JAPAN INTERNATIONAL COOPERATION AGENCY

CITY DISTRICT GOVERNMENT GUJRANWALA
LOCAL GOVERNMENT AND COMMUNITY DEVELOPMENT DEPARTMENT
GOVERNMENT OF THE PUNJAB
ISLAMIC REPUBLIC OF PAKISTAN

PROJECT FOR INTEGRATED SOLID WASTE MANAGEMENT MASTER PLAN IN GUJRANWALA

INTERIM REPORT

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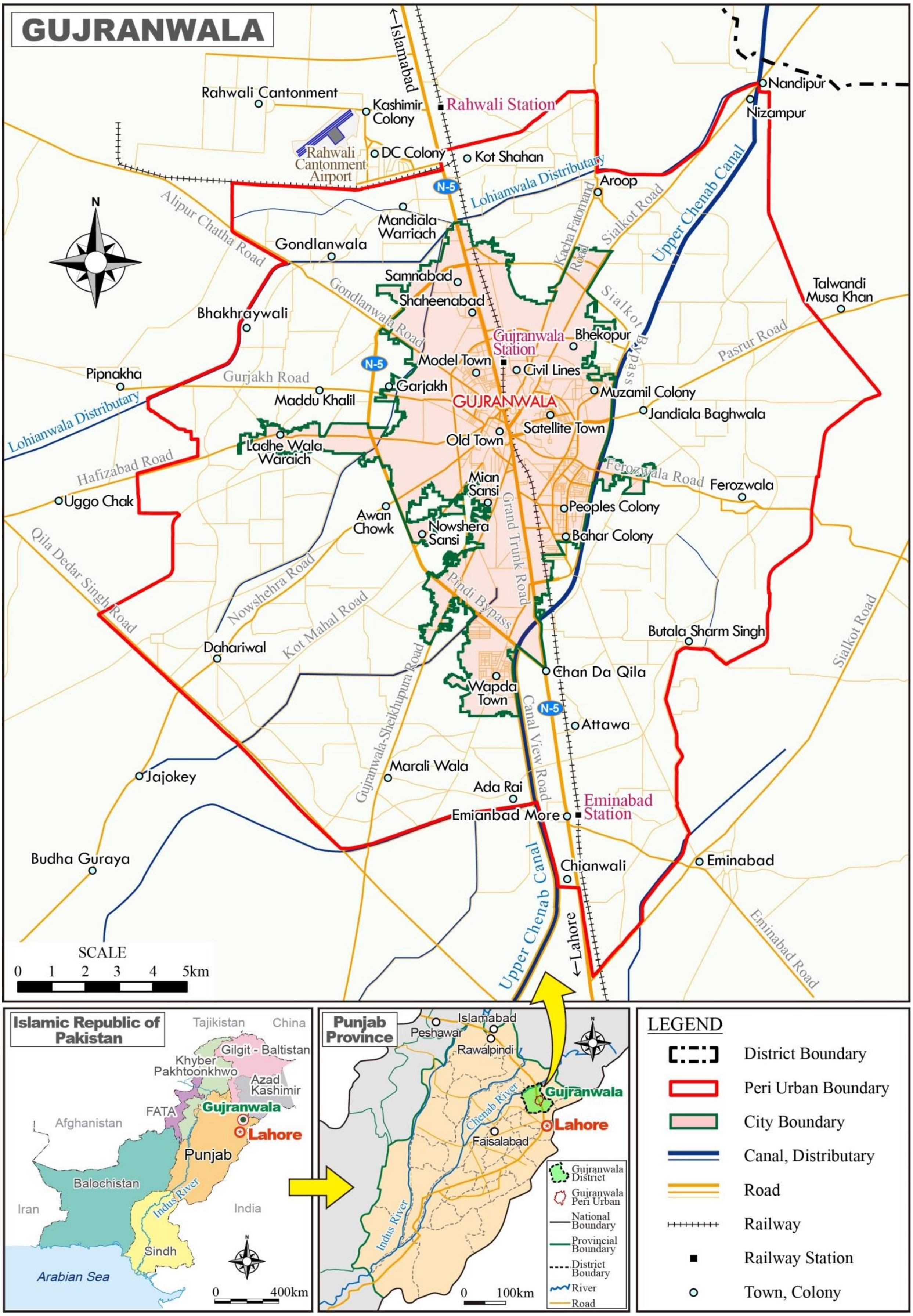

LOCATION MAP

PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN IN GUJRANWALA

INTERIM REPORT

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LIST OF ANNEXES

Annex **Record of Meeting** for the Second Joint Coordinating Committee (JCC) on Project for Integrated Solid Waste Management Master Plan in Gujranwala in the Republic of Pakistan, 19 December, 2014

ABBREVIATIONS AND ACRONYMS

3R : Reduce, Reuse, Recycle
ADB : Asian Development Bank
BHUs : Basic Health Units
BOT : Build-Operate-Transfer
CBO : Community-Based Organisation
CCB : Citizen Community Board
CCS : CO_2 Capture and Storage
C&D : Construction and Demolition
CDGG : City District Government Gujranwala
CDGL : City District Government Lahore
CDM : Clean Development Mechanism
CEO : Chief Executive Officer
CLTS : Community-Led Total Sanitation
CVM : Contingent Valuation Method
DAP : Di-Ammonium Phosphate
DCO : District Coordination Officer
DHQ : District Headquarters
DO : District Officer
EAD : Economic Affairs Division
EDO : Executive District Officer
EIA : Environment Impact Assessment
EIRR : Economic Internal Rate of Return
EPD : Environment Protection Department
FBR : Federal Board of Revenue
FIRR : Financial Internal Rate of Return
FML : Flexible Membrane Liner
GCCI : Gujranwala Chamber of Commerce and Industry
GDA : Gujranwala Development Authority
GDP : Gross Domestic Product
GEO : Gujranwala Environmental Organisation
GHG : Greenhouse Gas
GIS : Geographic Information Systems
GOJ : Government of Japan
GOP : Government of Pakistan
GOPb : Government of the Punjab
GWMC : Gujranwala Waste Management Company
HPM : Hedonic Pricing Method
HDPE : High Density Polyethlene
IEC : Information, Education and Communication
IEE : Initial Environmental Examination
ISWM : Integrated Solid Waste Management
JCC : Joint Coordinating Committee
JICA : Japan International Cooperation Agency
KOICA : Korean International Cooperation Agency
LDA : Lahore Development Authority
LG & CDD : Local Government and Community Development Department
LWMC : Lahore Waste Management Company
MCH : Mother-Child Health
MCL : Metropolitan Corporation Lahore
MD : Managing Director
MDGs : Millennium Development Goals
MICS : Multiple Indicator Cluster Surveys

MIS : Management Information System
MRF : Material Recovery Facility
MS : Municipal Services
NEP : National Environmental Policy
NEPRA : National Electric Power Regulatory Authority
NEQS : National Environmental Quality Standards
NGO : Non-Governmental Organisation
NPV : Net Present Value
NTN : National Text Number
O&M : Operation and Maintenance
OPE : Organisation Pan Environment
P&D : Planning and Development
Pak-EPA : Pakistan Environmental Protection Agency
PEPA : Pakistan (or Punjab) Environmental Protection Act
PEPC : Pakistan Environmental Protection Council
PHA : Parks and Horticulture Authority
PMU : Project Management Unit
PLGO : Punjab Local Government Ordinance
PPP : Public-Private-Partnership
PR : Public Relations
PRTR : Pollutant Release and Transfer Register
PSP : Private Sector Participation
RCV : Refuse Collection Vehicle
R/D : Record of Discussions
RDF : Refuse Derived Fuels
RHC : Rural Health Centre
Rs. : Pakistan Rupee
SAAMA : Service and Asset Management Agreement
SEA : Strategic Environmental Assessment
SECP : Securities and Exchange Commission of Pakistan
SIE : Small Industrial Estate
SMS : Short Message Service
SNS : Social Networking Service
SOP : Standard Operation Procedures
STEPS : Social Transmission & Environmental Protection Society
SWM : Solid Waste Management
TMA : Teshil Municipal Administration
USD : United States Dollar
UU : The Urban Unit
WACS : Waste Amount and Composition Survey
WASA : Water and Sanitary Agency
WB : The World Bank
WSS : Water Supply, Sewerage and Sanitation
WTP : Willingness to Pay

CHAPTER 1. INTRODUCTION

1.1 Background of the Project

Solid Waste Management (hereinafter referred to as "SWM") has become a serious problem in Punjab due to rapid urbanisation, uncontrolled population, lack of resources, institutional weaknesses and lack of civic sense towards solid waste disposal. The average solid waste collection efficiency in Punjab is only around 50%, causing spread of multiple diseases such as diarrhea and dengue fever.* Whatever quantity of waste collected is, normally seen as waste dumped in open areas along the roadside, canal bank and low-lying areas. Soil contamination is affecting the quality of groundwater from shallow depth. Un-collected waste is illegally piled on sidewalks, in open spaces, sewer lines, or even in canals, and blockage of wastewater flow in the sewers are seen, causing additional problem by the local government. (Note:* The relationship between solid waste management and diseases has been well known broadly from the public health point of view. For example, see the following papers: Robert J. Anderson, M.D., "The Public Health Aspect of Solid Waste Disposal", *Public Health Reports,* Vol. 79, No. 2, February 1964, pp. 93-96; Ministry of the Environment, Japan, "History and Current State of Waste Management in Japan", February 2014; Masaaki Osawa, Takayuji Shimaoka and Hirofumi Nakayama, "Waste Management Roles in the Improvement of Public Hygiene", *Journal of Material Cycles and Waste Management,* Vol. 20, No. 5, pp. 291-302, 2009.)

In the Punjab Vision 2020, waste management is located under the priority area of water supply, sewerage and sanitation (hereinafter referred to as "WSS"), and through the Urban Unit (hereinafter referred to as "UU") of the Government of the Punjab (hereinafter referred to as "GOPb"), solid waste management strategy was developed as the *Guidelines of Solid Waste Management* issued in 2007. GOPb has been tackling the issues which contribute to an improvement of SWM based on the guidelines. However, the budget for SWM in Punjab is restrictive, and about 80% of the budget is spent on personnel expenses or institutional administrative expenses. Moreover, although SWM is to be performed under the responsibility of each district government under the law, the manner on how to conduct SWM effectively and efficiency under their limited human resources and budget has been an important issue to be solved, since the laws or guidelines on SWM are not fully implemented.

In 2009, the Japan International Cooperation Agency (hereinafter referred to as "JICA") commissioned a sector study to take stock of the current status, problems, and necessity of assistance in the SWM sector in seven major cities of Punjab Province: Faisalabad, Gujranwala, Lahore, Multan, Rawalpindi, Sargodha and Sialkot. Through the study, the degree of assistance necessary for SWM, SWM related budget, number of related department personnel, existence of master plan, existence of other donor support, existence of self-financed activities, motivation/commitment of top management, etc., were investigated. Based on the results of the study, followed by a series of discussions made by GOPb and JICA, the necessity of assistance for the SWM sector was ascertained, and in addition, Gujranwala City was identified as the highest priority among the surveyed cities considering the highly motivated top management and SWM related staff, non-existence of donor support, the problem of conducting waste collection under the limited budget, etc.

The Government of Japan (hereinafter referred to as "GOJ") received the official request for the Technical Cooperation to formulate the Master Plan to address improvement of SWM in Gujranwala from the Economic Affairs Division (hereinafter referred to as "EAD"), which was submitted by the City District Government Gujranwala (hereinafter referred to as "CDGG") through UU on 30 July 2010. GOPb has also a plan to replicate the results of the Project to other major cities in Punjab.

In response to the request from the Government of Pakistan (hereinafter referred to as "GOP"), the Japanese Detailed Planning Study Team (hereinafter referred to as "the Team") was dispatched by JICA to Pakistan for the purpose of discussing and confirming the scope of work for the ***Project for Integrated Solid Waste Management Master Plan in Gujranwala*** (hereinafter referred to as "the Project") from 28 September to 19 October 2011.

The Project was started in February 2014 upon agreement on the "Record of Discussions" (hereinafter referred to as "R/D") that was reached between GOP and JICA on the 20th of February 2013.

After the commencement of the Project, the Pakistani side requested JICA to amend the R/D in March 2014. In response to the request, JICA held a series of discussions with the authorities concerned of GOP, GOPb and CDGG. As a result, both sides agreed on the second amendment and signed the Minutes of Meetings on the 14th of May 2014.

1.2 Outline of the Project

1.2.1 Objective of the Project

The objectives of the Project are set out as follows:

- To develop a Master Plan of Integrated Solid Waste Management for Gujranwala City including the peri-urban area of Gujranwala;
- To enhance the institutional capacity for implementation of the SWM Master Plan; and
- To draw lessons and best practices for replication of the master plan in other major cities in Punjab.

1.2.2 Project Site

The Project covers the whole area of Gujranwala City including the peri-urban area of Gujranwala, as shown in the Location Map.

1.2.3 Project Schedule

The Project, in principle, will be carried out from February 2014 to December 2015 although the original schedule was that the Project would end up on July 2015, because the second visit to Pakistan planned in August 2014 was postponed for almost one month due to security reasons. The total duration of the project will be changed to approximately 22 months divided into three phases: Phase 1 from March 2014 to December 2014; Phase 2 from January 2015 to May 2015; and Phase 3 from June 2015 to December 2015. Reports as listed below will be submitted in the course of the Project. A Joint Coordinating Committee (hereinafter referred to as "JCC") Meeting as a kick-off event was held on 27 March 2014, and other seminars will be held after submission of the Interim Report and Draft Final Report, respectively.

Reports to be submitted are as set out below:

- Inception Report, to be submitted within seven (7) days after commencement of the Project;
- Progress Report, to be submitted at the end of Phase 1 (December 2014);
- Interim Report, to be submitted at the end of Phase 2 (around April 2015);
- Draft Final Report, to be submitted at the end of the last survey period in Pakistan (around August 2015); and
- Final Report, to be submitted within two (2) months after receiving JICA's comments on the Draft Final Report.

1.3 Administration of the Project

The proposed organisational structure is given in **Figure 1.3.1,** which was confirmed in the first JCC meeting held on 27 March 2014.

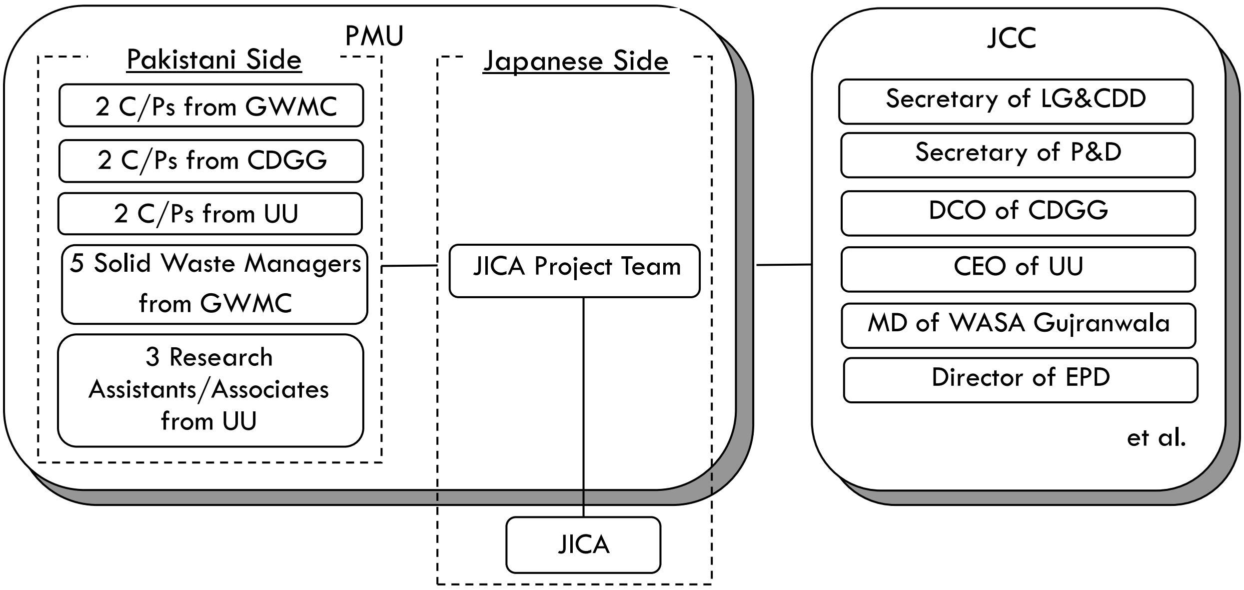


Figure 1.3.1 Organisational Chart of the Project

Note: GWMC: Gujranwala Waste Management Company; CDGG: City District Government Gujranwala; LG&CDD: Local Government and Community Development Department; P&D: Planning & Development Department; DCO: District Coordination Officer; CEO: Chief Executive Officer; MD: Managing Director; WASA: Water and Sanitary Agency; EPD: Environmental Protection Department

1.3.1 Project Management Unit (PMU)

JICA Project Team, CDGG and GOPb had created the Project Management Unit (hereinafter referred to as "PMU") which is implementing and managing the Project, as shown in **Figure 1.3.1**.

