

**GROSS NATIONAL HAPPINESS COMMISSION
THE KINGDOM OF BHUTAN**

**PREPARATORY SURVEY
ON THE PROJECT
FOR IMPROVING SOLID WASTE MANAGEMENT
IN BHUTAN
FINAL REPORT**

MAY 2020

JAPAN INTERNATIONAL COOPERATION AGENCY

**YACHIYO ENGINEERING CO., LTD.
JAPAN ENVIRONMENTAL SANITATION CENTER**

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Preface

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to the joint venture of Yachiyo Engineering Co., Ltd. and Japan Environmental Sanitation Center.

The survey team held a series of discussions with the officials concerned of the Royal Government of Bhutan, and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Royal Government of Bhutan for their close cooperation extended to the survey team.

May, 2020

Eiji Iwasaki
Director General
Global Environment Department
Japan International Cooperation Agency

Summary

1. Overview of Bhutan

The Kingdom of Bhutan (hereinafter referred to as “Bhutan”) is located in the southeastern part of Himalayas and its elevation is between 100 m (in the southern part bordering India) and 7,500 m (in the northern part located in Himalayas). As a result, the terrain is very rough and the country has limited flat areas. Thimphu Thromde (2,300 m elevation) is located in the central part of Bhutan. Phuntsholing Thromde (300 m elevation), Gelephu Thromde (220 m elevation) and Samdrupjongkhar Thromde (170 m elevation) are located close to the southern border with India. The climates of Thimphu Thromde and the other three cities are classified respectively as monsoon climate and subtropical climate with high precipitation from May to September.

The GDP of Bhutan is approx. 0.45 billion USD (2018), GDP growth rate is 3.0%, and per-capita GDP is 3,243 USD (World Bank). Bhutan has been carrying out socio-economic development based on development plan stipulated every five years since 1961. The 11th five-year plan commenced in July 2013. Many of working population have been engaged in agriculture that is a core industry of Bhutan. Recently, industrial sector share of the GDP is increasing because of the development of electricity sector by, among others, the construction of hydroelectric power plants, and selling electricity to India.

In 2018, the exported amount of the country was approx. 592 million USD, and imported amount was approx. one billion USD, leaving a total trade deficit of approx. 430 million USD. Major exported products in 2018 were electricity, silicon, stone, cement etc. On the other hand, major imported products are light oil, petrol, iron products, and rice, which account for more than 80% of all imported products. Currently, Bhutan depends on foreign countries including India for the imports of both consumer goods and capital goods, and this has led to a constant trade deficit. Moreover, development of tourism is one of the biggest challenges that Bhutan is facing, since Bhutan needs to acquire foreign currency other than Indian Rupee that accounts for a large proportion of the foreign trading currently.

Approx. 60% of population in Bhutan live in rural areas, and they are engaged in agriculture with intensive farming and local self-sufficiency. On the other hand, the current trend of the rapid labor market expansion shows the private sector as the major sector creating employment opportunities. Unemployment rate in Bhutan was approx. 2.4% in 2018. But young population (20–24 years old) that are seeking for jobs are increasing mostly in urban areas, and the unemployment of young generation is becoming a major issue.

2. Background and Outline of the Project

In Bhutan, the influx of population from rural areas to urban areas is increasing with the recent economic growth. Moreover, the increase in access to information with economic growth increases the consumption of the people as well as imported products, and leads to the improvement of the living standard. The urban population growth and living standard improvement with the increase of imported products expand the amount of waste generation. In a situation like this, inadequate solid waste management causes deterioration of living environment and public health. Thus, improvement of solid waste management system is urgently needed.

A concept of “Gross National Happiness (GNH)” is emphasized in Bhutan, in addition to “Gross National Product (GNP)”, and various efforts were made to maximize the GNH. The GNH has four important pillars and one of them is the “environmental conservation and sustainability”, which is related to the waste management sector. Through the improvement of living environment and public health by an appropriate waste management system, an increase in the happiness level of the people is expected.

Considering the above points, building appropriate waste collection/ transportation system is what the target cities (Thimphu, Phuntsholing, Gelephu and Samdrupjongkhar Thromde) need most in terms of the solid waste management. In the circumstances, the solid waste management system is required to strengthen, whereas shortage and deterioration of waste collection equipment are issued to be faced very soon in Bhutan. It is under this circumstance that the Government of Bhutan requested grant aid of Japan

to improve its solid waste management.

3. Summary of the Survey Result and Contents of the Project

JICA dispatched a survey team to Bhutan to conduct the first survey in the country, Bhutan-1, (between August 10 and 31, 2019) and the second survey, Bhutan-2, (between September 21 and October 26, 2019). The team confirmed the contents of the request and conducted a field survey for the planning of the solid waste management equipment. After returning to Japan, the team analyzed the data collected in the field surveys, prepared an outline design with the Project cost estimation. The team conducted the Outline Design Survey in Bhutan between December 7 and December 14, 2019 based on the result of the analysis.

The JICA survey team prepared the basic components of the Project as mentioned below based on the results of the field surveys and the discussion with the Bhutan side, after returning to Japan.

(1) Project Components

The Project components are shown below.

1) Waste Collection Equipment

The waste collection equipment to be procured by the Project for the four target cities are shown in Table-1.

Table-1 Waste Collection Equipment Component

Target City	Waste Collection Equipment					
	Compactor			Container Carrier	Container (4–6m ³)	Maintenance Tools for Workshops
	Medium	Small	Sub-total			
Thimphu	6	11	17	3	24	1 set
Phuntsholing		5	5			1 set
Gelephu		4	4			1 set
Samdrupjongkhar		2	2			1 set
Total	6	22	28	3	24	-

Note: Each vehicle will include standard spare parts and standard in-vehicle tools
Source: JICA Survey Team

2) Landfill Equipment

The landfill equipment to be procured for the four target cities is shown in Table-2.

Table-2 Landfill Equipment Component

Target City	Landfill Equipment		
	Bulldozer	Excavator	Backhoe Loader
Thimphu	1		
Phuntsholing		1	
Gelephu			1
Samdrupjongkhar			1
Total	1	1	2

Note: Includes standard spare parts
Source: JICA Survey Team

3) Soft Component

The objective of the Project is to provide a proper waste management services to the citizens in the target four cities. Based on this understanding, the purpose of the soft component of this Project is to secure the sustainability of the Project through the improvement of the waste management skills of each city, i.e., providing proper waste collection services in line with the source separation and implementing safety and proper landfill works over a long time. The soft component will be described in detail as follows:

- Support for Preventive Maintenance
- Support for Repair Management System
- Support for Spare Parts Management System
- Support for Improving Waste Collection / Transportation and Landfilling Method
- Support for Awareness Raising on Solid Waste Management
- Support for Operation Safety and Sanitation

4. Project Period and Project Cost Estimation

This part is not disclosed due to confidentiality for one year until final verification of the contract of the supplier. The cost of implementing this Project undertaken by Bhutan side is estimated at 150 million JPY, including Bank Commissions and Green Tax. The obligations of the Bhutan side shall be the payment of Green Tax, the payment of Bank Commissions, the payment of the cost for operation and maintenance of the equipment including staffs, and the preparation of parking spaces and workshops. A period of approx. 20 months is required for the implementation of this Project, from the field survey and detailed design to the completion (including the Soft Component).

5. Project Evaluation

(1) Relevance

1) Beneficiaries of the Project

The number of direct beneficiaries of this Project is approx. 170 thousand people in the four target cities of Bhutan.

2) Urgency

In Bhutan, in spite of increase in the amount of waste generated, proper waste collection and final disposal have not been implemented due to the shortage and deterioration of the equipment. Therefore, immediate implementation of the Project is required for improving people's living environment.

3) Integrity with Solid Waste Management in Bhutan

The objectives "National Waste Management Strategy (2019-2030)" formulated in 2019 includes "Achievement of zero waste by 2030", and it aims to realize it by "Efficient solid waste management through collecting discharged waste with minimizing waste discharge". Moreover, construction of drop-in centers and construction of a new landfill site (or improvement of existing landfill site) are proposed in this strategy. This Project contributes to the achievement of the above objectives by procuring equipment necessary for collection, transportation and disposal of waste.

4) Consistency with the Assistance Policies and Strategies of the Government of Japan

The assistance strategy (medium target) for Bhutan in 2015 is providing "Support for environmental issues and climate changes by dealing with sustainable urban environment issues, climate changes and disaster prevention, since Bhutan is vulnerable to environmental deteriorations and climate changes with environmental disasters and socio-economic changes". This Project will contribute to the improvement of the environmental hygiene, waste management capacity and service of the administration, and it is consistent with Japan's ODA policies and strategies.

(2) Effectiveness

1) Quantitative Effects

Table-3 shows the quantitative indicators of the effects expected from this Project including the current (baseline) values and the target values (i.e., after completion of the Project) of the indicators. The "amount of wastes collected by the cities (t/d)" is used as an indicator.

Table-3 Quantitative Effects Expected from the Implementation of this Project

Target City	Baseline (2019) (t/d) (Actual)	Target (2023) (t/d) (2 years after project completion)	Target (2024) (t/d) (3 years after project completion)
Total	78.2	95.5	97.0
Thimphu Thromde	52.4	66.9	68.6
Phuntsholing Thromde	15.3	17.1	17.3
Gelephu Thromde	5.4	5.8	5.8
Samdrupjongkhar Thromde	5.1	5.7	5.8

Source: JICA Survey Team

2) Qualitative Effects

The following qualitative effects can be expected from the implementation of this Project:

- (1) Improvement of living environment through decreasing illegal disposal etc. of the target four cities
- (2) Improvement of solid waste management capacity of the target four cities

Because the Project is expected to have sufficient beneficial effects as mentioned above, the appropriateness of implementing this Project with grant aid from the Government of Japan has been confirmed.

In order to implement the Project with high efficiency and effectiveness, not only the establishment of a system for the operation and maintenance but also employment and assignment of appropriate personnel to the system immediately and allocation of the budget necessary for operation and maintenance are required.

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Note: ("Thromde" means "City" or "municipality" in Bhutan)

Location Map

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Abbreviation

A/P	Authorization to Pay
B/A	Banking Arrangement
BCBS	Bhutan Central Bureau of Statistics
BTN	Bhutanese Ngultrum
C/P	Counterpart
E/N	Exchange of Notes
G/A	Grant Agreement
GCF	Green Climate Fund
GNHC	Gross National Happiness Commission
GOJ	Government of Japan
JESC	Japan Environmental Sanitation Center
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
LAP	Local Area Plan
LFS	Landfill Site
M/D	Minutes of Discussion
MoF	Ministry of Finance
MoWHS	Ministry of Works and Human Settlement
MRF	Material Recycling (or Recovery) Facility
NEC	National Environmental Commission
O/M	Operation and Maintenance
OVI	Objectively Verifiable Indicator
RGoB	The Royal Government of Bhutan
SWM	Solid Waste Management
t/d	Ton per day
UNDP	United Nations Development Programme
USD	United States Dollar

CHAPTER 1 Background of the Project

1-1 Background

1-1-1 Background and Original Request

1-1-1-1 Background

In Bhutan, the influx of population from rural areas to urban areas is increasing with the recent economic growth. In addition, the increase in access to information with economic growth increases the consumption of the people as well as imported products, and leads to the improvement of the living standard. The urban population growth and living standard improvement with the increase of imported products expand the amount of waste generation. In a situation like this, inadequate solid waste management causes deterioration of living environment and public health. Thus, improvement of solid waste management system is urgently needed.

The concept of “Gross National Happiness (GNH)” is emphasized in Bhutan, in addition to “Gross National Product (GNP)”, and various efforts were made to maximize the GNH. The GNH has four important pillars, and one of them is the “environmental conservation and sustainability”, which is related to the waste management sector. Through the improvement of living environment and public health by an appropriate waste management system, increase of the happiness level of the people is expected.

The National Waste Management Strategy (NWMS) (2019) has important policies, and it targets “Zero Waste Bhutan by 2030” by minimizing generation of waste through 3Rs (Reduce, Reuse, Recycle) etc. Appropriate collection and transport system of waste shall be promoted, improved and constructed.

Realization of appropriate collection and transport system of solid waste in the four major cities targeted by this Project (Thimphu, Phuntsholing, Gelephu and Samdrupjongkhar Thromde) is regarded as the most important issue in the above situation. The four cities are suffering from poor solid waste collection service caused by shortage of the equipment.

It was in these circumstances that Gross National Happiness Commission (GNHC) requested grant aid of Japan for procurement of waste collection vehicles for the four cities. Japan International Cooperation Agency (JICA) decided to conduct a preparatory survey for the grant aid project. The goal of the survey is to confirm the necessity and relevance of the grant aid project by conducting a field survey, and to study procurement conditions, prepare an equipment plan, an implementation plan and the schedule. An outline design of the equipment with the project cost estimation will be also prepared.

1-1-1-2 Original Components Requested

The original components requested by GNHC are as follows:

- Waste Collection Vehicles of Solid Waste for target Thromdes: total 42 vehicles (Thimphu 25, Phuntsholing 10, Gelephu 5 and Samdrupjongkhar 2)

1-1-1-3 Components Requested by Bhutan Side

Bhutan side emphasized the importance of comprehensive efforts for improvement of solid waste management including technical assistance.

1-1-2 Natural Conditions of the Project Sites

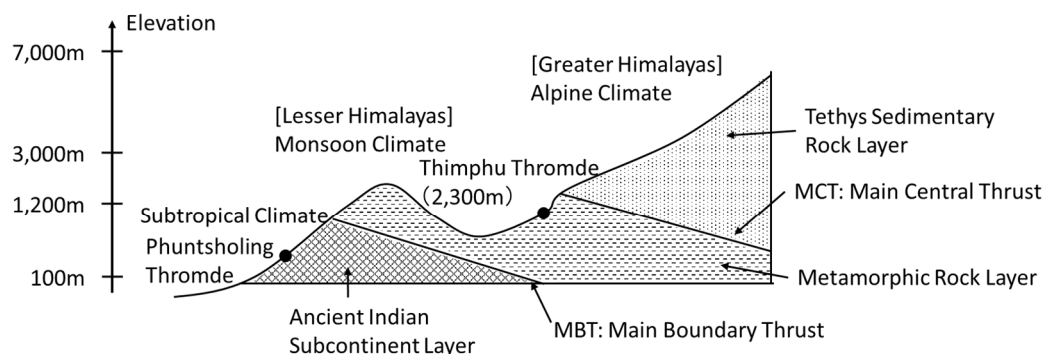
1-1-2-1 Climate Conditions

Bhutan is located in the southeastern part of Himalayas and its elevation is between 100 m (in the southern part close to Indian border) and 7,500 m (in the northern part located in Himalayas). As a result, the terrain is very rough and the country has limited flat areas. Thimphu Thromde (2,300 m elevation) is located in the central part of Bhutan, and the other three Thromdes (Phuntsholing Thromde with 300 m elevation, Gelephu Thromde with 220m elevation, and Samdrupjongkhar Thromde with 170 m

elevation) are located close to southern border with India.

The climates of Bhutan are classified into the following three types: (a) subtropical climate in southern part of Bhutan (100–1,200 m elevation); (b) monsoon climate in central part of Bhutan (1,200–3,000 m); and (c) alpine climate in northern part of Bhutan (over 3,000 m)

The climate of Thimphu Thromde is classified as a monsoon climate, and that of other three cities is classified as subtropical climate. Topology, geography and climate of Bhutan are summarized in Figure 1-1-1.



※Actual geological layer is complicated due to folding layers and erosion etc.

Figure 1-1-1 Geographic Profile of Bhutan

1-1-2-2 Rainfall

The annual mean precipitations of Bhutan are characterized by the zones as follows: (a) 3,000–5,000 mm (south Indian border area); (b) 1,200–2,000 mm (South Himalaya area); (c) 500–1,000 mm (central inland canyon area), and (d) under 500 mm (alpine area located in 4,000m elevation over). Most the annual precipitation is recorded in the rainy season (June–September) of the country.

Thimphu Thromde is located in the central inland canyon area, and most of the annual rainfall is recorded between June and August. The monthly precipitation in the four Thromdes, including the other three Thromdes located in south Indian border area, is shown in Table 1-1-1.

Table 1-1-1 Monthly Precipitation in the Four Thromdes (2017)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Thimphu Thromde (Simtokha)												
Monthly Total (mm)	2.6	0.8	60.5	45.4	84.6	88.2	162.6	93.3	56.0	11.9	0.8	0.0
Maximum (mm)	2.6	0.8	37.0	16.3	19.2	23.2	30.4	19.5	18.5	6.9	0.8	0.0
Phuntshogling Thromde												
Monthly Total (mm)	4.7	9.0	92.4	325.4	450.9	488.6	1317.7	1506.9	653.0	129.8	1.0	0.0
Maximum (mm)	4.7	5.5	18.2	118.4	86.2	81.0	280.0	285.4	117.3	30.6	0.6	0.0
Gelephu Thromde (Bhur)												
Monthly Total (mm)	7.2	15.7	50.2	153.6	455.8	1075.3	923.7	2077.8	1032.0	127.1	11.9	0.0
Maximum (mm)	6.2	7.3	28.1	48.8	87.4	174.4	179.4	258.2	126.4	36.3	10.6	0.0
Samdrupjongkhar Thromde (Deothang)												
Monthly Total (mm)	5.2	39.8	66.1	262.6	148.3	830.6	490.1	787.1	764.0	175.5	12.4	0.0
Maximum (mm)	5.2	13.0	15.0	50.6	35.0	167.0	131.4	147.0	113.2	61.4	12.4	0.0

Source: Climate Data Book of Bhutan 2018, National Center for Hydrology and Meteorology

1-1-2-3 Temperature

Thimphu Thromde has an average maximum temperature of approximately 20°C. The other three Thromdes are relatively hot even in winter season due to their locations. The monthly temperatures in the four Thromdes are shown in Table 1-1-2.

Table 1-1-2 Monthly Temperature in the Four Thromdes (2017)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Thimphu Thromde (Simtokha)												
Maximum Temperature (°C)	16.3	18.1	18.4	22.9	23.8	27.4	26.6	28.0	27.9	24.6	20.6	19.4
Minimum Temperature (°C)	-3.8	0.9	3.2	7.3	10.3	14.0	15.3	15.1	14.0	9.4	0.6	-2.3
Phuntshogling Thromde												
Maximum Temperature (°C)	28.6	26.1	28.7	30.9	30.6	30.2	29.1	29.5	30.0	29.2	28.1	26.2
Minimum Temperature (°C)	21.5	20.7	15.2	18.5	19.6	22.2	22.0	22.3	21.8	19.5	15.4	13.4
Gelephu Thromde (Bhur)												
Maximum Temperature (°C)	24.5	26.0	25.7	27.1	29.0	29.0	29.7	28.9	28.6	29.0	28.0	25.9
Minimum Temperature (°C)	15.0	17.4	18.2	21.0	22.8	23.7	24.6	24.1	23.4	22.2	18.3	16.6
Samdrupjongkhar Thromde (Deothang)												
Maximum Temperature (°C)	22.5	23.6	24.0	25.6	27.2	27.8	28.8	27.9	27.8	27.1	25.6	23.4
Minimum Temperature (°C)	10.9	12.8	13.7	16.9	19.0	20.3	20.9	21.3	20.6	18.1	14.1	12.0

Source: Climate Data Book of Bhutan 2018, National Center for Hydrology and Meteorology

1-1-2-4 Humidity

Humidity in the four Thromdes is high in the rainy season (June–September). The monthly humidity in the four Thromdes is shown in Table 1-1-3.

