to construct a 5 m wide perimeter road for post-closure maintenance, bulldozers will be used from the west, east, south, and north sides to push and compact the waste and create the final shape. The following is an illustration of the work.

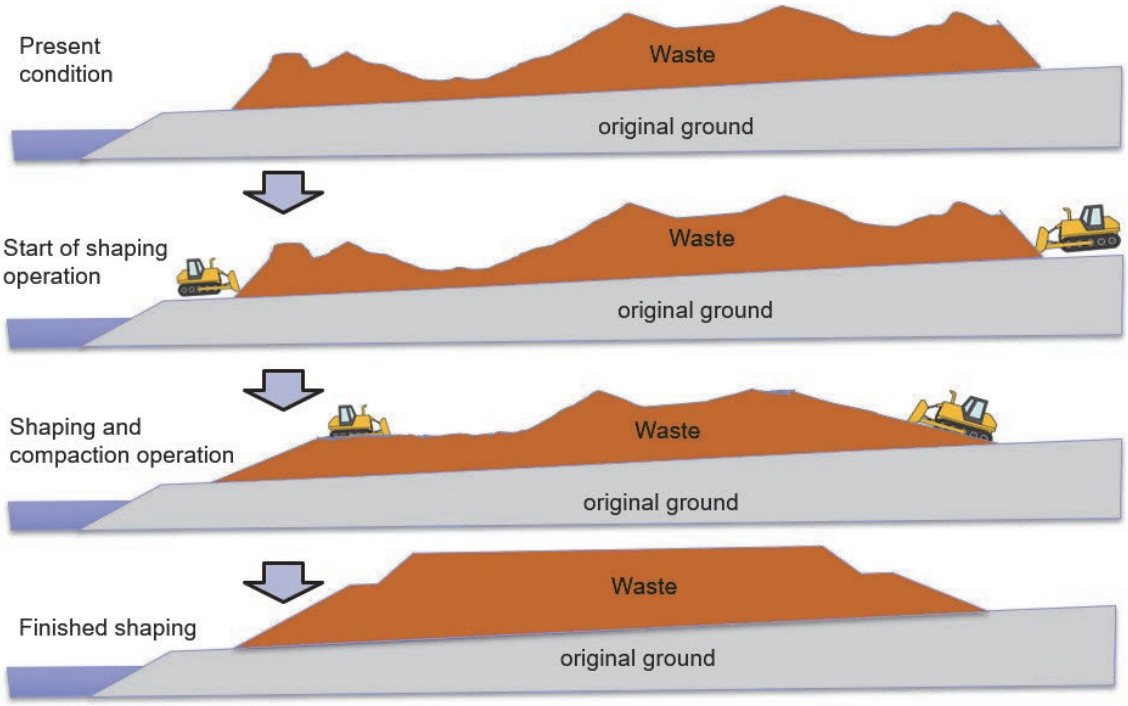


Figure 4-28 Conceptual image of the landscaping method

(h) Stormwater drainage plan

CEA's "Technical Guidelines on Solid Waste Management in Sri Lanka" addresses stormwater drainage planning in 9.2.5.5 and stipulates that "Strom water management shall include detention/retention ponds and drainage ways and shall be designed which, at a minimum, prevents storm water from the peak discharge of the 25-year storm event from running on to those portions of the landfill which have not been closed".

Based on the above, the 25-year probability rainfall intensity equation is applied. The rainfall intensity formula for Colombo with 25-year probability[9] is (y=101.58X-0.648)

If the rainfall duration is one hour, the rainfall intensity is 101.58 X 1-0.648 = 101.58 mm/h

The amount of rainwater generated from each of the ten zones, as shown in the diagram below, was calculated using the formula below:

$$Q = 1/360\ f\ r\ A$$

A drainage gutter of 300 mm × 300 mm and a slope of 1 per mill was used to determine the amount of potential runoff and the safety factor for the amount of runoff.

As a result, the safety factor exceeded 1.0 in all areas, so the 300 mm x 300 mm gutter was judged capable of carrying the runoff.

[99] Development of Rainfall Intensity-Duration-Frequency (IDF) Curves for Colombo, Sri Lanka, Suhajinee Gunawardana, Irrigation Department, Sri Lanka, October 2018

Table 4-16 Flow calculation results

Location	f	r	A (ha)	Q (m^3/sec)	Allowable flow velocity of waterway (m^3/sec)	Safety factor
A	0.5	101.58	0.204	0.0288	0.033191	1.15
B	0.5	101.58	0.1842	0.0260	0.033191	1.28
C	0.5	101.58	0.0449	0.0063	0.033191	5.24
D	0.5	101.58	0.1966	0.0277	0.033191	1.20
E	0.5	101.58	0.1671	0.0236	0.033191	1.41
F	0.5	101.58	0.1218	0.0172	0.033191	1.93
G	0.5	101.58	0.1255	0.0177	0.033191	1.87
H	0.5	101.58	0.2214	0.0312	0.033191	1.06
I	0.5	101.58	0.2126	0.0300	0.033191	1.11
J	0.5	101.58	0.2249	0.0317	0.033191	1.05

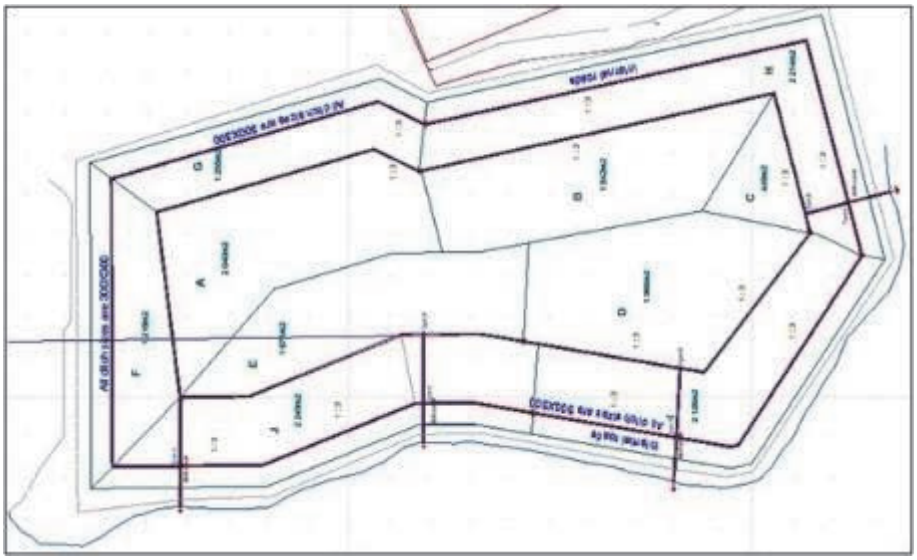


Figure 4-29 Stormwater drainage compartment map

(i) Gas venting facilities

A gas venting facility should generally be installed every 2,000 m^2, based on Japanese experience.

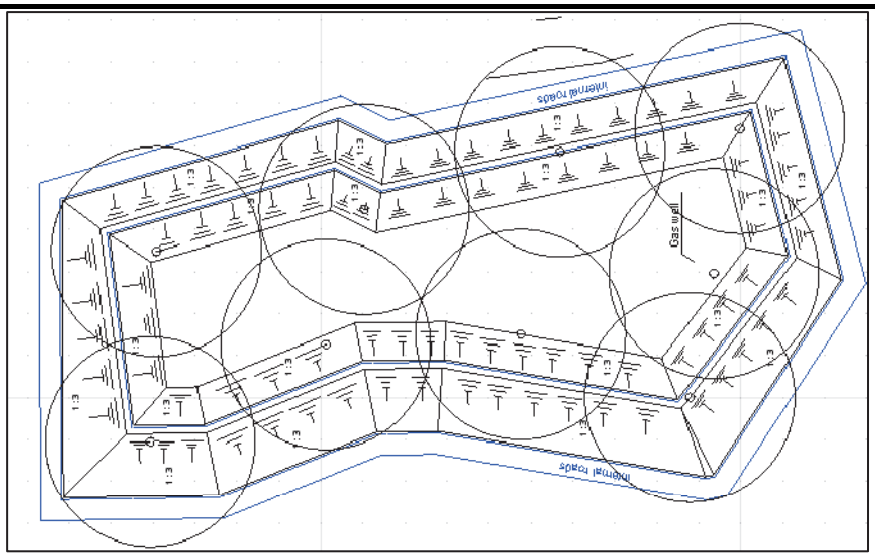
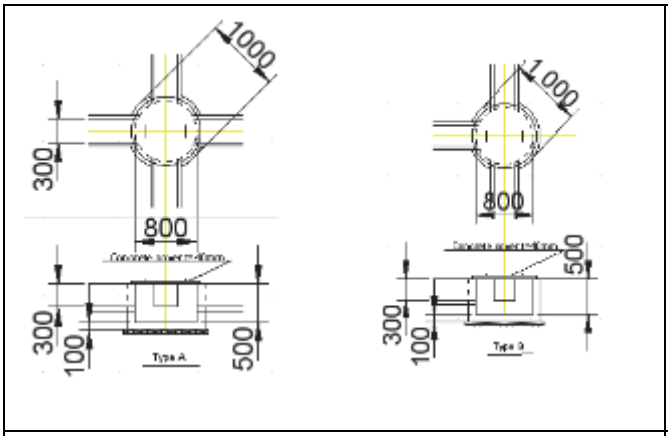
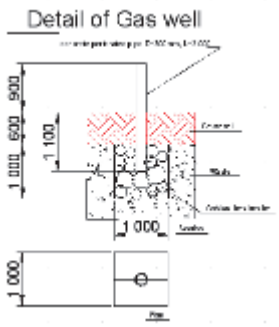


Figure 4-30 Gas venting facilities map

(j) Detailed drawings of rainwater drainage boxes and gas venting facilities

A detailed drawing of the stormwater drainage box and gas venting facility is shown below.





Stormwater drainage box	Gas venting facility

Figure 4-31 Stormwater drainage box and Gas venting facility

(k) Required quantity for closure plan

The required quantities to implement the safe closure works is shown below. The estimated amount of existing waste that needed to be moved was assumed to be 50% of the total amount of waste.

Table 4-17 Summary of required quantities

Item	Quantity	unit
Earthworks	1	set
Turfing	1	set
Storm drainage	1	set
Gas venting facility	1	set
External works	1	set
Internal road	1	set
Sub-total		
Contingency	30%	
TOTAL		

Table 4-18 Quantity breakdown

Item		Quantity	unit
Earthworks	Waste moving and compaction	26,000	m^3
	Waste embankment	26,000	m^3
	Purchasing soil for cover clay soil	13,650	m^3
	Compaction of cover soil	10,500	m^3
total			
Turfing	weed	18,000	m^2
total			
Storm drainage	U-shaped gutter 300x300	1,133	m
	Grating W=300	20	m
	Combined box Type-A	4	nos.
	Combined box Type-B	3	nos.
total			
Gas venting facility		9	nos.
total			
External works	Fence h=2.0m	580	m
	Gate W=5m, h=2.0m	1	place
total			
Internal road	W=5000 gravel-covered road	540	m
total			

(l) Required duration of work

The table below shows the estimated time required for safe closure based on the above-mentioned quantities.

Table 4-19 Estimated time required for safe closure

Item	Amount	Work rate	Days	Months Required (20days/month)
Earthworks	39,650	320 m^3/day	123.9	6.2
Compaction of soil cover	13,650	140 m^3/day	97.5	4.9
Preparatory period				3.0
Sub-total				14.1
Contingency	30%			4.2
Total				18.3

(4) Karadiyana compost improvement

After consultation with the C/P agencies and JICA the Karadiyana Compost Improvement Project was added as new pilot project for Outcome 4 in July 2021.

(a) Background

The Karadiyana landfill site was receiving 500-600 tons per day of municipal solid waste from seven LAs, and the National Building Research Organization recommended its closure in June 2020 because it had reached its final disposal capacity. In addition, the waste incineration project which was originally planned to be completed in September 2019 had been cancelled. Furthermore, in March 2021, a court order was issued to present a plan for the improvement and closure of the Karadiyana landfill.

Under these circumstances, the Western Province Waste Management Authority (WMA), which operates the Karadiyana landfill, requested support from JICA and the JICA Expert Team to improve the Karadiyana composting plant and provide equipment since the closure of the Karadiyana landfill and the treatment of all organic waste were urgent issues.

After consultation with the C/P, the JICA Expert Team confirmed the need for improvement support and prepared a draft plan for the improvement of the Karadiyana composting plant. The pilot project to be implemented for Outcome 4 is already the improvement of the Kalutara composting plant, but in contrast to the small and medium-sized composting plant, the Karadiyana composting plant is a large-scale composting plant and is the core organic waste treatment facility of Master Plan. It was decided to use the implementation of Karadiyana composting plant improvement plan as a model for the improvement of another large-scale composting facility (Muthurajawela composting plant), and to describe the improvement process in the Master Plan.

Karadiyana final disposal site

Composting plant and final disposal site (Site A)

Karadiyana composting plant

JICA Sri Lanka office staff observe the situation of Karadiyana final disposal site (Site A)

Figure 4-32 Status of Karadiyana final disposal site and composting plant

(b) Outline design of the Karadiyana composting plant improvement plan

◆ Project site

Karadiyana final disposal site and composting plant

◆ Project period

From June 2021 to the end of 2023 (expected implementation period at the time of outline design)

◆ Outline of the project

Rehabilitation of the final disposal site for organic waste and improvement of the treatment capacity of the large-scale composting plant. The first phase is the planning and equipment procurement period, the second phase is the final disposal site rehabilitation period, and the third phase is the composting period.

The project will rehabilitate the final disposal site, which receives about 250 tons/day of organic waste from seven LAs in Colombo District, and improve the composting capacity of the composting plant, thereby reducing the environmental impact of the project. The rehabilitation process to be carried out in this project will also be described in the master plan as a model for the rehabilitation of the Muthurajawela final disposal site, another large-scale organic waste

treatment and disposal facility.

The compost produced will be stored in a covered composting plant and sold to farmers in the Western Province and the Maldives, who are existing customers, as well as to markets in the Southern Province and Sabaragamuwa Province, where other WMA composting plants are selling their products.

◆ Purpose of the project

The implementation of the improvement plan for the Karadiyana final disposal facility, which continues to receive municipal solid waste beyond its final disposal capacity, will rehabilitate the final disposal site for organic waste and enable the treatment of the entire volume of organic waste received (approximately 250 tons/day). The project will serve as a model for improving the treatment capacity of organic waste treatment facilities in Sri Lanka and will be applied to other large-scale organic waste treatment facilities.

◆ Expected outcome

There are four expected benefits from the implementation of the Karadiyana Compost Improvement Project:

i. Increased treatment capacity for organic waste.
ii. Enhanced knowledge on how to increase the treatment capacity of organic waste treatment facilities.
iii. Rehabilitation of the final disposal site to reduce odour and environmental impact.
iv. Reduction of greenhouse gas (methane) emissions from the final disposal site.

◆ Procurement of equipment and its usage

Table 4-20 Procurement of equipment and usage

No	Equipment	Usage
1	Heavy-duty sieving machine	Landfill mining and compost sieving for the Karadiyana Compost Improvement and Rehabilitation Project.
2	Tractor mounted with a bucket	Tractors are used to transport organic waste for landfill mining at the final disposal site, and to deliver organic waste to Trommel No. 1.
3	Forklift	The compost bagged in the composting plant are loaded onto trucks for transport.
4	Crushing machine	The crushing machine is used to crush organic waste for easy sieving in the trommel.
5	Compost bagging machine	The compost bagging machine is used to bag the matured compost into jute bags in the composting plant.

(c) Detailed design of the Karadiyana Compost Improvement Plan

i. Background.