1.3.2 Joint Coordinating Committee (JCC)

The Joint Coordinating Committee (JCC) was established to facilitate inter-organisational coordination. Its members were appointed as shown in **Figure 1.3.1.** JCC meetings are held whenever it is deemed necessary.

The JCC supports the implementation of the Project through the following roles:

- To review the progress and achievements of the whole Project; and
- To provide advice concerning the result of the Project based on experience and technical knowledge of the parties involved in the Project.

1.4 Limitations of the Project

Since an appropriate Integrated Solid Waste Management (hereinafter referred to as "ISWM") system requires a long period of time to achieve because the system is in general complicated and is composed of many integrated sub-systems related to technical, social, environmental and political issues that influence each other, adjustments are required, especially in the way of raising public awareness that shall be supported by local governments and communities which is necessary in the long run. In addition, impacts on local communities by the introduction of proposed systems, including waste collection, waste charges and composting, shall be carefully examined even after completion of the Project due to the extremely limited time of execution of the Project. The results of hospital waste and industrial waste study shall also be reviewed and updated after more detailed surveys and analyses because it is beyond the scope of the Project and the difficulty of data collection limits the completeness of the discussions in this report.

1.5 Staffing Schedule of the Project

The members of the PMU are as listed in the following **Table 1.5.1**.

Table 1.5.1 Members of the Project Management Unit (PMU)

Name	Designation or Field of Expertise
Pakistani Side	
Dr. Ata-ul-Haq	Managing Director, Gujranwala Waste Management Company (GWMC)
Murad Rana	Senior Manager (Operation), GWMC
-	Executive District Officer (EDO) (MS: Municipal Services), City District Government Gujranwala (CDGG) [*1]
Nauman Raza	District Officer (DO) (Additional Charge for SWM), CDGG
Dr. Kiran Farhan	Senior SWM Specialist, The Urban Unit (UU)
Kashif Nadeem	UU
Fatima Zia	Waste Manager, GWMC
Hina Aslam	Waste Manager, GWMC
Ambreen Ghazanfar	Waste Manager, GWMC
Aqsa Sadiq	Waste Manager, GWMC
Hina Ishaque	Waste Manager, GWMC
Arkham Wahid	Research Assistant, UU
Umama Saleh	Research Assistant, UU
Sami Ullah	Research Assistant, UU
JICA Project Team	
Masakazu MAEDA	Team Leader / Solid Waste Management / Waste Collection & Transportation Plan 1
Masaharu TAKASUGI	Final Disposal Plan
Kazuhiko NAKAMURA	Waste Collection & Transportation Plan 2
Shinsuke HORI	Intermediate Treatment and 3R Promotion / Administrative Coordinator 2[*2]
Keigo ITO	Intermediate Treatment and 3R Promotion / Administrative Coordinator 2[*3]
Shinsuke OKAMOTO	Environmental Education
Takehiko OGAWA	Economic and Financial Analysis
Hisato TAKEDA	Environmental and Social Considerations[*4]
Yasumi TSUTSUI	Environmental and Social Considerations[*5]
Keiko TSUJI	Institutional Strengthening / Administrative Coordinator 1

Note: [*1] EDO (MS) is a vacant position as of March 2015.
[*2] The assignment was started from March 2014 and ended to December 2015.
[*3] The assignment was started from February 2015.
[*4] The assignment was started from March 2014 and ended to April 2014.
[*5] The assignment was started from August 2014.

The staffing schedule of the JICA Project Team is as shown in **Figure 1.5.1**.

	Role	Name	Company	2014											2015											M/M	
				JFY2013		JFY2014												JFY2015									
				2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	Pakistan	Japan
Pakistan	Team Leader / Solid Waste Management / Waste Collection and Transport Plan 1	Mr. Masakazu MAEDA	CTII		3/3 37 (1.23)	4/8				8/30	9/7 9 (0.30)		11/26	12/26 31 (1.03)		2/5 41 (1.37)	3/17		36 (1.20)			45 (1.50)				6.63	
	Final Disposal Plan	Mr. Masaharu TAKASUGI	NJS		3/8 35 (1.17)	4/11				8/30	35 (1.17)	10/3	11/20	45 (1.50)	1/3	2/15	3/26 40 (1.33)		40 (1.33)			35 (1.17)				7.67	
	Waste Collection and Transport Plan 2	Mr. Kazuhiko NAKAMURA	NJS		3/8 35 (1.17)	4/11				8/30	9/13 15(0.50)		11/20	45 (1.50)	1/3	2/2	60 (2.00)	4/2	35 (1.17)			35 (1.17)				7.50	
	Intermediate Treatment and 3R Promotion / Administrative Coordinator 2	Mr. Shunsuke HORI	CTII		3/8 41 (1.37)	4/17				8/30 10 (0.33)	9/13 5 (0.17)			12/10 12/19 10 (0.33)												2.03 (0.17)	
	Intermediate Treatment and 3R Promotion / Administrative Coordinator 2	Mr. Keigo ITO	CTII													2/16 36 (1.20)	3/28 5 (0.17)					33 (1.10)	7 (0.23)			2.30 (0.40)	
	Environmental Education	Mr. Shinsuke OKAMOTO	EX		3/15 22 (0.73)	4/5										2/12	3/13 30 (1.00)					23 (0.77)				2.50	
	Economic and Financial Analysis	Mr. Takehiko OGAWA	CTII		3/7 30 (1.00)	4/5										2/28	3/29 30 (1.00)					45 (1.50)				3.50	
	Environmental and Social Considerations	Mr. Hisato TAKEDA	NJS		3/19 18 (0.60)	4/5																				0.60	
	Environmental and Social Considerations	Ms. Yasumi TSUTSUI	NJS							8/30	9/25 27 (0.90)					2/27	35 (1.17)	4/2				25 (0.83)				2.90	
	Institutional Strengthening / Administrative Coordinator 1	Ms. Keiko TSUJI	CTII		3/8 20 (0.67)	4/17 21 (0.70)										2/12 29 (0.97)	3/17 5 (0.17)					25 (0.83)				2.50 (0.83)	
																									Subtotal	38.13	
Japan	Team Leader / Solid Waste Management / Waste Collection and Transport Plan 1	Mr. Masakazu MAEDA	CTII	6 (0.30)									6 (0.30)					6 (0.30)					10 (0.50)				1.40
	Final Disposal Plan	Mr. Masaharu TAKASUGI	NJS	2 (0.10)									2 (0.10)					2 (0.10)					2 (0.10)				0.40
	Waste Collection and Transport Plan 2	Mr. Kazuhiko NAKAMURA	NJS	2 (0.10)									2 (0.10)					2 (0.10)					2 (0.10)				0.40
	Intermediate Treatment and 3R Promotion / Administrative Coordinator 2	Mr. Shunsuke HORI	CTII										2 (0.10)														0.10
	Intermediate Treatment and 3R Promotion / Administrative Coordinator 2	Mr. Keigo ITO	CTII																				4 (0.20)				0.20
	Environmental Education	Mr. Shinsuke OKAMOTO	EX										2 (0.10)										4 (0.20)				0.30
	Economic and Financial Analysis	Mr. Takehiko OGAWA	CTII										2 (0.10)										4 (0.20)				0.30
	Environmental and Social Considerations	Ms. Yasumi TSUTSUI	NJS										2 (0.10)										4 (0.20)				0.30
	Institutional Strengthening / Administrative Coordinator 1	Ms. Keiko TSUJI	CTII										2 (0.10)										4 (0.20)				0.30
																									Subtotal (NOT changed)		3.70
	Reports				▲Inception Report(Mar)									Progress Report(Dec)▲				Interim Report(Apr)▲				Draft Final Report(Aug)▲			▲Final Report(Nov)		
	Seminar/JCC Affiliate Consultation				◆JCC(1)						★Stakeholders Meeting(1)			◆JCC(2)			◆JCC(3)		Stakeholders Meeting(2)/ Seminar(1) ★			◆JCC(4) ★Seminar(2)					

Legend :	
▬	Work in Pakistan
▭	Work in Japan
▨	Work in Pakistan at private expenses

CTII : CTI Engineering International Co., Ltd.
NJS : NJS Consultants Co., Ltd.
EX : EX Research Institute Ltd.

Figure 1.5.1 Staffing Plan of the JICA Project Team

CHAPTER 2. DESCRIPTION AND EVALUATION OF CURRENT CONDITION

2.1 Introduction

The JICA Project Team started the first field work in Pakistan on 3 March 2014 and completed it on 15 April 2014 to collect relevant data and information. Subsequently, a JCC meeting was held on 27 March 2014 to discuss the results. The second visit was made between 30 August and 3 October 2014 to prepare the contracts for the site surveys, such as soil investigation and topographic survey for disposal sites, social survey, and water quality survey, and to conduct the remaining data collection and site reconnaissance. The third visit was made between 20 November 2014 and 3 January 2015 to follow up and receive some of the results of the site surveys. In this period, the second JCC meeting was held to review the Progress Report that was submitted to the JICA headquarters and the Pakistani side including a part of the results of the site surveys. The minutes of meeting is attached as **Annex** in this report. The results of the site surveys are used as basic data for the identification and evaluation of the existing conditions of solid waste management (SWM) in Gujranwala. This chapter presents the current condition of SWM mainly in terms of technical, financial and institutional aspects.

First of all, the survey on generated waste amount and composition in the city at present are explained in **Section 2.2** although the survey for the first and second seasons was finished. In view of the technical approaches, collection and transportation, final disposal and intermediate treatment and 3R studies were conducted as described in **Sections 2.3, 2.4** and **2.5,** respectively. Environmental education and public awareness on SWM is considered in **Section 2.6** as well, based on the results of the public and establishment awareness survey and field investigation.

As other important components for implementation of the SWM programme, the city's economic and financial conditions are analysed in **Section 2.7**. **Section 2.8** covers the environmental and social considerations on the current situation of SWM, outlines the existing laws and regulations related to the environmental and social considerations in Pakistan, and reviews the environmental impact assessment (EIA) on a candidate final disposal site.

Finally, from the institutional point of view, the analysis and evaluation of the present arrangements, not only for institutional but also organisational and human resource management aspects, are carried out and described in **Section 2.9**. The current conditions of hospital and industrial, and construction and demolition waste are additionally described in **Section 2.10.**

2.2 Waste Amount and Composition Survey (WACS)

2.2.1 Objective of the Survey

The Solid Waste Amount and Composition Survey (hereinafter referred to as "WACS") was started as a part of the study for Integrated Solid Waste Management Master Plan in Gujranwala to identify the amount and composition of the different types of waste generated in Gujranwala City. The characteristics of representative municipal solid wastes were obtained through the WACS for domestic waste, commercial waste, institutional waste, market waste, street waste, etc., at the waste generation sources. The results/analysis of WACS are used for the basic data to formulate the waste collection, 3R, intermediate treatment and waste disposal plans for review, updating and formulation of the SWM Master Plan.

The WACS was contracted out with a local contractor and its field survey was started in October 2014 and continued up to June 2015 to cover three different seasons including the wet and dry seasons. The results of the first field survey conducted from 13 to 20 October 2014 and the second field survey from 9 to 16 February 2015 are now under compilation and encoding for the analysis planning.

2.2.2 Waste Amount Survey

(1) Type of Waste Generation Sources and Number of Samples

The types of waste generation sources and number of samples for the waste amount survey according to the generation sources are shown in **Table 2.2.1**.

Table 2.2.1 Types of Waste Generation Sources and Number of Samples for Waste Amount Survey

Type		Waste Amount Survey				
		Area	Samples per Area	Number of Samples	Survey Days	Total Samples
				A × B		C × D
		A	B	C	D	E
Household	High Income	2	5	10	8	80
	Middle Income	6	5	30	8	240
	Low Income	4	5	20	8	160
	Rural Area	2	5	10	8	80
Commercial	Restaurants	1	5	5	8	40
	Others	1	5	5	8	40
Markets (Food, Vegetable, etc.)		5	2	10	8	80
Institution		5	1	5	8	40
Street Sweeping		1	1	1	8	8
Park		1	1	1	8	8
Total			---	97	---	776

Note: The number of samples is for one season only.

(2) Union Council Classification

The division of Gujranwala urban union councils (UCs) into high, middle and low income areas on the basis of income level was a pre-requisite to the conduct of various surveys including this WACS for the subject master plan. However, the data regarding these three income levels per UC is not available. Therefore, the criterion used for this classification was set by infrastructure including road condition and width, and house size and landscape. The views of the field staff of GWMC deployed in jurisdiction areas and the observations made after visiting the representative areas were taken into account for this task, as described below.

- Level of Infrastructure

  The UCs having small houses and mostly unpaved and narrow streets are categorised as low income areas where the sanitation service is poor and most of the drains are open. The UCs tagged as high income areas have bigger houses and wider streets and receive relatively good sanitation services. The UCs in middle income areas are situated in between the two. The houses in middle income areas mostly range from 5 to 10 *marlas* (from 126.47 m^2 to 252.93 m^2).

- Level of Income

  Actually, it is quite difficult to obtain the data of income level for each household in Pakistan. The classification as shown below is, therefore, not based on any scientific research but only for reference.*

  High Income : more than Rs. 100,000 per month
  Middle Income : from around Rs. 20,000 up to Rs. 100,000 per month
  Low Income : less than around Rs. 20,000 per month

Note:* *http://www.dawn.com/news/219652/defining-income-groups:* Afshan Subohi, *Defining income groups, Dawn published Nov 20, 2006 12:00 am.* The range of income level is modified based on this article.

(3) Survey Method

This survey has selected a total of 97 sampling points from each type of waste generation source to obtain the waste amount discharge ratio by generation source. The selection of sampling areas for each type was made through discussion between the Pakistani side and the JICA Project Team in the initial stage of the Project. The number of sampling points is summarised in the table above. The Contractor has carried out the survey and obtained 8-day results of at least the total number of samples for each type as shown in the table.

It is necessary that sampling is conducted for the duration of eight days consecutively. The result of the first day sample is disregarded assuming that the first day may have some waste accumulated together with the previous day. The first day sampling is carried out to familiarise the participating sectors and the JICA Project Team personnel on the collection of samples.

Before the execution of sampling, the required number of plastic bags was distributed to all selected sampling points except the points for market waste. Samples discharged from markets were collected by a collection vehicle specially assigned to the Project.

Each plastic bag of collected waste from the sampling points is bound with code numbers according to the generation source, so that no intermingling of samples will occur. Then, the amount of waste is measured by weight and recorded on the recording sheet at the collection points.

For market wastes transported by collection trucks, the collection truck loaded with waste is measured by a weighbridge before going to the disposal site for the waste composition survey.

The Contractor obtained the necessary data/information for estimation of unit waste generation rate on each type of waste generation resource in consultation of the Client.

The waste amount survey included the sampling of amounts of recycling material of self-treated waste at each generation source. The unit generation amount at each generation source was verified through comparative examination with existing data.