Table 1-1-3 Monthly Humidity in the Four Thromdes (2017)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Thimphu Thromde (Simtokha)												
Mean (%)	51.8	49.6	50.1	51.6	51.5	51.2	67.6	65.0	61.4	53.5	45.8	47.8
Maximum (%)	79.0	73.0	100.0	83.0	80.0	95.0	90.0	100.0	81.0	89.0	76.0	93.0
Minimum (%)	28.0	21.0	35.0	27.0	34.0	26.0	52.0	46.0	43.0	34.0	24.0	17.0
Phuntshogling Thromde												
Mean (%)	71.4	59.3	63.5	71.4	78.8	81.7	86.5	88.7	88.3	76.1	63.3	63.2
Maximum (%)	93.0	85.0	95.0	95.0	92.0	97.0	96.0	96.0	96.0	96.0	76.0	84.0
Minimum (%)	34.0	34.0	42.0	44.0	56.0	61.0	65.0	65.0	71.0	55.0	50.0	36.0
Gelephu Thromde (Bhur)												
Mean (%)	61.0	65.3	68.5	78.7	85.8	90.7	89.8	92.9	92.8	79.3	71.5	70.1
Maximum (%)	89.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	90.0	90.0
Minimum (%)	43.0	41.0	53.0	32.0	63.0	73.0	72.0	72.0	84.0	61.0	54.0	47.0
Samdrupjongkhar Thromde (Deothang)												
Mean (%)	51.0	56.8	66.5	78.2	81.0	87.3	86.8	92.2	92.9	79.4	56.7	59.3
Maximum (%)	78.0	89.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	80.0	91.0
Minimum (%)	28.0	38.0	32.0	41.0	65.0	71.0	65.0	81.0	81.0	54.0	34.0	22.0

Source: Climate Data Book of Bhutan 2018, National Center for Hydrology and Meteorology

1-2 Environmental and Social Considerations

This Project is categorized as “C” based on the “JICA Guidelines for Environmental and Social Considerations” issued in April, 2010, for the following reasons: (a) this Project is for procurement of waste collection equipment, and hence, impacts on the environment are not likely to be significant; and (b) the Project target areas are neither sensitive areas nor areas that need special considerations. Accordingly, permission for environment consideration is not needed. However, regarding the emission

gas, the vehicles to be used in Bhutan need to be comply with the regulation of emission gas (EURO II) in general considering environment and health effects. As result, it was confirmed to NEC and GNHC that the vehicles to be provided “in this Project” need to conform to either EURO II or equivalent regulations.

CHAPTER 2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Overall Goal and Project Objective

Project Objective	To ensure that the target four (4) cities provide solid waste management services to citizens for sound environment and healthy life.
Outcome	Equipment necessary for the above 4 cities of Bhutan (Thimphu, Phuntsholing, Gelephu and Samdrupjongkhar Thromde) are provided
Project Outcome Indicator	<u>Quantitative indicator</u> 1. Waste collection improvement - Amount of wastes collected (t/d) <u>Qualitative indicator</u> 1. Improvement of living environment 2. Improvement of solid waste management services

Source: JICA Survey Team

2-1-2 Outline of the Project

2-1-2-1 Proposed Components

(1) Waste Collection Equipment

The components of the waste collection equipment proposed by the Project are shown in Table 2-1-1. The collection equipment for improvement of waste collection are for all the 4 cities.

Table 2-1-1 Components of Waste Collection Equipment

Target City	Waste Collection Equipment					
	Compactor			Container Carrier	Container (4–6m ³)	Maintenance Tools for Workshops*
	Medium	Small	Sub-total			
Thimphu	6	11	17	3	24	1 set
Phuntsholing		5	5			1 set
Gelephu		4	4			1 set
Samdrupjongkhar		2	2			1 set
Total	6	22	28	3	24	-

Note: * The contents of the tools are shown in the following table. Each vehicle will include standard spare parts and standard in-vehicle tools.

Source: JICA Survey Team

*Maintenance Tools for the City Workshops

The summary of the maintenance tools for the four city workshops is shown in the following table.

Table 2-1-2 Preliminary List of Maintenance Tools for the Workshops (Draft)

No.	Workshop Equipment Items	Unit	Quantity
1	3/4" Sq. Drive Socket Set	set	4
2	3/8" Sq. Drive Socket Set	set	4
3	Combination Spanner Set	set	4
4	Heavy Duty Combination Spanner Set	set	4
5	Adjustable Wrench	set	4
6	Ratchet Torque Wrench	set	4
7	Adjustable Pipe Wrench (250 mm)	set	4
8	Adjustable Pipe Wrench (450 mm)	set	4
9	Strap Wrench	set	4
10	Angle Key Set (Normal Size)	set	4
11	Angle Key Set (Large Size)	set	4
12	Long Pattern Hexagon Key Set	set	4
13	Driver Set	set	4
14	Fiberglass Shaft Club Hammers	set	4

No.	Workshop Equipment Items	Unit	Quantity
15	Fiberglass Shaft Sledge Hammers	set	4
16	Bar	set	4
17	Pry Nail Bar	set	4
18	Pliers Set	set	4
19	Crimping Tool	set	4
20	Drawer Roller Cabinet	set	4

Source: JICA Survey Team

(2) Landfill Equipment

The components of the landfill site management equipment proposed by the Project are shown in Table 2-1-3. The equipment for improvement of landfilling is for landfill sites of the 4 cities.

Table 2-1-3 Components of Landfill Equipment

Target City	Landfill Equipment		
	Bulldozer	Excavator	Backhoe Loader
Thimphu	1		
Phuntsholing		1	
Gelephu			1
Samdrupjongkhar			1
Total	1	1	2

Note: Includes standard spare parts

Source: JICA Survey Team

2-1-2-2 Soft Component

The soft component is for improving the technical operation and maintenance system, and it includes the following:

- ✧ Support for Preventive Maintenance
- ✧ Support for Repair Management System
- ✧ Support for Spare Parts Management System
- ✧ Support for Improving Waste Collection and Landfilling Method
- ✧ Support for Awareness Raising on Solid Waste Management
- ✧ Support for Operation Safety and Sanitation

2-1-3 Target Year

The target year of the Project shall be set as 2023, which is the target year of the short-term objectives of the “National Solid Waste Management Strategy 2019”.

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policies

Solid waste management capacity shall be improved through procurement of necessary equipment for the target cities considering the shortage of and urgent needs for waste collection equipment to keep the cities clean and sanitary. At the same time, the collected waste shall be treated or disposed properly, and the necessary equipment for the operation of landfill sites shall also be prepared according to a proper plan. In addition, in order to operate this equipment sustainably, the Project needs to consider the operation and maintenance of the equipment.

The target waste is municipal waste from households and business entities (schools, markets, commercial establishments, offices, etc.).

2-2-1-2 Policy on the Natural Environmental Conditions

In the Project area, the moisture content of solid waste is high in rainy season, so special equipment measures, such as leachate storage tank for compactor, will be required. In addition, it will be necessary to supervise the operation to avoid overloading the vehicles.

2-2-1-3 Policy on the Socio-Economic Conditions

Many of the roads in Bhutan are narrow and winding even in the central areas of large cities, and consideration should be made to avoid traffic congestion. The type of collection equipment shall be selected taking into account the above road conditions.

2-2-1-4 Policy on Procurement Conditions

There are some local companies (local agencies) affiliated with car manufacturing companies in Japan that can carry out repair works locally. The number of technical staffs (engineers, mechanics, etc.) of these affiliated agencies is estimated as 10–30 per agency.

Technical level for repairing waste collection vehicles needs not to be considered, as daily maintenance can be carried out without hindrance, and serious repairing can be dealt with dispatch from car manufacturing or agency. General spare parts and special spare parts of Japanese vehicles can be obtained respectively from India and Singapore/ Japan within approx. three weeks. However, in the case of necessary special spare parts, procurement from Japan is recommended. In this case, the implementing agency needs to secure the budget for that, and the procurements of the parts may take several months.

2-2-1-5 Policy on Employment of Local Companies

Local companies will be utilized for inland transportation, maintenance, etc.

2-2-1-6 Policy on Operation and Maintenance

Equipment to be procured by the Project shall be delivered to the four target cities, and each city has to operate and maintain the equipment by itself. Since the compactors are commonly used in the target cities, no problems in their operation and maintenance are expected. Waste collection services in Thimphu and Phuntsholing Thromde are consigned to private companies and waste collection equipment is lent to them. In Thimphu Thromde, vehicles will be maintained in the public workshop, which is now under preparation, and private workshops. In the remaining 3 cities, they will be maintained in the private workshops. The same system will be applied to heavy equipment to be used in the landfill site.

2-2-1-7 Policy on the Selection of Grades of Equipment

The collection and landfill equipment of this Project will be a standard grade with no operation and maintenance problems.

2-2-1-8 Policy on Procurement Method and Project Schedule

The waste collection and transportation equipment will be in principle procured from Japanese manufacturers. Third countries may be considered for the procurement of landfill equipment including bulldozers, excavators, and backhoe loaders. The procurement period will consider the transportation of the large amount of equipment to the four target cities. The plan for maritime transportation to Kolkata Port in India and the inland transportation route to Phuntsholing will be carefully planned.

2-2-2 Basic Plan (Procurement Plan)

2-2-2-1 Basic Policy

Basic policies for the planning are as follows:

- (1) National regulation and strategy base
- (2) Reasonable and effective equipment plan
- (3) Sustainable operation and maintenance plan
- (4) Synergy effect with other donors' supports to solid waste management

2-2-2-2 Preliminary Equipment Plan in Thimphu Thromde

2-2-2-2-1 Planning Concept

The planning concept for the waste collection vehicles and other equipment related to solid waste management in Thimphu Thromde is as follows:

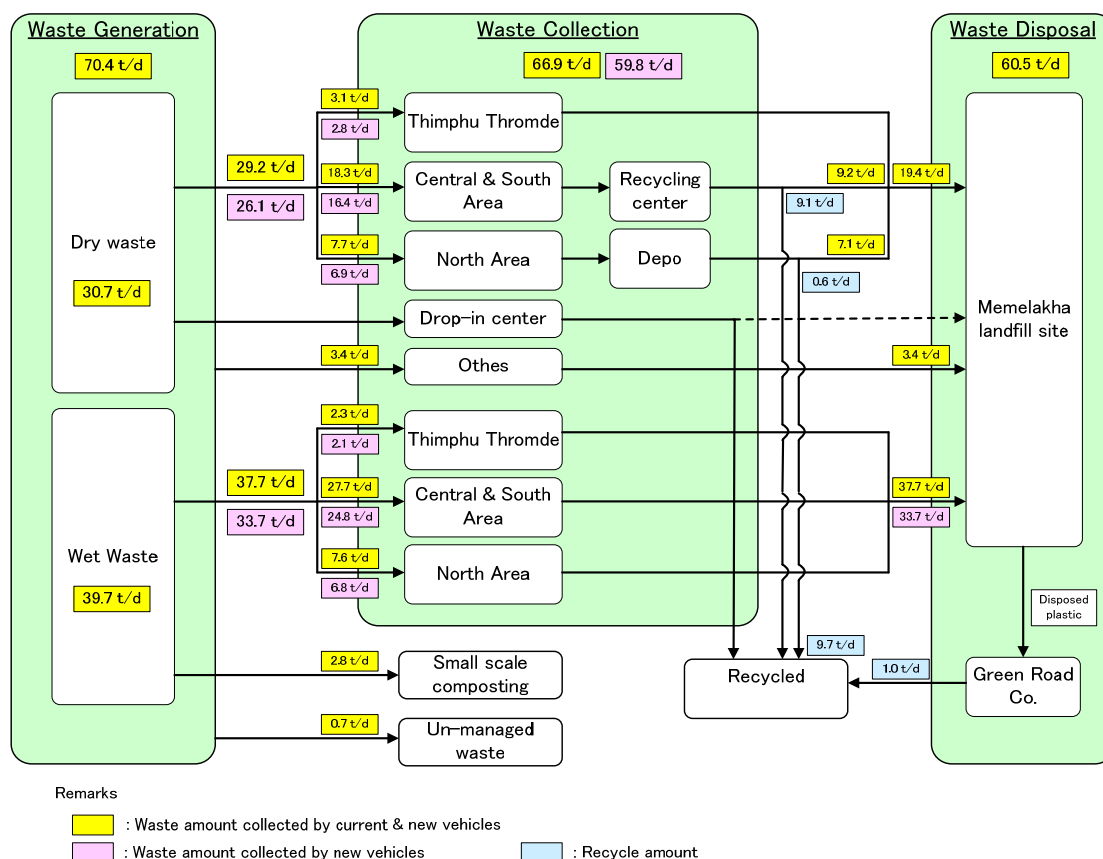
- Target collection ratio in 2023 is set as 95%, as shown in Table 2-2-1. The target will be 100% by 2030.
- Because of widespread practices of discharging waste using bags, compactor collection applying door-to-door collection with bell system (noticing sound) seems to be a proper collection system for Thimphu Thromde.
- As waste separation at source into dry waste and wet waste is widely practiced and firmly in place in Thimphu Thromde, separate compactors should be used for each type of waste.
- Taking into account the narrow roads and steep slopes of hillsides in both west and east side of Thimphu Thromde, and considering the collection efficiency at such locations, the specification of the compactor should be middle class (8m³) and of small class (4m³) types.
Also, considering the working space limited by the parking spaces on the sides of the main roads of Thimphu Thromde, middle and small class compactors should be procured.
- Required numbers of vehicles should be calculated considering the current contract-out system of collection services to north area and central/south area.
- For the direct collection and emergency measures by Thimphu Thromde, certain numbers of collection vehicles should be secured for the city. In order to reduce the burden on the collection vehicles, and to keep the proper operation period/years of the collection vehicles, working shifts should be limited to one shift, and the operation hours of each vehicle should be more or less 6 hours.
- For the same above reasons, the number of trips of each collection vehicle should be two in average.
- In the areas where large amount of waste is generated and discharged (such as markets, institutional buildings, national hospitals), the current container collection system should be properly operated. At the drop-in center, container system is a proper way for segregation, storing and transportation.
- In Thimphu Thromde, ten drop-in centers are planned, one of them has already started operation, and three will be completed by Thimphu Thromde by June 2020.
- A new workshop is planned to be operated by Thimphu Thromde, and part of maintenance platform has been already constructed. Workshop building should be constructed and equipped with proper maintenance and repair tools/ equipment.
- In order to operate the Memelakha Landfill Site properly, adequacy of landfill equipment and related equipment, such as bulldozer, should be ensured.

Table 2-2-1 Target Collection Ratio and Amount of Waste to be Collected in 2023

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Population	114,551	117,415	120,350	123,359	126,443	129,604	132,844	136,165	139,569	143,059	146,635	150,301	154,058	157,910
Amount of waste generated (t/d)	60.7	62.2	63.8	65.4	67.0	68.7	70.4	72.2	74.0	75.8	77.7	79.7	81.7	83.7
(Brakedown)	Dry waste (t/d)	26.5	27.1	27.8	28.5	29.2	30.7	31.5	32.3	33.1	33.9	34.7	35.6	36.5
	Wet waste (t/d)	34.2	35.1	36.0	36.9	37.8	39.7	40.7	41.7	42.8	43.8	44.9	46.1	47.2
Collection ration (%) current/ target			82%				95%							100%
Collection amount (t/d)			52.4				66.9							83.7
(Brakedown)	Dry waste (t/d)			35.6			29.2							36.5
	Wet waste (t/d)			16.8			37.7							47.2

Source: JICA Survey Team

Waste flow in 2023 is shown in Figure 2-2-1.



Source: JICA Survey Team

Figure 2-2-1 Waste Flow of Thimphu Thromde in 2023

2-2-2-2 Preliminary Equipment Plan for Collection Equipment

(1) General Calculation Method for Waste Collection Vehicles

Quantity of waste collection vehicles procured was examined by the following method:

- (1) Calculating the amount of waste generated by each of the four cities in 2023
- (2) Calculating the waste collection capacity of existing vehicles of each of the four cities in 2023
- (3) Setting the collection amount to be covered by the newly procured vehicles
- (4) Setting two types of compactors (medium and small) considering road conditions (narrow and/or steep)
- (5) Setting one shift and two trips/shifts for each compactor, considering the waste amount to be collected, distance to the final disposal site, and reduction of excess burden on the compactor

Most of the existing collection vehicles are old (more than 10 years) and in a deteriorated condition, causing high maintenance costs and operation problems. The equipment plan for waste collection vehicles is formulated in accordance with the methodology shown below, including waste collection capacity of each collection vehicle.

$$\text{Capacity} = [\text{Vehicle volume (m}^3\text{)}] \times [\text{No. of trips}] \times [\text{Loading density (t/m}^3\text{)}] \\ \times [\text{Loading rate}] \times [\text{Operation rate}] \times [\text{Effective rate}]$$

Loading rate, operation rate, and effective rate are defined as follows:

Loading rate: 90% of loading rate is applied considering actual loading volume. In the case of TATA collection trucks, 50% is applied based on the actual condition.

Operation rate: 86% (6 days per weeks) of operation rate is applied considering actual working days.

Effective rate: Considering the age of vehicle, following effective rates are applied:

Vehicle age in the target Year (2023)	Effective Rate
Less than 4 years (Manufactured year in or after 2019)	100%
5-9 years (Manufactured year between 2014 and 2018)	50%
10 years or more (Manufactured year before 2013)	0% (Scrapped)

The design loading density of the waste for each waste collection vehicle type is shown in Table 2-2-2.

Table 2-2-2 Loading Density of Wastes for Waste Collection Vehicles

Vehicles	Density (t/m ³)
Compactor	0.50
Container carrier	0.35
Dump truck	0.35
Container Trailer + Tractor	0.30

Source: JICA Survey Team

(2) Preliminary Output of Equipment in Thimphu Thromde

1) Waste Collection Vehicles

The number of compactors required for Thimphu Thromde is shown in Table 2-2-3.

Table 2-2-3 Calculation of Required Collection Vehicles in Thimphu

Collection amount in 2023 (t/d)				66.9 t/d	
				Dry waste	Wet waste
				29.2 t/d	37.7 t/d
Number of current compactors to be operated in 2023				5	
Collection amount to be collected by current compactor in 2023 (t/d)				7.1 t/d	
Amount to be collected by newly procured compactors by the Project in 2023 (t/d)	Total			59.8 t/d (= 66.9 t/d – 7.1 t/d)	
	Breakdown into Dry & Wet			26.1 t/d	33.7 t/d
	Breakdown into Areas				
	Thromde			2.8 t/d	2.1 t/d
	North area			6.9 t/d	6.8 t/d
	Central & South Area			16.4 t/d	24.8 t/d
Numbers of newly procured compactors in 2023	Total			17	
	Breakdown into vehicle types				
	8m ³			3	3
	4m ³			4	7
	Thromde	Vehicle Type	8m ³	0	0
			4m ³	1	1
	North Area	Vehicle Type	8m ³	1	0
			4m ³	1	3
	Central & South Area	Vehicle Type	8m ³	2	3
			4m ³	2	3

Note: 1. Ratio of dry waste and wet waste is estimated based on the waste composition.

2. Share of collection amount of Thromde, North area (by Clean City) and Central & South area (by Greener Way) is estimated based on the collection amount in 2018.

Source: JICA Survey Team

2) Maintenance Tools

Thimphu Thromde needs one set of maintenance tools.

3) Container Carrier and Containers

The required numbers of container carriers and containers for Thimphu Thromde are as follows:

- ✧ Container carrier: 3 (one operated by Thimphu Thromde and two by private contractors)
- ✧ Container: 24 (6 containers for each of 4 drop-in centers, including Kelki drop-in center)

The production years of existing container carriers are 2006 (1 container carrier) and 2011 (2 container carriers). All vehicles will be replaced because their useful life has exceeded 10 years.

The container carriers and containers are used for segregation of recyclable material at drop-in centers and transportation of residues to the landfill site. The transportation capacity of solid waste of container carriers is not included in the above domestic solid waste collection capacity.

2-2-2-2-3 Preliminary Equipment Plan for Final Disposal Equipment

(1) Calculation Method for Landfill Equipment for Final Disposal

The quantity of the landfill operation equipment needed was calculated by the following method:

- (1) Estimate the amount of waste disposed to the landfill site
- (2) Estimate the necessary soil covering amount
- (3) Calculate the required quantity of landfill equipment

(2) Preliminary Output of Landfill Equipment in Thimphu Thromde

1) Landfill Plan

Memelakha Landfill Site in Thimphu Thromde will receive approximately 60.5 t/d of waste in 2023. The operation plan of the landfill site is as follows:

- Operating hours of the site: 9 hours, from 9 am to 6 pm
- Working hours of the equipment: maximum 6 hours
- Cover soil: 10% of incoming waste (cover soil layer of 20 cm thick for each 2 m height of disposed waste)
- Landfill works should be carried out by moving/levelling & compaction of waste and covering soil, digging cover soil and transporting.