NSWMSC, WMA, CEA, and the JICA Expert Team developed in May 2021 a rehabilitation plan for the Karadiyana composting plant (hereinafter the “Rehabilitation Plan”) as a schematic

design that used Google Earth data to determine the shape of the facility. However, given the accuracy of Google Earth, the plan did not reflect the actual geometry of the facility.

In this pilot activity, topographical surveys of the site were carried out. The results were used to reflect on the layout of the facility for the rehabilitation plan. A detailed plan was developed to implement this plan based on the results of the schematic design.

ii. Current condition of the project site

The target site for the project consists of Site A, Site B, and the composting plant. The area to be improved is Site A.

Figure 4-33 Target site

The final stage of the rehabilitation of the final disposal site is the third phase, in which 200 tons/day of organic waste is received at Site A and composted using the windrow method. However, there is not enough space to install a windrow. Therefore, in the second phase, landfill mining is carried out at the organic waste collection site (landfill site), where waste has already been piled up for several months to several years and is sufficiently stable, and a flat area will be created at the collection site and used as a space for installing windrows.

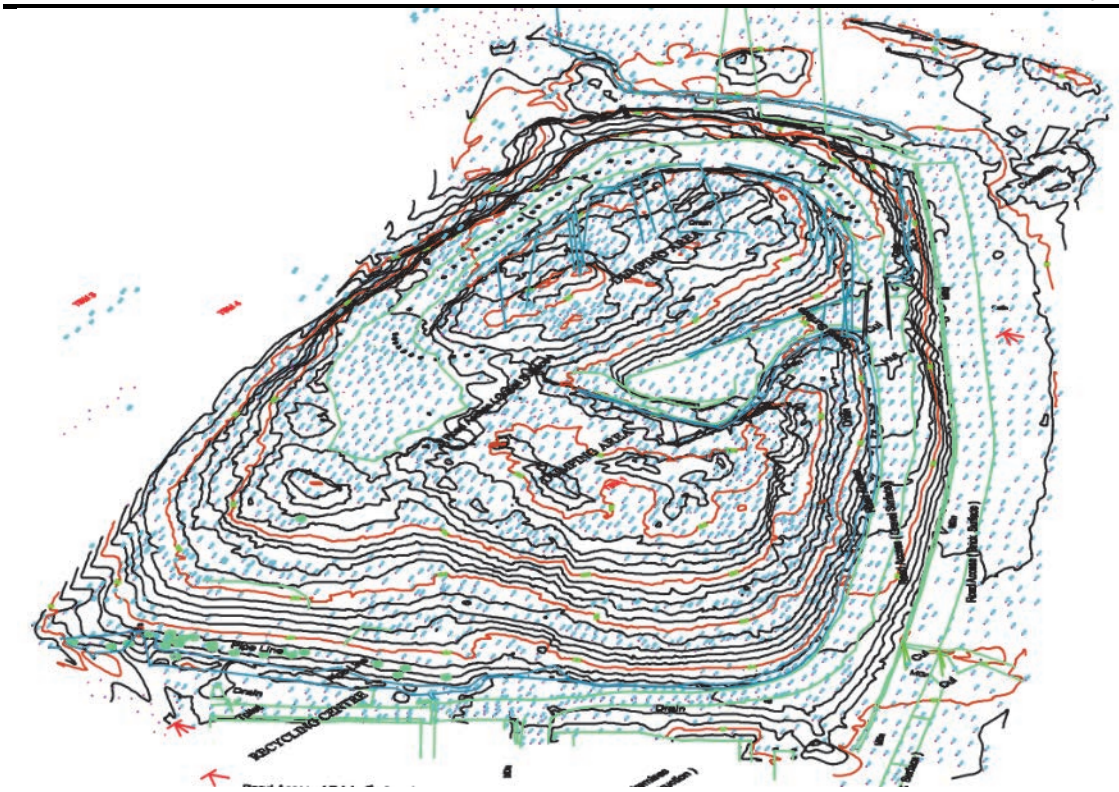


Figure 4-34 Isometric of organic waste accumulation area viewed from the southwest of the Site A

iii. Landfill mining implementation method

In the third phase, space for the installation of windrows is available, so the collected organic waste can be used to create a windrow and undergo aerobic treatment directly, but in the second phase, there is not enough land available for the installation of a windrow, so the following steps are required. The collected organic waste is first placed under anaerobic conditions for volume reduction. Then, a windrow is made from this reduced organic waste and treated aerobically. Finally, it is sieved to make compost.

In particular, at the current organic waste landfill site (Site A), the top of the landfill is to be flattened by removing the mixed organic and non-organic waste from the landfill. The removed waste will be transported to Site B or a transfer site.

After flattening, the existing organic waste layer (Site A in the diagram below) is excavated to create a receiving pit for fresh organic waste. The fresh organic waste (Fresh waste section in the diagram below) is then placed into this pit and treated under anaerobic conditions for 90 days.

After 90 days of anaerobic treatment, 200 tons per day of fresh organic waste and part of the old waste will be treated aerobically in windrow for 30 days.

This process is repeatedly carried out to gradually remove the piles of organic waste and eventually secure a site for the third phase of the project. A conceptual diagram of this process is shown below.

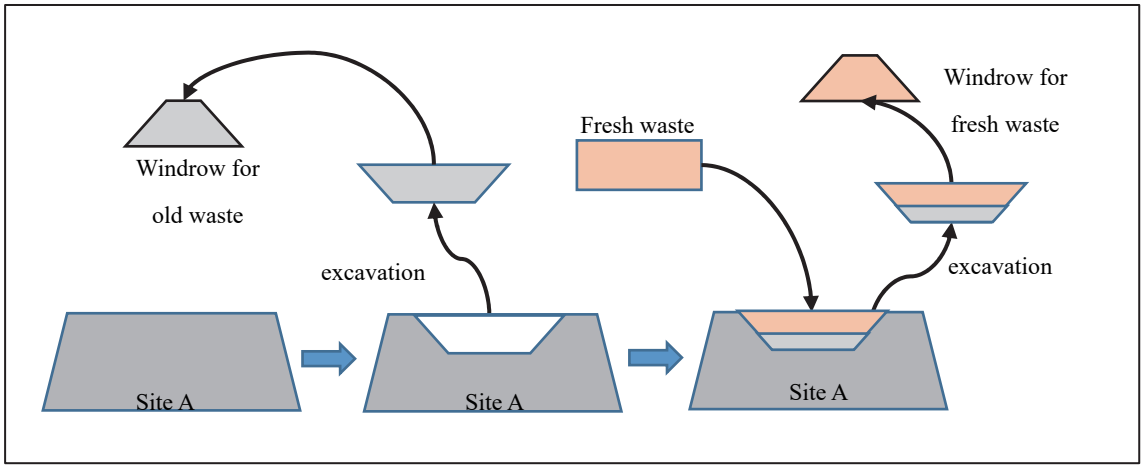


Figure 4-35 Conceptual diagram of the landfill mining implementation method

iv. Amount to be handled per day

The amount of waste after anaerobic decomposition that can be handled in a day is set at 200 tons/day due to the limited capacity of the transport vehicles.

v. Material balance

➢ **Anaerobic decomposition**

The anaerobic decomposition of organic waste proceeds in stages, as shown in the figure below, resulting in methane and carbon dioxide.

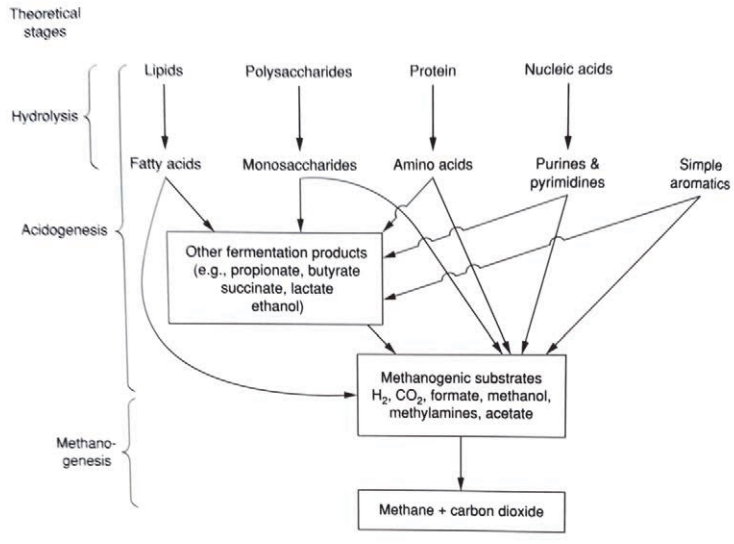


FIGURE 14-1
Pathways leading to the production of methane and carbon dioxide from the anaerobic digestion of the organic fraction of MSW [from Holland, *et al.*, *Anaerobic Bacteria*, ©1987, p. 184. Reprinted by permission of Blackie Academic & Professional (an imprint of Chapman and Hall)].

Source: Integrated solid waste management Engineering principals and management issues,680 pare, McGraw-Hill, Inc

Figure 4-36 Anaerobic decomposition process of organic waste

According to the above source literature, if the waste is completely anaerobically decomposed, the amount of methane and carbon dioxide produced from 1 kg of waste is as follows:

Methane: 0.20 kg/waste kg
Carbon dioxide: 0.48 kg/waste kg
Total 0.68 kg/ waste kg

The amount of methane and carbon dioxide produced by the complete decomposition of the organic content of 200 tons/day of organic waste is as follows:

Methane: 200 × 1,000 × 0.20 = 40,000 kg = 40 tons
Carbon dioxide: 200 × 1,000 × 0.48 = 96,000 kg = 96 tons
Total: 136 tons

As a result, 136 tons are discharged into the atmosphere, leaving 64 tons of residues. However, this is the figure when anaerobic decomposition is complete.

Assuming that anaerobic decomposition is complete in 12 months, the amount decomposed in 90 days is 136 tons × (3/12) = 34 tons.

Based on this assumption, the following results from the calculation of the amount of organic waste after 200 tons per day were fed into the anaerobic decomposition cell and decomposed anaerobically for 90 days.

Table 4-21 Material balance from anaerobic decomposition

Input amount	200	tons/day
Retention time	90	days
Total input amount	18,000	tons

Conversion factor		Converted amount (ton)
Methane	0.20	4,500
CO_2	0.48	10,800
Total		15,300

Retention time	90	days
Degradation factor	25	%
Reduced amount	3,060	tons

Remaining amount	14,940	tons
Daily output amount	166	tons/day

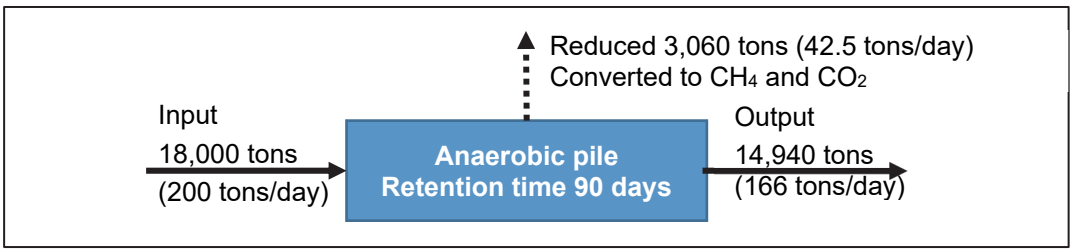


Figure 4-37 Material balance sheet by anaerobic decomposition

➢ **Aerobic decomposition**

The balance of aerobic decomposition is calculated using the same source literature as for anaerobic decomposition.

Table 4-22 Carbon dioxide emissions from aerobic decomposition

	lb	kg
Process input		
Organic material	1 000	454
Oxygen	708	321
Total	1 708	**775**
Process output		
Organic material	400	181
Carbon dioxide	974	**442**
Water	332	151
Total	1 706	774

Source: Integrated solid waste management - Engineering principals and management issues, p. 677 to 683, McGraw-Hill, Inc.

The amount of carbon dioxide produced per kilogram of waste according to the above table is 442 ÷ 775 = 0.57 CO_2 kg/waste kg. The amount of carbon dioxide generated by aerobic treatment (windrow) is 166 × 1,000 × 0.57 = 94,620 kg/day = 94 tons/day.

If the removal of old organic waste is completed and a windrow is installed at an elevation of 10 m from the ground, and the fresh waste is directly treated aerobically, the amount of carbon dioxide generated is decreased.

vi. Procedure for item removal during landfill mining

Four cells capable of storing each 200 tons per day of fresh waste for 30 days are created in Site A by landfill mining, and fresh waste is fed into the cells sequentially for anaerobic decomposition. After 90 days, the anaerobically decomposed material is excavated to create a windrow for aerobic decomposition.

	Cell				Time
Month	1	2	3	4	
1	■				
2		■			30 days
3			■		
4				■	
5	■				
6		■			30 days
7			■		
8				■	
9	■				
10		■			30 days
11			■		
12				■	

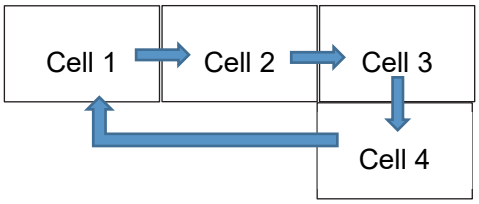


Figure 4-38 Order of cell use

Figure 4-39 Actual cell layout

vii. Material balance in Phase2

Since the amount of waste that can be carried out daily after anaerobic decomposition is 200 tons/day due to the limitation of transport vehicles, the amount of old organic waste carried out daily is 200 tons/day - 166 tons/day = 34 tons/day. A material balance sheet was prepared using this, and the results above are shown below.