(4) Survey Result

The waste generation amount per capita per day of each generation source is as shown in **Table 2.2.2**. The average waste generation amount per capita per day of the four groups in residential areas ranges from 0.33 kilogrammes per capita per day (kg/c/d) to 0.46 kg/c/d, as shown in **Figure 2.2.1.**

Table 2.2.2 Waste Generation Rate of Each Generation Source

Type		Unit	Waste Generation (kg/day)		
			1st Survey 13-20 October 2014	2nd Survey 9-16 February 2015	Average
Household	High Income	person	0.46	0.45	0.46
	Middle Income	person	0.41	0.36	0.39
	Low Income	person	0.40	0.40	0.40
	Rural Area	person	0.33	0.36	0.35
Commercial	Restaurants	establishment	11.00	20.00	16.00
	Others	establishment	2.10	2.10	2.10
Markets (Food, Vegetable, etc.)		market	200.00	360.00	280.00
Institution		establishment	4.70	9.00	6.90
Street Sweeping		m	0.61	0.19	0.40
Park		park	9.40	10.00	9.70

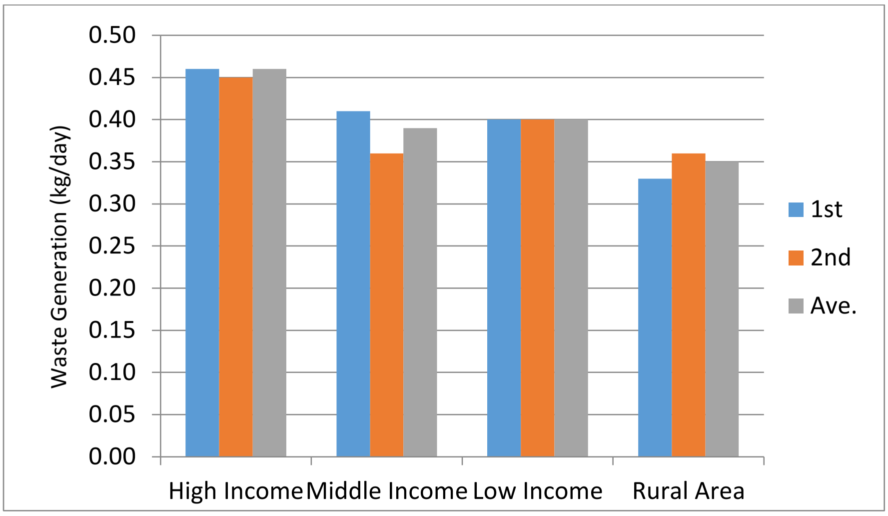


Figure 2.2.1 Waste Generation per Capita in Household in Gujranwala

2.2.3 Waste Composition Survey (Physical Composition: Wet Base)

(1) Type of Waste Generation Sources and Number of Samples

The type of waste generation sources and number of samples for waste composition survey according to the generation sources are shown in **Table 2.2.3** below. This sample came from the reduction method described in Item (2) below; that is, the sample of Waste Amount Survey in the previous section is different from that of Waste Composition Survey in this section.

Table 2.2.3 Types of Waste Generation Sources and Number of Samples for the Waste Composition Survey

Type of Waste Generation Source		Waste Composition Survey		
		Samples	Survey Days	Number of Physical Composition
				F × G
		F	G	H
Household	High Income	1	8	8
	Middle Income	1	8	8
	Low Income	1	8	8
	Rural Area	1	8	8
Commercial	Restaurants	1	8	8
	Others	1	8	8
Markets (Food, Vegetable, etc.)		1	8	8
Institution		1	8	8
Street Sweeping		1	8	8
Park		1	8	8
Total		10	-	80

Note: The number of samples is for one season only.

(2) Survey Method

The samples analysed are among those extracted during the waste amount survey. Samples from ten discharge sources, i.e., residential sources (high, middle and low income groups, and rural areas as the peri-urban area) and non-residential sources (restaurants, other commercial entities, markets, institutions, streets, park), are brought to the workshop of the Gujranwala Waste Management Company (GWMC) separately. The samples of large waste generation sources are then subjected to the reduction method that entails repetition of the process below until the intended sampling weight of approximately 200 kg is obtained.

- Mixing of wastes; bulky items in waste are cut into pieces.
- Division of waste into four piles of approximately the same volume once the mixture is homogeneous.
- Removal of two portions at diagonally opposite ends and the mixture of the remaining amount.

The above procedures are illustrated in **Figure 2.2.2**.

Then, the waste is loaded into a plastic bucket. The plastic bucket containing the waste is dropped three times from a height of 30 cm to the ground, and then the volume is measured by a measuring tape and the total weight by a scale.

The Apparent Specific Gravity (ASG) is calculated through the following formula:

$$\text{ASG} = \text{Weight of Waste (kg)}/\text{Volume of Waste } (\text{m}^3)$$

Then the physical composition of waste is sorted into the following 15 items:

1. Kitchen waste
2. Paper (recyclable/clean paper)
3. Paper (other paper)
4. Textile
5. Grass and wood
6. Plastic (recyclable plastic)
7. Plastic (non-recyclable plastic)
8. Leather and rubber
9. Metal (recyclable metal)
10. Metal (non-recyclable metal)
11. Bottle and glass (recyclable bottles and glasses)
12. Bottle and glass (non-recyclable bottles and glasses)
13. Ceramic, stone and soil etc.
14. Domestic hazardous wastes
15. Miscellaneous

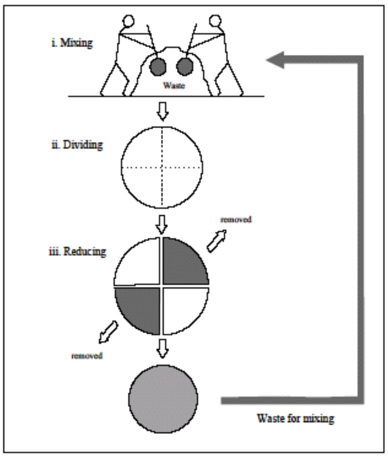


Figure 2.2.2 Method of Physical Composition Analysis

(3) Survey Result

The average waste composition in the first and second survey season was adopted to calculate the physical composition of waste. The results are summarised in **Table 2.2.4** and **Table 2.2.5**, and presented also in **Figure 2.2.3** and **Figure 2.2.4**. From these tables and figures, the characteristics of the two survey results are summarised as follows:

- The highest percentage of waste composition is kitchen waste from households (43-68%), restaurants (77-90%) and markets (49-78%) followed by paper (3-15%) or plastics (7-12%).
- High percentage of grass and wood from institutions (43-48%), street sweeping (3-17%) and parks (66-76%) can be observed because they might include garden waste.
- Except the waste from street sweeping, the ratio of organic waste is quite high at 68 to 99%.
- The ratio of recyclable material such as paper, plastic, metal and glass from households varies from 4% to 10%, and its average is around 5.6% considering the rate of population for each

income group (Detailed discussions are presented in **Section 4.3**).

Table 2.2.4 Waste Composition of Each Generation Source (First Survey)

(Unit: %)

Waste Composition		Household				Commercial		Market	Institution	Street sweeping	Park
		High Income	Middle Income	Low Income	Rural Area	Restau-rants	Others				
Kitchen Waste		66.3	55.2	67.6	42.9	76.9	1.2	49.0	5.3	3.5	3.2
Paper	Paper (recyclable/clean)	7.4	5.2	3.2	2.9	13.8	52.1	6.7	10.8	1.7	1.0
	Paper (others)	0.5	1.9	0.5	0.2	0.6	3.8	0.4	0.8	0.3	0.2
	Subtotal-Paper	*7.9*	*7.1*	*3.7*	*3.1*	*14.4*	*55.9*	*7.1*	*11.6*	*2.0*	*1.2*
Textile		5.4	5.7	4.9	3.8	0.1	5.5	2.4	0.5	1.8	0.1
Grass and wood		0.4	0.7	0.5	9.3	0.0	0.0	26.8	42.6	16.7	76.3
Plastics	Plastic (recyclable)	1.8	1.4	0.8	0.8	0.0	3.8	0.1	0.8	0.1	7.4
	Plastic (non-recyclable)	9.8	8.4	10.9	6.6	7.3	25.3	4.7	7.4	3.5	2.0
	Subtotal-Plastic	*11.6*	*9.8*	*11.7*	*7.4*	*7.3*	*29.1*	*4.8*	*8.2*	*3.6*	*9.4*
Leather and rubber		0.6	1.5	1.8	0.5	0	0.0	0.6	0.0	0.2	0.2
Organic Waste - Subtotal		**92.2**	**80.0**	**90.2**	**67.0**	**98.7**	**91.7**	**90.7**	**68.2**	**27.8**	**90.4**
Metal	Metal (recyclable)	0.2	0.5	0.1	0.5	0.0	0.0	0.1	0.5	0.0	0.0
	Metal (non-recyclable)	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	7.2
	Subtotal-Metal	*0.2*	*0.5*	*0.1*	*0.5*	*0.0*	*0.4*	*0.1*	*0.5*	*0.0*	*7.2*
Bottle and glass	Bottle and glass (recyclable)	0.3	1.0	1.5	0.0	1.3	5.5	0.0	0.2	0.1	0.0
	Bottle and glass (non-recyclable)	1.0	0.5	0.7	0.0	0.0	1.7	0.2	0.3	0.0	0.0
	Subtotal-Bottle and glass	*1.3*	*1.5*	*2.2*	*0.0*	*1.3*	*7.2*	*0.2*	*0.5*	*0.1*	*0.0*
Ceramic, stone and soil etc.		0.5	8.3	2.5	27.2	0.0	0.1	8.5	30.7	72.1	1.2
Inorganic Waste - Subtotal		**2.0**	**10.3**	**4.8**	**27.7**	**1.3**	**7.7**	**8.8**	**31.7**	**72.2**	**8.4**
Domestic Hazardous Waste		0.5	1.0	0.8	0.5	0.0	0.1	0.5	0.0	0.0	0.3
Miscellaneous		5.3	8.7	4.2	4.8	0.0	0.5	0.0	0.1	0.0	0.9
Total		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 1). (This work was subcontracted to the company by the JICA Project Team under the Project.

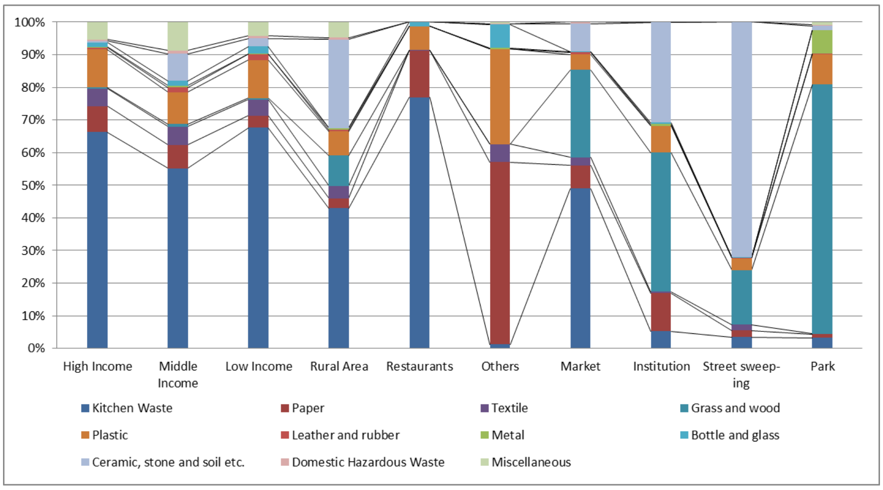


Figure 2.2.3 Physical Composition of Each Generation Source (First Survey)

Table 2.2.5 Waste Composition of Each Generation Source (Second Survey)

(Unit: %)

Waste Composition		Household				Commercial		Market	Institu-tion	Street sweep-ing	Park
		High Income	Middle Income	Low Income	Rural Area	Restau-rants	Others				
Kitchen Waste		68.0	55.6	63.9	60.9	89.8	4.0	78.1	2.8	16.0	20.3
Paper	Paper (recyclable/clean)	2.6	2.6	2.7	2.8	0.2	14.4	0.7	3.0	0.9	1.1
	Paper (others)	12.4	15.2	10.4	3.7	2.6	33.3	4.1	5.1	4.8	1.6
	Subtotal-Paper	*15.0*	*17.8*	*13.1*	*6.5*	*2.8*	*47.7*	*4.8*	*8.1*	*5.7*	*2.7*
Textile		2.3	5.9	3.4	3.0	2.2	7.2	1.3	0.7	1.6	0.5
Grass and wood		1.5	1.6	1.8	5.0	0.2	0.2	4.2	47.8	3.3	66.1
Plastics	Plastic (recyclable)	1.2	1.0	0.6	1.6	0.0	5.4	0.1	0.8	0.3	0.5
	Plastic (non-recyclable)	5.8	7.8	6.7	5.3	4.1	23.8	3.2	6.7	3.2	5.2
	Subtotal-Plastic	*7.0*	*8.8*	*7.3*	*6.9*	*4.1*	*29.2*	*3.3*	*7.5*	*3.5*	*5.7*
Leather and rubber		1.0	1.0	0.3	1.2	0.2	1.8	0.4	0.1	0.1	0.7
Organic Waste - Subtotal		**94.8**	**90.7**	**89.8**	**83.5**	**99.3**	**90.1**	**92.1**	**67.0**	**30.2**	**96.0**
Metal	Metal (recyclable)	0.4	0.2	0.1	0.6	0.0	0.7	0.0	0.2	0.0	0.0
	Metal (non-recyclable)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Subtotal-Metal	*0.4*	*0.2*	*0.1*	*0.6*	*0.0*	*0.7*	*0.0*	*0.2*	*0.0*	*0.0*
Bottle and glass	Bottle and glass (recyclable)	0.9	1.3	0.9	0.6	0.3	3.4	0.0	0.0	0.1	0.3
	Bottle and glass (non-recyclable)	0.2	0.2	0.0	0.7	0.3	0.0	0.0	0.7	0.0	0.0
	Subtotal-Bottle and glass	*1.1*	*1.5*	*0.9*	*1.3*	*0.6*	*3.4*	*0.0*	*0.7*	*0.1*	*0.3*
Ceramic, stone and soil etc.		0.5	1.8	1.0	2.9	0.0	0.4	0.9	5.3	2.4	0.2
Inorganic Waste - Subtotal		**2.0**	**3.5**	**2.0**	**4.8**	**0.6**	**4.5**	**0.9**	**6.2**	**2.5**	**0.5**
Domestic Hazardous Waste		0.6	0.9	0.3	0.3	0.1	0.3	0.0	0.1	0.3	0.0
Sieve Remaining		1.7	4.0	4.0	4.6	0.0	3.7	3.5	6.0	18.5	1.3
Miscellaneous		0.9	0.9	3.9	6.8	0.0	1.4	3.5	20.7	48.5	2.2
Total		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 1). (This work was subcontracted to the company by the JICA Project Team under the Project.

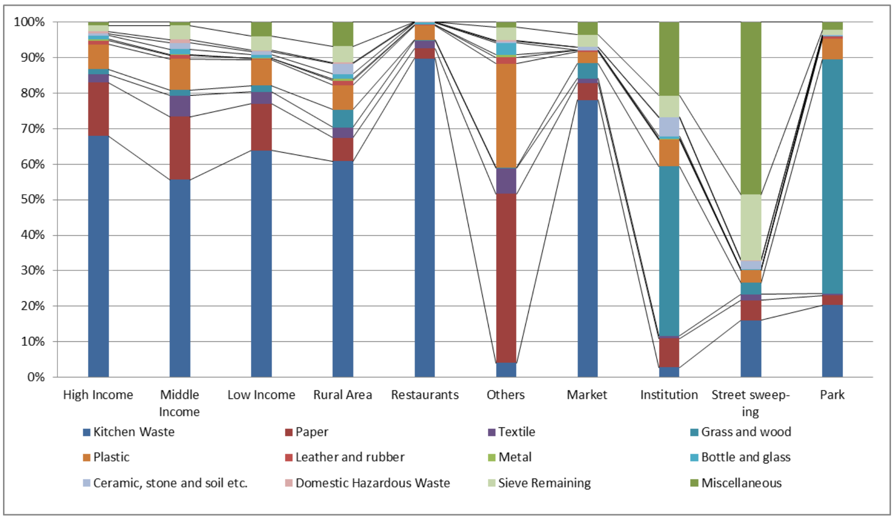


Figure 2.2.4 Physical Composition of Each Generation Source (Second Survey)

The Apparent Specific Gravity (hereinafter referred to as “ASG”) of solid waste in ton/m^3 is an important tool required to assess the total mass and volume of waste. The average ASG calculation results for each generation source survey in the first and second time are shown in **Figure 2.2.5.** As shown in the following figure, commercial waste especially those from restaurants have the highest apparent specific gravity of about 0.5 ton/m^3 while the other commercial waste from shops have the lowest. The apparent specific gravity of household is at around 0.25 ton/m^3.