The work volumes of the landfill equipment are shown in Table 2-2-4.

Table 2-2-4 Required Work Volume of Landfill Equipment

Items	Unit	Plan in Landfill Site	Remark
a. Planned waste amount to be disposed	t/d	60.5	
b. Waste density before compaction	t/m ³	0.5	
c. Planned waste amount to be disposed before compaction	m ³ /d	121	= a/b
d. Estimated amount of cover soil	m ³ /d	12	= c x 10%
e. Required work volume			
e-1. Moving/levelling and compaction of waste & cover soil	m ³ /d	133	= c+d
e-2. Digging and transporting cover soil	m ³ /d	12	= d

Source: JICA Survey Team

2) Procurement Plan of New Landfill Equipment

To meet the following conditions, the equipment for moving/levelling and compaction of waste and cover soil shall be bulldozers of 21-ton class or higher:

- The landfill site is located in the valley and a main road runs downstream of the site. There is a need to stabilize the landfill by proper compaction works.

- The capacity of existing landfill site is limited, and there is a need to maximize the landfill capacity by proper compaction works.

The type of the landfill equipment was selected based on the design policy and planning conditions as shown in Table 2-2-5.

Table 2-2-5 Selection of Landfill Equipment

Target City	Planning Conditions			Landfill Equipment
	Landfill Amount (m ³ /d)	Topographic	Landfill Site Capacity	Moving/Levelling and Compaction of Waste and Cover Soil
Thimphu	133	Valley	Limited	Bulldozer

Source: JICA Survey Team

One bulldozer will be required for Memelakha Landfill Site, assuming the effective operation volumes in 2023 as shown below. The standard work volumes of the heavy equipment are based on Japanese guidelines.

a) Bulldozer

Standard work volume of a 21-ton class bulldozer is 600 m³/d

Operation condition of landfill equipment is shown in Table 2-2-6.

Table 2-2-6 Operation condition of Landfill Equipment

Site	Required work volume (m ³ /d)	New Landfill Equipment					Remarks
		Unit	Specification	Standard work volume (m ³ /d)	Operation hours	Work volume (m ³ /d)	
Memelakha Site	133	1	20 ton class	600	4	133	

Note: Considering types of products, “20-ton class or more” is applied in the specifications.

Source: JICA Survey Team

2-2-2-3 Preliminary Equipment Plan in Phuntsholing Thromde

2-2-2-3-1 Planning Concept

The planning concept for the waste collection vehicles and other equipment related to solid waste management in Phuntsholing Thromde is as follows:

- Target collection ratio in 2023 is set as 95%, as shown in the table below. The target will be 100% by 2030.
- Because of unsanitary condition of overflowing waste scattered around the containers, a compactor collection applying door-to-door collection with bell system seems to be a proper collection system for Phuntsholing Thromde.
- As waste separation at source into dry waste and wet waste is introduced in Phuntsholing Thromde, separate compactors should be used for each type of waste.
- Taking into account the narrow roads and some steep slopes of hillsides of Phuntsholing Thromde, the specification of the compactor should be a small class (4m³) type.
- Also, considering the working space limited by parking spaces on the sides of the main roads of the city center of Phuntsholing Thromde, small class compactor should be procured.
- In order to reduce the burden on the collection vehicles and to keep the proper operation period/years of the collection vehicles, working shifts should be limited to one shift, and the operation hours of each vehicle should be more or less 6 hours.
- For the above-mentioned reasons, the number of trips of each collection vehicle should be two in average.
- In the areas where large amount of waste is generated and discharged (such as housing complexes, markets, institutional buildings), the current container collection system should be properly operated.
- At the current garage of Phuntsholing Thromde, an additional building should be constructed, and

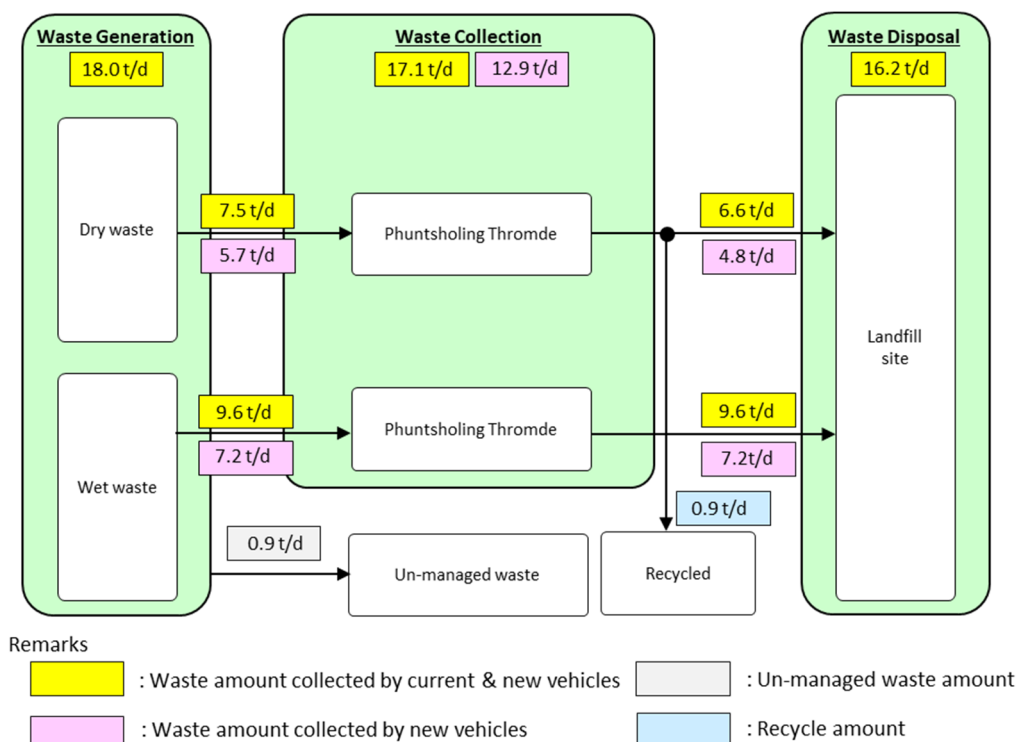
- spare parts and maintenance tools should be stored.
- At Pekarzhing Landfill Site, waste is disposed dropping the waste down from top of the hill over a steep slope, and it might have the risk of landslide.
- In order to operate the landfill site properly, appropriate landfill equipment should be acquired.

Table 2-2-7 Target Collection Ratio and Amount of Waste to be Collected in 2023

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Population	27,658	27,962	28,270	28,581	28,895	29,213	29,534	29,859	30,188	30,520	30,855	31,195	31,538	31,885
Amount of waste generated (t/d)	14.7	14.8	15.0	15.1	15.3	15.5	15.7	15.8	16.0	16.2	16.4	16.5	16.7	16.9
Amount of waste by floating population (15%) (t/d)	2.2	2.2	2.2	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.5	2.5	2.5
Total (t/d)	16.9	17.0	17.2	17.4	17.6	17.8	18.0	18.2	18.4	18.6	18.8	19.0	19.2	19.4
(Brakedown)	Dry waste (t/d)	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5
	Wet waste (t/d)	9.5	9.6	9.7	9.8	9.9	10.0	10.3	10.4	10.5	10.6	10.7	10.8	11.0
Collection ration (%) current/ target			89%				95%							100%
Collection amount (t/d)			15.3				17.1							19.4
(Brakedown)	Dry waste (t/d)		3.7				7.5							8.5
	Wet waste (t/d)		3.0				9.6							11.0
	Mix waste (t/d)		8.6				0.0							0.0

Source: JICA Survey Team

Waste flow in 2023 is shown in Figure 2-2-2.



Source: JICA Survey Team

Figure 2-2-2 Waste Flow of Phuntsholing Thromde in 2023

2-2-2-3-2 Preliminary Equipment Plan for Collection Equipment

(1) Calculation Method for Waste Collection Vehicles

The method used for calculating the quantity of waste collection vehicles is as shown in Section 2-2-2-2-2.

(2) Preliminary Output of Equipment

1) Waste Collection Vehicles

The number of compactors necessary for Phuntsholing Thromde is shown in Table 2-2-8.

Table 2-2-8 Calculation of Required Collection Vehicles in Phuntsholing

Collection amount in 2023 (t/d)		17.1 t/d	
		Dry waste	Wet waste
		7.5 t/d	9.6 t/d
Number of current compactors to be operated in 2023		2	
Collection amount to be collected by current compactors in 2023 (t/d)		5.6 t/d	
Amount to be collected by newly procured compactor by the Project in 2023 (t/d)	Total	11.5 t/d (= 17.1 t/d – 5.6 t/d)	
	Breakdown into Dry & Wet	5.0 t/d	6.5 t/d
Numbers of newly procured compactors in 2023	Total	5	
	Breakdown into vehicle types	8m ³	0
		4m ³	3

Note: 1. Ratio of dry waste and wet waste is estimated based on the waste composition.

2. Compactors are planned for each dry and wet waste separately.

Source: JICA Survey Team

2) Maintenance Tool

Phuntsholing Thromde needs one set of maintenance tool.

2-2-2-3-3 Preliminary Equipment Plan for Final Disposal Equipment

(1) Landfill Plan

The Pekarzhang Landfill Site in Phuntsholing Thromde will receive approximately 16.2 t/d of wastes in 2023. The operation plan of the landfill site is as follows:

- Operating hours of the site: 8 hours, from 9 am to 5 pm
- Working hours of the equipment: maximum 6 hours
- Cover soil: 10% of incoming waste (cover soil layer of 20 cm thick for each 2 m height of disposed waste)
- Landfill works should be carried out by moving/levelling and compaction of waste and covering soil, digging cover soil and transporting.

The work volumes of the landfill equipment are shown in Table 2-2-9.

Table 2-2-9 Required Work Volume of Landfill Equipment

Items	Unit	Plan in Landfill Site	Remark
a. Planned waste amount disposed	t/d	16.2	
b. Waste density before compaction	t/m ³	0.5	
c. Planned waste amount disposed before compaction	m ³ /d	32.4	= a/b
d. Estimated amount of cover soil	m ³ /d	3.2	= c x 10%
e. Required work volume			
e-1. Moving/levelling and compaction of waste & cover soil	m ³ /d	35.6	= c+d
e-2. Digging and transport cover soil	m ³ /d	3.2	= d

Source: JICA Survey Team

(2) Procurement Plan for New Landfill Equipment

Landfill equipment is selected considering the following factors:

- Pekarzhang Landfill Site is a small-scale with an expected disposal waste amount of 16.2 t/d (forecast in 2023). An excavator which can be used for compaction of waste and cover soil, digging cover soil and partial moving/ levelling of waste will be selected.

- Soil from inside the landfill site will be used as cover soil, and when the cover soil has to be transported from outside, dump truck should be rented.
- Former landfill area of Pekarzhang Landfill Site is scheduled to be rehabilitated by excavating the old waste accumulated at the site. New excavator should also be used for this rehabilitation works.
- At the Pekarzhang Landfill Site, waste is disposed by dropping the waste down from an upper level over a steep slope of the landfill site. Therefore, since there is a risk of landslide, it is necessary to apply a safe landfill method.

The type of landfill equipment was selected based on the design policy and planning conditions as shown in Table 2-2-10.

Table 2-2-10 Selection of Landfill Equipment

Target City	Planning Conditions			Landfill Equipment		
	Landfill Amount (m ³ /d)	Topographic	Landfill Site Capacity	Partial Moving/ Levelling of Waste Compaction of Waste and Cover Soil	Digging Cover Soil	Excavation of Waste at Old Landfill Area
Phuntsholing	35.6	Mountain slope	10 Years	Excavator		

Source: JICA Survey Team

Standard work volume of landfill equipment calculated based on Japanese guidelines:

b) Excavator

Standard work volume of excavator is calculated by the following formula:

$$Q = 3,600 \times q_0 \times K \times f \times E / C_m$$

Q: Standard work volume (m³/h), q₀: Bucket capacity (m³), K: Bucket coefficient (0.8), f: Conversion factor of soil (1.0/1.25), E: operation efficiency (0.8), C_m: Cycle time (83 and 32sec)

In case of 0.8 m³ of bucket capacity, the standard work volume is calculated as 17.8 and 41.0 m³/hour.

$$Q = 3,600 \times 0.8 \times 0.8 \times (1.0/1.25) \times 0.8 / 83 = 17.8 \text{ m}^3/\text{h}$$

$$Q = 3,600 \times 0.8 \times 0.8 \times (1.0/1.25) \times 0.8 / 32 = 41.0 \text{ m}^3/\text{h}$$

The operation condition of landfill equipment is shown in Table 2-2-11.

Table 2-2-11 Operation Condition of Landfill Equipment

Item	Required work volume (m ³ /d)	New excavator			
		Unit	Bucket (m ³)	Standard work volume (m ³ /h)	Operation time (hours)
Partial moving/ levelling of waste Compaction of waste and cover soil	35.6	1	0.8	17.8	2.0
Digging cover soil	3.2			41.0	0.1
Total	-	-	-	-	2.1

Source: JICA Survey Team

2-2-2-4 Preliminary Equipment Plan in Gelephu Thromde

2-2-2-4-1 Planning Concept

Planning concept for the waste collection vehicles and other equipment related to solid waste management in Gelephu Thromde is as follows:

- Target collection ratio in 2023 is set as 95%, as shown in the table below. In the year 2030, the target will be 100%.
- Compactor collection, applying door-to-door collection with bell system is a proper collection system for Gelephu Thromde. Dump truck collection system should be abolished because of its inefficiency in loading the waste.
- As waste separation at source into dry waste and wet waste is introduced in Gelephu Thromde, separate compactors should be used for each type of waste.
- Taking into account the narrow roads of the city center area of Gelephu Thromde, specification of

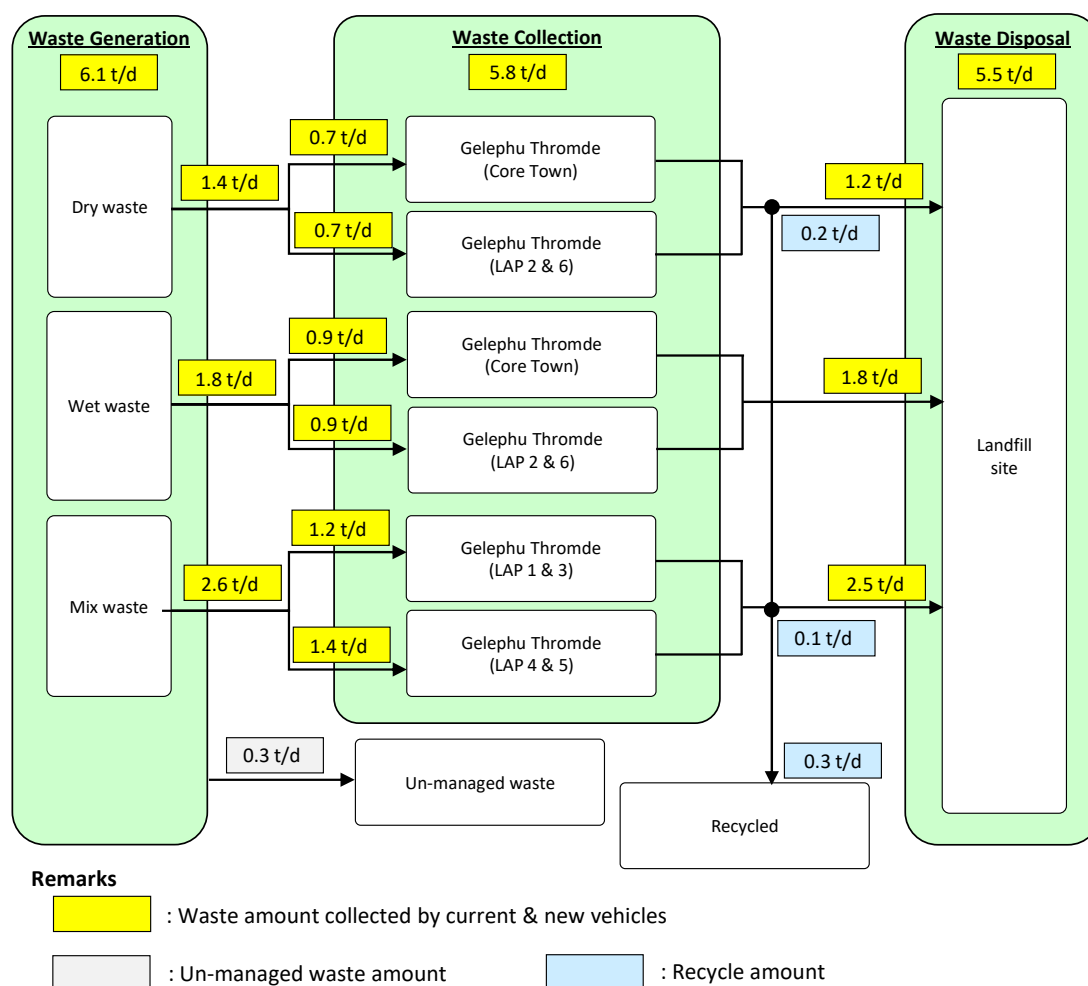
- the compactor should be a small class (4m³) type.
- Also, considering the working space limited by parking spaces on the sides of the main road of the city center of Gelephu Thromde, a small class compactor should be procured.
- In order to reduce the burden on the collection vehicles and to keep the proper operation period/years of the collection vehicles, working shifts should be limited to one shift, and the operation hours of each vehicle should be more or less 6 hours. In Gelephu Thromde, 1 trip/shift/day is applied to keep the current practice collection system.
- At the current garage of Gelephu Thromde, an additional building where spare parts and maintenance tools to be stored should be constructed. Alternatively, the current vehicle workshop contracted out to a private sector, which will be returned to Gelephu Thromde by the end of 2019, may be used as a garage. In this case, a place to store spare parts and maintenance tools should be constructed.
- In order to operate the Bhur Landfill Site properly, appropriate landfill equipment should be acquired.

Table 2-2-12 Target Collection Ratio and Amount of Waste to be Collected in 2023

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Population	9,858	9,876	9,894	9,911	9,929	9,947	9,965	9,983	10,001	10,019	10,037	10,055	10,073	10,091
Amount of waste generated (t/d)	5.2	5.2	5.2	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Amount of waste by floating population (15%) (t/d)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total (t/d)	6.0	6.0	6.0	6.0	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.2
(Brakedown)	Dry waste (t/d)	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.7
	Wet waste (t/d)	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.5	3.5	3.5	3.5
Collection ration (%) current/ target			90%				95%							100%
Collection amount (t/d)			5.4				5.8							6.2
(Brakedown)	Dry waste (t/d)			0.9			1.4							2.7
	Wet waste (t/d)			0.6			1.8							3.5
	Mix waste (t/d)			3.9			2.6							0.0

Source: JICA Survey Team

Waste flow in 2023 is shown in Figure 2-2-3.



Source: JICA Survey Team

Figure 2-2-3 Waste Flow of Gelephu Thromde in 2023

2-2-2-4-2 Preliminary Equipment Plan for Collection Equipment

(1) Calculation Method for Waste Collection Vehicles

The method used for calculating the quantity of waste collection vehicles is as shown in Section 2-2-2-2-2.

1) Waste Collection Vehicles

The number of compactors necessary for Gelephu Thromde is shown in Table 2-2-13.

Table 2-2-13 Calculation of Required Collection Vehicles in Gelephu

Collection amount in 2023 (t/d)		5.8 t/d	Dry	Wet
Breakdown into Areas	Core Town	1.6 t/d	0.7 t/d	0.9 t/d
	LAP 1 & 3	1.2 t/d	1.2 t/d (mix waste)	
	LAP 2 & 6	1.6 t/d	0.7 t/d	0.9 t/d
	LAP 4 & 5	1.4 t/d	1.4 t/d (mix waste)	
	Total		6 (4 new and 2 existing)	
Numbers of compactors required in 2023	Core Town	4 m ³	1	1
	LAP 1 & 3	7 m ³	1 (existing)	
	LAP 2 & 6	4 m ³	1	1
	LAP 4 & 5	7 m ³	1 (existing)	

Note: 1. Ratio of dry waste and wet waste is estimated based on the waste composition.