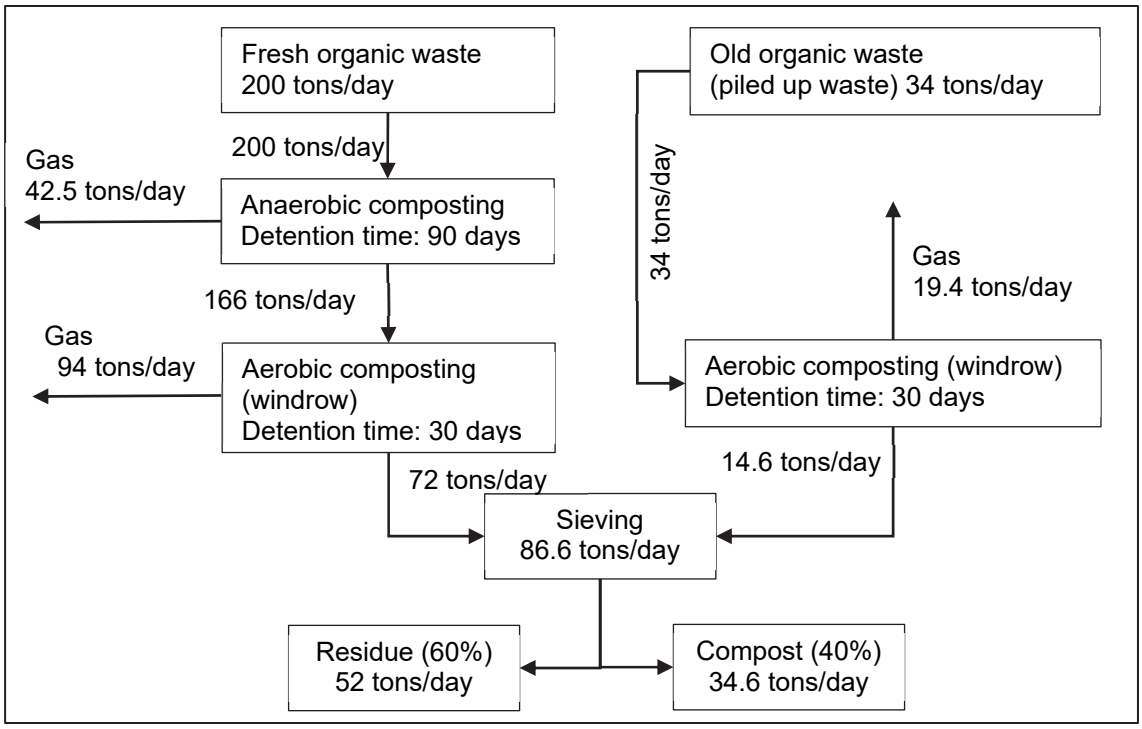


Figure 4-40 Material balance sheet

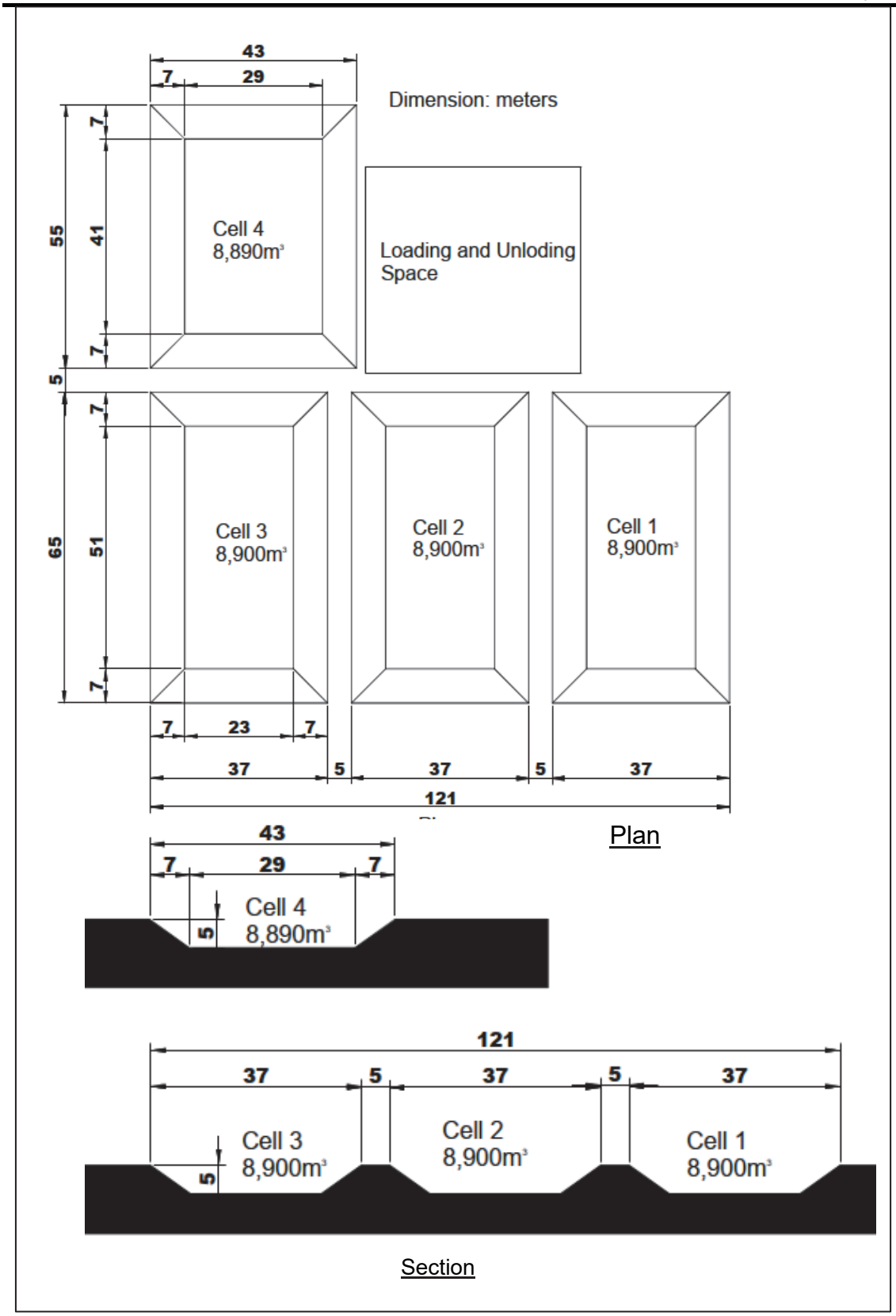


Figure 4-41 Plan view and cross-section of the cells

viii. Overall amount of items removed by landfill mining

The area inside the contour line was measured using CAD for each meter from an elevation of

10 m to the highest point of 26 m. The results are shown in the table below.

Table 4-23 Volume of the area above 10 m elevation

Elevation	Area(m^2)	Height(m)	Volume(m^3)
10.0	27,564	0.5	13,782
13.0	24,059	1.0	24,059
14.0	22,522	1.0	22,522
15.0	20,336	1.0	20,336
16.0	18,754	1.0	18,754
17.0	16,571	1.0	16,571
18.0	15,033	1.0	15,033
19.0	13,657	1.0	13,657
20.0	12,192	1.0	12,192
21.0	10,451	1.0	10,451
22.0	7,185	1.0	7,185
23.0	4,977	1.0	4,977
24.0	3,458	1.0	3,458
25.0	1,299	1.0	1,299
26.0	1,233	1.0	1,233
Total	199,291		185,509

The figure obtained by removing the volume of the embankment at the 15 m north elevation from the total volume given in the table above is the volume that needs to be removed.

The cross-sectional area of the embankment is 62.5 m^2, and the total length is 270 m, so the volume is 16,875 m^3.

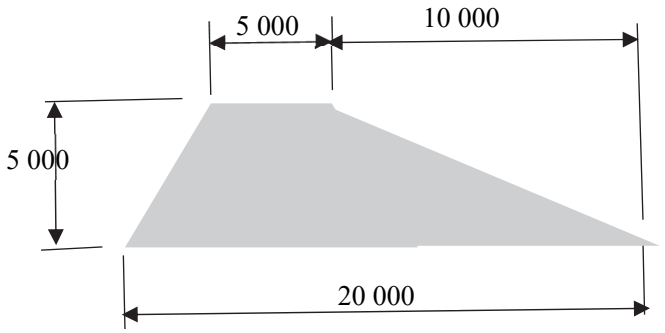


Figure 4-42 Cross-sectional of the embankment

From the above, the volume that needs to be removed to create a flat land at an elevation of 10 m is 168,634 m^3.

168,634 m^3 × 0.4 ton/m^3 = 67,454 tons

Assuming that the processing capacity of the sifting facility is 34 tons per day, it would take 1,983 days to process all the landfill-mined material.

Assuming that the sifting facility operates 300 days per year, it would take approximately 6.6 years to process all the material.

ix. Windrow layout plan in Phase2

As the space available for the windrows in Phase I was limited, large windrows with a cross-sectional area of 8 m^2 and able to receive 200 tons per day of organic material were considered, requiring a site of approximately 1 hectare.

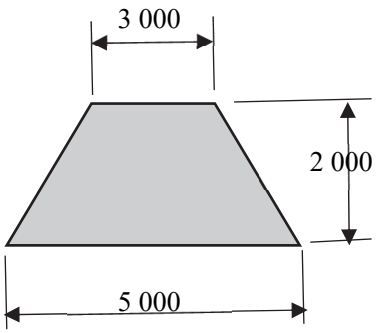


Figure 4-43 Cross section of a windrow in Phase II

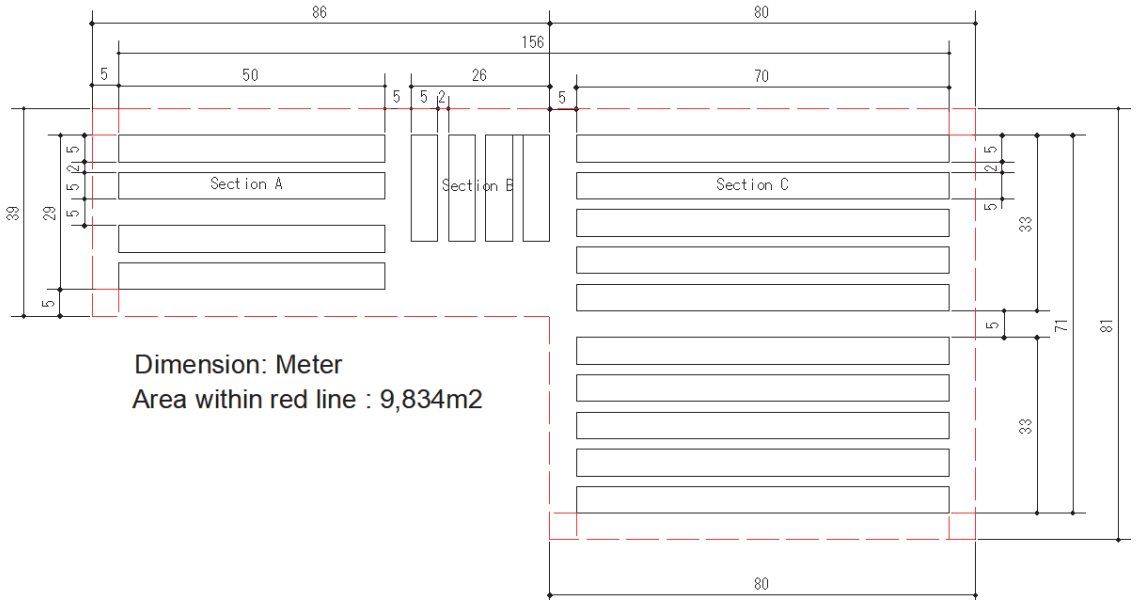


Figure 4-44 Windrow layout in Phase II

The potential site for the installation of the windrows is in and around the previously proposed incineration plant site. This site is at risk of flooding during the rainy season, and its use should be considered after observing the conditions during the rainy season.

Figure 4-45 Candidate site for windrows in Phase II

x. Windrow layout plan in Phase3

The May 2021 rehabilitation plan estimates the total windrow volume needed for composting at 11,460 m^3, and the cross-sectional area of the windrow is planned at 4.0 m^2 (see figure below).

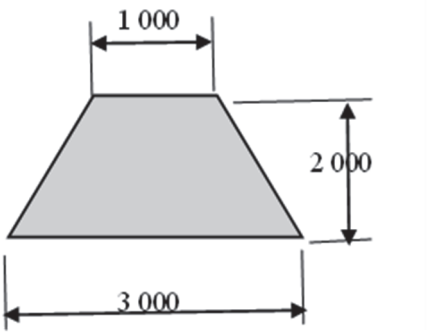


Figure 4-46 Cross section of a windrow in Phase 3

Based on the above cross section, the required total length of the windrow was obtained by dividing 11,460 m^3 by 4.0 m^2 (cross-sectional area) to give 2,865 m, and the final layout of the windrow was set using this value (see below).

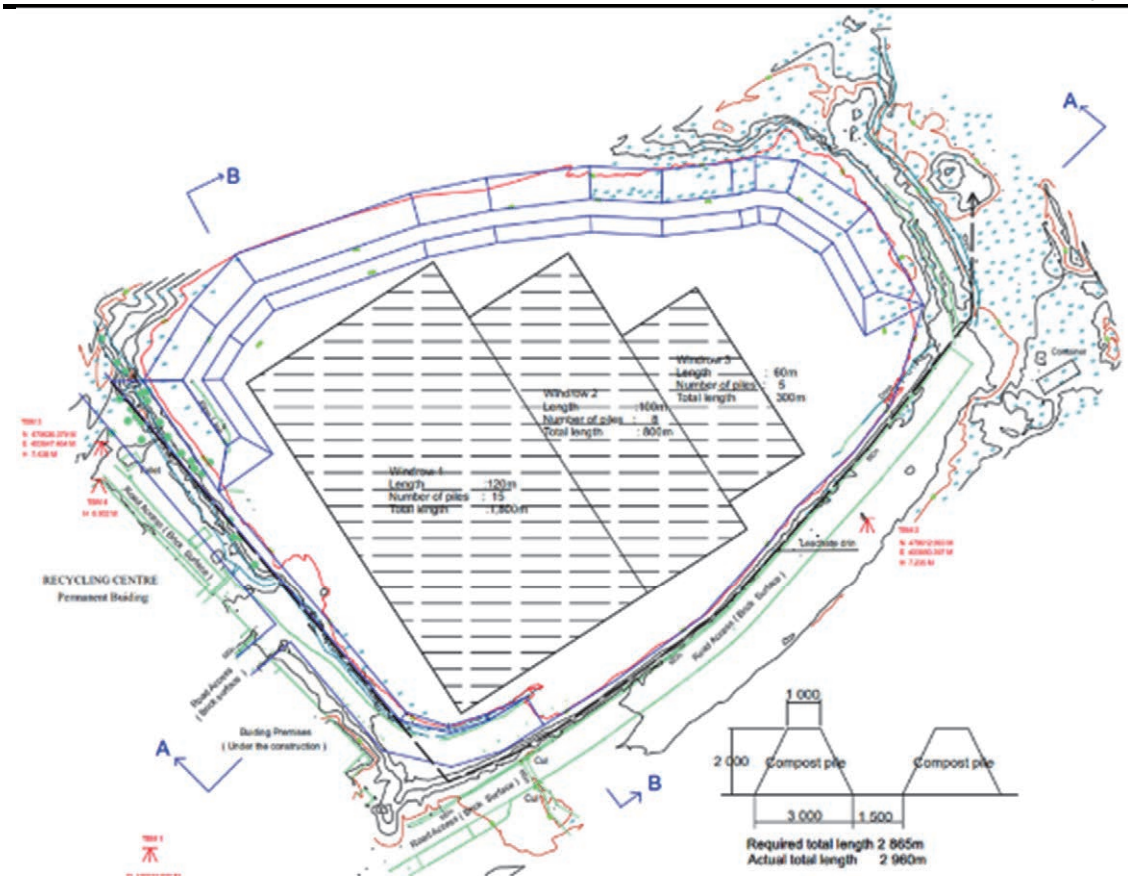


Figure 4-47 Windrow layout plan

In the above figure, base elevations of 15 m and 10 m were considered for the flat land, but the 15 m elevation was not feasible for the site area, so the required site area was secured based on a 10 m elevation.

In addition, since a waterway and a private house are located on the north side of the site, a 15 m high embankment has been planned on the north side to mitigate the negative impacts on these properties.