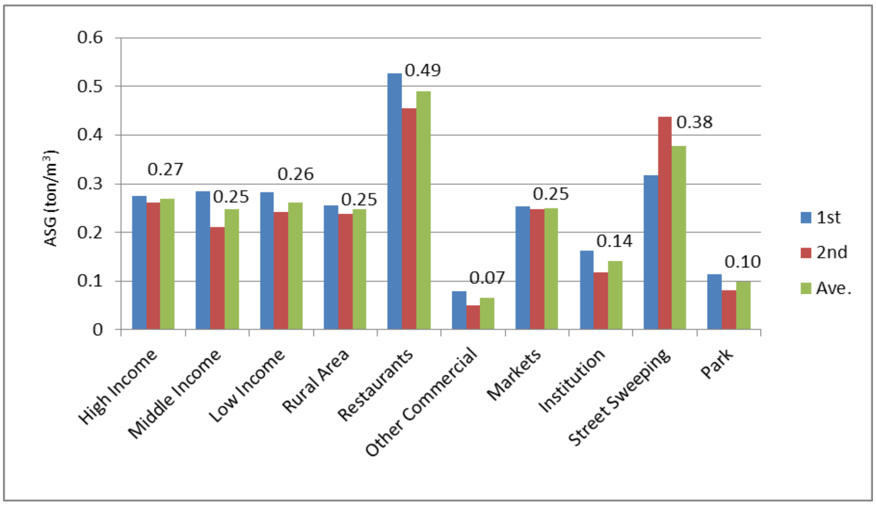


Figure 2.2.5 Apparent Specific Gravity

2.2.4 Three (3) Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis

(1) Type of Waste Generation Sources and Number of Samples

In consideration of the possibility of intermediate treatment, the large waste discharge amount from domestic waste and market waste is subject to the Three Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis. Three Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis is carried out for the waste discharge sources/types specified in **Table 2.2.6**. The total number of samples for the analysis is as follows:

Three Components Analysis	:	3 samples × 3 days × 4 discharge sources = 36 samples
Carbon and Nitrogen Analysis	:	3 samples × 3 days × 4 discharge sources = 36 samples
Moisture Contents	:	3 samples × 3 days × 4 discharge sources = 36 samples

Table 2.2.6 Number of Samples for Chemical Composition Survey

Type		Chemical Composition Survey			
		Discharge Source	Three Component Analysis	Carbon and Nitrogen Analysis	Moisture Contents
		F	Samples	Samples	Samples
Households	High Income	1	3 × 3 days = 9	3 × 3 days = 9	3 × 3 days = 9
	Middle Income	1	3 × 3 = 9	3 × 3 = 9	3 × 3 = 9
	Low Income	1	3 × 3 = 9	3 × 3 = 9	3 × 3 = 9
Markets (Food, Vegetable, etc.)		1	3 × 3 = 9	1 × 3 = 9	3 × 3 = 9
Total		4	36	36	36

Note: Number of samples is for one season only.

(2) Survey Method

Data and information from the Three (3) Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis of wastes are used as the basic data for considering the introduction of intermediate treatment facilities. The following analysis is carried out:

- Analysis of the three components (waste types 1 to 15)
- Analysis of Carbon and Nitrogen concentration in wastes (waste type 1, 2, 3 and 5)
- Measurement of moisture content of combustible waste (waste type 1, 2, 3, 4, 5 and 8)

The above analysis is carried out for seven consecutive days in eight days as shown in **Table 2.2.7** below.

Table 2.2.7 Daily Schedule of Chemical Composition Survey

Physical Composition	1st Day	2nd Day	3rd Day	4th Day	5th Day	6th Day	7th Day
1. Kitchen Waste		3 components; C and N; Moisture content		3 components; C and N; Moisture content		3 components; C and N; Moisture content	
2. Paper (recyclable /clean paper)		3 components; C and N; Moisture content		3 components; C and N; Moisture content		3 components; C and N; Moisture content	
3. Paper (non-recyclable/clean paper)		3 components; C and N; Moisture content		3 components; C and N; Moisture content		3 components; C and N; Moisture content	
4. Textile		3 components; Moisture content		3 components; Moisture content		3 components; Moisture content	
5. Grass and Wood		3 components; C and N; Moisture content		3 components C and N; Moisture content		3 components; C and N; Moisture content	
6. Plastic (recyclable plastic)		3 components		3 components		3 components	
7. Plastic (non-recyclable plastic)		3 components		3 components		3 components	
8. Leather and Rubber		3 components; Moisture content		3 components; Moisture content		3 components; Moisture content	
9. Metal (recyclable metal)		3 components		3 components		3 components	
10. Metal (non-recyclable metal)		3 components		3 components		3 components	
11. Bottle and Glass (recyclable bottles and glasses)		3 components		3 components		3 components	
12. Bottle and Glass (non-recyclable bottles and glasses)		3 components		3 components		3 components	
13. Ceramics, Stone and Soil, etc.		3 components		3 components		3 components	
14. Domestic Hazardous Waste		3 components		3 components		3 components	
15. Miscellaneous		3 components		3 components		3 components	

Note: "Three (3) components" is obtained from the result of waste composition survey and water content for estimating the percentage of combustible waste, incombustible waste including ash and water content.

(3) Survey Result

Data and information from the Three (3) Component Analysis, Carbon and Nitrogen Analysis, and Moisture Contents Analysis of wastes are used as the basic data for considering the introduction of intermediate treatment facilities.

For this study, the chemical analysis considered was the chemical property analysis of the three contents, namely; moisture, ash and combustible. The average results of the three-content analysis for each generation source in the first and second seasons are shown in **Table 2.2.8** and **Figure 2.2.6**. The three components exhibit almost the same tendency, i.e., the ratio of moisture, ash and combustible ranges from around 67% to 74%, 4% to 13% and 20% to 23%, respectively. Wastes from the high income groups in residential areas showed the highest value of moisture content while the market wastes have the highest percentages of ash content.

Table 2.2.8 Results of Three-Component Analysis of Each Generation Source

Type of Waste Generation Source		Moisture		Ash		Combustible	
		1st 2nd	Average	1st 2nd	Average	1st 2nd	Average
Household	High Income	70.28	74.2	1.82	3.6	27.90	22.2
		78.03		5.44		16.53	
	Middle Income	63.25	69.8	10.02	8.7	26.73	21.5
		76.28		7.39		16.33	
	Low Income	65.46	71.7	2.95	5.7	31.59	22.6
		77.89		8.49		13.63	
Markets (Food, Vegetable, etc.)		65.62	67.0	8.95	12.7	25.43	20.3
		68.33		16.49		15.18	

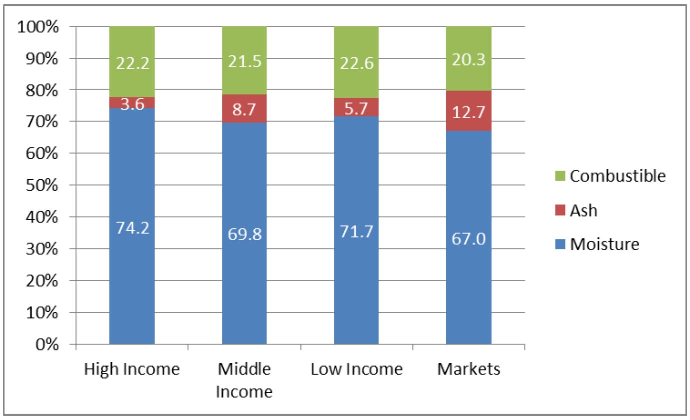


Figure 2.2.6 Results of Three-Component Analysis

2.3 Waste Collection and Transportation Study

2.3.1 Time and Motion Study for Collection Work

(1) General

There is no organised data/record and information available for the waste management activities especially for the efficiency of waste collection and transportation vehicles in operation in Gujranwala. The Time and Motion Study was therefore conducted to evaluate the efficiency of waste collection and transportation by the vehicles operated by the Gujranwala Waste Management Company (GWMC). The first field survey was carried out by the JICA Project Team with the collaboration of GWMC and the Urban Unit (UU), Government of the Punjab from 9 December to 24 December 2014. The results of the survey are evaluated as the basic data for the waste collection and transportation plan while the second survey is to be implemented in April 2015.

(2) Objective of the Study

The objectives of the Time and Motion Study are as follows:

- To grasp the operation conditions of the different types of waste collection and transportation vehicles in service;
- To evaluate the loading, unloading, travelling and total operational time from the viewpoints of loading, unloading and total operation time in relation to waste collection and transportation amount, travelling distance and fuel consumption; and
- To develop the basic data for the formulation of a waste collection and transportation plan.

(3) Study Method

Four (4) teams consisting of the Waste Managers, Research Assistants (hereinafter referred to as “counterparts”) and survey assistants carried out the Study under the guidance of the JICA Project Team. The study included the recording of time for travelling, loading and unloading of waste, tracking of the collection route and travelling distance, waste collection amount, fuel consumption and waste collection operation efficiency, etc.

All of the activities from the starting point of the collection vehicles (i.e., GWMC Workshop hereinafter referred to as “garage” located at Sheikhupura Road) to the collection points and return to the garage were recorded as to time and route by GPS devices. The main activities carried out during the field survey are summarised as follows:

- Chasing of the objective collection vehicle and the recording of time consumed for each stop/departure by GPS device;
- Recording of the mileage of odometre respectively for start of collection work, end of collection work, arrival at disposal site for unloading, start of 2nd/3rd collection work, etc., in data sheets;
- Recording by GPS device of the collection route of each objective vehicle;
- Recording of the fuel consumption of each vehicle, and
- Recording of observed road conditions, traffic conditions, condition of collection points, workers behaviour, etc.

(4) Study Result

The primary purpose of using a mini-dumper is to collect waste from narrow streets or roads that are not accessibleto tractor trolleys and arm-roll trucks. Tractor trolleys were used for both waste collection and transportation whereas the arm-roll trucks were to transport the wastes collected by handcarts and donkey carts from the primary collection points to the dump site. The number of vehicles subjected to the field survey of 5 days was 8 and the total number of samples collected was 40.

The results of the field survey were evaluated based on the average values computed and tabulated in **Table 2.3.1** for the key factors of waste collection and transportation activities. As mentioned above, due to the different types of services allotted to each t vehicles, the values cannot be compared simply but comparison or evaluation of the performance or the efficiency of the three types of vehicles are described in the following subsections.

Table 2.3.1 Summary of Waste Collection and Transportation Analysis by Vehicle Type

No.	Evaluation Items	Vehicle Type		
		Arm-roll truck	Tractor trolley	Mini-dumper
1.	Average Waste Handling Amount (kg)	12,050.0	3,502.0	2,430.0
2.	Average Mileage (km)	144.0	50.0	49.0
3.	Average Number of Trips (times/day)	4.6	1.7	5.4
4.	Average Number of Crews (persons)	1.0	2.7	2.5
5.	Average Loading Time (minutes: min.)	40.0	193.0	282.0
6.	Average Travelling Time (min.)	364.0	265.0	234.0
7.	Average Unloading Time (min.)	40.0	12.0	31.0
8.	Average Total Operating Time (min.)	444.0	480.0	547.0
9.	Average Mileage per Unit Fuel Consumption (km/litre)	4.1	3.4	5.4
10.	Average Waste Handling Amount per Unit Distance (kg/km)	84.0	69.0	50.0
11.	Average Waste Handling Amount per Loading Time (kg/hr)	1,774.0	1,084.0	517.0
12.	Average Waste Amount per Travelling Time (kg/hr)	1,979.0	793.0	622.0
13.	Average Waste Handling Amount per Total Time (kg/hr)	1,620.0	446.0	266.0
14.	Average Waste Handling Amount per Unit Fuel Consumption (kg/litre)	345.0	245.0	266.0

(a) Average Waste Handling Amount (kg)

The value indicates the average amount of waste handled per day or shift of each type of vehicle used for the waste collection and transportation or only for waste collection or transportation.

An arm-roll truck was used only for transferring the waste containers to the disposal site. The amount of waste carried by an arm-roll truck per day (12 tons) is 3.5 times more than that of a tractor trolley (3.5 tons) although it cannot be compared simply with the performance of a tractor trolley which was used both for waste collection and waste transportation.

Mini-dumpers collect less waste (2.4 tons) compared with the tractor trolleys which collect and transport waste since mini-dumpers have many collection points and waste loaded is only 517 kg/hr (see **Item (l)** below).

(b) Average Mileage (km)

Arm-roll trucks were used only for hauling a waste container to the disposal site, so that the number of trips and travelling distance is more. The Daily average mileage of an arm-roll truck is 144km, which is approximately three times more than that of the tractor trolley (50km). Tractor trolleys were used for waste collection and transportation, but most of them are old so that performance was low, and the average travelling distance per shift was shorter.

Mini-dumpers are allocated in the surrounding area of waste container sites which are used currently as the temporary transfer stations. The mini-dumpers collect waste form many points and the loading time is long, so that the average travelling distance per shift is short. The daily average mileage of both the tractor trolley and mini-dumper is almost the same at 50km, respectively.

(c) Average Number of Trips (times/day)

The number of trips in a day for the arm-roll truck is from 3 to 5 and 4.6 on average while that of the tractor trolley is only one or two and 1.7 on average. The mini-dumper operates more frequently at 4 to 5 trips a day and 8 at maximum and 5.4 on average although the mini-dumper has many collection points. Since all tractor trolleys are old and consume more fuel, there is a tendency that the arm-roll trucks and mini-dumpers are preferable to be used in the site.

(d) Average Number of Crew (persons)

The average number of crew per arm-roll truck, tractor trolley or mini-dumper is 1.0, 2.7 and 2.5, respectively. The arm-roll truck requires one driver only; however, the tractor trolley or the mini-dumper always require one or two loaders and one driver. In terms of manpower, the tractor trolley is the most efficient.

(e) Average Loading Time (minutes: min.)

The arm-roll trucks are to load, transport and unload the waste containers. Therefore, they do not take much time to load wastes (40 min.) and takes only about one-fifth of the operation time compared with that of the tractor trolley (193 min.). On the other hand, the mini-dumpers take 4 hours and 42 minutes (282 min.) to load waste, which is almost equal to 50 percent of the total working time per day.

When the efficiency of average loading time of each vehicle is compared with the average waste loading time per waste amount per trip, the arm-roll truck has 0.7 min./ton/trip (=40/12.05/4.6), the tractor trolley has 32 min./ton/trip (=193/3.50/1.7), and the mini-dumper has 21 min./ton/trip (=282/2.43/5.4). Based on these results, the loading time by the tractor trolley is the longest of the three while the arm-roll truck shows very high efficiency.

(f) Average Traveling Time (min.)

The travelling time of arm-roll truck is longer than the others. The time is spent for frequent round-trips between the waste container sites and the disposal site. Around 6 hours per day or 80% of the total operating time is spent for the travelling time.

Average travelling time of the tractor trolley is 4 hours and 25 minutes (265 min.) per day. The average transportation time of the mini-dumper is about 4 hours per day (234 min.), which is 40% of the total operating time per day. Average travelling time will be used for comparing average travelling time per waste amount.

(g) Average Unloading Time (min.)

The unloading time of each type of vehicle varies depending on the number of transportation times. The arm-roll trucks transport waste containers and unload the waste at the disposal site about 5 times per day for spending the total unloading time of 40 minutes.

On the other hand, tractor trolleys transport waste 2 times and spend 12 minutes for the daily operation. The total unloading time of a mini-dumper is 31 minutes, and it was found that the unloading time at the disposal site is more than 5 times at the temporary transfer station site.

(h) Average Total Operating Time (min.)

The longest total operating time per day was approximately 9 hours by the mini-dumper (547 min.). The average total operating times per day of the arm-roll truck and tractor trolley are 7 hours and 24 minutes (444 min.), and 8 hours (480 min.), respectively.

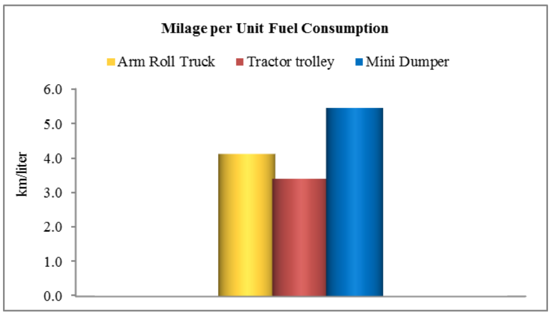


Figure 2.3.1 Mileage per Unit Fuel Consumption by Type of Vehicle

(i) Average Mileage per Unit Fuel Consumption (km/litre)

The average mileage per unit fuel consumption of a mini-dumper is the highest among the three objective vehicles calculated at 5.4km per litre. The engine capacity of a mini-dumper is 800cc, which is relatively small compared with that of the other two types of vehicle and it reflects the fuel consumption efficiency of the vehicle.

The average mileage per unit fuel consumption of a tractor trolley is calculated at 3.4 km per litre which is the worst value among the three vehicles. The tractor trolley is not good at travelling long distances. In addition, these vehicles have been used for more than 10 years. Therefore, it is considered that the vehicle is decrepit. Reference also shall be made to **Figure 2.3.1**.

(j) Average Waste Handling Amount per Unit Distance (kg/km)

The total waste hauling amount per mileage covered by the arm-roll truck is 84 kg/km which is the highest among the three types of vehicle. The total waste hauling amount per mileage covered by the tractor trolley is 69 kg/km while the mini-dumper truck performed only 50 kg/km. Due to the difference of utilisation purpose of each type of vehicle (transfer, transfer and collection, and collection), however, the average waste handling amount per unit distance cannot be simply compared. Reference also shall be made to **Figure 2.3.2**.