2. Compactor is planned for each dry and wet waste at Core Town and LAP2&6, respectively.

Source: JICA Survey Team

2) Maintenance Tool

Gelephu Thromde needs one set of maintenance tool.

2-2-2-4-3 Preliminary Equipment Plan for Final Disposal Equipment

(1) Landfill Plan

Bhur Landfill Site in Gelephu Thromde will receive approximately 5.5 t/d of wastes in 2023. The operation plan of the landfill site is as follows:

- Operating hours of the site: 8.5 hours, from 7:30 am to 4 pm
- Working hours of the equipment: maximum 6 hours
- Cover soil: 10% of incoming waste (cover soil layer of 20 cm thick for each 2 m height of disposed waste)
- Landfill works should be carried out by moving/levelling and compaction of waste and covering soil, digging cover soil and transporting.

The work volumes of the landfill equipment are shown in Table 2-2-14.

Table 2-2-14 Required Work Volume of Landfill Equipment

Items	Unit	Plan in Landfill Site	Remark
a. Planned waste amount disposed	t/d	5.5	
b. Waste density before compaction	t/m ³	0.5	
c. Planned waste amount disposed before compaction	m ³ /d	11.0	= a/b
d. Estimated amount of cover soil	m ³ /d	1.1	= c x 10%
e. Required work volume			
e-1. Moving/levelling and compaction of waste & cover soil	m ³ /d	12.1	= c+d
e-2. Digging and transport cover soil	m ³ /d	1.1	= d

Source: JICA Survey Team

(2) Procurement Plan for New Landfill Equipment

Landfill equipment is selected considering the following factors:

- Buar Landfill Site is a small-scale landfill site with an expected disposal waste amount of 5.5 t/d (forecast in 2023). The backhoe loader which can be used for moving/ levelling of waste and cover soil, digging cover soil, etc. will be selected.
- Since the backhoe loader cannot be used for compaction works, bulldozer should be rented regularly.
- In the rainy season, it is reported that the collection equipment cannot approach the landfill area, since the access road gets muddy. Therefore, in the rainy season, the access road should be treated with backhoe loader.
- At present, waste disposal is carried out at a flat land on the mountainside. In the future, it is recommended to use the current leachate control pond as the landfill area.

The type of the landfill equipment was selected based on the design policy and planning conditions as shown in Table 2-2-15.

Table 2-2-15 Selection of Landfill Equipment

Target City	Planning Conditions			Landfill Work Equipment		
	Landfill Amount (m ³ /d)	Topographic	Landfill Site Capacity	Moving/ Levelling of Waste and Cover Soil	Digging Cover Soil	Transportation of Cover Soil
Gelephu	12.1	Mountain slope	10 Years	Backhoe Loader		

Source: JICA Survey Team

Standard work volume of landfill equipment based on Japanese guidelines:

c) Backhoe Loader

Standard work volume of backhoe loader is calculated by the following formula:

$$Q = 3,600 \times q_0 \times K \times f \times E / C_m$$

Q: Standard work volume (m³/h), q₀: Bucket capacity (m³), K: Bucket coefficient (0.8), f: Conversion factor of soil (1.0/1.25), E: operation efficiency (0.8), C_m: Cycle time (83 and 173 sec)

In case of 0.8 m³ of bucket capacity, the standard work volume is calculated as 17.8 and 8.5m³/hour.

$$Q = 3,600 \times 0.8 \times 0.8 \times (1.0/1.25) \times 0.8 / 83 = 17.8 \text{ m}^3/\text{h}$$

$$Q = 3,600 \times 0.8 \times 0.8 \times (1.0/1.25) \times 0.8 / 173 = 8.5 \text{ m}^3/\text{h}$$

Operation condition of landfill equipment is shown in Table 2-2-16.

Table 2-2-16 Operation Condition of Landfill Equipment

Item	Required work volume (m ³ /d)	New excavator			
		Unit	Bucket capacity (m ³)	Standard work volume (m ³ /h)	Operation time (h)
Moving/ levelling of waste and cover soil	12.1	1	0.8	17.8	0.7
Digging cover soil and transportation	1.1			8.5	0.1
Total	-	-	-	-	0.8

Source: JICA Survey Team

2-2-2-5 Preliminary Equipment Plan in Samdrupjongkhar Thromde

2-2-2-5-1 Planning Concept

The planning concept for the waste collection vehicles and other equipment related to solid waste management in Samdrupjongkhar Thromde is as follows:

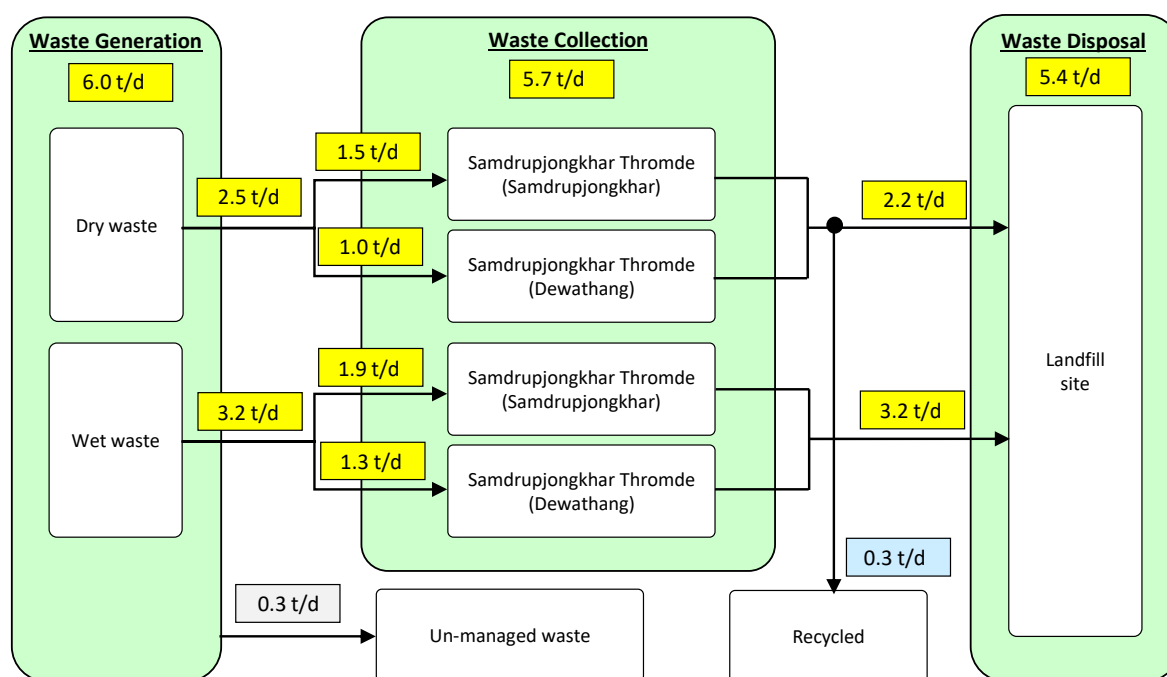
- Target collection ratio in 2023 is set as 95%, as shown in the table below. The target will be 100% by 2030.
- Compactor collection, applying door-to-door collection with bell system is a proper collection system for Samdrupjongkhar Thromde. The tractor collection system should be abolished because of its inefficiency in loading and transporting the waste.
- As waste separation at source into dry waste and wet waste is introduced in Samdrupjongkhar Thromde, compactors should be used exclusively for each type of waste.
- Taking into account the narrow roads of the city center area of Samdrupjongkhar and Dewathang, the specification of the compactor should be a small class (4m³) type.
- Also, considering the limited working space limited by parking spaces on the sides of the main roads of the city center of Samdrupjongkhar Thromde, a small class compactor should be procured.
- In order to reduce the burden on the collection vehicles and to keep the proper operation period/years of the collection vehicles, working shifts should be limited to one shift, and the operation hours of each vehicle should be more or less 6 hours. In Samdrupjongkhar area, 2 trips/shift/day is applied; in Dewathang area, 1 trip/shift/day is applied considering the long distance and mountainous area.
- The current vehicle workshop contracted out to a private sector will be returned to Samdrupjongkhar Thromde by the end of 2019, and it will be used as a garage and for storage.
- In order to operate the Tashipokto Landfill Site properly, adequacy of landfill equipment should be ensured.

Table 2-2-17 Target Collection Ratio and Amount of Waste to be Collected in 2023

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Population	9,325	9,415	9,505	9,596	9,688	9,781	9,875	9,970	10,066	10,162	10,260	10,358	10,458	10,558
Amount of waste generated (t/d)	4.9	5.0	5.0	5.1	5.1	5.2	5.2	5.3	5.3	5.4	5.4	5.5	5.5	5.6
Amount of waste by floating population (15%) (t/d)	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Total (t/d)	5.7	5.7	5.8	5.8	5.9	6.0	6.0	6.1	6.1	6.2	6.3	6.3	6.4	6.4
(Brakedown)	Dry waste (t/d)	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.7	2.7	2.7	2.8	2.8	2.8
	Wet waste (t/d)	3.2	3.2	3.3	3.3	3.3	3.4	3.4	3.5	3.5	3.5	3.6	3.6	3.6
Collection ration (%) current/ target				88%			95%							100%
Collection amount (t/d)				5.1			5.7							6.4
(Brakedown)	Dry waste (t/d)			3.6			2.5							2.8
	Wet waste (t/d)			1.3			3.2							3.6
	Mix waste (t/d)			0.2			0.0							0.0

Source: JICA Survey Team

Waste flow in 2023 is shown in Figure 2-2-4.



Remarks

- : Waste amount collected by current & new vehicles
- : Un-managed waste amount
- : Recycle amount

Source: JICA Survey Team

Figure 2-2-4 Waste Flow of Samdrupjongkhar Thromde in 2023

2-2-2-5-2 Preliminary Equipment Plan for Collection Equipment

(1) Calculation Method for Waste Collection Vehicles

The method used for calculating the quantity of waste collection vehicles is as shown in the previous section 2-2-2-2-2.

1) Waste Collection Vehicles

The number of compactor necessary for Samdrupjongkhar Thromde is shown in Table 2-2-18.

Table 2-2-18 Calculation of Required Collection Vehicles in Samdrupjongkhar

Collection amount in 2023 (t/d)		5.7 t/d	Dry	Wet
Breakdown into Areas	Samdrupjongkhar area	3.4 t/d	1.5 t/d	1.9 t/d
	Dewathang area	2.3 t/d	1.0 t/d	1.3 t/d
Numbers of compactors required in 2023	Total		4 (2 new and 2 existing)	
	Samdrupjongkhar area	4m ³	1 (existing)	1 (new)
	Dewathang area	4m ³	1 (existing)	1 (new)

Note: 1. Ratio of dry waste and wet waste is estimated based on the waste composition.

2. New compactor is planned for wet waste at Samdrupjongkhar area and Dewathang area, respectively.

Source: JICA Survey Team

2) Maintenance Tool

Samdrupjongkhar Thromde needs one set of maintenance tools.

2-2-2-5-3 Preliminary Equipment Plan for Final Disposal Equipment

(1) Landfill Plan

Tashipokto Landfill Site in Samdrupjongkhar Thromde will receive approximately 5.4 t/d of wastes in 2023. The operation plan of the landfill site is as follows:

- Operating hours of the site: 8 hours, from 9 am to 5 pm
- Working hours of the equipment: maximum 6 hours
- Cover soil: 10% of incoming wastes (cover soil layer of 20 cm thick for each 2 m height of disposed waste)
- Landfill works should be carried out by moving/levelling and compaction of waste and covering soil, digging cover soil and transporting.

The work volumes of the landfill equipment are shown in Table 2-2-19

Table 2-2-19 Required Work Volume of Heavy Equipment

Items	Unit	Plan in Landfill Site	Remark
a. Planned waste amount disposed	t/d	5.4	
b. Waste density before compaction	t/m ³	0.5	
c. Planned waste amount disposed before compaction	m ³ /d	10.8	= a/b
d. Estimated amount of cover soil	m ³ /d	1.1	= c x 10%
e. Required work volume			
e-1. Moving/levelling and compaction of waste & cover soil	m ³ /d	11.9	= c+d
e-2. Digging and transport cover soil	m ³ /d	1.1	= d

Source: JICA Survey Team

(2) Procurement Plan of New Landfill Equipment

Landfill equipment is selected considering the following factors:

- Tashipokto Landfill Site is a small-scale landfill site with an expected disposal waste amount of 5.4 t/d (forecast in 2023). The backhoe loader which can be used for moving/ levelling of waste and cover soil, digging cover soil etc. will be selected.
- Since the backhoe loader cannot be used for compaction works, a bulldozer should be rented regularly.
- In the rainy season, it is reported that the collection equipment cannot approach the landfill area, as the access road gets muddy. Therefore, in the rainy season, access road will be developed with backhoe loader.

- At Tashipokto Landfill Site, waste is disposed by dropping waste down from an upper level over a steep slope of the landfill site. Therefore, since there is a risk of landslide, it is necessary to change the landfill method to a safe method.

The type of the landfill equipment was selected based on the design policy and planning conditions as shown in Table 2-2-20.

Table 2-2-20 Selection of Landfill Equipment

Target City	Planning Conditions			Landfill Work Equipment		
	Landfill Amount (m ³ /d)	Topographic	Landfill Site Capacity	Moving/ Levelling of Waste and Cover Soil	Digging Cover Soil	Transportation of Cover Soil
Samdrupjongkhar	11.9	Mountain slope	10 Years	Backhoe Loader		

Source: JICA Survey Team

Standard work volume of landfill equipment based on Japanese guidelines:

d) Backhoe Loader

Standard work volume of backhoe loader is calculated by the following formula:

$$Q = 3,600 \times q_0 \times K \times f \times E / C_m$$

Q: Standard work volume (m³/h), q₀: Bucket capacity (m³), K: Bucket coefficient (0.8), f: Conversion factor of soil (1.0/1.25), E: operation efficiency (0.8), C_m: Cycle time (83 and 173 sec)

In case of 0.8 m³ of bucket capacity, the standard work volume is calculated as 17.8 and 8.5m³/hour.

$$Q = 3,600 \times 0.8 \times 0.8 \times (1.0/1.25) \times 0.8 / 83 = 17.8 \text{ m}^3/\text{h}$$

$$Q = 3,600 \times 0.8 \times 0.8 \times (1.0/1.25) \times 0.8 / 173 = 8.5 \text{ m}^3/\text{h}$$

Operation condition of the landfill equipment is shown in Table 2-2-21.

Table 2-2-21 Operation Condition of Landfill Equipment

Item	Required work volume (m ³ /d)	New excavator			
		Unit	Bucket capacity (m ³)	Standard work volume (m ³ /h)	Operation time (hours)
Moving/ levelling of waste and cover soil	11.9	1	0.8	17.8	0.7
Digging cover soil and transportation	1.1			8.5	0.1
Total	-	-	-	-	0.8

Source: JICA Survey Team

2-2-3 Outline Design

2-2-3-1 Thimphu Thromde

2-2-3-1-1 Technical Specification for Waste Collection Vehicles

The technical specifications of the 8m³ and 4m³ compactors, and 4m³ container carriers are, respectively, shown below.

(1) Medium Compactor (8 m³)

- Body capacity: 8m³ class
- Gross vehicle weight: 13 ton or more
- Engine: 240PS or more

(2) Small Compactor (4 m³)

- Body capacity: 4m³ class
- Gross vehicle weight: 7 ton or more
- Engine: 135PS or more

(3) Container Carrier (4 m³)

- Body capacity: 4m³ class
- Gross vehicle weight: 12 ton or more
- Engine: 240PS or more

2-2-3-1-2 Technical Specification for Landfill Equipment

The specifications of the equipment for the final disposal site to be procured by the Project shall be as shown below.

(1) Bulldozer

- Operating weight: 20 ton or more
- Engine: 200 HP or more

2-2-3-2 Phuntsholing Thromde

2-2-3-2-1 Technical Specification for Waste Collection Vehicles

The technical specification of the 4m³ compactor is shown below.

(1) Small Compactor (4 m³)

- Body capacity: 4m³ class
- Gross vehicle weight: 7 ton or more
- Engine: 135PS or more

2-2-3-2-2 Technical Specification for Landfill Equipment

The specifications of the equipment for the final disposal site to be procured by the Project shall be as shown below.

(1) Excavator

- Bucket capacity: 0.8m³
- Engine: 150 HP

2-2-3-3 Gelephu Thromde

2-2-3-3-1 Technical Specification for Waste Collection Vehicles

The technical specification of the 4m³ compactor is shown below.

(1) Small Compactor (4 m³)

- Body capacity: 4m³ class
- Gross vehicle weight: 7 ton or more
- Engine: 135PS or more

2-2-3-3-2 Technical Specification for Landfill Equipment

The specifications of the equipment for the final disposal site to be procured by the Project shall be as shown below.

(1) Backhoe Loader

- Bucket capacity: 0.8m³
- Engine: 90 HP

2-2-3-4 Samdrupjongkhar Thromde

2-2-3-4-1 Technical Specification for Waste Collection Vehicles

The technical specification of the 4m³ compactor is shown below.

(1) Small Compactor (4 m³)

- Body capacity: 4m³ class
- Gross vehicle weight: 7 ton or more
- Engine: 135PS or more

2-2-3-4-2 Technical Specification for Landfill Equipment

The specifications of the equipment for the final disposal site to be procured by the Project shall be as shown below.

(1) Backhoe Loader

- Bucket capacity: 0.8m³
- Engine: 90 HP

2-2-4 Implementation Plan

2-2-4-1 Implementation Policy

(1) Project Implementation Organizations

After conclusion of the Exchange of Notes (E/N) and Grant Agreement (G/A) on the grant aid cooperation of the Project, Bhutan shall select a consultant and a supplier and conclude contracts with them. After the completion of detailed design and bidding documents, a contract with a Japanese supplier selected by bidding will be concluded, and procurement of the equipment will be implemented.

1) Responsible Organization

The GNHC shall be the organization responsible for the implementation of the Project. It is necessary to establish a comprehensive management organization to ensure the smooth implementation of the Project, and close cooperation among the Japanese consultant, supplier, and the GNHC.

2) Implementing Organization

The implementing organization shall be the GNHC.

The operation and maintenance of the equipment of this Project shall be the responsibility of the cities of Thimphu, Phuntsholing, Gelephu and Samdrupjongkhar Thromdes. Each of the four cities needs to work in cooperation with the GNHC, Japanese consultant and the supplier.

NEC and MoWHS shall be advisory organizations of the Project.

(2) Consultant

The Japanese consultant shall conclude a contract with GNHC for the preparation of detailed designs and supervision of procurement in order to facilitate the procedure and management in this Project. The consultant shall prepare bid documents and coordinate the bidding on behalf of GNHC. The responsibilities of the consultant at each stage of the Project implementation are described below.

1) Detailed Designs

The consultant shall prepare detailed designs based on the outline design and prepare bid documents. The consultant shall also provide answers to technical questions on the contents of the bid documents and evaluate the technical proposals submitted by bidders.

2) Procurement Supervision

The consultant shall supervise the procurement of the equipment. The consultant shall inspect procured equipment in terms of quality, functions, quantities and damage on the exterior surface caused during

the transportation. If defect is found during the inspection, the consultant shall prepare a report on the defect immediately, and parties concerned shall have discussions on how to address the issue.

(3) Supplier

A Japanese company will be selected by the Bhutan side as the supplier of this Project in a general open bid implemented in accordance with the scheme of the grant aid program of Japan. Sufficient attention shall be paid to the communication and coordination with the counterpart after the handover of the equipment concerned as after-sales services such as provision of spare parts and responses to malfunctions will be required.

2-2-4-2 Implementation Conditions

(1) Initial Operation Guidance to Bhutan Side

Engineers from the manufactures of the equipment shall provide initial operation guidance to Bhutan staff (operators and mechanics) to transfer technologies concerning the procured equipment after the delivery.