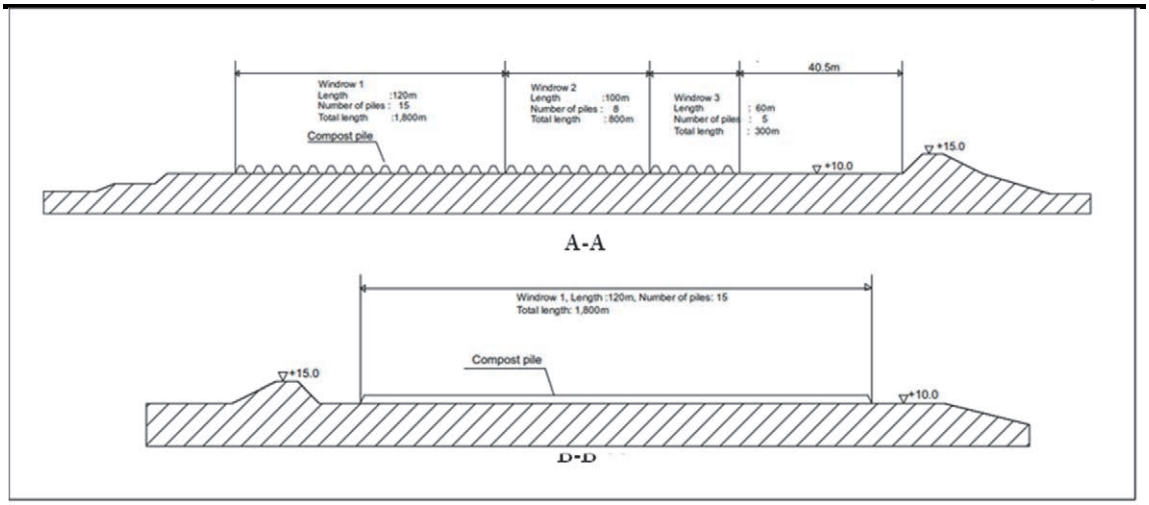


Figure 4-48 Windrow section

Table 4-24 Total length of windrows

Name	Length of one pile (m)	Number of piles	Total length(m)
Windrow 1	120	15	1,800
Windrow 2	100	8	800
Windrow 2	60	5	300
Total	-	-	**2,900**

(d) Schedule of Karadiyana Composting Plant Improvement Plan

The Karadiyana Compost Improvement Project is planned to be implemented until the end of 2030, and the JICA Expert Team will procure the above equipment and provide technical support to WMA from June 2021 to the end of June 2023, in accordance with the following implementation schedule. Until the completion of this project, CEA and NSWMSC will conduct regular monitoring to confirm the progress of implementation by WMA.

Table 4-25 Implementation schedule of Karadiyana Compost Improvement Plan

Phase	Item	2021				2022				2023				2024								2030			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2		Q4	Q1	Q2	Q3	Q4
Milestone								i		ii			iii			iv				v				vi	
Phase I	Installation of equipment for rehabilitation and composting		●	—	—	—	—	—	—	—	●														
Phase II	Landfill mining, anaerobic and aerobic composting (windrow)										●	—	—	—	—	—	—	—	—	—	—	—	—		
Phase III	Windrow composting at the stabilized area																						●	—	●

Note: Milestone monitoring shall be carried out by CEA and NSWMSC quarterly every year.

(e) Consensus-building pilot project for improvement of operations

Information on technical improvements to the plant will be disclosed to the residents.

4.2.6 C.4.6 C.4.5 is implemented

(1) Kalutara Composting Plant Improvement

(a) Installation of the first aeration system

On 24 December 2021, the air blower and perforated pipes were inserted and installed into the windrow piles and the performance test started.

- Two perforated pipes for air blowing were inserted into each of the three rows of windrows.
- The dimensions of one row of windrow piles are 15 m long, 4 m wide, and 2 m high, with a mass of about 40 tons.
- The gas composition and temperature of a conventional windrow pile and of a pile with an aeration system were measured.
- Waste decomposition and leachate generation were measured.

Figure 4-49 Aeration system and perforated pipes, performance measurement

(b) Performance evaluation after 45 days of the first aeration system

Forty-five days after the installation of the aeration system in the three rows of windrow piles, its performance was evaluated. The performance evaluation confirmed that the installation of the aeration system reduced environmental problems and increased treatment capacity. The summary of the evaluation is as follows:

- The windrow pile with the aeration system received sufficient oxygen concentration (19%) and optimum temperature (58°C) for aerobic decomposition by forced aeration.
- The conventional windrow pile had a very low oxygen concentration (less than 1%) and anaerobic conditions (high hydrogen gas production).
- In the conventional windrow pile, the accumulated carbon oxides caused anaerobic conditions and produced bad odour (mercaptan, H2S, NH4, etc.).
- In the conventional windrow pile, it is assumed that low aeration caused water vapor accumulation and increased leachate.
- In the windrow pile with the aeration system, forced aeration (30 minutes per hour) maintained sufficient oxygen concentration (18%) and optimal temperature (57°C) for aerobic decomposition.
- The windrow pile with the aeration system was deemed ready for sieving after an additional 4-6 weeks of maturation.
- Conventional windrow piles need to be laid down and aged for another 10-12 weeks.

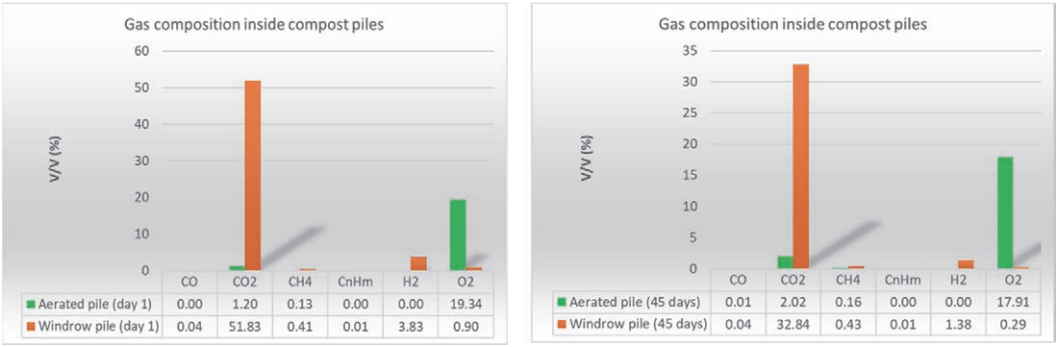


Figure 4-50 Performance comparison of the 1st aeration system at installation and after 45 days

Although the performance of the aeration system was confirmed, it was recognized that the perforated pipes protruding from the ground were an obstacle to heavy equipment operations. It was therefore decided that the second phase would not include a new 7-row aeration system, but rather remedial measures such as embedding the existing three rows of perforated pipes in trenches in the concrete floor.

The modification was completed in April 2023.

The operation manual for introduction of a forced aeration system is attached as Appendix 8.

(2) Consensus-building pilot project for the improvement of operations

(a) Awareness

Public awareness-raising was conducted based on the results of the focus group discussion and the socio-economic baseline survey. In particular, as requests for technical explanations (education) were raised in the survey, the JICA Expert Team explained the technical interventions to be implemented in this pilot project. Furthermore, the results of the socio-economic baseline survey were shared to emphasize that the project is working on improvements that reflect residents' views.

Table 4-26 Agenda of awareness-raising activity

Date	6 November 2022
Venue	Nagoda MahaVidyalaya
Number of attendees	10
Agenda	1. Sharing the result of POS (Public Opinion Survey) by Prof. Mallika Pinnawala, University of Peradeniya 2. Explanation on the rehabilitation of the composting plant and the construction of a new composting plant by Dr. Naofumi Sato, Leader of the JICA Project 3. Q & A

Table 4-27 List of attendees

No.	Name of Attendees	Title
1	Senanie Galle Arachchi	ACLG Office Kalutara
2	Shanika Adkaram	CEA
3	B. Shanika Madushani de Silva	D.S. Office Kalutara
4	D.M.L Dissanayake	Environmental Police
5	Ven. Nagoda Dhammawansha Thero	Temple Priest
6	Nilantha Dharmappriya	Representative of residents
7	Prof. Mallika Pinnawala	University of Peradeniya
8	I.G.A. Nirmala	PHI-Kalutara UC
9	Niranja Jayasena	WMA
10	Channa Kasun	WMA

Greeting from District Manager of Kalutara

Sharing of POS result

Figure 4-51 Awareness-raising activity

(b) Training of Trainers

To understand how to deal with various stakeholders, and to have basic knowledge in order to conduct a training program to local authorities, Training of Trainers (ToT) to WMA, CEA and NSWMSC was conducted as follows.

Table 4-28 Agenda of Training of Trainers

Date	17 January 2023
Venue	Western Provincial Council
Number of attendees	14 (including WMA staff, CEA staff, NSWMSC staff)
Agenda	1. Stakeholder analysis 2. How to deal with each stakeholders

Training given to WMA staff by Prof. Mallika

Hearing the issues from WMA staffs

Figure 4-52 Training of Trainers

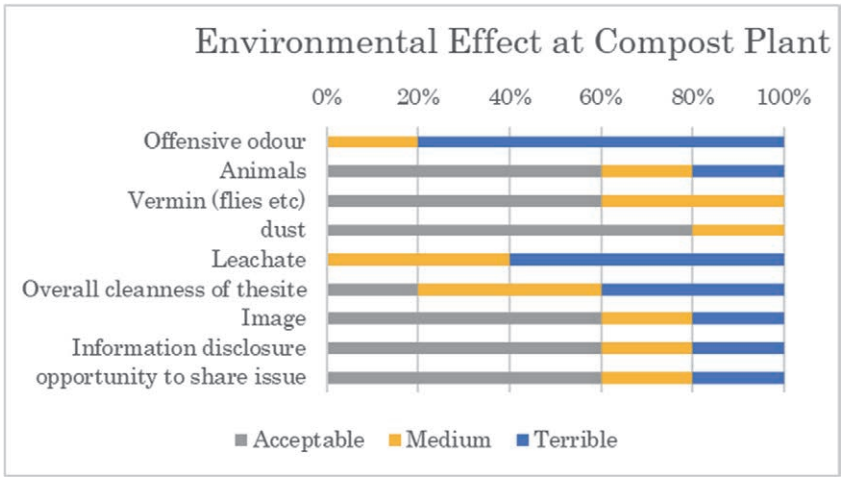
(c) Monitoring committee

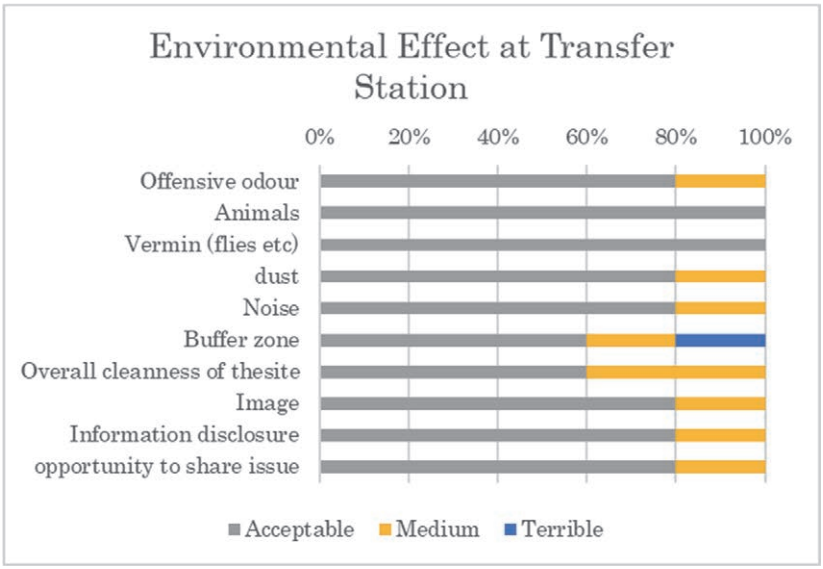
Based on the result of the socio-economic baseline survey which showed a high level of interest in environmental monitoring and monitoring reports on the improvement of both facilities, a monitoring committee involving residents was established. According to the project plan, monitoring was originally to be carried out three times - before construction, during construction and at the start of operations - but was reduced to two times as it had been difficult to hold physical meetings due to COVID-19 for a long period.

■ First monitoring committee (during construction)

The first Monitoring Committee meeting was held on 18 January 2023. The monitoring results are as follows.

For the composting and open dumping site, an odour problem was identified, similar to the results of the socio-economic baseline survey. Furthermore, with regard to the open dumping site, leachate and overall sanitation were also noted, and the need for a transfer station and the closure of the existing open dumping site were confirmed.





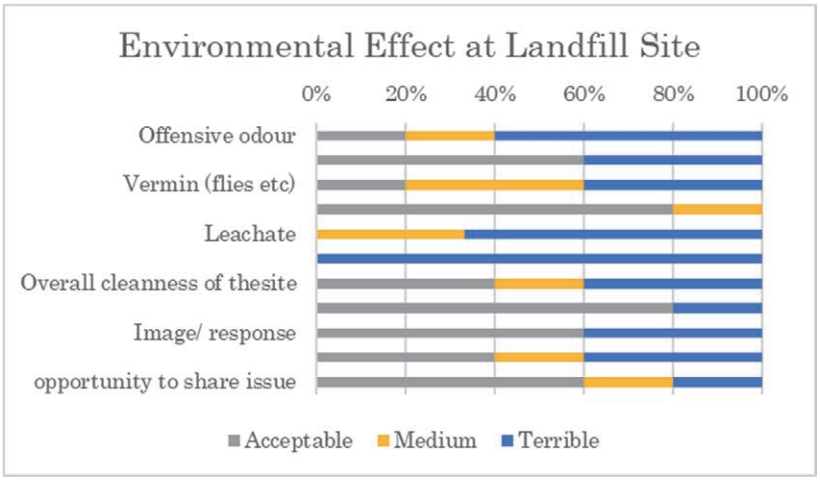


Figure 4-53 Environmental Effect at each facility from the residents' view of point

Table 4-29 Agenda of the monitoring committee

Date	18 January 2023
Venue	Kalutara Mihisaru Resource Management Centre
Number of attendees	23
Agenda	1. Explanation of outline of the pilot project by Mr. Nalin, director of WMA 2. Exchange of opinions 3. Monitoring

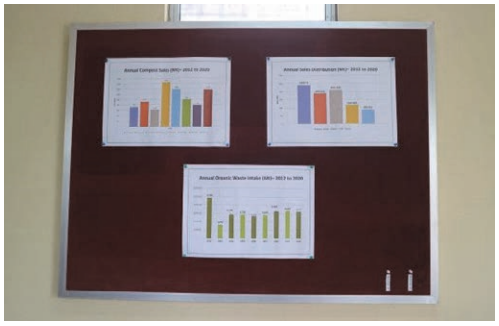
Table 4-30 List of attendees

No.	Name of attendees	Title
1	Ven. Nagoda Dhammawansha Thero	Siri Sudarshanarama Temple
2	Mr. Amir Nasir	Chairman, Kalutara Municipal Council, Kalutara
3	Mr. Nalin Mannapperuma	Director, Waste Management Authority (WMA)
4	Mr. S. Thrimanna	Divisional Secretary - Kalutara
5	Mrs. Niranja Jayasena	District Manager (Kalutara), WMA
6	Mrs. M.D.K. Chandrakanti	Community Development Officer
7	Mr. U.K.D. Palitha Udayanga	Manager, Mihisaru Compost Project, Kalutara
8	Mr. SDS Vimukthida Silva	Environment Officer, Central Environment Authority (Kalutara)
9	Mr. S.K. Suresh	Technical Officer, Kalutara Municipal Council
10	Mr. Geet	Inspector, Kalutara Regional Council
11	Mr. TP Wijenayake	Superintendent of Health
12	Mr. Udayanga Prasad	Public Health Inspector
13	Mr. Susath Kumar	Supervisor, Mihisaru Project, Kalutara
14	Mr. Sajith Suranga	Management Assistant (Finance), Mihisaru Project, Kalutara
15	Ms. Sajani Dinusha	Management Assistant (Admin.), Mihisaru Project, Kalutara
16	Mr. Sagara Kariyapperuma	Comunity leader
17	Mr. Nilantha Dharmapriya	Comunity leader
18	Mr. Chandima Rajasinghe	Comunity leader
19	Professor Mallika	University of Peradeniya
20	Ms. Rie Kawanishi	JICA Expert Team
21	Mr. Hamza Cherki	JICA Expert Team
22	Ms. Maheshwari	JICA Expert Team
23	Mrs. Nayana Samaraweera	JICA Expert Team

Explanation of the outline of the pilot project by the director of WMA

Monitoring

Monitoring at the transfer station under construction



Information board at Kalutara composting plant

Figure 4-54 Monitoring Committee

It should be noted that the second Monitoring Committee, which was scheduled to take place at the start of operations, could not take place during the project period due to delays in the operation of the transfer station. It was confirmed with the C/Ps that a Monitoring Committee would be held within three months after the start of operations.