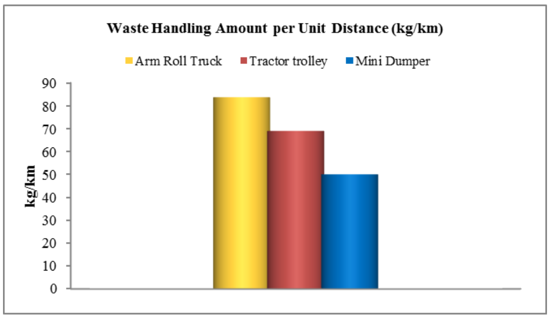


Figure 2.3.2 Waste Handling Amount per Unit Distance by Type of Vehicle

(k) Average Waste Handling Amount per Loading Time (kg/hr)

The average waste handling amount per loading time of arm-roll truck is 1.8 tons per hour which is 1.7 times more than that of the tractor trolley (1.1 tons). The waste handling amount per loading time of the mini-dumper is approximately 0.5 tons per hour which is one-half of the performance of the tractor trolley. This is because of the operation mode of the mini-dumper for collection of waste from many collection points including door-to-door collection although this value also cannot be compared simply due to the difference of utilisation purpose of each type of vehicle.

(l) Average Waste Handling Amount per Travelling Time (kg/hr)

The average waste handling amount per travelling time of the arm-roll truck is approximately 2 tons per hour which is the most efficient value among the three types of vehicle. The handling amount per travelling time of arm-roll truck is approximately 2.5 times higher than that of the waste handling amount of the tractor trolley (0.8 tons).

The result of mini-dumper is the lowest at 0.6 tons per hour due to the collection from many collection points including door-to-door collection. This value also cannot be compared simply due to the difference of utilisation purpose of each type of vehicle for transportation, collection and transportation or only for waste collection.

(m) Average Waste Handling Amount per Total Time (kg/hr)

The average waste handling amount per total operating time of arm-roll truck is approximately 1.6 tons/hr, which is the highest value among the three types of vehicle. The mini-dumper performed approximately 0.3 tons/hr, which is 60 % of the value performed by of the tractor-trolley (0.4 tons/hr).

From the result of average waste handling amount per total operating time of arm-roll truck and mini-dumper, it was found that the capacity of 6 units of mini-dumper is

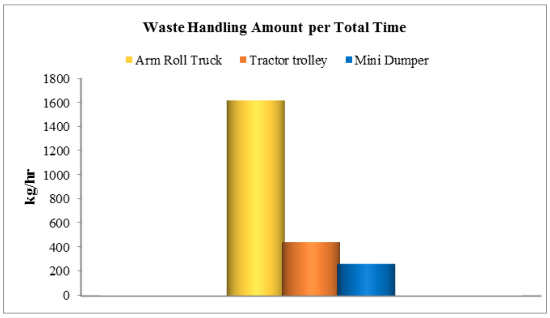


Figure 2.3.3 Waste Handling Amount per Total Time by Type of Vehicle

equivalent to the capacity of one unit of arm-roll truck. These values also cannot be compared simply due to the difference of the utilisation purpose or service of each type of vehicle. Reference shall be made also to **Figure 2.3.3**.

During the field survey, the key factors regarding loading, unloading and travelling times which consist of the total time were observed as explained in detail in **Table 2.3.2**.

Table 2.3.2 Key Factors affecting Operation Time during the Survey

Objective	Arm-roll truck	Tractor trolley	Mini-dumper
Loading Time	40 minutes (min.) (9% of total time)	3:13 (hr : min.) (41% of total time)	4:42 (hr : min.) (52% of total time)
	a) Driver has to wait for a container to be fully filled due to late transportation of primary collected waste. b) Partial filling and littering of waste outside the container. c) Improper location of container and traffic problem. d) Loaded the container from the temporary transfer station and skipped the allotted containers.	a) Lack of designated crew for loading. b) Delay due to late sweeping of roads/ streets by sanitation satff. c) Timing of traffic congestion at school and offices ite. d) Routes to access the containers are also used by mini-dumpers. e) In UC-19 & 46, handcarts are also unloaded from mini-dumpers and tractor trolleys.	
Traveling Time	6:04 (hr : min) (82% of total time)	4:25 (hr : min) (56% of total time)	3:54 (hr : min) (43% of total time)
	a) Container was not or partially filled at the arrival of arm-roll truck and the driver had to move the vehicle to find some other allotted points for loading filled/partially filled container. b) Allotted containers are not from adjacent UCs and far from each other. c) Fan belt of Hino-11 was broken.	a) Travelled at a speed of 5-6km/hr. b) 20 years old machinery, engine struck out of TT-9774, Gear Plate and Hauling Jack of TT-Holland-1 was out of order, Belt of cylinder broke out and tyre of Holland-2 was also punctured.	a) Most drivers made first trip with partially filled dumper. b) Travelled at slow speed to avoid the littering of waste.
Unloading Time	40 minutes (9% of total time)	12 minutes (3% of total time)	31 minutes (5% of total time)
	a) Absence of record keeper at 7:30 a.m. b) Delay in alignment of remaining waste of previous day at Gondlanwala. c) Delay due to dumping of other vehicles at designated points.	a) Bucket unloaded the waste from tractor trolley (Holland-1) due to the problem in hauling jack.	a) Delay due to dumping of other mini-dumpers at the transfer station.

(n) Average Waste Handling Amount per Fuel Consumption (kg/litre)

The average waste handling amount per fuel consumption or per unit fuel amount of the arm-roll truck, tractor trolley and mini-dumper are calculated at 345 kg, 245 kg and 266 kg per litre, respectively. This means that the arm-roll truck collects and transports 1.4 times the amount of waste per litre compared with that of the tractor trolley in the area where a mini-dumper does not collect waste.

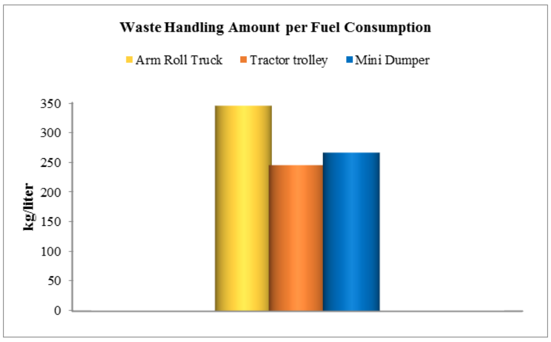


Figure 2.3.4 Comparison of Waste Collection and Transportation Vehicles against Fuel Consumption

In case of waste collection and transportation by the combination of mini-dumper and arm-roll truck, the mini-dumper needs to have 1.3 litre of fuel for collecting 345 kg of waste which is the waste amount transported by one arm roll truck. In this case, 345 kg of waste is collected and transported by mini-dumper and arm-roll truck using 2.3 litre of fuel.

Thus, this combination of two types of vehicle, i.e., mini-dumper and arm-roll truck has the capability of waste collecting and transporting 150kg of waste per litre (=345kg/2.3litre). Comparing the value with that of the result of tractor trolley that was 245 kg/litre, the number of average waste handling amount per fuel consumption of these two vehicles is approximately 60% of the value performed by the tractor trolley. Reference also shall be made to **Figure 2.3.4**.

(5) Major Findings and Recommendations

Based on the results of the time and motion study, major findings and the matters to be recommended with respect to improvement of the operation of waste collection and transportation vehicles are as summarised below.

- The arm-roll truck with a container is the most efficient vehicle among the three types in terms of handling waste amount, operating time and manpower. However, since the container placement is limited to relatively wide roads or vacant spaces, the utilisation of mini-dumpers for narrow streets/roads recommendable.
- Average mileage of the tractor trolley is as low as 3.4 km/litre and the traveling performance as well as waste handling amounts is low. In addition, most of the tractor trolleys are aging, so that maintenance costs wood increase. Tractor trolley shall therefore be replaced with other appropriate types of vehicle as soon as possible from the viewpoint of cost-effectiveness.
- Loading efficiency of mini-dumper is quite low at 517 kg/litre due to the large number of collection points and door-to-door operation. The loading efficiency must be improved by increasing the number of workers to two persons and asking cooperation from the residents on the method of discharging waste from their households.
- The efficiency of the combination work by mini-dumper and arm-roll truck for collection and transportation work is lower than that of the performance of tractor trolley in terms of fuel consumption. Since the distance to the disposal site is less than 10 km from the centre of the city and not much time and fuel is needed, this kind of waste transfer operation shall be limited to the minimum to save on cost.

In addition to the recommendations above, the following matters observed and learned during the survey are also recommended to improve operations:

- The parking lot for each vehicle at GWMC garage should be fixed because the early comer drivers have to wait for the late comers and this results in the delay to start the waste collection service.
- Repair and maintenance equipment for tire puncture, etc., should also be made available at the GWMC garage, since most of the drivers do not check the vehicles at the start of operation, which causes the problems during the work.
- Waste collection points and routes for each vehicle should be defined for routine work since the driver has to call and sometimes ask about the next collection points and this causes the waste of time.
- Route of mini-dumper should be different from that of donkey cart and handcart to avoid duplication of the service area and the service area can be maximised.
- Adjacent container points should be allocated to each arm-roll truck to avoid extra traveling distance for loading and transporting the waste.
- UC supervisor should supervise the container points sine arm-roll trucks skip their designated container points and load the container from the temporary transfer station to meet their allotted 4-5 trips per shift.

2.3.2 Present Status of Waste Collection and Transportation Work

(1) Functions of the GWMC

GWMC currently collects solid waste generated in only 64 UCs and covers the following functions:

(i) Waste collection and transportation
(ii) Street cleansing
(iii) Drainage and gutter cleansing along streets (partially*)
(iv) Dead animal collection
(v) Others

Note:*The width of more than two feet is managed by WASA and GWMC is responsible for the remaining drainage and gutters.

GWMC collects some construction and demolition wastes while cleaning the city roads/streets although it is not obligated to collect them. The issues on construction and demolition waste are as presented in **Subsection 2.10.3**.

(a) Primary Collection

Basically, residents throw waste into containers allotted by GWMC if there is a container near their houses, but containers are not located all over the city [see **Item (3)**]. Therefore, sanitary workers collect the garbage put in front of the door of each household. In some places, sanitary workers collect garbage directly from the residents. The hearing survey is to clarify that sanitary workers receive some amount of money from households in this case.

The hearing survey is also to clarify that there are few cases where some retired sanitary workers conduct primary collection and receive collection fee from households. Some waste pickers take valuables out from the garbage put outside the door of households and pass the remaining waste to the sanitary workers. Valuable wastes in the garbage from households are collected by waste pickers or sanitary workers.

There is no waste collection service in some union councils (UCs). In these areas, residents throw their garbage into nearby open plots and on the streets. The waste left on the open plots and streets are then scattered by animals scavenging for food, and these become illegal dumping sites.

(b) Secondary Collection

The situation of secondary garbage collection conducted by GWMC is summarised as follows:

- Collection System: One to three 5m^3 containers and/or 10m^3 containers, and normally 6 to 7 handcarts are deployed in each UC. However, the number of containers is limited, so that no container is deployed in some parts of a UC.
- Frequency of Collection: Garbage collection from the containers is made every day. If the container is not full, the garbage is not collected.
- Collection Method: Collection is by arm-roll truck, tractor trolley or mini-dumper based on the infrastructure conditions such as road width, accessibility and space for placement. The current collection service is carried out by a combination of 37 tractor trolleys working together with 7-8 units of handcarts deployed at each UC and 26 units of arm-roll trucks and 35 mini-dumpers for the 231 units of waste containers placed in the town area.
- Collection Equipment: Arm-roll truck, tractor trolley, mini-dumper, handcart, donkey cart and motorbike.
- The collection method varies depending mainly on the size of road. An arm-roll truck and a tractor trolley are utilised on large and medium-sized streets. In a small street, the donkey cart and handcart is utilised. Since the end of 2014, GWMC started using mini-dumpers instead of donkey carts and handcarts for the collection of waste.

(2) Service Area

GWMC collects garbage from the whole city of Gujranwala which consists of 64 union councils (UCs) and the service area for waste collection is demarcated by the same UCs' boundary as shown in **Figure 2.3.6 (next page)**. As shown in this figure, there are three categories in terms of waste collection service level covered by GWMC, namely; the served area, partially served area and unserved area. **Table 2.3.3** shows the area of each category and the ratio to total area. GWMC provides the waste collection services for 76% of the total area of 64 UCs including the partially served area while 34 UCs in the peri-urban area are not covered by GWMC collection services. Detailed analysis regarding the service area is given in **Subsection 4.3.1**.

Table 2.3.3 Waste Collection Service Coverage Area and Its Percentage

Service Coverage	Area (km^2)	Percentage (%)	
		Of 64 UCs	Of 98 UCs
64 UCs			
Served	22.6	34.8	6.9
Partially served	26.7	41.2	8.1
Unserved	15.7	24.0	4.8
Sub-Total	*65.0*	*100.0*	
34 UCs in peri-urban area			
Unserved	262.6	-	80.2
Total	327.6	-	100.0

After GWMC's commencement of operation, the UCs were divided into 8 zones for management purposes, as shown in **Figure 2.3.5**.

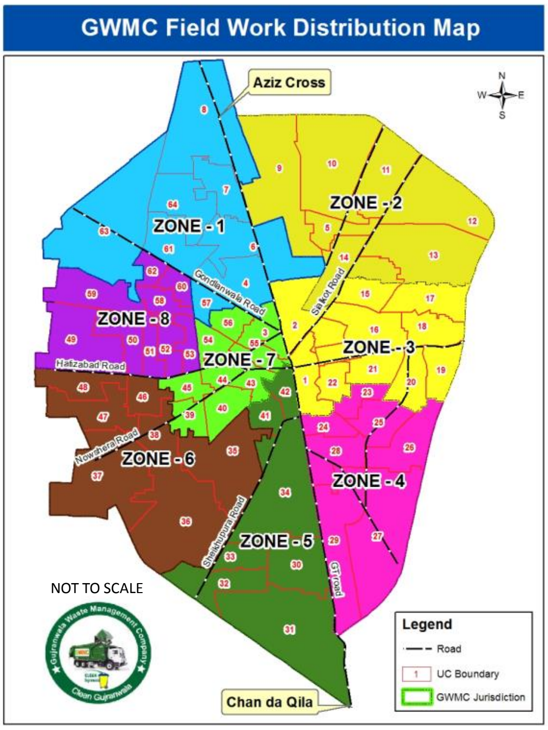


Figure 2.3.5 Zoning Map of GWMC Service Area

Source: GWMC

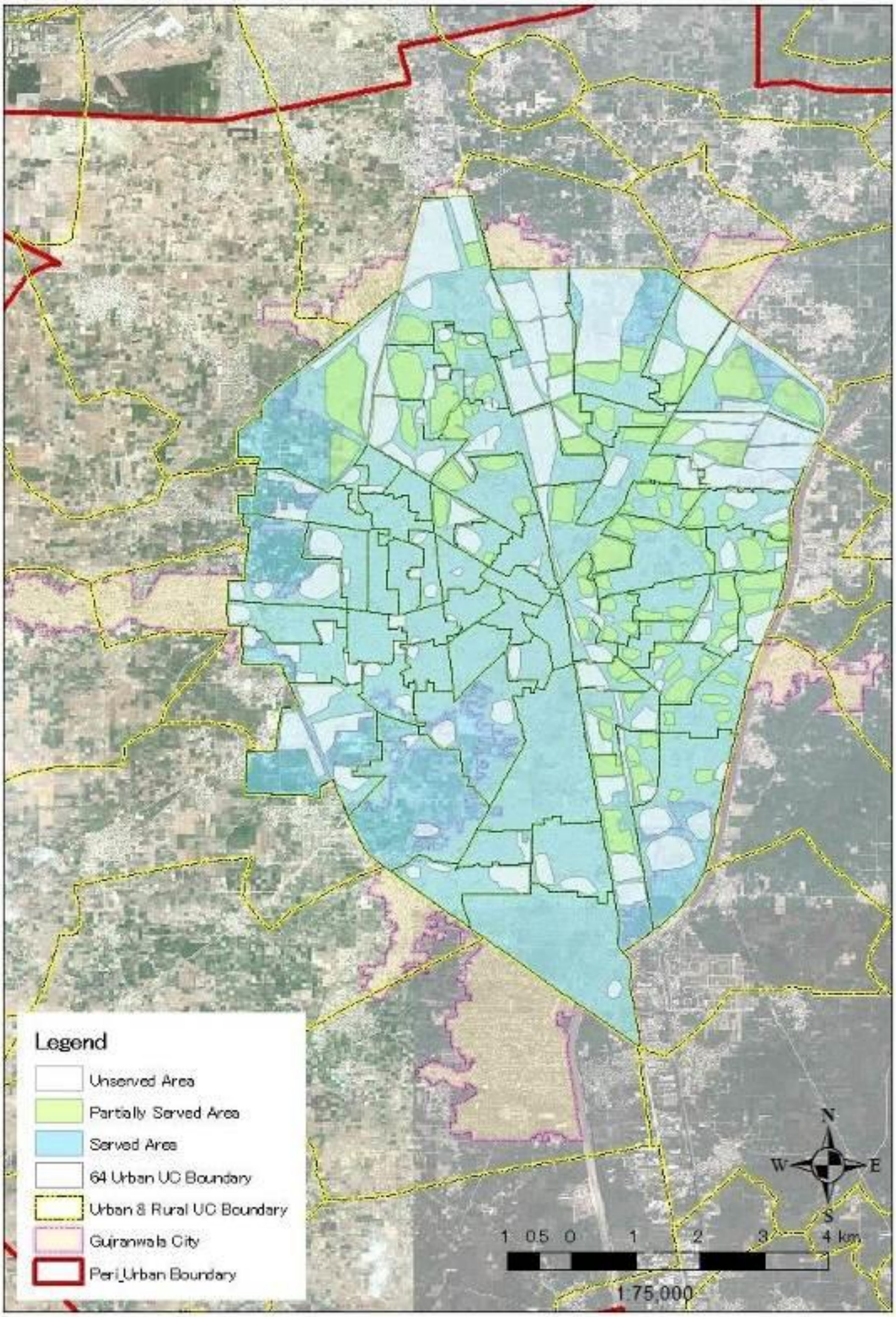


Figure 2.3.6 Service Area Map of Waste Collection in Union Councils

Source: GWMC, April 2014.