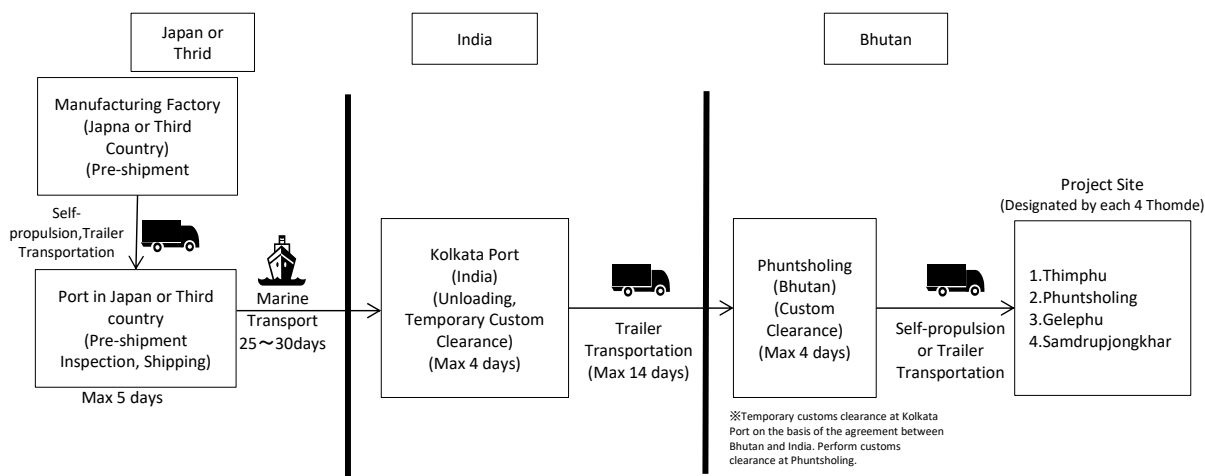
(2) Exemption of Customs Duties and Taxes

Bhutan shall take actions required for tax exemption (including Green Tax) on equipment to be procured by this Project. However, the supplier shall monitor the progress of the tax exemption application, so that any delay in the process would not result in extension of the Project period.

(3) Transportation Plan

Transportation of equipment from production country to the main port of India (Kolkata Port) is basically planned using RO-RO (roll-on/roll-off) ship by maritime transport. The transportation period is assumed to be maximum 60 days from production country to Bhutan including customs clearance at Phuntsholing Thromde.

The equipment will be transported first from Kolkata Port to Phuntsholing by trailers. Then the equipment will be transported from Phuntsholing to the other three cities again by trailers. However, self-propulsion will be considered, considering the road conditions (mostly in rainy season and winter).



Source: JICA Survey Team

Figure 2-2-5 Equipment Transportation Plan

(4) Bidding Package of the Project

The bidding will be conducted in one package including the whole equipment for the following reasons:

- Multiple packages or lots in bidding will increase procedure and risk of stagnation, and will reduce scale-merit for the bidders.
- One-package lot will be simpler and smoother in procedure.

- It will be better to manage and coordinate customs clearance and transportation of various kinds of equipment to each of the 4 cities by one supplier.

2-2-4-3 Consultant Supervision

The consultant shall prepare the detailed design, support the bidding, and supervise the procurement in compliance with the scheme of the grant aid of the Government of Japan. The consultant shall dispatch engineers specialized in various stages in accordance with the progress of the procedure. The issues requiring special attention in the consultant supervision are as follows.

(1) Monitoring of Progress

The consultant will supervise the supplier to ensure the completion of the work by the day stipulated in the contract and monitor the progress of the Project. When delay in the progress of work is found, the consultant will report the delay, and draw the attention of the supplier to the delay and request submission of a plan of countermeasures and their implementation.

(2) Quality and Quantity Control

The consultant will inspect the equipment to be procured to confirm if it meets the quality and quantities stipulated in the contract documents using the following methods:

- i) Inspecting the drawings and specifications of the equipment
- ii) Inspecting the shop or verifying the commissioned shop inspection results
- iii) Checking initial operation guidance and operation and maintenance guidance of the supplier

If the verification reveals any variation in the quality or quantity of the manufactured equipment, the consultant will request the supplier to correct, replace or repair it.

(3) Basic Policy for Consultant Supervision

A large quantity of equipment will be procured. Therefore, the consultant will examine the transportation period and necessary permissions/licenses. The consultant will also inspect the equipment, which is to be procured from various places, to confirm that it meets the required specifications.

2-2-4-4 Quality Control Plan

The quality control shall be implemented simultaneously with the consultant supervision mentioned above. The consultant shall verify whether the manufactured and delivered equipment satisfy the qualities and specifications specified in the contract documents.

(1) Schedule Management

The consultant will confirm the progress based on the report of the supplier, and issue a warning on compliance with the schedule if necessary. The procurement schedule management will be as follows:

- Considering the period required for the grant aid system and the period necessary for the production of the equipment, a guideline procurement schedule will be prepared. The schedule will be presented with the bid documents. The consultant will check whether the schedule submitted by the supplier with the bidding is adequate or not.
- The consultant will compare the actual progress reported by the supplier and the original schedule.
- The consultant will warn and advise the supplier to take countermeasures to catch up the original schedule in case of delay.

(2) Quality Management

Basically, quality of equipment should be secured in the production factory by the manufacturer. The quality management of the consultant will be as follows:

- The consultant will confirm that the specifications of the basic design are stipulated in the bid document.
- The consultant will check if the equipment proposed by the supplier satisfies the specifications

- stipulated in the bid documents in bidding.
- The consultant will confirm the details to the supplier if necessary.
 - The consultant will confirm the quality of the equipment through reviewing the supplier's report and pre-shipping inspection at factory. The consultant will instruct the supplier to take remedy measures if necessary.

2-2-4-5 Procurement Plan

The country of procurement and the country of origin of the equipment are as follows.

Table 2-2-22 Country of Origin of the Equipment to be Procured

No.	Item	Country of Procurement			Country of Origin		
		Japan	Bhutan	Third Country	Japan	Bhutan	Third Country
1-1	Small Compactor	○			○		
1-2	Medium Compactor	○			○		
1-3	Container Carrier	○			○		
2-1	Bulldozer			○			○
2-2	Excavator	○			○		
2-3	Backhoe Loader			○			○
1-4	Container	○			○		
3	Maintenances Tool	○			○		

Source: JICA Survey Team

2-2-4-6 Operational Guidance Plan

(1) Initial Operation Guidance Plan

For delivery of equipment, it is necessary to provide guidance to the four cities on handling and maintenance. The guidance is planned to be carried out by a vehicle manufacturer engineer (1 person) and a heavy equipment manufacturer engineer (1 person). The number of days required for this guidance will be decided based on the model and area that are assumed at the time of integration. Initial operation guidance will be given to the four target cities considering efficiency. Table 2-2-23 shows the personnel plan.

Table 2-2-23 Plan for Initial Operation Guidance and Operation/Maintenance Guidance

Target City	Target Equipment	Location	Workday (vehicle x1, equipment x1)	Driver	Mechanic
Thimphu	Waste Collection Equipment: 20 Units Landfill Equipment: 1 Units	Thimphu	6 days x2	±40	±6
Phuntsholing,	Waste Collection Equipment: 5 Units Landfill Equipment: 1 Units	Phuntsholing	4 days x2	±20	±4
Gelephu	Waste Collection Equipment: 4 Units Landfill Equipment 1 Units	Gelephu	4 days x2	±10	±2
Samdrupjongkhar	Waste Collection Equipment: 2 Units Landfill Equipment: 1 Units	Samdrupjon gkhar	4 days x2	±10	±2

Source: JICA Survey Team

(2) Operation and Maintenance Guidance Plan

Following the initial operation guidance, the supplier will implement operation and maintenance guidance for the staff and engineers of the Bhutan side.

After completing the initial operation guidance and operation and maintenance guidance, the supplier submits the final report to the consultant. If the content of the report is confirmed by the Bhutan side and the consultant, the consultant will issue a technical completion certificate to the supplier with approval from the Bhutan side.

2-2-4-7 Soft Component Plan

2-2-4-7-1 Background

Even if the four target cities of the Project (i.e., Thimphu, Phuntsholing, Geleph and Samdrupjongkhar) try to improve the solid waste management, shortage of collection equipment will remain one of the serious issues.

In order to manage and operate the collection equipment properly in the four target cities, equipment operation and maintenance system should be strengthened in terms of organization, human resources and technology. Meanwhile, it is noted that the current equipment operation and maintenance situation, issues and needs for assistance vary among the four cities.

In this Project, procurement of required number of collection equipment and landfill equipment will be implemented. Currently, even though the basic measures for operation and maintenance have been taken by each city, further improvement and strengthening is necessary.

Considering the above conditions, proper and steady operation and maintenance is indispensable in order to operate the equipment to be procured by the Project for a long time. Without such measures, the equipment would stop their operation in a short time, before the expected lifetime. Therefore, technical assistance or “soft component” will be proposed to support the building of suitable operation and maintenance system in the cities.

2-2-4-7-2 Objective of the Soft Component

The objective of the Project is to provide proper waste management services to the citizens in the target four cities. Based on this understanding, the purpose of the soft component of this Project is to secure the sustainability of the Project through the improvement of the waste management capacity of each city, i.e., providing proper waste collection services in line with the source separation and implementing safe and proper landfill works over a long time.

2-2-4-7-3 Outputs of the Soft Component

The output of the soft component is composed of the following four items:

Output-1: Operation and maintenance skills of waste management equipment are improved.

Output-2: Waste collection and landfill method is improved.

Output-3: Awareness on the source separation of the residents is raised.

Output-4: Awareness on the occupational safety and health of the city government officials in charge of the solid waste management is raised.

2-2-4-7-4 Activities of the Soft Component

The initial guidance to be provided by manufactures of the equipment will focus on the basic operation of the procured equipment only. The soft component will cover the following components, which are not included in the above initial guidance:

1. Support for Preventive Maintenance: Preparing of a rule for the preventive maintenance that drivers should follow to carry out daily maintenance etc. to prevent a serious breakdown of equipment.
2. Support for Repair Management System: Instruction on the improvement of the system for checking the equipment repair and repair contents.
3. Support for Spare Parts Management System: Instruction on the improvement of the system for storage and management of spare parts and consumable stores.
4. Support for Improving Waste Collection and Landfilling Method: Support for review/revision of the current waste collection system, such as door-to-door collection, fixed time & collection

locations, by utilizing procured equipment of the Project; Support for introduction of safe landfill method by utilizing procured equipment of the Project.

5. Support for Awareness Raising on Solid Waste Management: Support for the training of the trainers of municipal officials on the citizen's awareness for source separation; Dissemination of practices carried out by JICA's grass root project at Thimphu Thromde to other three target cities.
6. Support for Operation Safety and Sanitation: Provision of safety guidance on the operation and sanitation to the equipment operators and workers to prevent serious accidents that the procured equipment might cause during operation.

2-2-4-7-5 Method for Achievement of the Outcomes

The methods to verify the achievement of the outcomes for each activity are shown in the table below.

Table 2-2-24 Methods to Verify Achievement of Outcomes

Activities		Outcome	Index	Measurement
1-1	Support for Preventive Maintenance	Daily inspection and periodical inspection will be improved and implemented thoroughly.	<ul style="list-style-type: none"> • Instruction paper on preventive maintenance will be prepared. • Seminar will be held for understanding and consensus. 	<ul style="list-style-type: none"> • Instruction paper (for 4 cities) • Record of seminar
1-2	Support for Repair Management System	Repair management system will be improved with guideline.	<ul style="list-style-type: none"> • Instruction paper on improved repair management system will be prepared. • Seminar will be held for understanding and consensus. 	<ul style="list-style-type: none"> • Instruction paper (for 4 cities) • Record of seminar
1-3	Support for Spare Parts Management System	Spare parts and consumables management system will be improved.	<ul style="list-style-type: none"> • Instruction paper on improved spare parts and consumables management system will be prepared. • Seminar will be held for understanding and consensus. 	<ul style="list-style-type: none"> • Instruction paper (for 4 cities) • Record of seminar
2	Support for Improving Waste Collection / Transportation and Landfilling Method	Waste collection services based on source separation will be improved. The landfilling method will be improved.	<ul style="list-style-type: none"> • Current waste collection and transportation plan will be improved. • Plan on the landfilling improvement method will be prepared 	<ul style="list-style-type: none"> • Modified waste collection and transportation plan • Improvement plan for landfilling
3	Support for Awareness Raising on Solid Waste Management	Resident's awareness on source separation will be improved. Awareness raising capacity of the trainers on source separation will be fostered.	<ul style="list-style-type: none"> • Seminars for city staffs on the implementation method of awareness raising will be implemented. • Seminars for residents and/or communities on source separation will be planned and implemented. 	<ul style="list-style-type: none"> • Activity plan for awareness raising • Record of the seminars • Result for questionnaire to the participants of the seminars
4	Support for Operation Safety and Sanitation	Waste collection will be carried out safely and sanitary with instruction and education on operation safety and sanitation.	<ul style="list-style-type: none"> • Instruction paper on operation safety and sanitation will be prepared. • Seminar will be held for understanding and consensus. 	<ul style="list-style-type: none"> • Instruction paper • Record of seminar

Source: JICA Survey Team

2-2-4-7-6 Products of the Soft Component

The consultants of the soft component shall submit the products mentioned in the table below to the implementing organizations and JICA.

Table 2-2-25 List of Products

Activities		Products
Overall		Soft Component Completion Report
1-1	Support for Preventive Maintenance	Instruction paper on preventive maintenance
1-2	Support for Repair Management System	Instruction paper on improved repair management system
1-3	Support for Spare Parts Management System	Instruction paper on improved spare parts and consumables management system
2	Support for Improving Waste Collection and Landfilling Method	Modified waste collection / transportation plan and Landfilling method
3	Support for Awareness Raising on Solid Waste Management	Environment education materials Activity plan for awareness raising
4	Support for Operation Safety and Sanitation	Instruction paper on operation safety and sanitation planning
Total	Progress reporting Completion reporting	Soft component progress report Soft component completion report

Source: JICA Survey Team

2-2-4-7-7 Responsibility of the Bhutan Side

GNHC, as an executing agency, should appoint a person in charge of the soft component, and the person should manage the whole scheme of the soft component. The target 4 cities should appoint a person in charge of the activities shown in the following table, and carry out the soft component together with the Japanese experts.

Table 2-2-26 Person in Charge of Bhutan side

Activity	Person in charge
Activity 1	Operation and maintenance of equipment
Activity 2	Collection and disposal
Activity 3	Citizen awareness raising
Activity 4	Operation safety and sanitation

2-2-4-7-8 Implementation Schedule of Soft Component (tentative)

In the first fieldwork, assistance shall be provided for strengthening the institutional O/M system leading to sustainable O/M, and for strengthening technical O/M system of the 4 cities after handing-over of the equipment. At the beginning of the first field survey, a workshop will be held for explanation and discussion on the improvement of the O/M system at Thimphu Thromde. The trial improvement for the 4 cities will be carried out by the consultant with local assistants for one month. In the second fieldwork, the results of the trial will be reviewed and the problems will be analyzed. Based on the monitoring, the instruction paper will be reviewed and finalized. At the end of the second fieldwork, a workshop will be held to explain and discuss about the sustainable O/M system in Thimphu Thromde.

The tentative Project implementation schedule is shown in the table below.

Table 2-2-27 Tentative Project Implementation Schedule

Item	2021 Year			2022 Year		
	October	November	December	January	February	March
Handover of the equipment						
Initial Operation Guidance and Operation/Maintenance Guidance						
4 Thromde Taking-over Certificate						
Soft Component						
Improvement of Effective Utilization and Maintenance for the Equipments						
Domestic survey						
Field survey						
Local staff Employment period						
Environment Education / Improvement of Labor Safety and Sanitation Management						
Domestic survey						
Field survey						
Local staff Employment period						
Report						
				Progress Report		Final Report

Source: JICA Survey Team

2-2-4-8 Implementation Schedule

The tentative Project implementation schedule is shown in the following table.

Table 2-2-28 Tentative Project Implementation Schedule

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Contract	Exchange of Notes (E/N), Grant Agreement (G/A)																							
	Consultant Agreement																							
Detailed design, Bid documents, Bidding procedure	Work in Bhutan																							
	Detailed design, Bid documents preparation in Japan																							
	Bid Documents Approval																							
	Bid Notice																							
	Bidding																							
	Opening of Bid																							
	Bid Evaluation																							
	Contract of Supplier																							
Procurement works	Production drawing creation, approval																							
	Equipment production, procurement																							
	Transportation, Delivery																							
	Hand-over, Inspection, OJT(Initial operation guidance)																							

Source: JICA Survey Team

2-3 Security Plan

2-3-1 Condition of Inter-city Road

Bhutan is located in the southeastern part of Himalayas and its elevation is between 100 m and 7,500 m (mountain peak). Therefore, Bhutan does not have large flat areas. Thimphu Thromde (elevation of 2,300 m) is located in the middle-west part of Bhutan, and the other three cities, i.e. Phuntsholing (elevation of 300 m), Gelephu (elevation of 220 m), and Samdrupjongkhar (elevation of 170 m), are located in the southern part of Bhutan, which is adjacent to India.

Most of the inter-city roads in Bhutan are mountainous. The east-west road between Thimphu and Trashigang (located at the east end of Bhutan) passes over several mountains with height of approx. 3,500 m. Although the road is only approx. 200 km, it takes approx. two days. Meanwhile, the inter-city roads between the north and south areas, such as the roads between Thimphu and Phuntsholing, Trongsa (located in the central area of Bhutan) and Gelephu, Trashigang and Samdrupjongkhar, have an elevation difference of approx. 3,000 m, and their longitudinal section is precipitous.

The inter-city road between Thimphu and Phuntsholing is one of the main and relatively well-developed

roads in Bhutan. However, during the rainy season, from June to September, landslide sometimes occurs and blocks the road. Therefore, as a safety measure, this Project will avoid using this road during the rainy season.

Meanwhile, this Project will use Indian roads throughout the year for transporting the equipment to Geleph and Samdrupjongkhar Thromdes via Phuntsholing because of their good topographical and road conditions.

2-3-2 Security Issues in India

It is necessary to pass through the immigration when crossing the border between Bhutan and India. Phuntsholing, Geleph and Samdrupjongkhar Thromdes are all border cities adjacent to India, and immigration offices of both countries exist at the country border nearby each city. The JICA survey team traveled to Geleph Thromde and Samdrupjongkhar Thromde via India and observed that immigration process in both country was smooth. However, the team was informed by Samdrupjongkhar Thromde that the Bhutan immigration office located at Samdrupjongkhar Thromde sometimes closes for the security issues on the Indian side, such as demonstration. Therefore, the security situation in India and closure of immigration office at Samdrupjongkhar Thromde should be checked from time to time.

2-3-3 Dengue Fever and Hydrophobia

The spread of dengue fever has been observed in the southern part of Bhutan, including Phuntsholing, Geleph and Samdrupjongkhar Thromdes. Therefore, necessary measures, such as getting a vaccination and getting rid of mosquitoes, will be taken.

Moreover, because of the national animal protection policy of Bhutan, there are many stray dogs in the country. It is noted that they are active mainly in the nighttime. Measures in this regard, such as getting vaccination, keeping away from dogs, and getting first-aid services in case bitten by a dog, will be taken.

2-4 Obligations of Recipient Country

2-4-1 Major Undertakings to be taken by Each Side

Major undertakings of each side are shown in the following table.