In the past, the operation of waste management facilities in Sri Lanka has often been the subject of complaints from nearby residents, with some facilities resulting in court cases. For this reason, this project was implemented as a pilot project to involve residents from the construction planning stage of the facility and to build consensus by integrating the voice of residents into the planning. The consensus building carried out in this pilot project demonstrated the importance of involvement from the planning stage, transparency and continuous monitoring and implementation, rather than dealing with public objections after they were raised. In particular, at this site, as the majority of the residents are Sinhalese, the involvement of a priest from the temple located in front of the composting plant as a representative of the residents and the incorporation of his comments were effective in ensuring the smooth running of the monitoring committee.

As the root cause of the odour is the open dumping site, there has been no drastic improvement, and residents continue to express concern about the odour. It is expected to improve once the open dumping site is closed after construction of the transfer station. C/Ps will continue to monitor after the project is completed to build consensus among residents.

“General guidelines on Consensus-building” is attached as Appendix 9

(3) Karadiyana Compost Improvement

(a) Procurement of equipment

As of October 2022, procurement of all planned equipment was completed, but due to the suspension of imports and exports at the Port of Colombo caused by the deterioration of the Sri Lankan economy, there were delays in the delivery of equipment with the exception of tractors. In addition, the delivery of the heavy-duty sieving machine was also delayed due to a strike at the port of India, and the deadline for delivery was extended to 5 July 2022 as a force majeure event. Also, some parts of the heavy-duty sieving machine needed to be replaced, so they were ordered under warranty.

After inspecting the Karadiyana composting plant in May 2022 and reconfirming the installation of the equipment, it was found that additional work (pulling of electrical wires) not mentioned in the specifications was required, and the contract amount for heavy-duty sieving machine was changed. The progress of the equipment procurement is described in the table below.

Table 4-31 Supplier of each equipment

No	Equipment	Supplier
1	Heavy-duty sieving machine	The contract was amended due to the additional work (pulling of electrical wires). The equipment was delivered to the Karadiyana composting plant at the end of July 2022 and was assembled and installed until the end of August. After a 2-week test run, inspection was completed at the end of September, and the plant started its operation in October 2022. Some parts were ordered under warranty.
2	Tractor mounted with a bucket	Two tractors were delivered to Karadiyana composting plant in March 2022 and immediately used for the maintenance of the facility. Some parts have been ordered to be replaced under warranty.
3	Forklift	The equipment was inspected and delivered to Karadiyana composting plant in June 2022 and immediately used for the maintenance of the facility.
4	Crushing machine	The equipment was delivered to Karadiyana composting plant in June 2022 and the inspection was completed in July 2022.
5	Compost bagging machine	The equipment was delivered to Karadiyana composting plant in June 2022 and the inspection was completed in July 2022.

Heavy duty Sieving Machine

Heavy duty Sieving Machine

Tractor mounted with a bucket

Forklift

Crushing Machine

Compost bagging Machine

Figure 4-55 Procured equipment for Karadiyana Compost Rehabilitation Plan

(b) Technical assistance for landfill mining

NSWMSC, WMA, CEA, and the JICA Expert Team developed a rehabilitation plan for the Karadiyana composting plant in May 2021, and the JICA Expert Team provided the following technical assistance to put this plan into practice. The results were compiled in (c) Detailed design for Karadiyana Composting Improvement.

- Guidance on methods for reducing the volume of organic waste through anaerobic composting

The JICA Expert Team guided the C/Ps with the following presentation on the calculation of volume reduction and gas generation of fresh organic waste stored under anaerobic conditions for 90 days.

Reduction in organic waste amount by anaerobic treatment

1. Basic theory

Anaerobic decomposition of waste materials undergoes three stages, ultimately resulting in methane and carbon dioxide.

if organic waste is completely anaerobically decomposed, the amount of methane and carbon dioxide produced from 1 kg of waste

Methane:	0.20 kg/waste kg
carbon dioxide:	0.48 kg/waste kg
Total:	0.68 kg/waste kg

Source: Integrated solid waste management Engineering principals and management issues,680 pare, McGraw-Hill, Inc

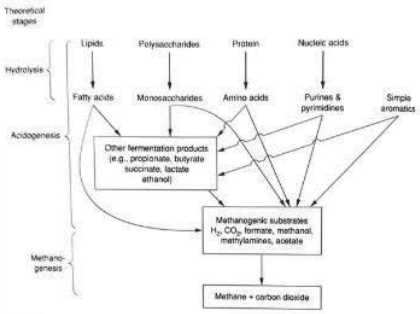


FIGURE 14-1
Pathways leading to the production of methane and carbon dioxide from the anaerobic digestion of the organic fraction of MSW [from Holland, et al., *Anaerobic Bacteria*, ©1987, p. 184. Reprinted by permission of Blackie Academic & Professional (an imprint of Chapman and Hall)].

Source: Integrated solid waste management Engineering principals and management issues,680 pare, McGraw-Hill, Inc

Reduction in organic waste amount by anaerobic treatment

2. Applied to Karadiyana

The amount of methane and carbon dioxide produced by the complete decomposition of the organic content in 250 ton/day of organic waste would be as follows

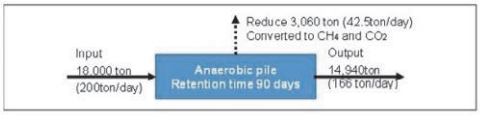
Methane:	250 x 1,000x 0.20 = 50,000k g=	50 ton
carbon dioxide:	250 x 1,000x 0.48 = 120,000kg=	120 ton
Total:		170 ton

- As a result, 170 tons are dissipated into the atmosphere, leaving 80 tons of solid residue.
- However, this is the case of complete anaerobic decomposition,
- The actual decomposition rate is unknown.
- Assuming complete decomposition over a 12month period,
- The decomposition rate over a 3month period 170 tons x (3/12) = 42.5 tons

Reduction in organic waste amount by anaerobic treatment

Based on the previous slide approach, calculate the amount of material to be removed after 90 days, assuming that 200 tons are brought in daily and the residence time for anaerobic decomposition is 90 days.

Input amount	200	ton/day
Retention time	90	days
Total input amount	18,000	ton
Conversion factor		Converted amount (ton)
Methane	0.20	3,600
CO2	0.48	8,640
total		12,240
Retention time	90	days
degradation factor	25%	
Reduce amount	3,060	ton
Remaining amount	14,940	ton
Daily output amount	166	ton/day

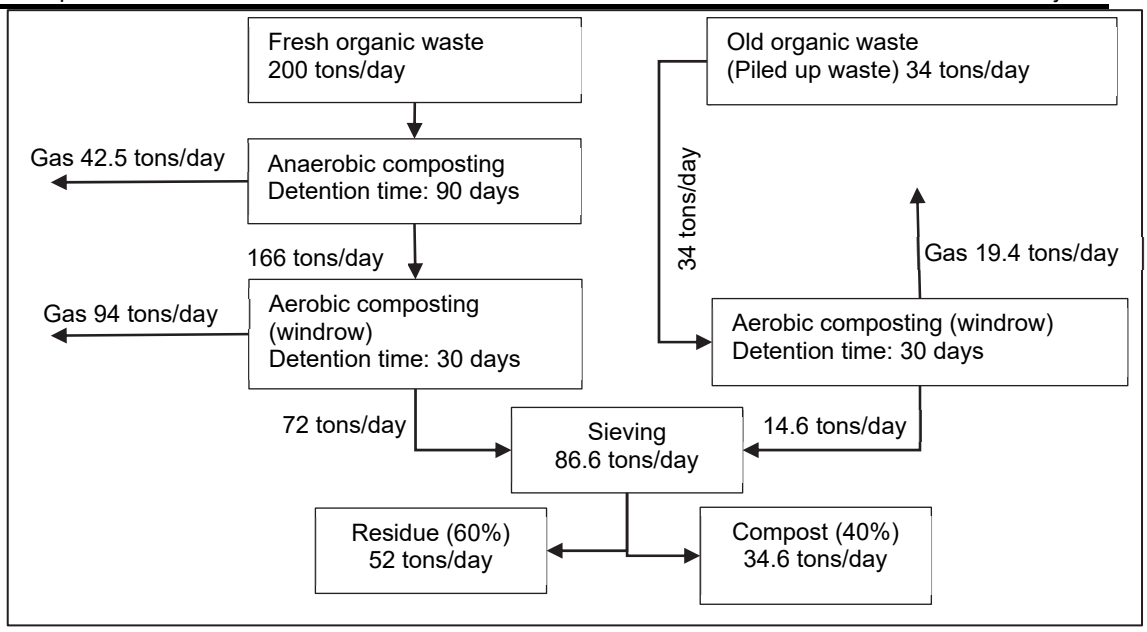


Cell 1	Cell 2
Cell 4	Cell 3

- New organic waste is put in each area for one month, moved to successive areas, and returned to the first area after three months.
- From this first area, 166 tons per day equivalent is processed in windrow with a residence time of one month and then fed into the trommel.

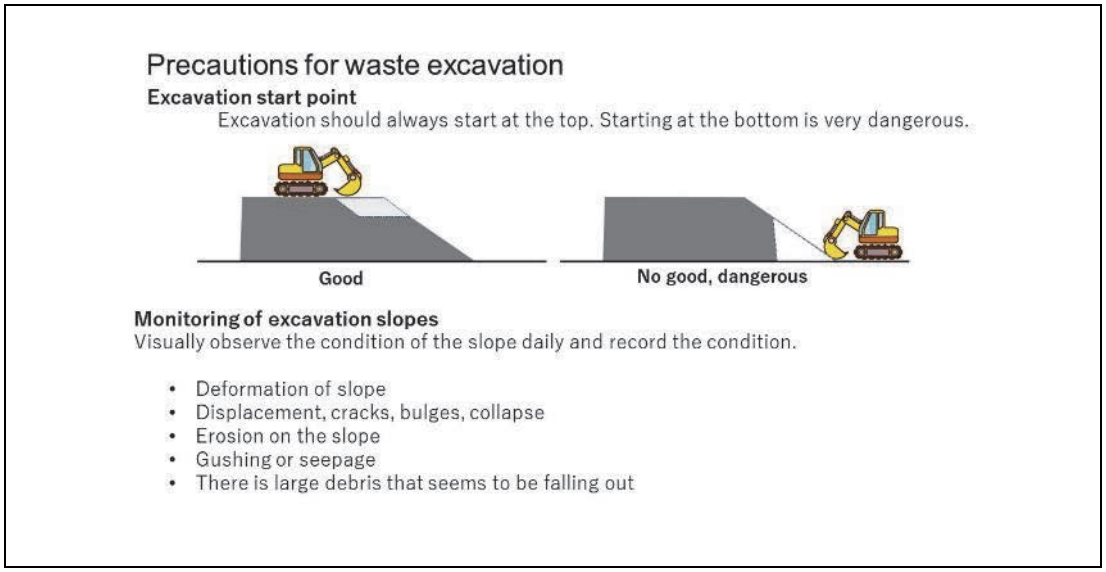
➢ Guidance on the combined anaerobic and aerobic composting treatment

The JICA Expert Team prepared a material balance of aerobic composting of organic waste after anaerobic treatment to facilitate the understanding of this method by the C/Ps.



- Guidance on the safe operation of landfill mining

Excavation methods, including precautions to be taken when excavating waste layers, as well as monitoring methods, have been explained to C/Ps and personnel involved in field operations to ensure their understanding. The presentation used for the explanation is shown below.



Precautions for waste excavation

Monitoring of excavation slopes
Example of monitoring sheet

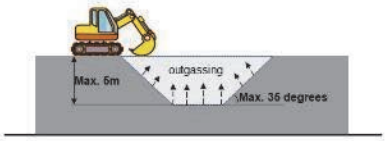
Location:							
Date							
Day of the week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Recorder Name							
Rainfall on the previous day(mm/day)							
Deformation of slope	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No
Displacement, cracks, bulges, collapse	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No
Erosion on the slope	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No
Gushing or seepage	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No
There is large debris that seems to be falling out	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No	☐Yes ☐No
Observations							

In addition, the JICA Expert Team explained that the gases produced during the excavation of the waste layers for landfill mining were mainly methane gas, but that there could be oxygen-depleted air at the bottom of the pit. As a countermeasure, the C/Ps thought of gas masks, but the JICA Expert Team explained that gas masks are not effective against oxygen-deficient air and that air respirators are necessary, which they understood with the help of the following presentation.

Precautions of waste excavation for landfill mining work

Maximum excavation depth : 5m max.

Angle of excavation slope : 35 degrees max.



Gas Countermeasures

Do not go inside the excavation site because carbon dioxide and methane gas are stored inside the excavation site.

Carbon dioxide is present in normal air at a concentration of 0.03%; at 3%, the respiratory center is stimulated, and symptoms such as headache and dizziness occur; at 7-8%, unconsciousness and death may occur within a few minutes.

Methane is harmless, but it decreases the oxygen concentration in the air and causes oxygen deficiency. Effects on the human body: Inhalation of methane-containing air for 30 minutes cause depression and despondency. There is a danger of explosion at a methane gas concentration of 5%. Before entering an excavation site, measure the gas concentration and confirm safety before entering.

Oxygen-deficiency accident

Oxygen concentration	Situation
21%	Normal air concentration
18%	Safe limit concentration
16%	Increased respiration and pulse, headache, nausea
12%	Muscle weakness, dizziness, nausea
10%	Pallor, unconsciousness, vomiting
8%	Coma, death in minutes
6%	Convulsions, respiratory arrest, death

Causes of oxygen deficiency
- Generation of various gases at the work site

Toxic gas
- Carbon monoxide: specific gravity to air 0.967, colorless, odorless, non-irritant.
- Hydrogen sulfide: specific gravity to air 1.1905, colorless gas, putrid egg odor.

Flammable gases
- **Methane gas**: specific gravity to air 0.66.
- Propane gas: Specific gravity to air 1.53.

Methane gas and **carbon dioxide** are mainly produced during the composting process.

Exhaust gas
- **Carbon dioxide**: specific gravity 1.55 relative to air; hazardous at levels exceeding 7%.

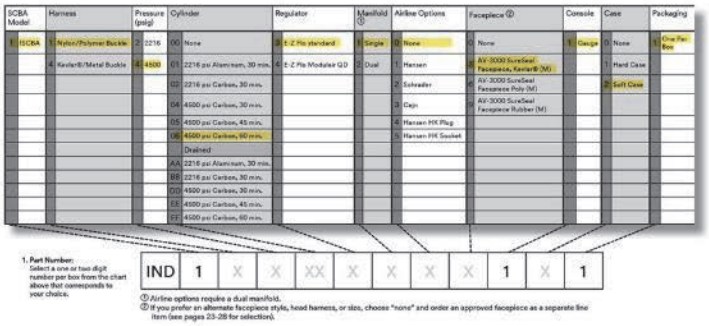
- The effects of oxygen deprivation are described previous Slide.
- Monitoring of oxygen levels in the workspace is necessary.
- Monitoring of carbon dioxide and methane is necessary because carbon dioxide and methane are produced from the anaerobic decomposition process of waste.
- Therefore, Oxygen concentration meter, Carbon dioxide concentration meter and Methane gas concentration meter are necessary for monitoring.