(3) Location of Garbage Containers

Some 216 sets of 5m^3 containers and 15 sets of 10m^3 garbage containers (see **Photo 2.3.1**) were allocated in Gujranwala City as of January 2015, as shown in **Table 2.3.4** and **Figure 2.3.7.** Considering the size of the city, the number of containers seems inadequate. To offset the situation, handcarts and/or donkey carts are utilised for garbage collection from households to the garbage containers. In addition, 24 dust bins are located in the city.

5m^3 container

10m^3 container

Photo 2.3.1 Shapes of 5m^3 and 10m^3 Garbage Containers

Table 2.3.4 Location of Garbage Containers in Gujranwala City

Location	UC Number/Road	Number of Containers		
		5m^3 Containers	10m^3 Containers	Total
Zone 1	4, 6, 7, 8, 57, 61, 63, 64	19	2	21
Zone 2	5, 9, 10, 11, 12, 13, 14	19	0	19
Zone 3	1, 2, 15, 16, 17, 18, 19, 20, 21, 22	36	0	36
Zone 4	23, 24, 25, 26, 27, 28, 29	25	2	27
Zone 5	30, 31, 32, 33, 34, 41, 42	33	0	33
Zone 6	35, 36, 37, 38, 46, 47, 48	19	0	19
Zone 7	3, 39, 40, 43, 44, 45, 54, 55, 56	14	1	15
Zone 8	49, 50, 51, 52, 53, 58, 59, 60, 62	13	0	13
Miscellaneous	G.T. Road, Sialkot Road, Sheikhupura Road	16	5	21
Workshop		0	2	2
On Arm-rolls		22	3	25
Total		216	15	231

Source: GWMC, January 2015.

Containers are supposed to be allocated in each UC. However, the number of containers allocated is not planned by GWMC, but based on the request of individual UCs. In other words, the location of containers is determined by the infrastructure conditions and residents' consent of each UC; that is, all the streets/roads are not wide enough to lift and place the containers. Moreover, most residents are reluctant to place a container near their houses, shops or stores due to the smell, flies, etc. Some of the UCs are therefore without containers and far from the location of containers, which resulted in the illegal dumping in the city.

Empty 5m^3 containers are attached to 22 arm-roll trucks and empty 10m^3 containers are attached to the arm-roll trucks before the daily collection starts. The reason for this is that the empty container is placed at the edge of the road to replace the container full of garbage which will be taken by the trucks to the final landfill site. Life duration of containers is approximately 5 to 7 years. Repair work for the container is conducted in the workshop. However, malfunctions that could not be fixed at the workshop are repaired by outsourcing.

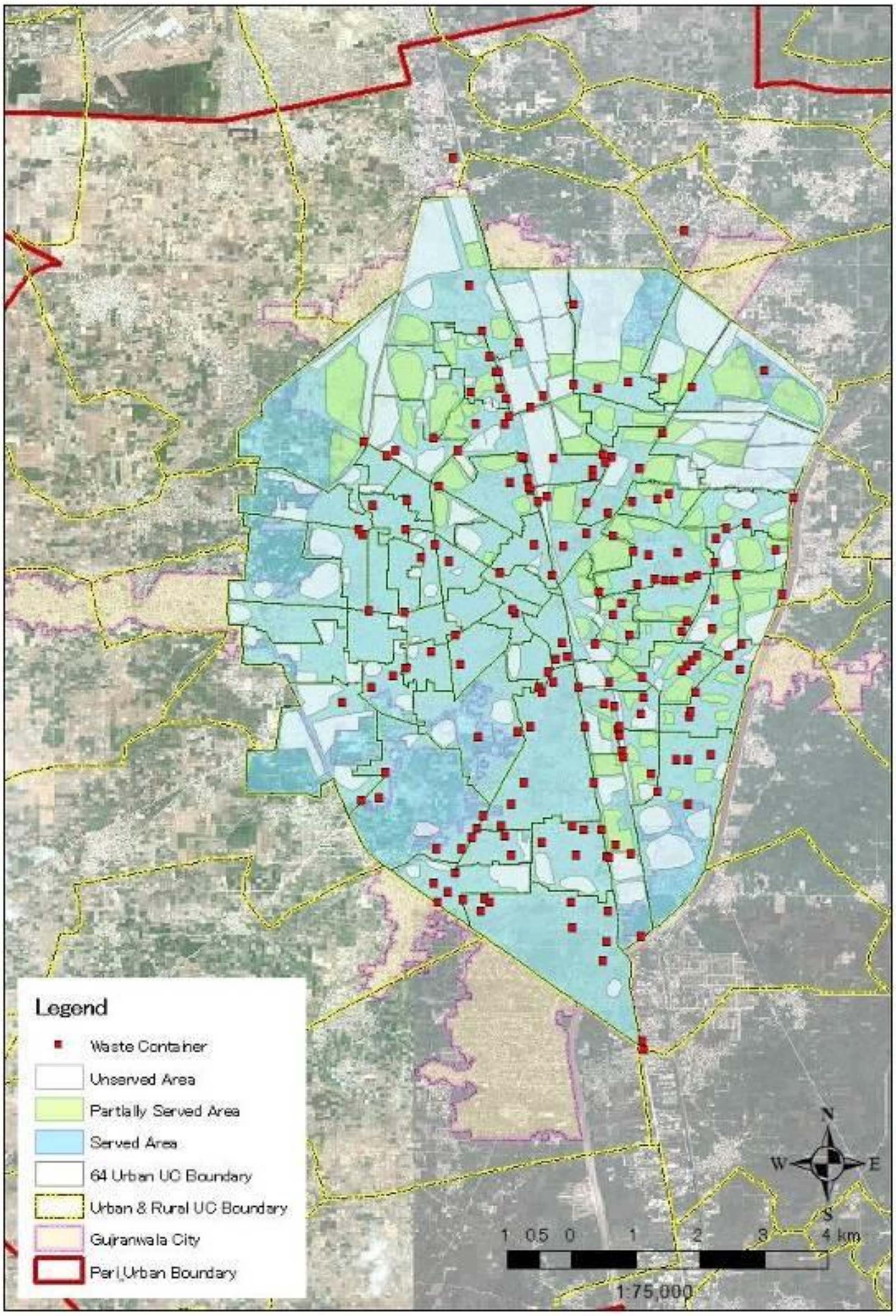


Figure 2.3.7 Location Map of Garbage Containers in Gujranwala City

Source: GWMC, April 2014.

(4) Transfer Station

(a) Function of Transfer Station

There are five (5) transfer stations/masonry enclosures in the city; namely, the Khali, Garjakh, and General bus stations, DHQ Hospital and Khan Maha. They were called transfer stations, but the containers are put on the concrete floor, practically, and only receive garbage from the surrounding UCs. There is no function such as transfer of garbage from other.

(b) Location and Operation Status on each Transfer Station

Figure 2.3.8 shows the location of transfer stations in Gujranwala City.

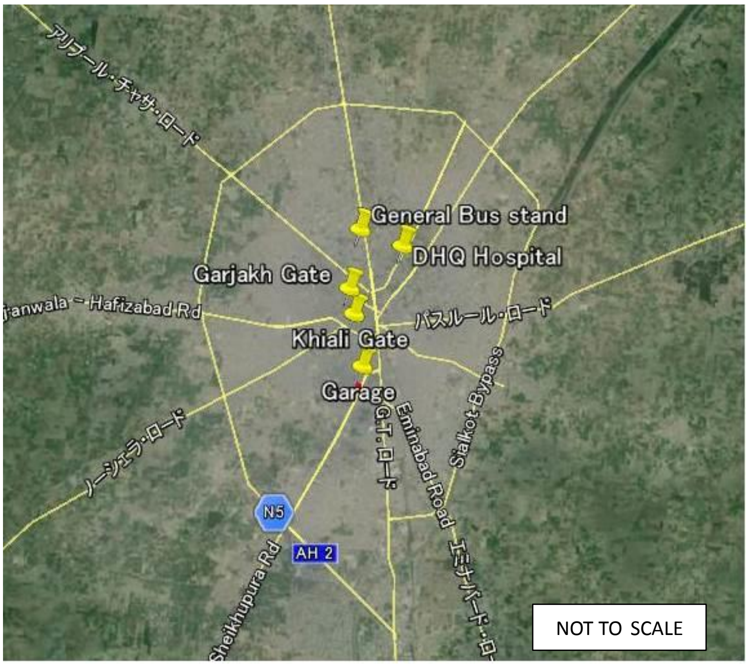


Figure 2.3.8 Location of Transfer Stations in Gujranwala City

Source: GWMC, April 2014.

(i) Khali Transfer Station

This transfer station is located in the centre of the commercial area. The operation started in 2008. Floor area is approximately 50m^2. The entrance to the transfer station is 5 metres wide which seems to be narrow for incoming vehicles. There is a working space of approximately 8 metres by 8 metres inside the station. The roof was covered with vinyl sheets when the station started operation, but some parts are now exposed due to aging and deterioration and the transfer station is almost located outside of the original location.

Two (2) containers are set inside the transfer station. Garbage from 3 or 4 targeted UCs are carried by donkey cart or handcart and dumped into the containers. These containers are taken to the final landfill site almost every day.

The working hour is from 6 a.m. to 3 p.m. One supervisor administers the operation of this station and no worker for sorting is assigned. Some waste pickers take out valuables from the garbage sorted outside the station, and finally put the garbage into the containers. In view of this situation, GWMC does not deploy workers at this transfer station.

No record of collection amount is kept but the waste manager in charge assumes that approximately 12m^3 of garbage is taken into the station according to the interview survey.

As-built drawings, other types of drawings and operation record/document, etc., are not kept in the office. **Photo 2.3.2** shows the current situation in Khali Transfer Station.

Photo 2.3.2 Current Situation of Waste Collection in Khali Transfer Station

(ii) Garjakh Transfer Station

This transfer station is located in the centre of the commercial area. The operation started in 2008. Floor area is approximately 50m^2. The station has no roof and the four sidewalls have collapsed so that it is completely exposed to the outside.

Two (2) containers are set in the station. Garbage from 2 targeted UCs is dumped into the containers by donkey cart or handcart. These containers are collected by arm-roll truck twice a day and are taken to the final landfill site.

The working hour is from 6 a.m. to 3 p.m. One supervisor administers the operation of this station and two workers are deployed. Waste pickers also collect valuables from the garbage in this transfer station. However, the working space is narrowing compared with the Khali Transfer Station and workers are deployed in the station. The number of waste pickers is fewer than those in the Khali Transfer Station.

No record of collection amount is kept, but the waste manager in charge assumes that approximately 16m^3 of garbage is taken into the station according to interview survey.

As-built drawings, other types of drawings and operation record/document, etc., are not kept in the office. **Photo 2.3.3** shows the current situation of waste collection in Garjakh Transfer Station.

Photo 2.3.3 Current Situation of Waste Collection in Garjakh Transfer Station

(iii) General Bus Station (Masonry Enclosure)

This transfer station is located in the General Bus Station. The operation started in 2008. Floor area is approximately 110m^2. The entrance to the enclosure is 5 metres wide and 12 metres in the longitudinal side. The roof is covered with vinyl sheet and it seems that weather condition does not affect the work inside of the station. Compared with the other two transfer stations, i.e., Khali and Garjakh, the working space is secure.

Two (2) containers are set in the station. Garbage from only one UC (No.4) is dumped into the containers by donkey cart or handcart. These containers are collected by arm-roll truck twice a day and are taken to the final landfill site.

The working hour is from 6 a.m. to 3 p.m. One supervisor administers the operation of this station and no worker for sorting is assigned. Some waste pickers take out valuables from the garbage sorted outside of the station, and finally put the garbage into the containers. In view of this enclosure, GWMC does not deploy workers at this enclosure. However, garbage has piled up on the floor and it seems that the sanitary condition is inadequate.

No record of collection amount is kept but the waste manager in charge assumes that approximately 12m^3 of garbage is taken into the station according to interview survey.

As-built drawings, other types of drawings and operation record/document, etc., are not kept in the office. **Photo 2.3.4** shows the current situation in General Bus Station.

Photo 2.3.4 Current Situation of Waste Collection in General Bus Station

(iv) DHQ Hospital (Masonry Enclosure)

This masonry enclosure is located in the street along the DHQ Hospital. Operation started in 2008. Floor area is approximately 38m^2. There are two entrances to the transfer station and each is 2.5 metres in height and 6 metres in longitudinal side. The roof is covered with vinyl sheet and it seems that weather condition does not affect the work inside of the station. Despite the large floor area, only one container is allocated, so that the working space is secured.

Two (2) containers are set in the enclosure. Garbage from 2 targeted UCs is dumped into the containers by donkey cart or handcart. These containers are collected by arm-roll truck twice a day and are taken to the final landfill site.

The working hour is from 6 a.m. to 3 p.m. One supervisor administers the operation of this station and no worker for sorting is assigned in the station. Some waste pickers take out valuables from the garbage sorted outside of the enclosure, and finally put the garbage into the containers. In view of this situation, GWMC does not deploy workers at this station. However, garbage is piled up on the floor and it seems that sanitary condition is inadequate.

No record of collection amount is kept but the waste manager in charge assumes that approximately 5m^3 of garbage is taken into the station according to interview survey.

As-built drawings, other types of drawings and operation record/document, etc., are not kept in the office.

(v) Khan Mahal (Masonry Enclosure): Closed

This masonry enclosure is located southwest of the GWMC workshop. The operation was started in 2008 but closed within a couple of weeks because the residents near the station strongly rejected CDGG’s utilisation of the station.

(5) Current State of Collected Waste

(a) Collected Waste Amount

Collected waste is conveyed to the dump site by collection vehicles. No record of disposed amount is available before the establishment of GWMC. However, GWMC studied the waste collection amount data utilising the data of a private weighbridge during May to August, 2014.

In addition, a new truck scale was installed in Gondlanwala and it started measuring the weight of each collection vehicle since 4 September 2014. **Figure 2.3.9** shows the said waste collection amount although this amount includes the waste collected by One-Time Cleaning Activity as mentioned in **Subsection 2.3.3**.

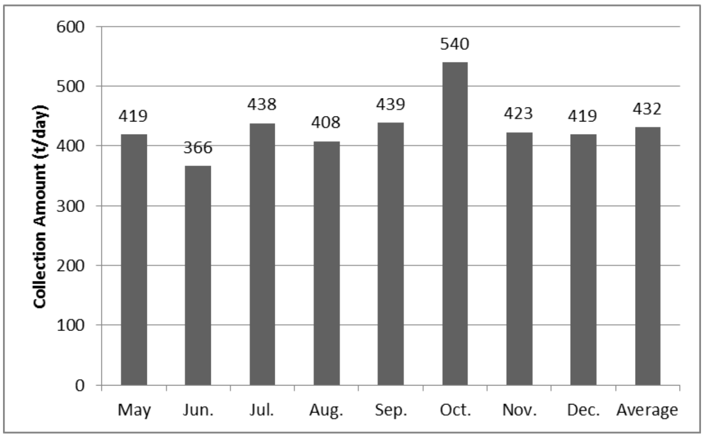


Figure 2.3.9 Total Waste Collection Amount (May - December 2014)

Approximately 370 to 540 tons of waste per day is collected and transported to the landfill site. Since GWMC started two-shift collection from July 2014, the waste collection amount increased from July. The waste amount in October was larger than that of the other months because people celebrated the "Eid Holiday" (*Eid ai-Fitr*, the festival of fast-breaking for Muslims), butchered and ate many goats or sheep resulting in a quite large amount of leftovers in the cityFigure 2.3.10 **Figure 2.3.10** and **Table 2.3.5** as reflected in the average daily tonnage per arm-roll truck/tractor trolley.