Table 2-4-1 Major Undertakings of Each Side

Stage	Procedures	Remarks	Recipient Government	Japanese Government	JICA	Consultants	Contractors	Agent Bank
Official Request	Request for grants through diplomatic channel	Request shall be submitted before appraisal stage.	x	x				
1. Preparation	(1) Preparatory Survey Preparation of outline design and cost estimate	—	x		x	x		
2. Appraisal	(2)Preparatory Survey Explanation of draft outline design, including cost estimate, undertakings, etc.		x		x	x		
	(3)Agreement on conditions for implementation	Conditions will be explained with the draft notes (E/N) and Grant Agreement (G/A) which will be signed before approval by Japanese government.	x	x (E/N)	x (G/A)			
	(4) Approval by the Japanese Cabinet	—		x				
	(5) Exchange of Notes (E/N)		x	x				

Stage	Procedures	Remarks	Recipient Government	Japanese Government	JICA	Consultants	Contractors	Agent Bank
3. Implementation	(6) Signing of Grant Agreement (G/A)		x		x			
	(7) Banking Arrangement (B/A)	Need to be informed to JICA	x					x
	(8) Contracting with consultant and issuance of Authorization to Pay (A/P)	Concurrence by JICA is required	x			x		x
	(9) Detail design (D/D)	—	x			x		
	(10) Preparation of bidding documents	Concurrence by JICA is required	x			x		
	(11) Bidding	Concurrence by JICA is required	x		—	x	x	
	(12) Contracting with contractor/supplier and issuance of A/P	Concurrence by JICA is required	x				x	x
	(13) Construction works/procurement	Concurrence by JICA is required for major modification of design and amendment of contracts.	x			x	x	
	(14) Completion certificate	—	x			x	x	
4. Ex-post monitoring & evaluation	(15) Ex-post monitoring	To be implemented generally after 1, 3, 10 years of completion, and subject to change	x		x			
	(16) Ex-post evaluation	To be implemented basically after 3 years of completion	x		x			

Notes:

1. Project Monitoring Report and Report for Project Completion shall be submitted to JICA as agreed in the G/A.
2. Concurrence by JICA is required for allocation of grant for remaining amount and/or contingencies as agreed in the G/A.

2-4-2 Other Major Undertakings to be taken by Bhutan Side

2-4-2-1 Procedure for Banking Arrangement and Authorization to Pay

Bhutan side should take necessary procedures for issuance of A/P (Authorization to Pay) required for payments to the Japanese consultant and supplier, and for bearing the following commissions to a bank in Japan for the banking services based upon the banking arrangement at the time of commencement of the Project:

- Advising commission of A/P
- Payment commission

2-4-2-2 Tax and Customs Duty Exemption of the Equipment

Bhutan side shall be responsible for tax and customs duty exemption including Green Tax for motor vehicles (not including heavy equipment such as bulldozer, excavator and backhoe loader).

Regarding the Green Tax on the vehicles, each of the target four cities shall secure the necessary fund in its 2021 fiscal year budget.

2-4-2-3 Allocation of Necessary Budget and Manpower for Operation of the Equipment

Bhutan side should secure and allocate necessary budget, manpower, space for the proper operation, and maintenance of the equipment immediately.

The equipment of the Project shall be operated and maintained properly for a long-term service.

Thimphu Thromde shall prepare four drop-in centers by 2020, including the existing one.

2-4-2-4 Provision of Proper Parking Spaces for Equipment

Bhutan side shall secure (construct or allocate) parking spaces for the equipment in each of the 4 cities for proper operation and maintenance.

2-4-2-5 Submission of Project Monitoring Report and Project Completion Report to JICA

Bhutan side shall submit the Project monitoring report and the Project completion report to JICA according to the Minutes of Discussions.

2-4-2-6 Securing Green Tax Budget

Each city should bear the Green Tax on equipment to be procured by Japan's Grant Aid; accordingly, the budget for green tax needs to be secured in 2021 fiscal year by each city.

2-4-2-7 Major undertakings of the Government of Bhutan

Major undertakings of the Government of Bhutan confirmed in the M/D are as shown below.

(1) Specific obligations of the Government of Bhutan which will not be funded by the Grant

1) Before the Tender

NO	Items	Deadline	In charge	Estimated Cost
1	To sign the banking arrangement (B/A) with a bank in Japan (the Agent Bank) to open bank account for the Grant	within 1 month after the signing of the G/A	GNHC	
2	To issue A/P to the Agent Bank for the payment to the consultant	within 1 month after the signing of the contract(s)	GNHC	
3	To bear the following commissions to the Agent Bank for the banking services based upon B/A:			
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)	GNHC	
	2) Payment commission for A/P	every payment	GNHC	
4	To secure and clear the following space	before notice of the bidding documents	4 Thromdes	
	1) Storage space for equipment to be procured			
5	To submit Project Monitoring Report (with the result of Detailed Design)	before preparation of the bidding documents	GNHC/ 4 Thromdes	

2) During the Project Implementation

NO	Items	Deadline	In charge	Estimated Cost
1	To issue A/P to the Agent Bank for the payment to the supplier and the contractor	within 1 month after the signing of the contract(s)	GNHC	as necessary
2	To bear the following commissions to the Agent Bank for the banking services based upon the B/A			
	1) Advising commission of A/P	within 1 month after the signing of the contract(s)	GNHC	
	2) Payment commission for A/P	every payment	GNHC	

NO	Items	Deadline	In charge	Estimated Cost
3	To ensure prompt customs clearance and to assist the Supplier(s) with internal transportation in the country of the Recipient	during the Project	GNHC	
4	To accord Japanese physical persons and/or physical persons of third countries whose services may be required in connection with the supply of the products and the services such facilities as may be necessary for their entry into the country of the Recipient and stay therein for the performance of their work	during the Project	GNHC	
5	To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the products and/or the service be exempted	during the Project	GNHC	
6	To bear all the expenses, other than those covered by the Grant, necessary for the implementation of the Project	during the Project	GNHC	
7	1) To submit Project Monitoring Report after each work under the contract(s) such as shipping, hand over, installation and operational training	within 1 month after completion of each work	GNHC/ 4 Thromdes	
	2) To submit Project Monitoring Report (final) (including as-built drawings, equipment list, photographs, etc.)	within 1 month after issuance of Certificate of Completion for the works under the contract(s)	GNHC/ 4 Thromdes	
8	To submit a report concerning completion of the Project	within 6 months after completion of the Project	GNHC/ 4 Thromdes	

3) After the Project

NO	Items	Deadline	In charge	Estimated Cost
1	To maintain and use properly and effectively the facilities constructed and equipment provided under the Grant Aid 1) Allocation of maintenance cost 2) Operation and maintenance structure 3) Routine check/Periodic inspection	After completion of the construction	GNHC/ 4 Thromdes	

(2) Other obligations of the Government of Bhutan funded with the Grant

NO	Items	Deadline	Amount (Million Japanese Yen)*
1	To provide equipment 1) To conduct the following transportation a) Marine transportation of the products from Japan to the country of the Recipient b) Internal transportation from the port of disembarkation to the Project site		
2	To implement detailed design, bidding support and procurement supervision (Consulting Service)		
	Total		

* The Amount is provisional. This is subject to the approval of the Government of Japan.

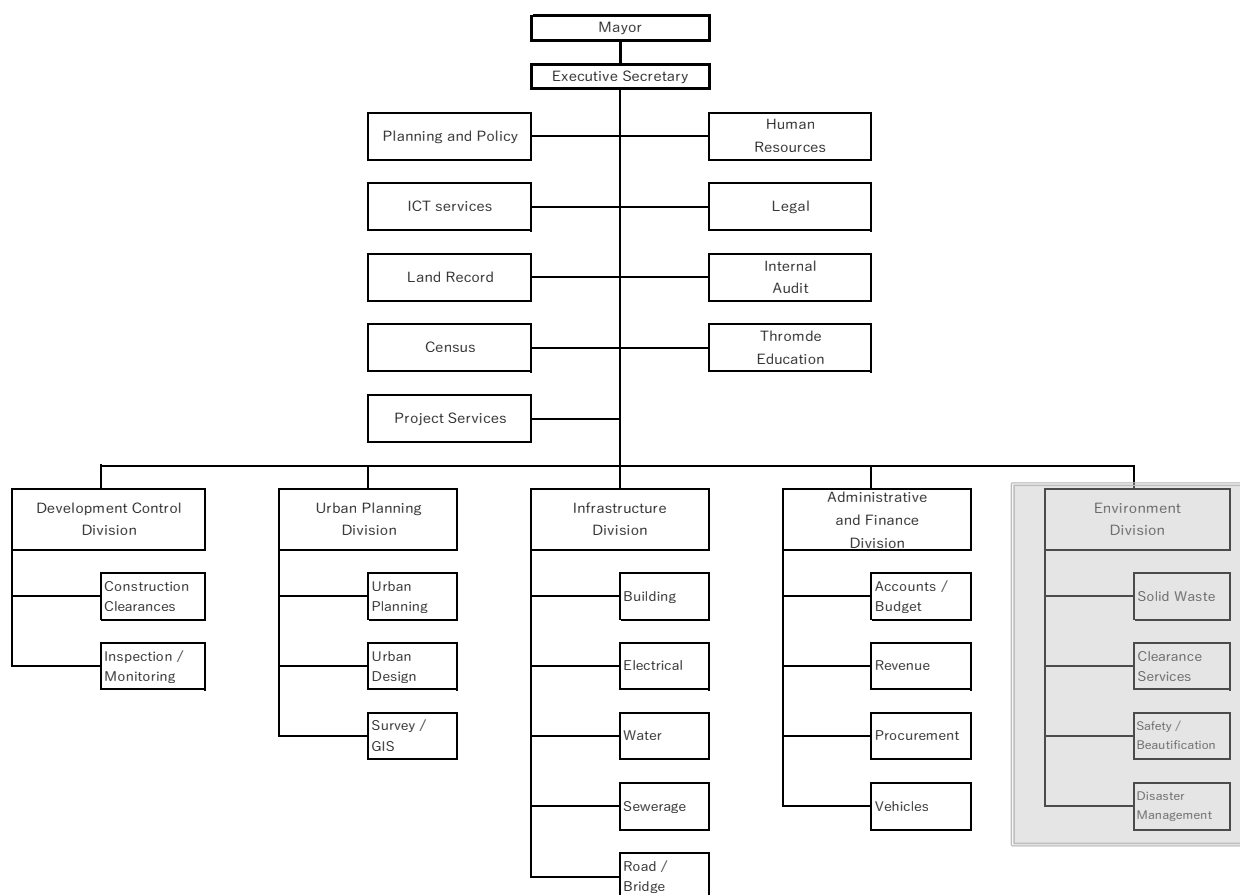
2-5 Project Operation Plan

2-5-1 Present Operation and Maintenance Condition

2-5-1-1 Thimphu Thromde

2-5-1-1-1 Operation and Maintenance

Thimphu Thromde shall be responsible for the management and operation of the equipment to be provided by the Project, and it shall function as a main counterpart of the JICA survey team for the Project. The organogram of Thimphu Thromde is shown in Figure 2-5-1 below.



Source: Thimphu Thromde

Figure 2-5-1 Organogram of Thimphu Thromde

Thimphu Thromde has consigned the collection of solid waste to two private companies, which are Greener Way and Clean City. Thimphu Thromde has also been implementing the collection of solid waste in some parts of the city by itself.

(1) Thimphu Thromde

Thimphu Thromde has human resources listed below for the solid waste management.

Table 2-5-1 Human Resources of Environmental Division in Thimphu Thromde

Position	Number of personnel
Environmental Officer	1
Sanitary Inspector	9
Senior Technician	1
Site Supervisor	2
Landfill Worker	7
Labor (mainly for sweeping road)	87

Source: Thimphu Thromde

The drivers and cleaners involved in the solid waste management belong to Administrative and Finance Division.

Table 2-5-2 Human Resources for Solid Waste Management of Administrative and Finance Division in Thimphu Thromde

Position	Number of personnel
Driver for solid waste collection	6
Cleaner	6

Source: Thimphu Thromde

Since three compactors and three tractors are currently operating in Thimphu Thromde, Thimphu employs 6 drivers and 6 cleaners. All drivers took the training for vehicle maintenance for one month, and as a result, they can implement simple maintenance of vehicle including daily check by themselves. In case of serious breakdown of vehicles, it outsources the maintenance works to the private repair company which it has concluded a contract with for the year or dealers of each vehicle.

(2) Greener Way

Greener Way is a private company, which has concluded a contract with Thimphu Thromde for solid waste management. Greener Way employs about seventy to eighty staff, including twenty-five drivers and two mechanics. There are at least two cleaners on each collection vehicle.

Greener Way is operating thirteen vehicles, including three vehicles under maintenance. The breakdown of its vehicles is listed as shown below.

Table 2-5-3 Vehicles Operated by Greener Way

Type of Vehicle	Owner	Conditions	Number
Compactor	Thimphu Thromde	Operating	4
		Under Maintenance	1
	Greener Way	Operating	2
Others	Thimphu Thromde	Under Maintenance	1
	Greener Way	Operating	4
		Under Maintenance	1
Sub-Total	Thimphu Thromde	Operating	4
		Under Maintenance	2
	Greener Way	Operating	6
		Under Maintenance	1
Total			13

Source: Thimphu Thromde

The number of drivers is enough for operating the vehicles. Two mechanics implement simple maintenance of vehicles including daily checks, and other repair and maintenance works are outsourced to the private repair company.

(3) Clean City

Clean City is a private company, which has concluded a contract with Thimphu Thromde for solid waste management. Clean City employs thirty staff. The breakdown of its staff is listed in the following table.

Table 2-5-4 Staff of Clean City

Position	Number of personnel
Office Staff	4
Driver	5
Cleaner	10
Segregator	11

Source: Thimphu Thromde

Clean City is operating five vehicles, including two vehicles under maintenance. The breakdown of its vehicles is listed in the following table.

Table 2-5-5 Vehicles Operated by Clean City

Type of Vehicle	Owner	Conditions	Number
Compactor	Thimphu Thromde	Operating	3
		Under Maintenance	1
Others	Thimphu Thromde	Operating	1
Sub-Total	Thimphu Thromde	Operating	4
		Under Maintenance	1
Total			5

Source: Thimphu Thromde

The number of drivers and cleaners corresponds to the number of operated vehicles in Clean City. Drivers implement daily maintenance, and other repair and maintenance works are outsourced to the private repair company.

2-5-1-1-2 Finance Condition

The financial condition of Thimphu Thromde is shown in the table below.

Table 2-5-6 Financial Condition of Thimphu Thromde

(Unit: mil BTN)	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Revenue	84.750	86.676	113.871	109.431	227.076
Subsidy and other income from central government	222.345	361.615	355.107	No information	No information
Expenditure (Budget Base)	251.880	249.000	302.043	453.000	653.546

Source: Revenue and Expenditure: Thimphu Thromde

Subsidy and the other income from central government: Ministry of Finance, Bhutan

The revenue of Thimphu Thromde mainly comes from tax collection. The personnel expenses, labor cost, consignment expenses and maintenance cost of equipment are scraped up from this revenue and the income from central government including subsidy.

In Thimphu Thromde, a part of consignment expenses is covered by a subsidy from the central government. Fuel cost and daily maintenance cost for the vehicles, which are used by the private companies are included in the contract price of the consignment, irrespective of whether the owner of the vehicles is Thimphu Thromde or private company.

Therefore, Thimphu Thromde bears the expenses for human resources, a part of consignment expenses, fuel cost for three compactors and three tractors, and vehicle maintenance costs in case of serious breakdowns.

On the other hand, budget for solid waste management is mainly covered by a part of property tax. Thimphu Thromde does not classify revenue and expenditure by their purpose of use.

The current solid waste management expenditure in Thimphu Thromde is estimated by JICA survey team, and it is shown in the following table.

Table 2-5-7 Estimated Current Solid Waste Management Expenditure in Thimphu Thromde

Item	Amount (BTN)	Remarks
Fuel cost for vehicles	1,720,000	
Fuel cost for heavy equipment	3,276,000	
Maintenance cost for vehicles	395,000	
Maintenance cost for heavy equipment	183,000	
Insurance cost for vehicle	27,000	
Insurance cost for heavy equipment	22,000	
Salary for drivers	936,000	
Salary for cleaners	702,000	
Salary for landfill workers	1,410,000	
Consignment expenses for solid waste management	17,400,000	For Greener Way And Clean City
TOTAL	26,071,000	

Notes: This expenditure excludes salary for office workers.

Source: JICA survey team has estimated the amount based on the information provided by key personnel of Thimphu Thromde.

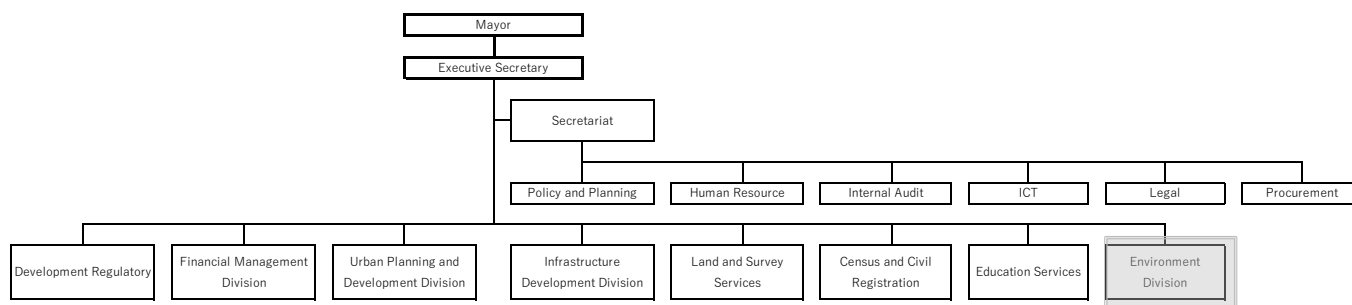
The current solid waste management expenditure corresponds to about four percent of the total expenditure of Thimphu Thromde.

2-5-1-2 Phuntsholing Thromde

2-5-1-2-1 Operation and Maintenance

Phuntsholing Thromde shall be responsible for management and operation of the items provided by the Project, and it function as a main counterpart of the JICA survey team for the Project.

The organogram of Phuntsholing Thromde is shown in Figure 2-5-2 below.



Source: Phuntsholing Thromde

Figure 2-5-2 Organogram of Phuntsholing Thromde

Phuntsholing Thromde started the consignment of solid waste management including collection of solid waste and management of landfill site to one private company, Druk Trash Solution, in September 2019.

(1) Phuntsholing Thromde

Phuntsholing Thromde has the human resources listed in the following table for solid waste management.

Table 2-5-8 Human Resources of Environmental Division in Phuntsholing Thromde

Position	Number of personnel
Division Head	1
Environmental Officer	1
Sanitary Inspectors	8
Drivers	8

Source: Phuntsholing Thromde

Before starting the consignment of solid waste management, Phuntsholing Thromde employed 75 street

sweepers and 5 landfill workers. Currently, the contractor employs most of them on behalf of Phuntsholing Thromde.

Since Phuntsholing Thromde currently operates five compactors, one dump truck, and two container-carriers, including one under repair, it employs eight drivers. A motor transport officer (MTO) under the General Administration Section is responsible for the management and maintenance of vehicles. In case of breakdown of vehicles, the officer outsources the maintenance to the private repair companies.

Phuntsholing Thromde also owns one Backhoe-loader, which is currently under repair. The MTO is responsible for the management and maintenance of this equipment. This equipment is rented and used from time to time for excavation, pushing, compaction and soil covering at the landfill site.

(2) Druk Trash Solution

Druk Trash Solution is a private company which has concluded a contract with Phuntsholing Thromde for solid waste management. Druk Trash Solution employs sixty-six staff. The breakdown of its staff is listed in the following table.

Table 2-5-9 Staff of Druk Trash Solution

Position	Number of personnel
Manager	1
Supervisor	1
Cleaners / Segregators	16
Street Sweepers	39
Landfill Workers	3
Drivers	5
Heavy Equipment Operator	1

Source: Phuntsholing Thromde

Druk Trash Solution is operating eight vehicles, including a vehicle under maintenance. The breakdown of the vehicles is listed below.

Table 2-5-10 Vehicles Operated by Druk Trash Solution

Type of Vehicle	Owner	Conditions	Number
Compactor	Phuntsholing Thromde	Operating	5
Others	Phuntsholing Thromde	Operating	2
	Phuntsholing Thromde	Under Maintenance	1
Sub-Total	Phuntsholing Thromde	Operating	7
		Under Maintenance	1
Total			8

Source: Phuntsholing Thromde

The number of cleaners is enough for the number of operated equipment in Druk Trash Solution. Fuel and maintenance of equipment are under the responsibility of Phuntsholing Thromde.

2-5-1-2-2 Finance Condition

The financial condition of Phuntsholing Thromde is shown in the table below.