Required equipment and facility for the landfill mining work

- **Oxygen concentration meter**
- **Carbon dioxide concentration meter**
- **Methane gas concentration meter**
- **Helmet**
- **Mask: air-supplied breathing apparatus see next slide**
- **Gloves (grip fit)**
- **Protective clothing made of Tyvek**
- **Safety shoes (toe protection, prevent overstepping)**
- **Rest hut (container house)**

Technical specifications of a Mask: air-supplied breathing apparatus

- **Industrial SCBA (ISCBA)**
- **3M™ Scott™ equivalent or better**
- **Item No. : IND 1 1 4 06 3 1 0 3 1 2 1**



https://www.3m.com/3M/en_US/p/d/b5005047151/

4.2.7 C.4.7 Capacity Assessment (post-test) for relevant organizations is conducted

The results of the capacity assessment for the Kalutara Composting Plant Improvement and Karadiyana Composting Plant Improvement pilot projects are shown below.

Table 4-32 Results of the capacity assessment for the Kalutara Composting Plant Improvement PP

Kalutara Composting Plant Improvement PP

Impact	The experience gained from the PP serves as a reference case for developing other composting plants.		External Conditions and Resources: ・Budget to operate the composting plant is secured at the moment. ・The plant is operating within budget.
Performance 1	Train other staff of WMA by showing/demonstrating to disseminate knowledge and experience. WMA is developing "Safety work guidelines" for the operation of composting plants and landfills. The outcome of the PPs will be incorporated in these guidelines.		
Performance 0	The efficiency of composting is increased in Kalutara.		
Capacity	**Core Capacity**	**Technical Capacity**	
	① Palitha Udayanga, ② Project Manager of Mihisaru Resource Management Center (Kalutara)	＜Input as PP activities/expected capacity＞ 0 (as baseline). Mr. Palitha (C/P) has 18 years of experience in composting plant operation , and joined WMA in 2011 as a composting plant manager. **① Improvement of composting operation ＜Score: 3→5＞** ①-1 C/P understands how to enhance the decomposition capacity of organic waste by promoting aerobic conditions. ①-2 C/P understands how to reduce odour and leachate generation by promoting aerobic conditions. The 3-row aeration system was introduced as a pilot project in the first phase. Based on this experience, the JICA Expert Team and C/P improved its mechanism and created the final design for the second phase. It can be judged that the C/P and the staff of the composting plant understand the mechanism and have the ability to keep it operating. **② Technical support for the safe closure of the open dumpsite ＜Score: 3→4＞** ②-1 C/P acquired knowledge about the overview of the safe closure plan. ②-2 C/P understands how to avoid environmental pollution at disposal sites by off-site treatment and transfer of waste to disposal facilities. ②-3 C/P understands leachate control and appropriate gas discharge method using landfill closure technology. C/P already possessed basic knowledge of safe closures. The JICA Expert Team explained and discussed with the C/P about the detailed method and plan for the open dumpsite. The local authority will apply for the budget for the actual closure and civil works, and WMA will support the application. The safe closure will be carried out as soon as the budget is secured. WMA is deemed to have the ability to give technical advice on the civil works of the safe closure.	・The Safety Guidelines Committee is currently not working due to the change of WMA chairman. ・Although not discussed in the committee, several safety measures have already been pointed out by officials and WMA is addressing them.
Environmental base			

Policy, institutional environment, organization and other general environment
* The background and expected procedure for the safe closure of the Kalutara open dumpsite are described below.
・Safe closure should be discussed between Kalutara UC (landlord and OD user), Kalutara PS (OD user), WMA (OD user/residue disposal from composting plant) and CEA.
・Safe closure is the responsibility of UC as landlord, and PS as well. The long dispute between Kalutara UC (and PS) and the neighboring community (PS residents), the community does not trust the local authorities. CEA's commitment will be essential.
・UC and PS should contract out the civil works for the closure with their own fundings, under the supervision of CEA and technical advice of WMA.

Source: Project team

Table 4-33 Results of the capacity assessment for the Karadiyana Composting Plant Improvement PP

Kaladyana Composting Plant PP			
Impact	The experience gained from the PP serves as a reference for improving the treatment capacity of organic waste treatment facilities in Sri Lanka and will be applied to other large-scale organic waste treatment facilities.		External Condition and Resources: ・Landfill mining/rehabilitation will be conducted within WMA's machine capacity and budget.
Performance 1	Train other staff of WMA by showing/demonstrating to disseminate knowledge and experience. WMA is developing official "Safety work guidelines" for the operation of composting plants and landfills. The outcome of the PPs will be incorporated in these guidelines.		
Performance 0	Improve the management of Karadyana composting plant, rehabilitate the final disposal site for organic waste, and treat the entire volume of organic waste received (approximately 250 tons/day).		
Capacity	Core Capacity	Technical Capacity	
	① Palitha Udayanga, ② Project Manager of Mihisaru Resource Management Center (Kalutara), WMA Manager of landfill mining/composting plant rehabilitation in Karadyana	＜Input as PP activities/expected capacity＞ 0 (as baseline). Mr. Palitha (CP) has 18 years of experience in composting plant operation and joined WMA in 2011 as composting plant manager. **① Landfill mining technique to follow the guideline developed by the landfill mining PP ＜Score: 2→5＞** ①- 1 Understanding of anaerobic decomposition of organic waste. ①-2 Understanding of processing methods combining anaerobic and aerobic decomposition of organic waste. The mechanism of anaerobic decomposition of organic waste was explained, and the C/P understood it well. The C/P also understood the treatment method that combines anaerobic and aerobic decomposition and formulated an implementation plan for this system himself. The C/P is deemed to have developed the required capacity. **② Conduct the safety procedure ＜Score: 2→5＞** ②-1 Understanding of excavation work environment (oxygen-deficient air, generation of methane gas) in organic waste deposits. ②-2 Understanding of civil engineering matters such as slope stability and maximum excavation depth for excavation of organic waste deposits. After explaining and discussing the existence of oxygen-deficient air and the countermeasures to be taken when excavating organic waste deposits, the C/P understood the work environment and necessary countermeasures, and started the procurement of PPE (personal protective equipment) that will be needed for implementation. The C/P also gained a good understanding of civil engineering matters.	・The Safety Guidelines Committee is currently not working due to the change of WMA chairman. ・Although not discussed in the committee, several safety measures have already been pointed out by officials and WMA is addressing them. ・Since January 2023, Mr. Palitha is in charge of landfill mining/composting plant rehabilitation in Karadyana.
Environmental base			
Policy, institutional environment, organization and other general environment			

Source: JICA Expert Team

4.2.8 C.4.8 C.4.6 is monitored and its results and knowledge are reported in written form

(1) Kalutara Compost Plant Improvement Pilot Project

The pilot project for the Kalutara composting and aeration system was divided into two phases. In the first phase, a perforated pipe was inserted directly into the composting windrow to supply oxygen. After the results of the first phase, the second phase improved on this method by

embedding the perforated pipe in the gutter with a concrete floor, filling the gutter with crushed stone, and covering the top with a non-woven fabric and a concrete lid with an air hole. Windrow compost was placed on top of the perforated concrete lid to supply oxygen.

Results and findings for the pilot project for the Kalutara Compost Aeration System are as follows.

(a) Construction aspects

Technical results were obtained regarding oxygen content, leachate volume, and treatment speed.

- The "method of supplying oxygen by inserting perforated tubes directly into the windrow compost (first method)," which supplies oxygen in the first phase, has more oxygen inside than the "method of supplying oxygen from a concrete lid with air holes to the windrow compost (second method)," which supplies oxygen in the second phase.
- The first method promoted aerobic decomposition due to the high oxygen content inside the windrow compost, resulting in less odor and leachate than conventional windrow composting.
- The second system has gutters in the floor for air supply, which can be used to implement proper leachate collection.
- Both the first and second methods treat faster than regular windrow composting, but they do not accelerate the decomposition of cellulose, so clumps remain.
- The construction cost as initial investment cost of the compost forced aeration system was 6,150,563,10 LKR/3lines for the first system, or 2,050,187.7 LKR/line per row.
- The initial investment cost of the second method was 9,645,649.10 LKR/3lines at 3,215,216.40 LKR/line per row, which is more expensive than the first method.
- If depreciation for both the first and second methods is 10 years, the total throughput for one row would be 3,000 tons/10year (50 tons/2months x 12months/year x 10year = 3,000 tons/10year).

(b) Operational aspects

Operational results regarding operation costs and heavy equipment operator proficiency were obtained.

- Compared to the usual windrow composting method, the first and second methods of supplying oxygen through perforated pipes require less frequent turning by heavy machinery and save on fuel costs, making them less expensive to operate.
- The first method can easily damage the perforated pipe if the entire composting plant procedure is not proper or if the heavy equipment operator is not familiar with the operation.

- Since both the first and second methods reduce the frequency of turning by heavy machinery, the molding of windrow compost tends to be sparse. Forming the correct windrow compost provides proper oxygen supply and contributes to managing the turning frequency.
- Cellulose that is not decomposed and remains as clumps is crushed by a crusher and returned to the windrow composting plant again for proper decomposition.
- In terms of operation costs, the compost forced aeration system was found to be inexpensive at 35,227.08 LKR/50 ton/Line compared to the usual windrow composting at 57.184.58 LKR/50 ton/Line.

(c) Knowledge

Both the first and second methods confirmed the effectiveness of the aeration system. The choice of which method to use depends on whether or not the initial cost is available and whether or not skilled heavy equipment operators can be secured.

- The Kalutara Compost Aeration System was found to contribute to increased oxygen supply, leachate, and odor reduction. This method will contribute to the enhancement of treatment capacity of small and medium-scale (10-50 ton/day) windrow composting plants in the western province and improve environmental issues.
- The first method has low initial investment costs and is highly effective in solving problems and improving treatment capacity, but requires careful operation by skilled heavy equipment operators.
- The second method is relatively easy to operate, but has the issue of relatively high initial costs. The method will be selected according to the operational capacity and budget of the implementing organization of the Western Province Windrow Composting Plant.

(2) Detailed design for the improvement of the Karadiyana composting facility

This pilot project is for the detailed design of the improvement of the Karadiyana composting facility and does not include the on-site construction process. Therefore, monitoring was carried out during the detailed design process.

The JICA Expert Team prepared a presentation based on the questions raised by the C/Ps during the detailed design process, as described in (b) “Technical assistance” above, and used this presentation to hold discussions with the C/Ps. The C/Ps understood the material balance of the combined anaerobic and aerobic treatment process and improved their technical capacity to carry out the detailed design. The Sri Lankan side, led by this C/P, then started preparing for the implementation of the facility improvement plan.

5 Implementation of the M/P and formulation of its relevant plans

5.1 Activities of Output 5

Output 5: Collaboration and coordination among relevant organization in Western Province for the implementation of MP, and formulation and implementation of its relevant plans (e.g. LA action plans, plans on waste management facilities) are strengthened

5.1.1 C.5.1 Meetings for the explanation of the MP are organized for LAs in Western Province and other relevant organizations (including central government organizations) are held

The draft Master Plan was explained to government stakeholders during a validation workshop held on 13 March 2023, and to local government officials of the Western Province during a local government workshop that took place on 14 March 2023. The respective agenda and parties involved are listed below.

(1) Validation workshop on 13March2023

1. Welcome Speech (NSWMSC) 9:30 A.M.
2. Opening Remarks (Secretary MOLGPC) 9:40 A.M.
3. Speech of JICA Representative 9:50 A.M.
4. Self-Introduction 10:00 A.M.
5. Outline of the Master Plan (JICA Expert Team) 10:10 A.M.
6. Tea Break 10:50 A.M.
7. Local Authority Action Plan 11:20 A.M.
8. Authorization Procedure and Inter-coordination body 11:35 A.M.
9. Discussion 11:50 A.M.
10. Closing Remarks 1:30 P.M.


Workshop members


Speech by the Chief Representative of the JICA Office


Explanation by JICA expert

Figure 5-1 Validation workshop on 13th March 2023

(2) Local government workshop on 14March2023

1. Registration and Refreshment 8:30 A.M.
2. Welcome Speech and Objectives (WMA) 9:30 A.M.
3. Opening Remarks (WMA Chairman) 9:45 A.M.

4. Speech of JICA Representative 10:00 A.M.
5. Outline of the Master Plan (JICA Expert Team) 10:10 A.M.
6. Local Authority Action Plan 10:25 A.M.
7. Experience of Pilot Projects 11:15 A.M.
    i. Database
    ii. Mobile Application
    iii. Transfer Station
    iv. Aeration Project
    v. Karadiyana PP
    vi. Consensus Building
    vii. Good Practices
    viii. Business Continuation Plan
8. Discussion 1:15 P.M.
9. Closing remarks 1:30 P.M.


Wide view of workshop


Participant of workshop


Explanation of JICA expert

Figure 5-2 Local government workshop on 14th March 2023

5.1.2 C.5.2The staff of WMA and other relevant organizations enhance their knowledge and skills for supporting LAs and other organizations in the formulation and implementation of the MP, its sub-plans and other relevant plans (e.g. LA action plans, plans on waste management facilities) through training and OJT

(1) Training to strengthen project formation capacity for district and zonal managers of WMA

(a) Overview

WMA project implementation (i.e. composting plant construction) has focused on budget expenditure. It rarely showed the targets that the project is aiming for quantitatively. Since there were no operation plan or performance indicators over the entire project life period, operational efficiency was below the capacity, maintenance was insufficient, and financial shortage occurred. Many facilities then continue to operate in an inefficient manner.

In this training, the objective was for WMA managers (officials who are in a position to monitor and advise on the implementation of waste management by the 49 local authorities in the Western Province) to be able to make project proposals, not only for the facility development plan but also for the operation and maintenance plan after completion. The training program used as case

studies projects that WMA plans to implement in the near future and focused on discussions and actual proposal preparation.

(b) Training target group

A total of 11 people attended the training:

- WMA Assistant Director, Technical (1 person)
- WMA District Managers (3 people: Gampaha District, Colombo District, Kalutara District)
- WMA Zonal Managers (7 people: Gampaha Zone, Negombo Zone, Kelaniya Zone, Kotte Zone, Dehiwala Zone, Kalutara Zone, Horana Zone)

(c) Case study projects

Each study team, consisting of the District Manager and 2-3 Zonal Managers from the District, had to select one project for their District and formulate a project proposal.

- Capacity enhancement to 11 tons per day of existing composting facility at Dikkivita (Gampaha District)
- Establishment of e-waste collection mechanism (Colombo District)
- Establishment of cluster-based 25 tons per day of MSW compost production in Maddegedarawatta, Mathugama (Kalutara District)

(d) Training schedule

Table 5-1 Training schedule: Project formation capacity building

Date	Topics
8 November 2021	Project objectives, Estimation of target waste
10 November 2021	Estimation of target waste, Plant capacity, Scope of project
12 November 2021	Scope of project, Cost estimates, Inter-organizational arrangement
15 November 2021	Implementation schedule, Inter-organizational arrangement, Results chain, Performance indicators
22 November 2021	Operation plan, Format of project proposal
December 2021 – January 2022	Drafting of proposals by each team
7 March 2022	Finalization of proposals after review and discussion
7 March 2023	Environmental benefits in waste management projects, especially CO2 reduction

Figure 5-3 Training on 8 November 2021

(2) Preparation of WMA Annual Report

When implementing and operationalizing the MP, it is crucial that WMA introduces and applies the PDCA. As one of the in-built mechanisms, the JICA Expert Team proposed to use the PDCA for the creation of the WMA annual report, and the WMA Annual Report 2021 was prepared by following the steps below:

- Review of regulatory requirements: Confirmation of the needs of public establishments to publish their annual reports with regard to the Finance Act, the National Audit Act, etc.
- Creation of a table of contents and information in each section.
- Elaboration of the work schedule, assignment of sections to division managers.
- Writing by the staff in charge and compilation of the draft.

The WMA Annual Report 2022 is in preparation at the end of the Project.