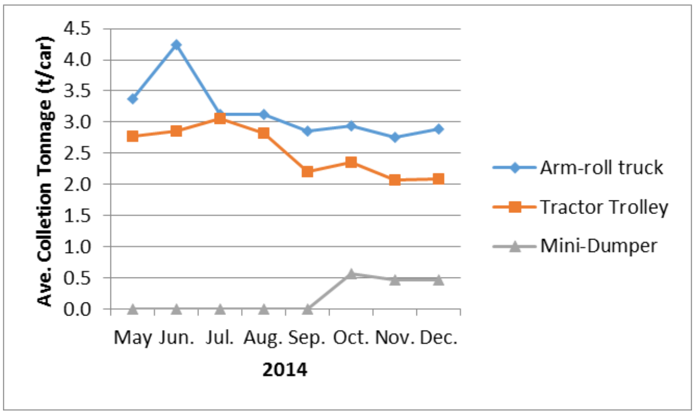


Figure 2.3.10 Average Daily Collection Tonnage per Arm-roll Truck/Tractor Trolley

Table 2.3.5 Average Daily Collection Tonnage per Arm-roll Truck/Tractor Trolley

Unit: ton/car

Item	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Arm-roll truck	3.37	4.25	3.12	3.12	2.85	2.94	2.76	2.89	3.16
Tractor Trolley	2.78	2.85	3.06	2.82	2.21	2.35	2.07	2.09	2.53
Mini-Dumper	-	-	-	-	-	0.56	0.47	0.46	0.50

According to the survey, an arm-roll truck conveys approximately 3.2 tons and a tractor trolley conveys 2.5 tons daily. A total of 35 mini-dumpers were newly commissioned for primary collection since October 2014 and are operating mainly in narrow streets and unloading their waste at a transfer station. A mini-dumper carries about 0.5 tons in a day.

The capacity of tractor trolley is approximately 3.0m^3, and it is three-fifths of the 5m^3 container capacity, i.e., around 1.5 tons of waste. The arm-roll truck transports a 5m^3 container with approximately 2.5 tons. In each case, it is found that both types of car carry an excess amount of waste. **Table 2.3.6** shows the average number of trips per arm-roll truck/tractor trolley. These values are slightly different from the results of the Time and Motion Study described in **Subsection 2.3.1** due to the different survey periods and subject vehicles.

Table 2.3.6 Average Number of Trips per Arm-Roll Truck/Tractor Trolley

Unit: trip/day

Item	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Arm-roll truck	2.9	2.8	4.3	4.1	4.2	4.9	4.7	4.5	4.1
Tractor Trolley	2.0	1.2	1.8	2.2	1.7	2.0	2.0	2.0	1.9
Mini-Dumper	-	-	-	-	-	1.8	1.7	2.4	2.0

(a) Collection Ratio

There is no data regarding collection ratio. According to the interview survey for waste managers, the collection seems to be fifty (50) percent in Gujranwala City.

According to the collection record, waste amount in a container is assumed at around 3 tons. The total waste amount that all of the containers could keep is, therefore, 570 tons since the number of containers before December 2014 was about 190; that is, 190 units × 3 tons = 570 tons. According to the interview survey for waste managers, approximately 1,000 tons of waste is generated in the city. Based on the result of the interview, it is assumed that 57% (570/1,000) of waste is collected. This is relatively close to the waste managers' estimate. The more detailed discussion in terms of the current collection rate is described in **Section 5.2**.

(6) Collection Workers

One zone is managed by one Assistant Manager (Operations) of GWMC who has one or two Chief Sanitary Inspectors under him. The Chief Sanitary Inspector manages some of UCs that every UC has at least one supervisor who manages around 10 to 30 sanitary workers. The total number of sanitary workers is 1,166.

The average number of sanitary workers deployed per UC is 18 which are not enough to cover the whole area. In actual work, 250-300 houses and 10-15 streets are allotted to one worker per day. Accordingly, workers skip their assigned job in some parts of the allotted area every day because the area is too wide to cover by only one worker in a day.

Workers are not provided with safety gadgets like masks, safety shoes and gloves. Workers sweep streets and collect waste from 6:00 a.m. to 2:00 p.m. in dusty areas where there is a high potential of getting asthma. Waste is not segregated at waste generation sources so that there is also the risk of handling sharp materials like needles or any dangerous material which may cause injury to the workers.

(7) Collection Vehicles

(a) Summary of Collection Vehicles

Table 2.3.7 shows the list of vehicles owned by GWMC as of January 2015. Currently, 119 vehicles are utilised for waste collection and transportation, and street cleansing operation. The oldest vehicle was procured in the year 1968 and the latest one was procured in the year 2014. Mini-dumpers were introduced by GWMC in the end of 2014. Most of the-arm roll trucks were procured in 2009 and the tractor trolleys were procured in 1996 by City District Government Gujranwala (CDGG) then all the vehicles were transferred to GWMC in 2014.

Based on the Time and Motion Study (see **Subsection 2.3.1**), the efficiency of tractor trolley is lower than those of the other main collection and transportation vehicles, i.e., arm-roll trucks and mini-dumpers. Only two (2) tractor trolleys were procured after the year 2007 and the rest were before 2000. The rate of operation of those superannuated tractor trolleys is thus low due to frequent maintenance and repair. Additionally, the truck bed of a tractor trolley is high for the workers to load waste from the ground that makes the loading time longer. High fuel consumption and low travelling performance are the disadvantages of a tractor trolley so that it is inappropriate to use them for the waste collection service. Moreover, if age deterioration of the vehicle is considered, GWMC also requires preparation of additional maintenance cost for the vehicles as well.

Table 2.3.7 List of Vehicles in GWMC

Type of Vehicle	Number of Vehicle	Procurement Year
Arm-roll truck (5m^3)	22	2007 - 2011
Arm-roll truck (10m^3)	4	2001, 2002
Tractor trolley	37	1977 - 2007
Mini-dumper	35	2014
Mechanical sweeper	4	2011
Tractor with bucket, 4×4	3	2008
Tractor with bucket, 2×2	4	1998, 2000
Tractor with blade	4	1988
Rikshaw	2	-
Water sprinkler	2	2009
Spray machine	1	2014
Water bowser	1	1968
Total	119	-

Source: GWMC, January 2015.

(b) Workshop/Garage

The workshop and the garage are located in Sheikhubura Road, which is 5 km away from the city centre. The area of the workshop is 6,000 m^2 and unpaved. The workshop/garage is also annexed to the administration building. Two engineers, two mechanics, one electrician, one welder and one helper are being assigned as of January 2015.

Operation condition of waste collection vehicles are monitored at the administration building. These conditions are recorded on a log book and driving operation is thus administered according to the log book. However, the driving route for each vehicle is not at all recorded on the book. Thus, waste collection and transportation are also administered according to the logbook.

There are docks for car repair/check-up in the garage/workshop. General check-up such as changing tires could be conducted in the workshop/garage, but vehicle malfunctions which could not be dealt with in the workshop are repaired by outsourcing.

There is no car wash facility in the workshop and waste collection vehicles are washed at private car wash facilities. The expense for car wash is paid by the driver and reimbursed once in every two weeks.

Used tires, broken containers and broken vehicles are stored in the workshop/garage. These items are planned to be sold by auction after repair. **Photo 2.3.5** shows the current situation of the workshop.

Photo 2.3.5 Current Situation of Vehicle Workshop

(c) Vehicle Condition

More than 110 vehicles are operated for waste collection and transportation in a day. Since GWMC requests the car dealers to undertake regular check-ups and maintenance of the vehicles, the condition of vehicles is relatively maintained.

According to the interview survey, the major cause of vehicle malfunction is flat tire by ceramics abundantly scattered on the streets. The number of malfunction by flat tire is more than the number of mechanical malfunction of vehicles.

(d) Spare Parts for Vehicles

Spare parts for car maintenance are procured through car dealers/private workshops in Gujranwala. Spare parts not available in Gujranwala are procured in Lahore. Therefore, no issue is found with the procurement of spare parts in particular.

Most of the collection vehicles were manufactured around the year 2000. Although it is impossible to procure genuine spare parts for these vehicles, generic spare parts or other alternatives such as other manufacturer's spare parts are utilised for the maintenance or repair of these vehicles.

(e) O&M Expense for Vehicles

Table 2.3.8 shows the operation and maintenance (O&M) expense paid by CDGG from 2006 to 2013.

Table 2.3.8 O&M Expense from 2006 to 2013

Item	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
O&M Expense (Rs.)	6,651,535	3,069,816	2,829,089	-	4,476,970	5,815,355	10,751,845

Source: CDGG

There is no data before year 2006, but the expenditure for O&M has been increasing in the past three (3) years. Since most of the vehicles were made in the year 2000 and utilised for almost 10 years, the O&M expense is getting higher.

(8) NGO

There was one NGO, OPE (Organisation Pan Environment), which worked in UC No. 8 (Shaheenbabad) during 2008 to 2010. The organisation used to conduct primary collection; however, some issues such as shortage of funds and not having cooperation by the residents occurred and the activity was terminated after two years.

(9) Waste Collection and Transportation Scheme Conducted by GWMC

Based on the results of the site reconnaissance and field surveys mentioned above, the waste collection and transportation scheme conducted by GWMC from generation sources to the final disposal site is illustrated in **Figure 2.3.11**. The amount of waste for each flow was identified in consideration of results of incoming waste survey, waste pickers survey and other related surveys and data collection as presented in **Section 4.3**.

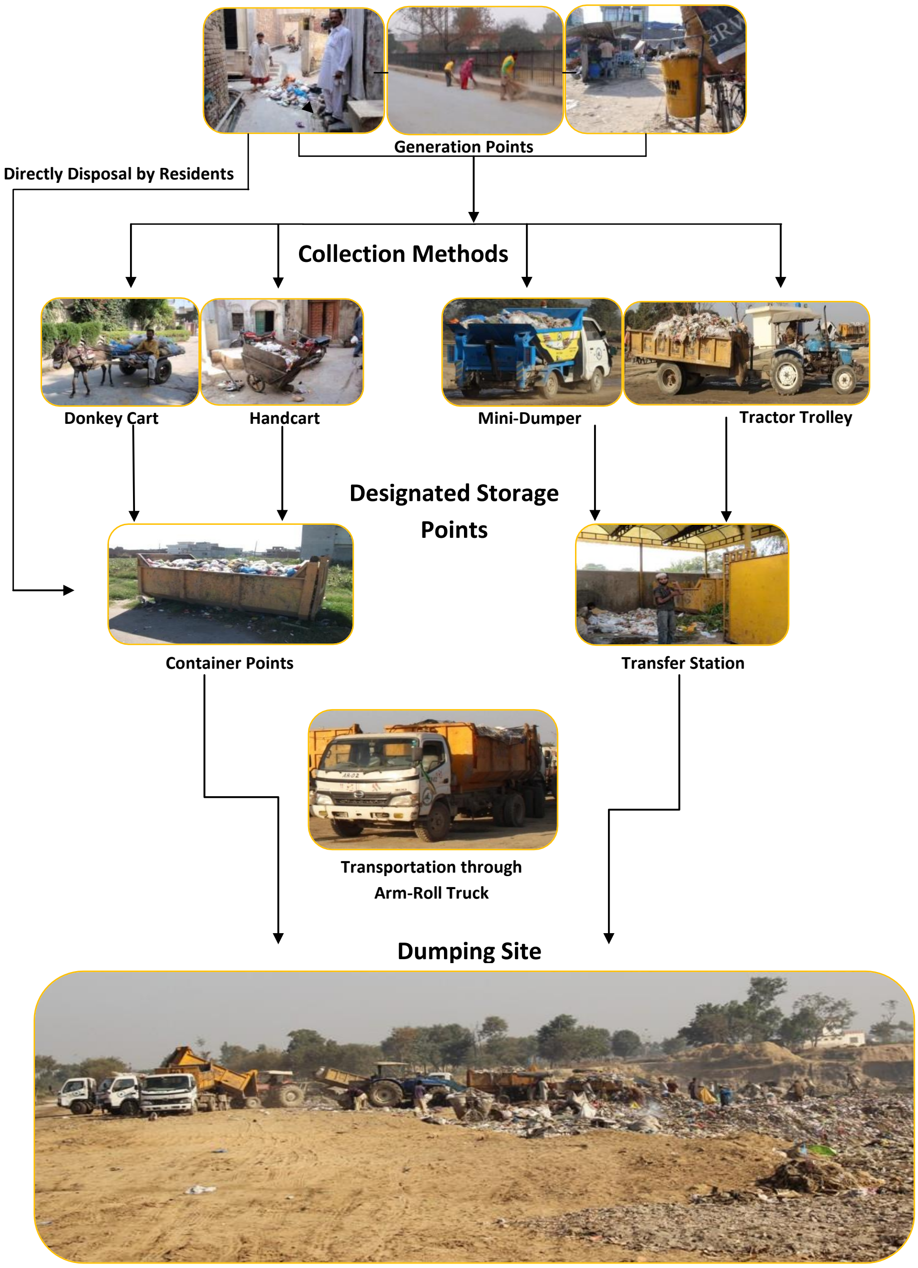


Figure 2.3.11 Waste Collection and Transportation Scheme Conducted by GWMC

2.3.3 One Time Cleaning Activity

(1) General

GWMC has conducted collection of accumulated waste throughout the city temporarily since June 2014. These wastes piled up in vacant lots and along the roads have been dumped illegally. During the early stage, the activity was implemented once a month, but it is currently conducted almost daily.

(2) Waste Amount Collected by the Activity

The waste amount collected by this one-time cleaning activity after the installation of truck scale at Gondlanwala is recorded and summarised in **Table 2.3.9**. Around 50 tons of waste were collected by the activity in a day in the latest three months. Roughly 5% of waste generation is being collected under the activity.

Table 2.3.9 Waste Amount Collected by the One Time Cleaning Activity

Month	Sep. 2014	Oct. 2014	Nov. 2014	Dec. 2014	Jan. 2015
Waste Amount per Day (ton/day)	11	167	52	51	42

(3) Vehicle Fleet Allocation

The One-Time Cleaning Activity is conducted daily by two sets of one tractor trolley, one tractor with bucket and one tractor with blade. After the activity, the fleet goes to join the ordinary waste collection and transportation operation.

2.3.4 Illegal Dumping

(1) Causes of Illegal Dumping

There are more than 700 illegal dumping sites in Gujranwala City and these sites are mainly vacant plots. According to the interview with UU and GWMC, the causes of illegal dumping are: (1) the insufficient number of containers; and (2) the long distance from a resident’s household to the container location, which temps a resident to dispose his garbage on an empty plot, road or gutter near his house although a container is located in the UC. Illegally dumped garbage on vacant lots or streets in the UC has thus piled up because they are not collected by the GWMC. Garbage is brought to these sites regularly and the number of illegal dumping sites had increased.

The residents do not feel that throwing garbage on a vacant lot is a bad practice, in particular. This shows the lack of sanitation consciousness which is one of the causes of illegal dumping of waste. Some parts of the illegal dumping sites used to be swamps and some landlords filled them with garbage and made flat.

At some locations, garbage is scattered around the containers and the situation is similar to the illegal dumping sites. This means that the residents near a container do not dispose their garbage into the container or they do not mind even if the tossed garbage drops outside of the container.

The organisation and budget for solid waste collection is also limited. Therefore, the current situation of data management, facility operation and the organisation has not improved.

Figure 2.3.12 shows the relationship between the containers and the illegal dumping sites. The red squares on the map show the location of containers in the 200 metre or 500 metre circles set on the map. These circles mean that residents in these circles are considered to be able to access the container within five minutes to ten minutes. Basically, illegal dumping sites are seen outside of the circles, which means that these illegal dumping sites are located in areas where collection service is not provided. Moreover, there are some illegal dumping sites even inside the 500-metre circles. This reveals that public awareness on solid waste is relatively low among the residents.

GWMC conducts the clean-up campaign once in a month as the countermeasure to illegal dumping sites as presented in the previous **Subsection 2.3.3**. In the campaign, waste on an illegal dumping site is removed by a wheel-loader, dumped into a container and taken to the final landfill site. A large number of illegal dumping sites exist and the scale of each site varies. No sweeping measure against illegal dumping has been planned by GWMC and hence illegal dumping is still done by the residents.