Table 2-5-11 Financial Condition of Phuntsholing Thromde

(Unit: mil BTN)	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Revenue	-	-	322.850	349.847	429.646
Subsidy and the other income from central government	105.857	234.155	248.219	No information	No information
Expenditure	-	-	317.603	328.330	319.440

Source: Revenue and Expenditure: Phuntsholing Thromde

Subsidy and the other income from central government: Ministry of Finance, Bhutan

The revenue of Phuntsholing Thromde mainly comes from tax collection. The personnel expenses, labor cost and maintenance cost of equipment are sufficiently covered by the revenue.

Phuntsholing Thromde bears the expenses for human resources, consignment expenses, fuel cost for compactors, dump trucks and container-carriers, and their maintenance cost.

On the other hand, budget for solid waste management is mainly covered by a part of property tax. Phuntsholing Thromde does not classify revenue and expenditure by their purpose of use. The current solid waste management expenditure in Phuntsholing Thromde is estimated by JICA survey team, and it is shown below.

Table 2-5-12 Estimated Current Solid Waste Management Expenditure in Phuntsholing Thromde

Item	Amount (BTN)	Remarks
Fuel cost for equipment	5,213,900	
Maintenance cost for equipment	3,360,000	
Insurance cost for equipment	72,000	
Salary for drivers	1,056,000	
Lease fee for equipment and drivers	-1,080,000	Income from Druk Trash Solution
Consignment expenses for solid waste management	9,361,992	For Druk Trash Solution
TOTAL	17,983,892	

Notes: This expenditure excludes salary for office workers.

Source: JICA survey team has estimated the amount based on the information provided by key personnel of Phuntsholing Thromde.

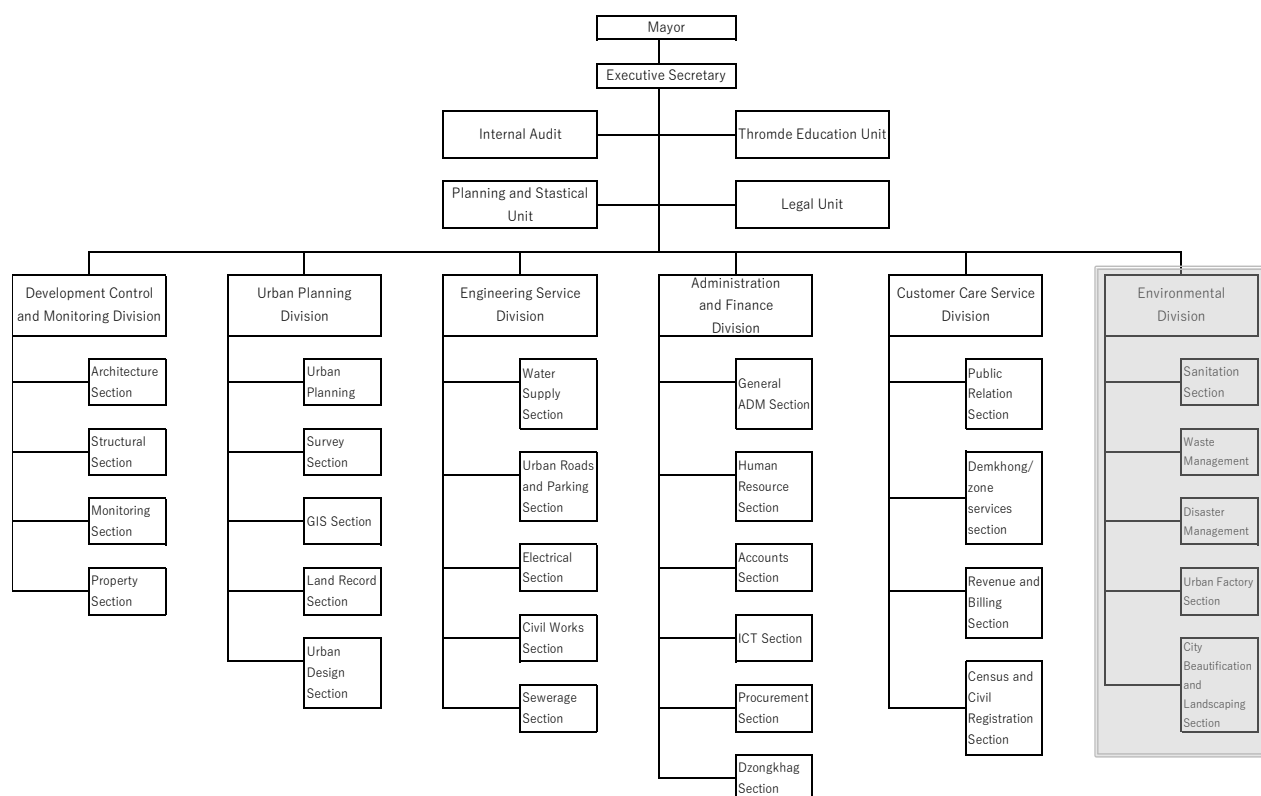
The current solid waste management expenditure corresponds to about five percent of total expenditure of Phuntsholing Thromde.

2-5-1-3 Gelephu Thromde

2-5-1-3-1 Operation and Maintenance

Gelephu Thromde is responsible for the management and operation of equipment to be provided by the Project, and it will function as the main counterparts of JICA survey team for the Project.

The organogram of Gelephu Thromde is shown in Figure 2-5-3 below.



Source: Gelephu Thromde

Figure 2-5-3 Organogram of Gelephu Thromde

Gelephu Thromde implements the solid waste management by itself. Gelephu Thromde has human resources listed below for the solid waste management.

Table 2-5-13 Human Resources for Solid Waste Management of Environmental Division in Gelephu Thromde

Position	Number of personnel
Waste Management Section Head	1
Sanitary Inspectors (Sanitation Section)	2
Drivers (Waste Management Section)	6

Source: Gelephu Thromde

Though Gelephu Thromde is operating three compactors, including one under repair, and one dump truck, it employs six drivers. The number of drivers is currently enough for driving city-owned waste collection vehicles. A motor transport officer (MTO) under the General Administration Section is responsible for the management and maintenance of vehicles. In case of breakdown of vehicles, the officer outsources the maintenance to the private repair companies.

Gelephu Thromde also owns one backhoe-loader, which is currently under repair. The MTO is responsible for the management and maintenance of this equipment. This equipment is rented and used from time to time for excavation, pushing, compaction and soil covering at landfill site.

Gelephu Thromde employs cleaners on a daily basis, based on needs. In principle, one driver and two cleaners work on each waste collection equipment.

2-5-1-3-2 Finance Condition

The financial condition of Gelephu Thromde is shown in the table below.

Table 2-5-14 Financial Condition of Gelephu Thromde

(Unit: mil BTN)	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Revenue	16.957	31.615	24.133	45.122	38.115
Subsidy and the other income from central government	121.325	202.358	235.871	No information	No information
Expenditure	118.186	156.948	274.492	363.724	340.986

Source: Revenue and Expenditure: Gelephu Thromde

Subsidy and the other income from central government: Ministry of Finance, Bhutan

The revenue of Gelephu Thromde mainly comes from tax and utilization fee including waste collection fee. The personnel expenses, labor cost and maintenance cost of equipment are scraped up from this revenue and the income from central government including subsidy.

Gelephu Thromde bears the expenses for human resources, fuel cost for compactors and dump trucks, and their maintenance cost.

Gelephu Thromde started collecting waste collection fee from the residents in their target area except LAP-4 in 2018, and it has a plan to collect it from LAP-4 soon. Gelephu Thromde does not classify revenue and expenditure by their purpose of use.

The detail of the waste collection fee is shown in the following table.

Table 2-5-15 Detail of Waste Collection Fee in Gelephu Thromde as of 2019

Area	Type	Category	Unit Price (BTN/month)	Number of units	Amount (BTN/month)	Percentage (%) (number basis)	Percentage (%) (amount basis)
Core Area	Large scale waste discharger	-	1,000	7	7,000	0.4%	8.2%
	Buildings / Houses	-	60	736	44,160	43.1%	51.6%
Sub-total				743	51,160	43.5%	59.7%
LAP	Large scale waste discharger	-	1,000	8	8,000	0.5%	9.3%
	Buildings / Houses	I	40	402	16,080	23.5%	18.8%
	Buildings / Houses	II	30	200	6,000	11.7%	7.0%
	Buildings / Houses	III	20	86	1,720	5.0%	2.0%
	Buildings / Houses	IV	10	270	2,700	15.8%	3.2%
Sub-total				966	34,500	56.5%	40.3%
Total				1,709	85,660	100.0%	100.0%

Source: JICA survey team has estimated the amount based on the information provided by key personnel of Gelephu Thromde.

The current solid waste management expenditure in Gelephu Thromde is estimated by JICA survey team, and it is shown in the following table.

Table 2-5-16 Estimated Current Solid Waste Management Expenditure in Gelephu Thromde

Item	Amount (BTN)	Remarks
Fuel cost for vehicles and equipment	1,680,000	
Maintenance cost for vehicles and equipment	960,000	
Insurance cost for vehicles	36,000	
Salary for drivers	979,200	
Salary for cleaners	672,000	
Salary for landfill labors	252,000	
TOTAL	4,579,200	

Notes: This expenditure excludes salary for office workers.

Source: JICA survey team has estimated the amount based on the information provided by key personnel of Gelephu Thromde.

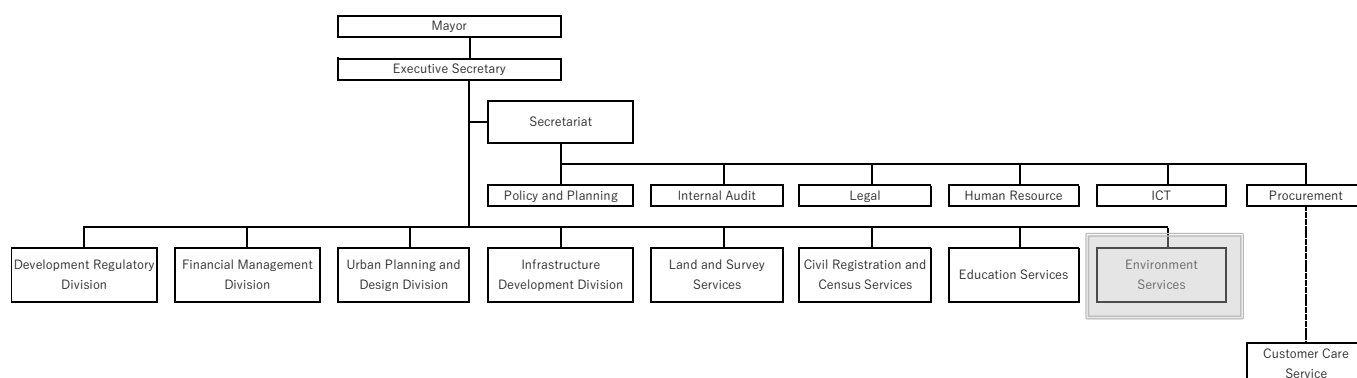
The current solid waste management expenditure corresponds to about one percent of total expenditure of Gelephu Thromde, and the total amount of waste collection fee can cover about twenty percent of the solid waste management expenditure.

2-5-1-4 Samdrupjongkhar Thromde

2-5-1-4-1 Operation and Maintenance

Samdrupjongkhar Thromde is responsible for the management and operation of the equipment to be provided by the Project, and it will function as the main counterparts of JICA survey team for the Project.

The organogram of Samdrupjongkhar Thromde is shown in Figure 2-5-4 below.



Source: Samdrupjongkhar Thromde

Figure 2-5-4 Organogram of Samdrupjongkhar Thromde

Samdrupjongkhar Thromde implements the solid waste management by itself. Samdrupjongkhar Thromde has the human resources listed below for the solid waste management.

Table 2-5-17 Human Resources of Waste Management Section of Environmental Division in Samdrupjongkhar Thromde

Position	Number of personnel
Environment Officer	1
Sanitary Inspector	2
Drivers	4
Cleaners and Sweepers	27
Gardeners	2

Source: Samdrupjongkhar Thromde

Since Samdrupjongkhar Thromde currently operates three compactors, including one under repair, and one tractor, it employs four drivers. The number of current drivers corresponds to the number of equipment used for the waste collection. In principle, one driver and two cleaners are assigned to each waste collection vehicles. A motor transport officer (MTO) under the Customer Service Center is

responsible for the management and maintenance of vehicles. In case of breakdown of vehicles, the officer outsources the maintenance to the private repair companies.

Samdrupjongkhar Thromde also owns one excavator and one robot skid. The MTO is responsible for the management and maintenance of the equipment. This equipment is rented and used from time to time for excavation, pushing, compaction and soil covering at the landfill site.

2-5-1-4-2 Finance Condition

The financial condition of Samdrupjongkhar Thromde is shown in the table below.

Table 2-5-18 Financial Condition of Samdrupjongkhar Thromde

(Unit: mil BTN)	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Revenue	4.123	5.589	3.317	2.843	32.280
Subsidy and the other income from central government	128.602	181.940	162.975	No information	No information
Expenditure	103.323	203.741	182.022	261.770	130.435

Source: Revenue and Expenditure: Samdrupjongkhar Thromde

Subsidy and the other income from central government: Ministry of Finance, Bhutan

The revenue of Samdrupjongkhar Thromde mainly comes from tax collection. The personnel expenses, labor cost and maintenance cost of equipment are scraped up from this revenue, and the income from central government including subsidy.

Samdrupjongkhar Thromde bears the expenses for human resources, fuel cost for compactors and a tractor, and their maintenance cost.

Samdrupjongkhar Thromde does not classify revenue and expenditure by their purpose of use. The current solid waste management expenditure in Samdrupjongkhar Thromde is estimated by JICA survey team, and it is shown below.

Table 2-5-19 Estimated Current Solid Waste Management Expenditure in Samdrupjongkhar Thromde

Item	Amount (BTN)	Remarks
Fuel cost and maintenance cost for vehicles and equipment	4,185,000	
Insurance cost for vehicles	28,000	
Salary for drivers	576,000	
Salary for cleaners	672,000	
Salary for landfill labors	252,000	
TOTAL	5,713,000	

Notes: This expenditure excludes salary for office workers.

Source: JICA survey team has estimated the amount based on the information provided by key personnel of Samdrupjongkhar Thromde.

The current solid waste management expenditure corresponds to about four percent of the total expenditure of Samdrupjongkhar Thromde.

2-5-2 Operation and Maintenance Plan

2-5-2-1 Waste Collection Vehicles

2-5-2-1-1 Operation Plan

In the Project, compactors and container carriers are planned to be procured for improving solid waste collection. Since compactors and container carriers are commonly used in the target cities, they can be utilized without any problems. In the soft component activities of the Project, Japanese expert will provide guidance on the proper way of using the equipment for solving the current problems.

2-5-2-1-2 Maintenance Plan

Thimphu Thromde is currently preparing a public workshop, and it will be ready soon. In addition, Thimphu is outsourcing the repair and maintenance of vehicles except daily maintenance, which is carried out by each driver, to some private workshops or dealers in the city, and it must be able to maintain vehicles to be procured by the Project as well.

The other three target cities are also outsourcing the repair and maintenance of vehicles to the private workshops, and they must be able to maintain vehicles to be procured by the Project as well. Gelephu Thromde and Samdrupjongkhar Thromde outsource the repair of vehicles to the private repair companies in Phuntsholing Thromde only in serious problem cases.

In the soft component activities of the Project, Japanese expert plans to provide guidance on preliminary maintenance techniques, proper actions in case of breakdowns and proper storage of spare parts and consumables of equipment etc. for improving individual actions.

2-5-2-2 Landfill Equipment

2-5-2-2-1 Operation Plan

Project plans to procure one bulldozer for Thimphu Thromde, one excavator for Phuntsholing Thromde and one backhoe loader for each Gelephu and Samdrupjongkhar Thromde for improving final disposal at landfill site. Since such equipment is commonly used in the target cities, it can be operated without any problems. In the soft component activities of the Project, officers in each city will prepare a safe disposal method under the supervision of Japanese expert, and this will enable them to treat solid waste properly at landfill site continuously.

2-5-2-2-2 Maintenance Plan

As mentioned above, a public workshop is currently under preparation in Thimphu Thromde and it will be ready soon. Therefore, the heavy equipment to be procured in the Project will be able to be maintained at the public workshop in the near future. In addition, Thimphu has some private workshops and dealers. Currently, it outsources the repair and maintenance of equipment except daily maintenance, which is implemented by each operator, to the private repair companies or dealers, and it must be able to maintain the equipment to be procured by the Project as well.

The other three target cities outsource the repair and maintenance of heavy equipment to the private repair companies, and they must be able to maintain equipment to be procured by the Project as well. Gelephu Thromde and Samdrupjongkhar Thromde outsource the repair of equipment to the private repair companies in Phuntsholing Thromde only in serious problem cases.

2-6 Project Cost Estimation

2-6-1 Initial Cost Estimation

(1) Cost Born by Japan Side

This part is not disclosed due to confidentiality for one year until final verification of the contract of the supplier.

(2) Cost Born by Bhutan Side

The total estimated cost to be undertaken by Bhutan side is approx. 89,400 thousand BTN (approx. 150 million JPN).

Bank Commissions: approx. 400 thousand BTN

Green Tax: 89,000 thousand BTN

(3) Estimation Conditions

- i) Time of estimation: October 2019
- ii) Foreign exchange rates: 1USD=108.36 JPY
1BTN=1.68 JPY
1EUR=120.91 JPY
- iii) Implementation period: The periods for the bid and procurement are shown in the execution schedule.
- iv) Miscellaneous matters: The costs are to be estimated in accordance with the provisions of the grant aid program of the Government of Japan.

2-6-2 Operation and Maintenance Cost

(1) Waste Collection Vehicles

Operation and maintenance cost must be secured by each city for both the existing vehicles and new vehicles to be procured by the Project. The number of vehicle will increase, but fuel cost and maintenance cost of some vehicles will decrease.

The operation and maintenance cost expected in 2023 is estimated as shown in Table 2-6-1 under the conditions that one driver and two cleaners are assigned to each collection vehicle work. The operation and maintenance cost is covered by the revenues of each city, including tax revenue, in principle. In case the revenue of each city is insufficient, the deficit will be covered by the subsidy from the central government.

(2) Landfill Equipment

The operation and maintenance cost expected in 2023 is estimated in Table 2-6-1 in accordance with the number of existing equipment and new equipment to be procured by the Project. Operation and maintenance cost is covered by the revenues of each city, including tax revenue, in principle. In case the revenue of each city is insufficient, the deficit will be covered by the subsidy from the central government.

Table 2-6-1 Operation and Maintenance Cost for Solid Waste Management Expected in 2023 in Each City

Target City	Items	Operation and maintenance cost (BTN)	Remarks
Thimphu	Salary for drivers and cleaners	1,116,000	
	Fuel cost for collection vehicles	670,271	
	Maintenance cost for collection vehicles (City use)	475,000	
	Maintenance cost for collection vehicles (Contractors use)	3,635,100	Ninety (90) percent of the total maintenance cost
	Salary for labors and operators working at landfill site	825,000	Including dump truck drivers
	Fuel cost for heavy equipment	2,359,032	Including fuel cost for dump trucks
	Maintenance cost for heavy equipment	1,289,000	
	Others	172,500	
	Consignment Fee	19,191,720	Forty (40) percent of the total direct cost shall be added as the management expense
	Total	29,733,623	BTN26,071,000- as of 2019
Phuntsholing	Salary for drivers and cleaners	1,056,000	
	Fuel cost for collection vehicles	2,974,752	
	Maintenance cost for collection vehicles	1,220,000	
	Salary for labors and operators working at landfill site	162,000	
	Fuel cost for heavy equipment	319,488	
	Maintenance cost for heavy equipment	412,000	
	Others	46,500	
	Consignment Fee	4,377,000	Forty (40) percent of total direct cost shall be added as the management expense. Rental cost for equipment for contractor shall be deducted.
	Total	10,567,740	BTN13,397,492- as of 2019
Gelephu	Salary for drivers and cleaners	2,076,000	
	Fuel cost for collection vehicles	987,985	
	Maintenance cost for collection vehicles	1,050,000	
	Salary for labors and operators working at landfill site	441,000	Including dump truck drivers
	Fuel cost for heavy equipment	515,424	Including fuel cost for dump trucks
	Maintenance cost for heavy equipment	381,000	
	Others	42,000	
	Total	5,493,409	BTN4,579,200- as of 2019
Samdrupjongkhar	Salary for drivers and cleaners	1,560,000	
	Fuel cost for collection vehicles	1,500,973	
	Maintenance cost for collection vehicles	710,000	
	Salary for labors and operators working at landfill site	420,000	Including dump truck drivers
	Fuel cost for heavy equipment	454,272	Including fuel cost for dump trucks
	Maintenance cost for heavy equipment	381,000	
	Others	33,000	
	Total	5,059,245	BTN5,713,000- as of 2019

Note: The amount of BTN 4,586,400- shall be deducted from the consignment fee in Phuntsuoling Thromde in 2019 as the consignment fee for road sweeping.