5.1.3 C.5.3 Support and guidance for the formulation of sub-plans and other relevant plans (e.g. LA action plans, plans on waste management facilities) in line with MP are given to LAs and other relevant organizations

a. Objectives of formulating a local authority action plan

In order to realize the Western Province Waste Management Master Plan, it is necessary for all 49 local authorities in the Western Province to set up and implement specific activities in line with the MP.

The future waste amount, numerical targets and capacity of future waste treatment facilities in the MP were originally determined based on the future waste amounts of the 49 LAs. Therefore, it is possible for the LAs to deploy the MP by formulating and implementing action plans based on their future waste amount.

An action plan has a planning period of five years and is reviewed every five years. For an LA, the objectives of the development of an action plan are i) to quantitatively identify the actual

situation and challenges in waste management, ii) to formulate action policies to address the challenges, and iii) to formulate feasible activities towards quantitative targets.

In addition, an annual work program (AWP) is prepared in line with the action plan. This AWP is not only the annual plan for implementing the action plan, but it is also an important tool for monitoring the action plan, and the AWP for the following year will be prepared after monitoring the progress of the previous year.

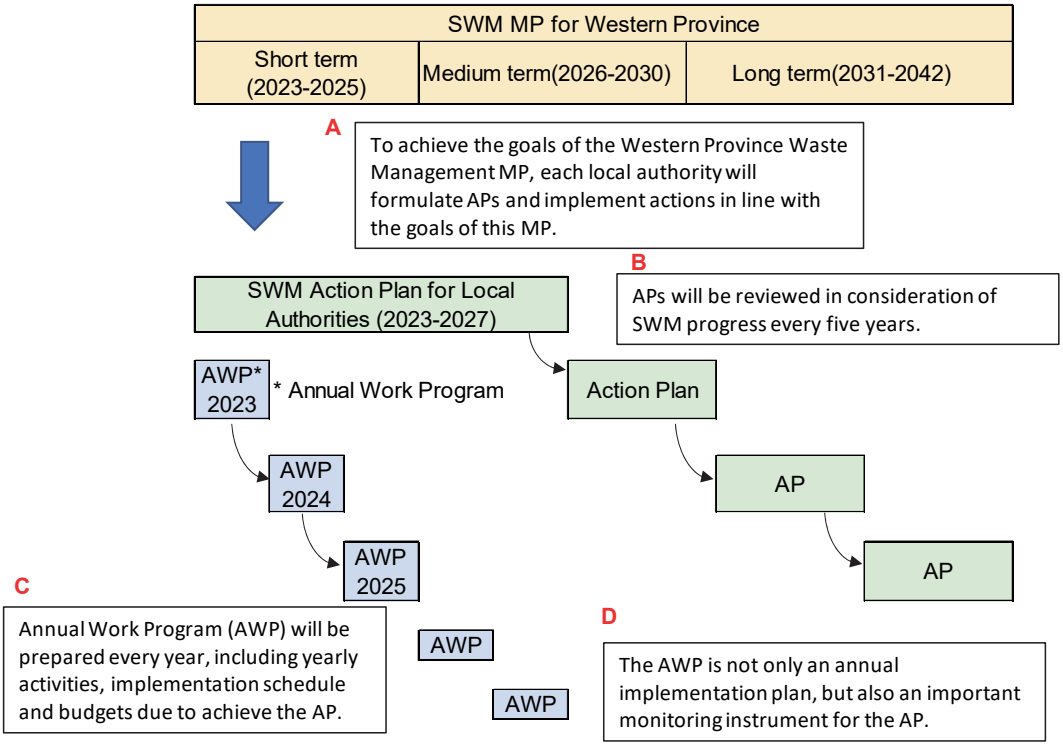


Figure 5-4 Relationship between SWM Master Plan for the Western Province (MP), Action Plans (AP) for Local Authorities and Annual Work Programs (AWP)

b. Contents of Action Plan

Unified tables have been prepared in collaboration with WMA to enable LAs to develop efficient and effective action plans. The content of the unified tables is shown below.

b.1. Understanding the present situation

b.1.1 Understanding the present situation of waste management using databases.

As the database contains the present situation of waste management in each LA, the main data related to waste management are extracted from the database and described in Unified tables 1 and 2.

- Basic information on local authorities

Table 5-2 Unified table 1: Basic information on local authorities

Name of Division/Department responsible for SWM		
Population		people
Number of households		households
Administrative area		km^2
Location map of the LA		

■ Present situation of SWM

Table 5-3 Unified table 2: Present situation of SWM

Item		Details
1. Bylaw and rules of the Local Authority		
2. SWM Plan	SWM Action Plan	
	Other plan on SWM (if any)	
3. SWM Organization	Name of the section/department in charge of SWM	
	Number of employees by position	
4. Technical system of SWM		
4.1 Home composting	Number of composting bins distributed during the last 3 years	
	Monitoring system	
4.2 Parisara Pola	Number of Parisara Pola program in 2022	
4.3 Collection and transportation	Population covered by the collection service (people and percentage)	
	Source separation and number of categories	
	Collection schedule/plan	
	Collection service provider(s)	
	Collection method	
	Collection frequency by waste category	
	Collection vehicles (type and number)	
	Enforcement of service charge for MSW based on Waste Management Rules 2008 No 1	
4.4 Transfer station	Transfer station	
	Transfer trucks	
	Recycling at transfer station	
4.5 Intermediate treatment	Composting facility	
	Recycling facility	
	Other facility	
4.6 Final disposal	Final disposal	
	Recycling at disposal site	

<table>
<tr><th colspan="2">Item</th><th>Details</th></tr>
<tr><td>5. Financial situation (LKR)</td><td colspan="2"><table>
<tr><td></td><td>2019</td><td>2020</td><td>2021</td></tr>
<tr><td>Total Recurrent Expenditure (LKR)</td><td></td><td></td><td></td></tr>
<tr><td>Total Recurrent Expenditure for Waste Management (LKR)</td><td></td><td></td><td></td></tr>
<tr><td>Waste Collection (annual tonnage)</td><td></td><td></td><td></td></tr>
<tr><td>Waste Management Unit Cost (LKR/ton collected)</td><td></td><td></td><td></td></tr>
<tr><td>Waste Management Recurrent Share (%)</td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>6. Illegal dumping</td><td>Legal provisions and sanctions against illegal dumping</td><td></td></tr>
<tr><td colspan="2">7. Environmental education and awareness-raising activities</td><td></td></tr>
<tr><td>8. Waste amount and composition data</td><td>Household waste, other than household waste</td><td></td></tr>
</table>

b.1.2 Understanding the present situation of waste management quantitatively based on waste flows

The current waste amount and waste flow are extracted from the Waste flow Excel file and described in Unified table 3.

■ Present waste amount

Table 5-4 Unified table 3: Present waste amount

Waste Flow	2022	
	Amount (Mt/day)	(%)
1. Generation		
7. Improper discharge		
5. Discharge (waste discharged for collection, including informal collection by collection crews)		
8. Informal recycling by collectors		
11.1 Composting		
11.3 Recycling at Sampath Kendraya (SK)		
11.4 Thermal recovery		
12. Intermediate untreated waste		
15. Final disposal		

■ Present waste flow

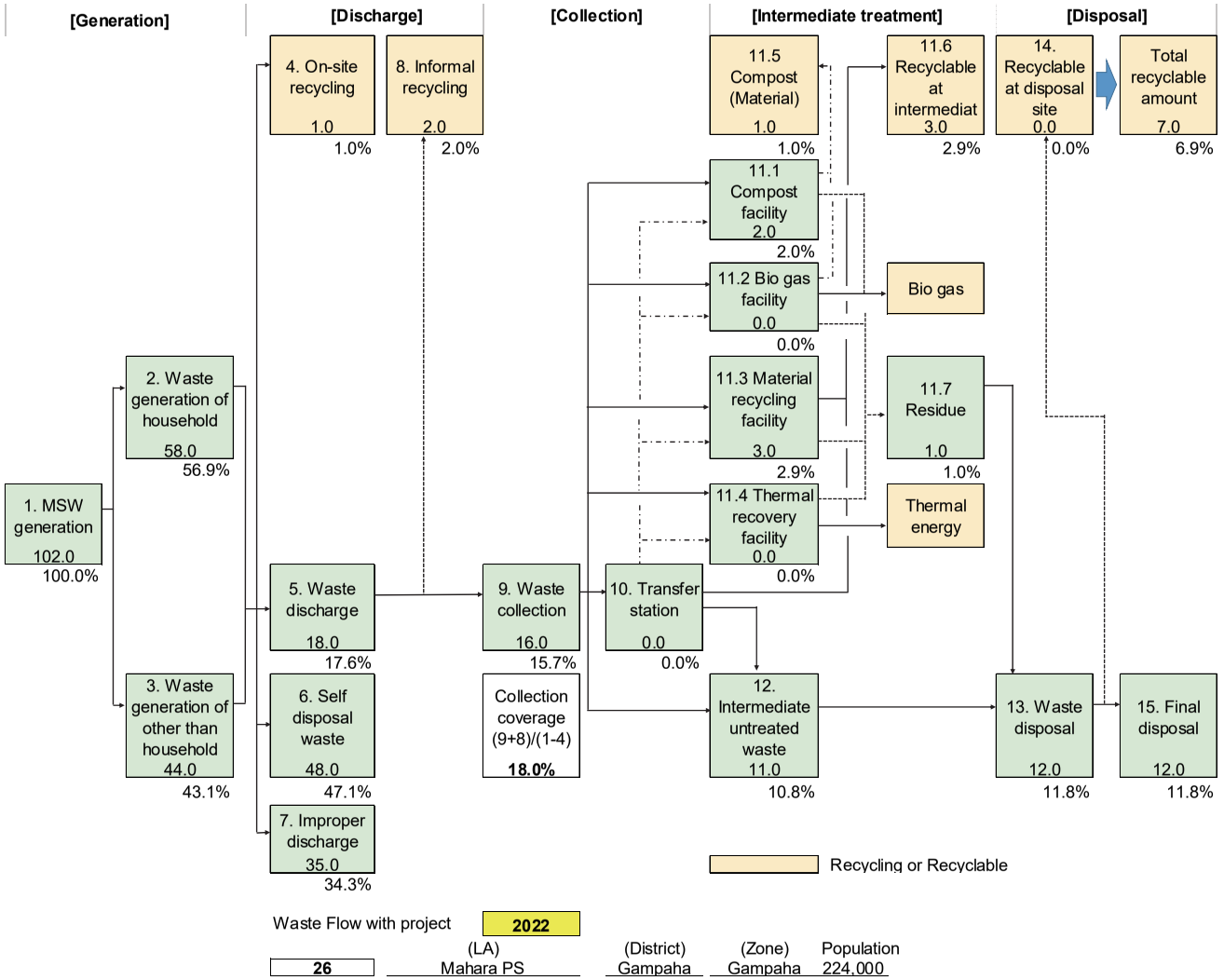


Figure 5-5 Unified figure 1: Present waste flow

b.2. Challenges in waste management

Based on the present situation of waste management extracted from the database and the present waste amount obtained from the waste flow excel file, the challenges at each stage of waste management are described in Unified table 4.

Table 5-5 Unified table 4 Challenges in waste management

Category	Waste	Waste amount (t/d)	Issues
Generation	1. Total amount of MSW generated		
	4. On-site recycling		
	5. Waste discharged for collection (8+9)		
	6. Self-disposal		
	7. Improper discharge		
Collection & Transportation	8. Recycling at discharge/collection stage		
	9. Waste collected		
	Collection coverage (%)		
	10. Waste transferred		
Intermediate treatment	11-1 Waste transported to a composting facility		
	11-2 Waste transported to a biogas facility		
	11-3 Waste transported to a recycling center (SK)		
	11-4 Waste transported to a TRF		
	11-5 Composted material		
	11-6 Recycling at intermediate facility (SK)		
	11-7 Residues generated at intermediate facility		
Disposal	12 Intermediate untreated waste		
	13. Waste for disposal		
	14. Recycling at disposal site		
	15. Waste for final disposal		
Recycling	Total amount recycled		
	Recycling rate (%)		
Others			

SK; Sampath Kendraya

b.3. Waste management action plan

b.3.1 Goals and numerical target for waste management

The Waste Flow Excel file not only shows the present waste amount, but also forecasts the future waste amount for each LA based on the planning conditions of the MP. This future waste amount is set as a numerical target for the action plan and is described in Unified table 5.

Table 5-6 Unified table 5: Goals and numerical targets for waste management

Goal							
Numerical Target	Items	Unit	2023	2024	2025	2026	2027
	1. Total amount of MSW generated	ton/day					
	5. Waste discharged (waste collected, including informal collection by collection crews)	ton/day					
	Collection coverage	%					
	10. Waste transferred	ton/day					
	11. Intermediate treatment	ton/day					
	11.1 Waste transported to a composting facility	ton/day					
	11.3 Waste transported to a recycling center (SK)	ton/day					
	11.4 Waste transported to a TRF	ton/day					
	15. Waste for final disposal	ton/day					
	Total amount recycled	ton/day					
	Recycling rate (%)	%					

b.3.2 Future waste amount and main action for the five years

Future activities to improve waste management are described in Unified table 6, based on the future waste flow and the present situation of waste management.

Table 5-7 Unified table 6: Future waste amount and main actions for the five years

Category	Waste	Waste amount (t/d)					Actions for five years	
		2023	2024	2025	2026	2027	Main Actions	Sub-actions
Generation & Discharge	1. Total amount of MSW generated							
	4. On-site recycling							
	5. Waste discharged for collection (8+9)							
	6. Self-disposal							
	7. Improper discharge							
Collection & Transportation	8. Recycling at discharge/collection stage							
	9. Waste collected							
	Collection coverage (%)							
	10. Waste transferred							
Intermediate treatment	11-1 Waste transported to a composting facility							
	11-2 Waste transported to a biogas facility							
	11-3 Waste transported to a recycling centre (SK)							
	11-4 Waste transported to a TRF							
	11-5 Composted material							
	11-6 Recycling at intermediate facility (SK)							
	11-7 Residues generated at intermediate facility							
Disposal	12 Intermediate untreated waste							
	13. Waste for disposal							
	14. Recycling at disposal site							
	15. Waste for final disposal							
Recycling	Total amount recycled							
	Recycling rate (%)							

b.3.3 Required number of collection vehicles

The number of collection vehicles required in the future for each waste category is predicted based on future waste amount and specified in Unified table 7.

Table 5-8 Unified table 7: Required number of collection vehicles

Type of waste	Year					Remarks	
	2023	2024	2025	2026	2027	Type of vehicle	Capacity (m^3)
Waste generated (ton/day)						-	-
Waste collected (ton/day)						-	-
Collection coverage (%)						-	-
Collection vehicles for organic waste						4-ton compactor	8.0
Collection vehicles for recyclables						Tractor trailer	6.6
Collection vehicles for other waste						4-ton compactor	8.0

b.3.4 Specific activities and implementation schedule

The specific activities and implementation schedule for the five-year period are detailed in Unified table 8.

Table 5-9 Unified table 8: Specific activities and implementation schedule

Specific activities and schedule for implementing actions National(MoPCLG) WP（WMA) LA

Action	Activities	2023				2024				2025				2026				2027			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

b.3.5 Budget planning for waste management

The waste management budget for the Action Plan planning period is budgeted based on waste amount growth and planned improvement actions, and specified in Unified table 9.