(BTN84,000/person×39 persons×(1+0.40(Management fee rate)))

Total cost for operation and maintenance BTN17,983,892-4,586,400=13,397,492

The operation and maintenance cost expected in 2023 in each city increases by about twenty percent in maximum, compared with the cost in 2019. The amount of the increase corresponds to less than one percent of the total expenditure of the city, and it can be covered by the subsidy from the central government.

CHAPTER 3 Project Evaluation

3-1 Preconditions

A precondition for the implementation of this Project is that the Bhutan side shall carry out all its obligations below:

- Procedures required for tax exemption and customs clearance
- Ensuring cost for operation and maintenance
- Ensuring required manpower
- Secure the place for parking of the equipment.

3-2 Necessary Inputs by the Recipient Country

The Bhutan side must take all necessary measures to ensure the following conditions for the realization of the objectives of the Project:

- (1) The equipment is appropriately operated and maintained.
- (2) The maintenance capability of each city is improved, and regular inspection of equipment and management of spare parts are carried out.
- (3) The strategy for sustainable solid waste management will be updated and waste collection and the landfill sites are properly managed.

3-3 Important Assumptions

The important assumptions made in the implementation of this Project are as follows:

- (1) There should be no major policy change in Bhutan's waste management administration. The system in which solid waste is managed by cities, including collection and transportation will continue.
- (2) The system for solid waste management including collection, intermediate treatment and disposal will be maintained and secured.

3-4 Project Evaluation

3-4-1 Relevance

(1) Beneficiaries of the Project

The number of direct beneficiaries of this Project is approximately one hundred seventy thousand people.

Table 3-4-1 Beneficiaries of the Project

Target City	Direct beneficiaries of this Project
Thimphu Thromde	126,202
Phuntsholing Thromde	28,057
Gelephu Thromde	9,467
Samdrupjongkhar Thromde	9,381
Total	173,107

Source: Statistic Yearbook of Bhutan 2018, MoWHS 2008, JESC 2018, JICA Survey Team

(2) Urgency

In spite of increase in generated amount of waste in Bhutan, no proper waste collection and final disposal have been established due to the shortage and deterioration of the equipment. Therefore, immediate implementation of the Project is required for improving people's living environment.

(3) Integrity with Solid Waste Management of Bhutan

The long-term objectives of "National Waste Management Strategy (2019-2030)" formulated in 2019 includes "Achievement of zero waste by 2030". The strategy aims to realize this vision by "Efficient solid waste management through collecting/recycling waste with minimizing waste disposal amount".

Moreover, construction of drop-in centers and construction of new landfill site (or improvement of existing landfill site) are proposed in this strategy. This Project contributes to the achievement of the above objectives by procuring equipment necessary for collection, transportation and disposal

(4) Consistency with the Assistance Policies and Strategies of the Government of Japan

The assistance strategy (medium target) for Bhutan in 2015 is providing "Support for environmental issues and climate changes by dealing with sustainable urban environment issues, climate changes and disaster prevention, since Bhutan is vulnerable to environmental deteriorations and climate changes with environmental disasters and socio-economic changes". This Project will contribute to the improvement the environment hygiene, waste management capacity and service of the administration, and it is consistent with Japan's ODA policies and strategies.

3-4-2 Effectiveness

3-4-2-1 Quantitative Effects

Table 3-4-2 shows the quantitative indicators of the effects expected from this Project, including the current (baseline) values and the target values (i.e., after completion of the Project) of the indicators. The "amount of wastes collected by the cities (t/d)" is uses as an indicator.

Table 3-4-2 Quantitative Effects Expected from the Implementation of this Project

Target City	Baseline (2019) (t/d) (Actual)	Target (2023) (t/d) (2 years after project completion)	Target (2024) (t/d) (3 years after project completion)
Total	78.2	95.5	97.0
Thimphu Thromde	52.4	66.9	68.6
Phuntsholing Thromde	15.3	17.1	17.3
Gelephu Thromde	5.4	5.8	5.8
Samdrupjongkhar Thromde	5.1	5.7	5.8

Source: JICA Survey Team

3-4-2-2 Qualitative Effects

The following qualitative effects described can be expected from the implementation of this Project:

- (1) Improvement of living environment of the target four cities through decreasing illegal disposal etc.
- (2) Improvement of solid waste management capacity of the target four cities

Annex

Annex-1 : Member List of the Survey Team

Annex-1: Member List of the Survey Team

(Japan International Cooperation Agency: JICA)

	Name	Assignment	Organization
1	Mimpei Ito	Leader	Japan International Cooperation Agency
2	Kenichiro Koiwa	Planning Management	Japan International Cooperation Agency

(Consultant)

	Name	Assignment	Organization
1	Naoyuki Minami	Chief Consultant / Solid Waste Management Plan -1	Yachiyo Engineering Co., Ltd.
2	Hisashi Yamauchi	Equipment Plan / Solid Waste Management Plan -2	Yachiyo Engineering Co., Ltd.
3	Makoto Yamamoto	Organization – Institution / Operation and Maintenance Plan	Japan Environmental Sanitation Center
4	Atsushi Kato	Procurement Plan / Cost Estimation	Yachiyo Engineering Co., Ltd.
5	Hiroki Ishihara	Coordination	Yachiyo Engineering Co., Ltd.

Annex-2 : Survey Schedule

(A2-1. Survey in Bhutan-1)

(A2-2. Survey in Bhutan-2)

(A2-3. Survey in Bhutan-3)

A2-1. Survey in Bhutan-1

Annex-2: Survey Schedule

A2-1. Survey in Bhutan -1

			JICA		Consultant				
			Leader	Planning Management	Chief Consultant	Equipment Plan	Organization – Institution / Operation and Maintenance Plan	Procurement Plan / Cost Estimation	Coordination
					/ Solid Waste Management Plan -1	/ Solid Waste Management Plan -2			
			Mimpei Ito	Kenichiro Koiwa	Naoyuki Minami	Hisashi Yamauchi	Makoto Yamamoto	Atsushi Kato	Hiroki Ishihara
1	10-Aug	Sat			Travel (Tokyo→Bangkok)				
2	11-Aug	Sun			Travel (Bangkok→Thimphu)				
3	12-Aug	Mon			Meeting with JICA Bhutan Office, Meeting with GNHC				
4	13-Aug	Tue			Meeting with MoWHS, Meeting with NEC, Meeting with Thimphu Thromde, Meeting with the Local Consultant				
5	14-Aug	Wed			Visit of Solid Waste Management Related Facilities (Drop-in Center, Landfill Site, Compost Center, Solid Waste Related Private Company, Recycle Center)				
6	15-Aug	Thu			Visit of Solid Waste Management Related Facilities(Solid Waste Related Private Company, Market)				
7	16-Aug	Fri			Meeting with Thimphu Thromde, Visit of Solid Waste Related Facility (Solid Waste Related Private Company)				
8	17-Aug	Sat			Data analysis				
9	18-Aug	Sun	Travel		Data analysis				
10	19-Aug	Mon	Visit of Solid Waste Related Facility (Recycle Center), Meeting with JICA						
11	20-Aug	Tue	Joint Meeting with (GNHC, MoWHS, NEC, Thimphu Thromde, JICA), Meeting with Thimphu Thromde						
12	21-Aug	Wed	Visit of Solid Waste Related Facilities (Drop-in Center, landfill Site, Solid Waste Related Company, Recycle Center)			Survey of Fundamental Data	Survey of Procurement Situation	Visit of Solid Waste Related Facilities	
13	22-Aug	Thu	Survey for Other Donors		Preparation of Field Report-1	Survey of Fundamental Data	Survey of the Procurement Situation	Preparation of Field Report-1	
14	23-Aug	Fri	Signing to Minutes of Discussion			Survey of Fundamental Data	Survey of Procurement Situation	Signing to Minutes of Discussion	
15	24-Aug	Sat	Travel		Data analysis				
16	25-Aug	Sun	Travel		Data analysis				
17	26-Aug	Mon			Meeting with Thimphu Thromde, Preparation of Field Report-1				
18	27-Aug	Tue			Visit of Solid Waste Related Facilities (Drop-in Center, Compost Centers, Recycle Center)	Survey of Fundamental Data	Survey of Procurement Situation	Visit of Solid Waste Related Facilities	
19	28-Aug	Wed			Meeting with Thimphu Thromde, Preparation of Field Report-1				
20	29-Aug	Thu			Explanation and discussion of Field Report with Bhutan side (preliminary result of the survey), Reporting to JICA Bhutan Office				
21	30-Aug	Fri			Travel (Thimphu→Bangkok)				
22	31-Aug	Sat			Travel (Bangkok→Tokyo)				

A2-2. Survey in Bhutan-2

A2-2. Survey in Bhutan -2

			Consultant				
			Chief Consultant / Solid Waste Management Plan -1	Procurement Plan / Cost Estimation	Equipment Plan / Solid Waste Management Plan -2	Organization – Institution / Operation and Maintenance Plan	Coordination
1	21-Sep	Sat			Travel (Tokyo→Bangkok)		
2	22-Sep	Sun			Travel (Bangkok→Thimphu)		
3	23-Sep	Mon			Meeting with JICA Bhutan Office, Visa Procedure		
4	24-Sep	Tue			Holiday in Bhutan		
5	25-Sep	Wed			Discussion with the Local Consultant, Visa Procedure		
6	26-Sep	Thu			Meeting with NEC, Survey in Thimphu Thromde		
7	27-Sep	Fri			Survey in Thimphu Thromde, Visa Procedure		
8	28-Sep	Sat	Travel (Tokyo→Bangkok)		Data analysis		
9	29-Sep	Sun	Travel (Bangkok→Thimphu)		Data analysis		
10	30-Sep	Mon	Meeting with GNHC, Survey in Thimphu Thromde, Visa procedure				
11	1-Oct	Tue	Discussion with the Local Consultant				
12	2-Oct	Wed	Travel (Thimphu → Phuntsholing)				
13	3-Oct	Thu	Meeting with Phuntsholing Thromde, Visit of Solid Waste Related Facilities (Landfill Site, Garage, Waste Collection with Containers)				
14	4-Oct	Fri	Visit of Solid Waste Related Facilities (Market, Waste Collection by Compactors, Waste Collection with Containers)				
15	5-Oct	Sat	Data analysis		Travel (Phuntsholing → Gelephu)		
16	6-Oct	Sun	Data analysis		Data analysis		
17	7-Oct	Mon	Survey of Procurement Situation (Conducting Interview to Dealers), Survey in Phuntsholing Thromde		Meeting with Gelephu Thromde, Visit of Solid Waste Related Facilities (Landfill Site, Scrap Dealers, Workshop, Market, Garage)		
18	8-Oct	Tue	Holiday in Bhutan				
19	9-Oct	Wed	Survey of Procurement Situation (Conducting Interview to Dealers), Survey in Phuntsholing Thromde		Visit of Solid Waste Related Facilities (Workshop, Waste Collection by Compactor, Waste Collection by Dump Truck)		
20	10-Oct	Thu	Survey of Procurement Situation (Conducting Interview to Workshops), Survey in Phuntsholing Thromde		Survey in Gelephu Thromde		
21	11-Oct	Fri	Meeting with Phuntsholing Thromde		Meeting with Gelephu Thromde		
22	12-Oct	Sat	Travel (Phuntsholing → Thimphu)		Travel (Gelephu → Samdrupjongkhar)		
23	13-Oct	Sun	Data analysis		Data analysis		
24	14-Oct	Mon	Meeting with GNHC, Meeting with Ministry of Finance, Meeting with Thimphu Thromde		Meeting with Samdrupjongkhar Thromde, Visit of Dewathang Area		
25	15-Oct	Tue	Meeting with NEC, Supplementary Survey in Thimphu Thromde		Visit of Solid Waste Related Facilities (Landfill Site, Scrap Dealers, School, Market, Workshop, Waste Collection by Compactor, Waste Collection by Tractor)		
26	16-Oct	Wed	Confirmation of Final Products from the Local Consultant, Supplementary Survey in Thimphu Thromde		Survey in Samdrupjongkhar Thromde		
27	17-Oct	Thu	Meeting with Thimphu Thromde, Supplementary Survey of Procurement Situation		Meeting with Samdrupjongkhar Thromde		
28	18-Oct	Fri	Supplementary Survey in Thimphu Thromde, Preparation of Field Report-2		Survey in Samdrupjongkhar Thromde, Preparation of FieldReport-2		
29	19-Oct	Sat	Data analysis		Travel (Samdrupjongkhar, Bhutan → Guwahati, India)		
30	20-Oct	Sun	Data analysis		Travel (Guwahati, Bhutan → Thimphu, Bhuitan) by air		
31	21-Oct	Mon	Discussion with the Local Consultant, Meeting with JICA Bhutan Office, Meeting with GNHC, Preparation of Field Report-2				

			Consultant				
			Chief Consultant / Solid Waste Management Plan -1	Procurement Plan / Cost Estimation	Equipment Plan / Solid Waste Management Plan -2	Organization – Institution / Operation and Maintenance Plan	Coordination
			Naoyuki Minami	Atsushi Kato	Hisashi Yamauchi	Makoto Yamamoto	Hiroki Ishihara
32	22-Oct	Tue	Meeting with UNDP, Meeting with MoWHS, Preparation of Field Report-2				
33	23-Oct	Wed	Meeting with NEC, Preparation of Field Report-2				
34	24-Oct	Thu	Explanation and discussion of Field Report with Bhutan side (GNHC, MoWHS, NEC, the Target Four Thromdes, JICA Bhutan Office)				
35	25-Oct	Fri	Travel (Thimphu→Bangkok)				
36	26-Oct	Sat	Travel (Bangkok→Tokyo)				

A2-3. Survey in Bhutan-3

A2-3. Survey in Bhutan -3

			JICA		Consultant	
			Leader	Planning Management	Chief Consultant / Solid Waste Management Plan -1	Equipment Plan / Solid Waste Management Plan -2
					Mimpei Ito	Kenichiro Koiwa
1	7-Dec	Sat			Travel (Tokyo→Bangkok)	
2	8-Dec	Sun	Travel (Tokyo→Bangkok)		Travel (Bangkok→Thimphu)	
3	9-Dec	Mon	Travel (Bangkok→Thimphu)			
			Courtesy call and meeting with GNHC, Meeting with JICA Bhutan Office			
4	10-Dec	Tue	Explanation and discussion of Draft Final Report and discussion of M/D (GNHC, MoWHS, NEC, the target four Thromdes), Discussion on the Minutes of Meeting with GNHC and JICA			
5	11-Dec	Wed	Discussion on M/D and signing of M/D			
6	12-Dec	Thu	Travel (Thimphu→Bangkok)		Meeting with GNHC, MoWHS, NEC and Thimphu Thromde	
7	13-Dec	Fri	Travel (Bangkok→Tokyo)		Travel (Thimphu→Bangkok)	
8	14-Dec	Sat			Travel (Bangkok→Tokyo)	

Annex-3 : List of Parties Concerned in the Recipient Country

Annex-3: List of Parties Concerned in the Recipient Country

Designation / Division	Name
Gross National Happiness Commission: GNHC	
Director	Rinchen Wangdi
Chief Program Coordinator / Development Cooperation Division	Wangchuk Namgay
Senior Program Coordinator / Development Cooperation Division	Sonam Yarphe
AMCO / Development Cooperation Division	Jigme Tenzin
Program Coordinator / Local Development Division	Sonam Choden
Assistant Program Officer / Local Development Division	Kuenzang Dorji
Motor Transport Officer	Karma
Ministry of Works and Human Settlement: MoWHS	
Director	Karma Dupchuk
Deputy Executive Engineer / Department of Engineering Service	Sonam Jamtsho
Chief Engineer / Department of Engineering Service	Dechen Yangden
Principal Engineer / Department of Engineering Service	Thinley Choden
Engineer / Department of Engineering Service	Ugyen Wangchuk
Chief Urban Planner / Department of Human Settlement	Bhawana Chhetei
Urban Planner / Department of Human Settlement	Tshering Pelden
Urban Planner / Department of Human Settlement	Yangki Dorji
Office Director / Department of Human Settlement	Tashi Penjik
National Environmental Commission: NEC	
Director	Phento Tshering
Chief / Waste Division	Thinley Dorji
Environment Officer / Waste Division	Rinchen Penjor
Assistant / Waste Division	Kezang Choden
Assistant / Waste Division	Nidup Zangmo
Assistant / Waste Division	Ugyen Tshomo
Ministry of Finance: MoF	
Chief / Department of National Budget (DNB)	Namgay Wangchuk
Budget Analyst / Department of National Budget (DNB)	T. N. Sharma
Budget Officer / Department of National Budget (DNB)	Dechon Wangmo
Regional Director / Regional Revenue & Customs Office	Sonam Dorji
Thimphu Thromde	
Mayor	Kinlay Dorjee
Head / Environment Division	Yeshe Wangdi
Environment Officer / Environment Division	Tshering Yangzom
Program Officer / Environment Division	Karma Dorji
Phuntsholing Thromde	
Mayor	Utter Kumar Rai
Executive Secretary	Lungten Jamtsho
Environment Officer / Environment Division	Lhendup

Designation / Division	Name
Senior Technician / Environment Division	Migma Sherpa
Assistant Engineer / Environment Division	Sonam Jamtsho
Junior Engineer / Environment Division	Migma Sherpa
Sanitary Inspector / Environment Division	Tandin Zangmo
Sanitary Inspector / Environment Division	Tshering Tashi
Planning Officer / Policy and Planning Services	Dorji Wangchuk
Chief Developing Regulatory Officer / Development Regulatory Division	Tshewaug Jeipo
Accountant Assistant / Finance Management Division	Ugyen Thinley
Gelephu Thromde	
Mayor	Tikaram Kafley
Executive Secretary	Tashi Wangmo
Environment Officer / Environmental Division	Karma Gyeltshen
Planning Officer / Environmental Division	Needup Zargmo
Chief / Engineering Service Division	Ugyen Dorji
Chief / Development Control and Monitoring Division	Jigme Tshering
Chief / Urban Planning Division	Chophey Dorji
AMCO / Planning and Statistical Unit	Gyem
Samdrupjongkhar Thromde	
Mayor	Karma Sherab Thobgyal
Executive Secretary	Taugay Choedup
Environment Officer / Environment Services	Sonam Choden
Engineer / Environment Services	Pema Chokey
Policy and Planning Officer / Secretariat	Cheda Jamtsho
Urban Planner / Urban Planning Design Division	Dorji Wangdi
Executive Engineer / Infrastructure Development Division	Nima Dorji
Senior Finance Officer / Finance Management Division	Lekdhen
Human Resource Officer / Human Resource Section	Sonam Jamtsho
Deputy Executive Engineer / Development Regulatory Division	Sangay Jamtsho
Census Officer / Civil Registration and Census Section	Dewdup Tshering
Senior ICT Officer / Information Communication Technology Section	Jigme Wangchuk
Administration Officer / Customer Care Service	Thumsh Phuntsho
National Statistics Bureau: NSB	
Deputy Chief Statistic Officer / Economic and Environmental Statistic Division	Tobden Tobden
Deputy Chief Statistic Officer / Economic and Environmental Statistic Division	Tashi Namgay
Greener Way Co., Ltd.	
CEO	Karma Yonten
Clean City Co., Ltd.	
Head (Adm. & Operations)	Jyoti Gurung

Designation / Division	Name
JICA Bhutan Office	
Chief Representative	Kozo Watanabe
Representative	Kota Wakabayashi
Project Formulation Advisor	Eizo Seko
Chief Program Officer	Krishna Subba
Program Officer	Tshering Dorji