Table 5-10 Unified table 9: Budget planning for waste management

Local Authority Waste Management Expenditure Summary: Actual, Budget and Future Estimate

		2020	2021	2022	2023	2024	2025	2026	2027
		Actual	Budget	Budget	Estimate	Estimate	Estimate	Estimate	Estimate
LA's Total Recurrent Expnditure (Rs.)	(i)								
Programme 8 - Waste Management									
Recurrent Expenditure (Rs.)									
1000 Salaries and Wages									
1100 Travelling									
1200 Supply									
1300 Repair and Maintenance									
1400 Administrative Expenses									
1500 Welfare Payments									
1600 Miscellaneous Expenses									
1700 Others									
1900 Financial Cost									
Total Recurrent for Waste Management	(ii)	0	0	0	0	0	0	0	0
Of which									
1208 Fuel and Lubricants									
1413 Outsourcing Contracts	(A) Annex I	0	0	0					
Capital Expenditure (Rs.)									
2102 Construction									
2109 Equipment					0	0	16	0	0
Others									
Total Capital Expenditure		0	0	0	0.0	0.0	15.6	0.0	0.0
Revenue Estimates									
4400 Service Charges									
4600 Other Sales									
Total Revenue Estimates		0	0	0	0	0	0	0	0
Indicators									
No. of Staff for Programme 8 Waste Management									
Total Recurrent Expenditure (Rs)	(i)	0	0	0	0	0	0	0	0
Total Recurrent for Waste Management (Rs.)	(ii)	0	0	0	0	0	0	0	0
Waste Collection (annual tonnage)	(iii)	0	0	5,110	5,840	6,570	7,300	8,395	9,125
Waste Management Unit cost (Rs./ton collected)	(iv)=(ii)/(iii)	#DIV/0!	#DIV/0!	0	0	0	0	0	0
Waste Management Recurrent Share (%)	(v)=(ii)/(i)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

b.4. Annual work program

Annual work programs (AWP) are prepared annually to achieve the five-year action plan. An AWP is not only the annual plan for implementing the Action Plan, but it is also an important tool for monitoring the Action Plan, and the AWP for the following year will be prepared after monitoring the progress of the previous year.

Table 5-11 Unified table 10: Annual work program

Annual Work Program – 2023

Project	Action	Physical Target				Financial Targets (LKR)				Out Put	Out come	Responsibility
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			

b.5. Support for formulating the Action Plan

The following support and guidance on the formulation of action plans has been implemented.

Table 5-12 Support and guidance on the formulation of action plans

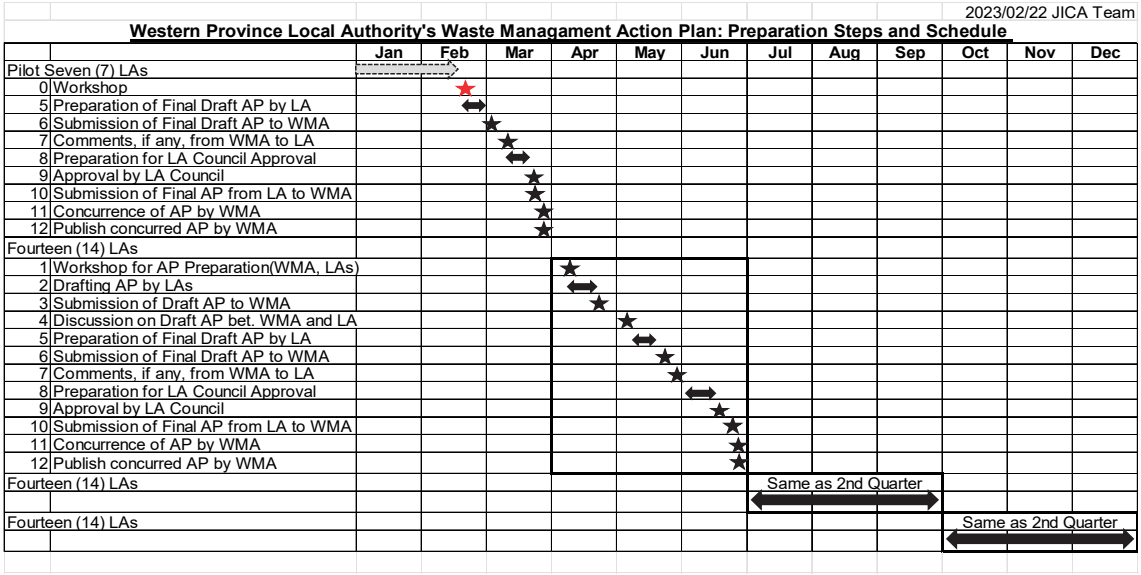
<table>
<tr><th>Date</th><th>Details of implementation</th></tr>
<tr><td>17 October 2022</td><td>The content of the SWM AP form was discussed with WMA, which is responsible for waste management in the Western Province, and training of trainers was provided to WMA zonal and district managers as well as to staff of relevant organizations to assist local authorities in formulating the SWM AP, based on the finalized AP form.
【Participants】
WMA zonal and district managers: 8 people
NSWMSC: 2 people
CEA: 1 person
UDA: 1 person
Mahara PS was selected as the local authority for the formulation trial and the formulation of the SWM AP was initiated with the support of the WMA zonal and district managers.</td></tr>
<tr><td>27 October 2022</td><td>The JICA Expert Team visited Mahara PS with WMA staff and briefed the mayor and other relevant officials on the AP and the approach for its formulation.
【Participants】
Mahara PS: 10 people
WMA zonal and district managers: 2 people</td></tr>
<tr><td>2 November 2022</td><td>The JICA Expert Team visited Mahara PS with WMA staff to assist in the formulation of the AP.
【Participants】
Mahara PS: 8 people
WMA zonal and district managers: 2 people</td></tr>
<tr><td></td><td>SWM AP formulation was carried out on a pilot basis with the support of the WMA zonal and district managers in the following LAs (one per zone, including Mahara PS):
<table>
<tr><th>LA</th><th>District</th><th>Zone</th></tr>
<tr><td>Mahara PS</td><td>Gampaha</td><td>Gampaha</td></tr>
<tr><td>Palindanuwara PS</td><td>Kalutara</td><td>Kalutara</td></tr>
<tr><td>Horana PS</td><td>Kalutara</td><td>Holana</td></tr>
<tr><td>Wattala UC</td><td>Gampaha</td><td>Kelaniya</td></tr>
<tr><td>Kotte MC</td><td>Colombo</td><td>Kotte</td></tr>
<tr><td>Homagama PS</td><td>Colombo</td><td>Dehiwara</td></tr>
<tr><td>Katana</td><td>Gampaha</td><td>Negambo</td></tr>
</table></td></tr>
</table>

23 February 2023	A workshop was held with the waste management officers of the seven pilot LAs selected to formulate an Action Plan, WMA zonal and district managers and other relevant authorities. The objectives of the workshop were as follows: ✓ Share the progress and challenges in the formulation of te action plans. ✓ Reconfirm and provide guidance on how to formulate action plans. ✓ Review and agree on a roadmap for the formulation of the action plan for each of the seven pilot LAs. 【Participants】 Commissioner of LG: 1 person WMA: 10 people LA: 20 people
28 February 2023	As more than three years had passed since the waste flow forecasting program was developed, discrepancies have been reported in some LAs between the waste amount projected by the waste flow and the actual waste amount measured by the local authority in 2022. In response, the JICA Expert Team modified the program to allow LAs to update their waste flow based on the waste amounts measured in 2022. Workshops were held for WMA zonal and district managers to use these modified waste flows.
13 March 2023	At the Validation workshop, the objectives of the SWM AP formulation and its content were briefly presented.
14 March 2023	At a workshop for all 49 LAs and relevant organizations, WMA staff gave a presentation on the purpose of AP formulation and formulation methods, and presented a roadmap for the future expansion of AP formulation. The Mahara PS action plan, which was formulated first, was also presented by the waste officer of Mahara PS.

b.6. Expanding the formulation of action plans

A roadmap for the formulation of action plans for the 49 local authorities in the Western Province has been agreed with WMA, which will assist in their formulation. The remaining 42 local authorities, which will formulate action plans in the future, will be divided into three groups, with the aim of completing action plans for all 49 local authorities by the end of 2023, according to the procedures implemented on a pilot basis.

Table 5-13 Roadmap for the formulation of action plans



5.1.4 C.5.4 A system to monitor the implementation of sub-plans and other relevant plans (e.g. LA action plans, plans on waste management facilities) in line with MP is established and documented

Monitoring of the implementation of sub-plans and other relevant plans in line with the Master Plan will be carried out by the Coordination Committee on Waste Management in the Western Province. The Committee's objectives, functions, organization, members and responsibilities are described in section 4.1.7 "C.1.7 An inter-organizational coordination body such as Provincial Solid Waste Management Committee which takes over the work of the Working Group is proposed". The establishment of such a committee was discussed and agreed upon at the JCC held on 4 November 2022. In order to formally set up the committee, the establishment of the committee will also be proposed and approved when the Provincial Council and the Cabinet of Ministers approve the Master Plan.

Since the planning and implementation agencies and implementation mechanisms differ from one LA to another, it is difficult to establish a standard procedure for the planning and monitoring of individual development plans, but the Action Plan and AWP enables local authorities to follow a standardized planning, implementation and monitoring procedure. Each LA takes the following steps for planning and monitoring.

Each LA prepares an AWP in line with its Action Plan. This AWP is the implementation plan for each year as well as an important monitoring instrument to check the progress of the action plan. Therefore, when formulating the AWP for the following year, the progress of the activities described in the previous year's AWP are reviewed and the activities and budget for the AWP of the following year are planned based on the results of the progress monitoring.

a. Content of the AWP

The AWP is composed of the following elements:

- Activities for the coming year to deploy the action plan
- Progress of the activities over the five-year period
- Budget for each activity and budget allocation in line with progress

b. AWP formulation procedure

The annual plan is formulated according to the PDCA cycle.

- Formulate the AWP (Plan)
- Implement the AWP (Do)
- Check the progress of the AWP (Monitoring) (Check)
- Reflect the monitoring results in the AWP for the following year (Action)

In addition, the AWP is submitted to NSWMC via WMA.

5.1.5 C.5.5 Budget plans for the implementation of the MP and a guidance for budget plan formulation to implement LAs' action plans are prepared

a. Eight projects require a large budget

Eight projects from the MP requiring significant short- and medium-term budgets were selected and the costs necessary for their implementation have been specified. Project costs for the first five years have been estimated as follows.

Table 5-14 Project cost required

Projects requiring large budgets	2023-2027 (million LKR)
Project 1: Development of five Primary Transfer Stations (PTS)	6,670
Project 2: Improvement of Kelaniya Transfer Station (KTS)	6,494
Project 3: Development of Cluster-based Waste Treatment Facilities (CWTF)	31,689
Project 4: Improvement of composting facilities	1,264
Project 5: Improvement of recycling facilities for recyclables collected through formal collection	2,274
Project 6: Procurement of collection and transfer vehicles	5,267
Project 7: Closure of current dumpsites managed by LAs	319
Project 8: Promotion of waste separation	66

b. Budget plan of the local authorities

The government and local authorities have considered creating a separate budget line for waste management expenditure in the local authority's budget to accurately identify waste management costs. Waste management expenditures were categorized as health-related expenditures in all

local authorities except CMC. Without an accurate cost, it was impossible to budget appropriately for the future. Under these circumstances, it has been decided that from 2021, waste management would become a separate expenditure item in the budget of all LAs as Programme 8, and this decision has been enforced in all LAs. However, as of the end of the project in the middle of 2023, the accumulated data for waste management expenditure is limited to only three years (budget and actual expenditure for 2021, budget and provisional expenditure for 2022 and budget for 2023).

In the LA budget estimates for the action plan, future budgets for the planning period are estimated based on (i) actual past data (amount of expenditure, volumes of collection, intermediate treatment and disposal, etc.) and (ii) future waste management plans. However, at the moment, budgets have to be estimated based on little information, and accuracy will improve in the future as actual past data is accumulated.

The LA Action Plan is accompanied by an annual plan specifying the annual schedule for the implementation of waste management as well as the budget required for its implementation. In addition, the following indicators have been included in the budget in order to be able to verify the adequacy of the budget:

- Waste management costs per ton of waste
- Waste management budget as a percentage of the total LA recurrent budget

Table 5-15 Indicators in the budget plan of AWP

Item	Formula	Budget / Waste amount	Indicator
Total Recurrent Expenditure (LKR)	(i)		
Total Recurrent for Waste Management (LKR)	(ii)		
Waste Collection (annual tonnage)	(iii)		
Waste Management Unit Cost (LKR/ton collected)	(iv)=(ii)/(iii)		
Waste Management Recurrent Share (%)	(v)=(ii)/(i)		

6 Others

6.1 Outsourcing

The following items are the tasks and their content that are assumed to be outsourced locally.

(1) Outsourcing activities

In this project, the work related to the following activities has been carried out through local outsourcing.

The implementation of the pilot project on proper waste management (Activity 3.5) was divided into two local subcontracts, namely “Schematic Design, Bidding Support, and Construction Supervision” and “Implementation”, while the implementation of the pilot project on improving the design and operation of pilot waste-related facilities (Activity 4.6) was divided into two locally outsourced activities: “Detailed Design and Construction Supervision” and “Construction”. All the works were completed in May 2023.

The final report of the first healthcare waste survey was submitted in November 2022.

The final report for the local outsourcing of the second survey on complaints and requests was submitted in January 2023.

The local outsourcing contract for the schematic design, bidding support, and construction supervision of the pilot project No.3 “Appropriate Waste Management (Construction of a Transfer Station)” was signed in June 2021, and the schematic design and bidding support have been provided. The local outsourcing contract for the implementation of the pilot project “Appropriate Waste Management (Construction of Transfer a Station)” was concluded with the selected contractor in March 2022. All the works were completed in May 2023.

The local outsourcing contract for the detailed design and construction supervision of the pilot project No.4 on “Technical Interventions to Improve Planning and Operation of Composting Plants (Improvement of Composting Plants)” was concluded in June 2021, and the detailed design has been completed. The local outsourcing contract for the construction of the pilot project “Technical Interventions to Improve the Planning and Operation of Composting Plants” was signed in September 2021 for the first phase, and construction was completed in December 2022. For the second phase, the original plan was to install a new 7-row aeration system, but it was decided to implement improvement measures such as embedding the existing three rows of perforated pipes in trenches in the concrete floor.

The local outsourcing contract for the Strategic Environmental Assessment (No.5) was scheduled to be signed in October 2021 and the report was due within three months, but the execution period was postponed to December 2022 in order to revise the draft MP. The SEA report was submitted in December 2022.

Table 6-1 Outline of outsourcing

	Phase	Activity	TOR
1	Phase I-II	Activity 2.2: SWM data collection.	To collect healthcare waste data from clinics and estimate healthcare waste generation rate from clinics.
2	Phase I-II	Activity 4.6: Implementation of pilot projects for improving planning/ operation of waste management facility	pilot project activities for social intervention to improve planning and management of composting plant site
3	Phase II	Activity 3.5	Pilot project activities for technical intervention to construct transfer station
4	Phase II	Activity 4.6	Pilot project activities for technical intervention to rehabilitate existing composting plant (preparation of tender)
5	Phase II	Activity 4.6	Pilot project activities for technical intervention to rehabilitate existing composting plant (Design and assembling)

6.2 Reports

(1) Reports

The Project Completion Report was submitted in May 2023 and is attached as Appendix 11.

(2) Technical supporting report

Out of the following materials were created through the project. (a) is attached with the final report as Appendix 10. (b), (c), and (d) are submitted to JICA on CD-R.

(a) MP of Western Province draft (English)

(b) MP of Western Province draft (Sinhala and Tamil)

(c) Survey report of Solid Waste Management in Western Province under output 2 (Japanese and English)

(d) Guideline for budget plan for sub-plans and other relevant plans (e.g. LA action plans, plans on waste management facilities) in line with MP (English).

End.