(2) Location of Illegal Dumping Sites

Table 2.3.10 shows the list of illegal dumping sites in the towns as of April 2014 while **Figure 2.3.13** shows their location. **Photo 2.3.6** shows the current situation of illegal dumping sites.

As mentioned in the preceding **Subsection 2.3.3**, GWMC conducts a clean-up drive against illegal dumping sites regularly. However, several dumping sites still exist in the city. It is difficult to clean up all dumping sites in a short period of time.

Table 2.3.10 List of Illegal Dumping Sites in the Towns

Town	Illegal Dumping Site
Aroop	319
Qila Dadir Singh	66
Nandi Pur	59
Khiali	329
Total	773

Source: GWMC, April 2014.

Photo 2.3.6 View of Illegal Dumping Sites in Gujranwala City

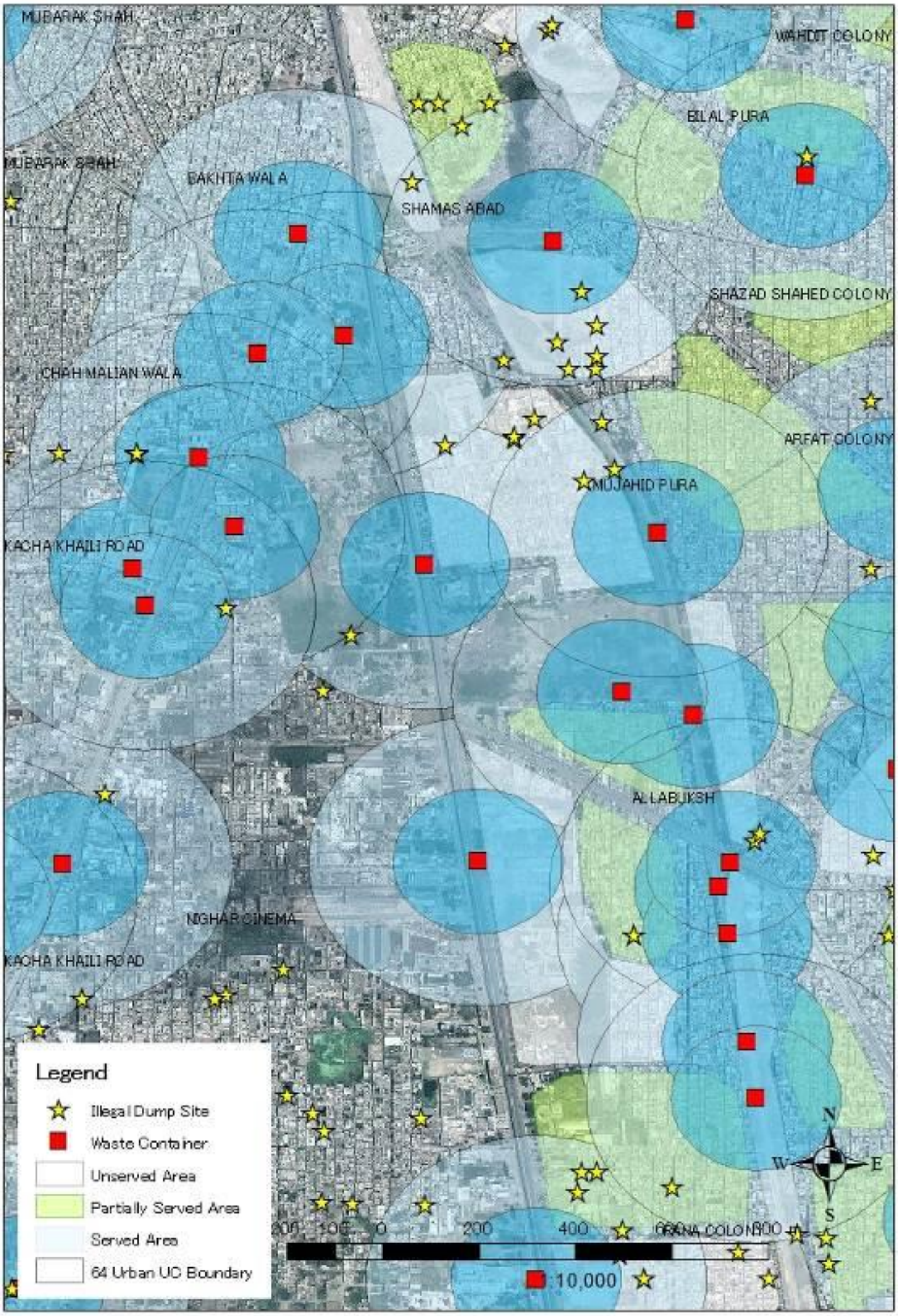


Figure 2.3.12 Relationship between Container and Illegal Dumping Site

Source: GWMC, April 2014.

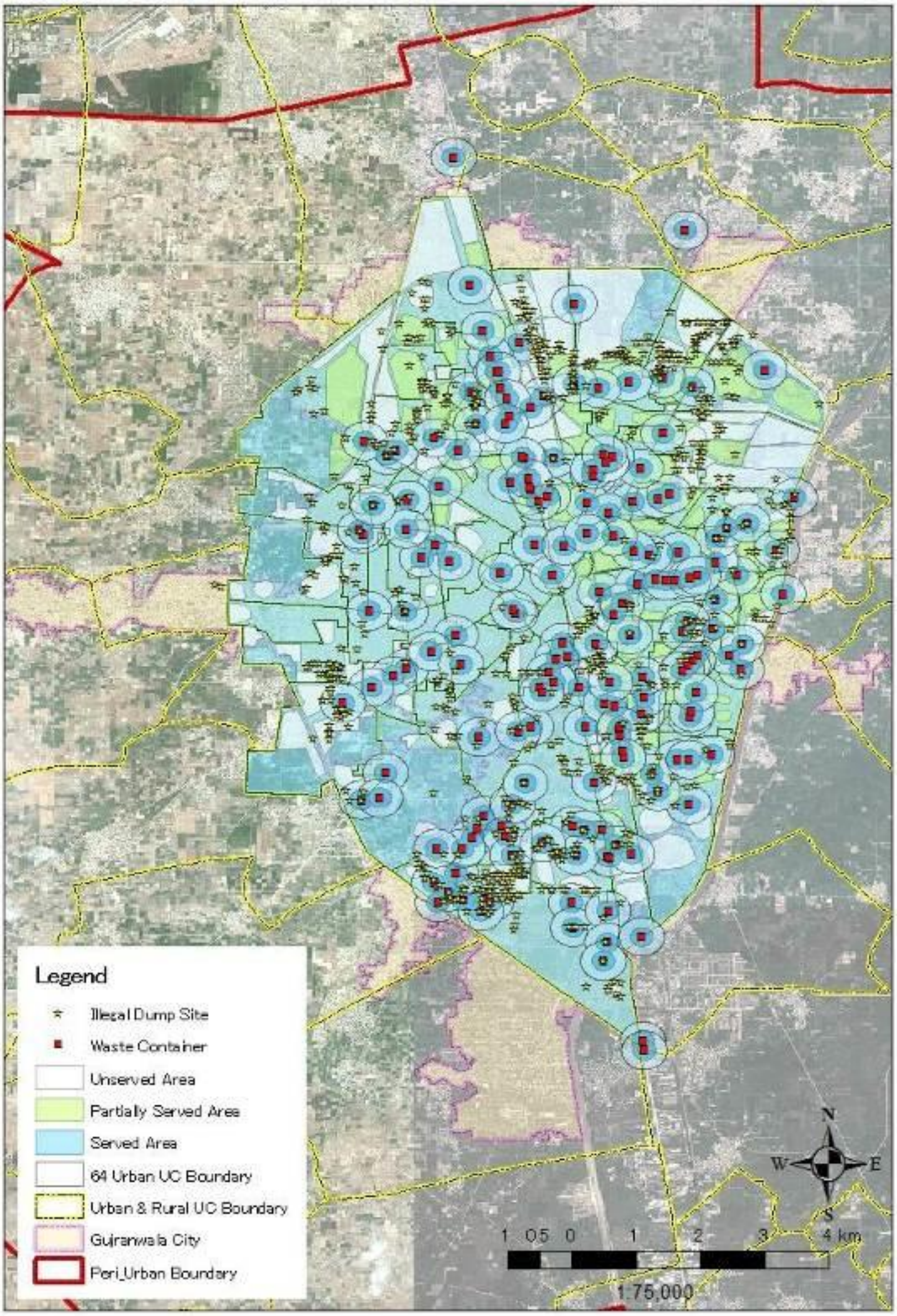


Figure 2.3.13 Location Map of Illegal Dumping Sites

Source: GWMC, April 2014.

2.3.5 Installation of a Truck Scale

(1) Purpose of Weighbridge Installation

No record of collected waste amount was kept by GWMC's own scale. A record of collected waste amount is important information for conducting solid waste management. A weighbridge has been procured in this project and starting operation since 4 September 2014. The new truck scale was also utilised for conducting the survey for incoming waste amount.

(2) Specification of the Weighbridge

Table 2.3.11 shows the specification of procured weighbridge while **Figure 2.3.14** shows its general plan.

A weighbridge, forty (40) tons of measurement capacity, has been procured in this project. The measurement capacity of 20 tons or 30 tons satisfies the existing arm-trucks or truck trolleys with collected waste on their assigned quota. However, GWMC plans to adopt 12m^3 or 19m^3 sized compactors in future, but the gross vehicle weight for each car is 18 tons or 26 tons and the weight exceeds the limit of measurement capacity of 20 tons or 30 tons weighbridge.

Table 2.3.11 Specifications of the Procured Weighbridge

1. PLATFORM STRUCTURE

Construction	:	Steel construction, Specially designed V Beam
Platform Side Rail System	:	Cylindrical form steel
Platform Size	:	12 m × 3 m
Capacity	:	40 tons maximum

2. TRUCK SCALE INDICATOR:

Display	:	6 Digit 20 mm LED display
Warning Symbols	:	Zero, tare, standstill, net, pcs, kg, weighing area
Keyboard	:	Membrane type, 8 function touch-key for zeroing and calibration
Storage Capacity	:	100000 vehicle ID's in Computer Software
Dimensions & Material LL 2	:	21×15×16 cm aluminium cast boxing

3. LOAD CELLS

Load Cells	:	Model CT 036 Analogue Load Cells, Stainless Steel
Nominal Capacity	:	30 tons each
Number of Load Cells	:	6
Material	:	Stainless Steel

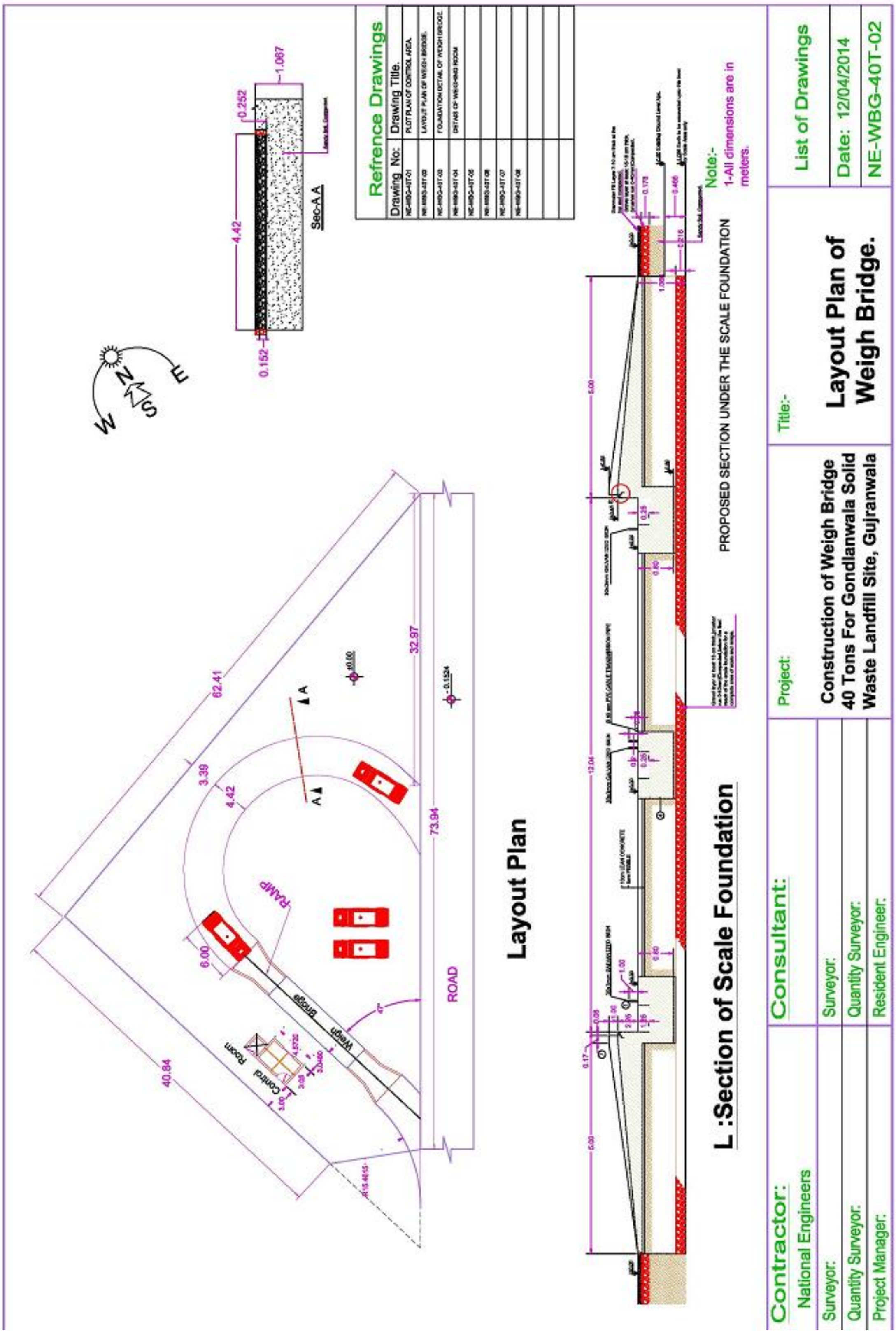


Figure 2.3.14 General Plan of Procured Weighbridge at Gondlanwala Solid Waste Landfill Site, Gujranwala

(3) Location of the Weighbridge

The weighbridge is installed at the northern side of the temporary Gondlanwala final landfill site. After the installation of the weighbridge, all GWMC collection vehicles were registered on the data collection system in a computer that connects to the weighbridge. Waste amounts brought to the final landfill site by each vehicle are recorded in the computer. However, this weighbridge is planned to be relocated at minimal cost, say less than a million rupees or so when the new landfill site is opened. **Photo 2.3.7** shows the installed weighbridge.

Photo 2.3.7 Installed Weighbridge at Gondlanwala

2.3.6 Evaluation of Waste Collection and Transportation Condition

The problems and issues in relation to waste collection and transportation activities under the current situation are summarised in **Table 2.3.12**. These items will be the basic elements to develop the plans, programmes and projects to comprise the waste collection and transportation plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table 2.3.12 Identification of Problems and Issues on Waste Collection and Transportation

Problem	Description of Problem	Issues for Solving the Problems
1. Not fully covered waste collection service for 64 urban UCs	Uncollected area and partially collected area exist in the current collection area, and 100% of the area or the entire area of 64 urban UCs has not always been collected. Therefore, as a result, waste is scattered in the streets and open spaces in the uncollected area and the partially collected area in the town area.	The method of waste discharge and temporary storage, type of collection vehicles, collection frequency, etc., shall be reviewed for improvement of the primary and secondary collection services that should cover the entire city area.
2. No waste collection service in rural 34 UCs	Waste collection work is being carried out only within the area of 64 urban UCs resulting in the scattering of waste in 34 rural UCs. GWMC will be responsible to cover the waste collection and transportation service with these extended areas in the future.	Waste collection service area in the developed area and the urbanised area of 34 peripheral UCs should be expanded to prevent the scattering of waste and tentative clean-up operation in the affected areas should be carried out continuously.
3. Insufficient number of waste container and arm-roll truck	The number of collection vehicles and waste containers is insufficient for the collection of all wastes generated in the city. As a result, it is causing obstacles to traffic, overflowing of waste from the waste containers and increase of illegal dumpsites in the town area. Such a situation has become a nuisance to daily life of the neighbouring residents.	Formulation and implementation of overall waste collection and transportation plan is required for future upgrading of the service. In particular, appropriate types of waste collection vehicle should be carefully considered to be fitted for the site conditions, such as road width, accessibility, space for container placement and so on.
4. Low efficiency by using a tractor trolley	Most of the tractor trolleys are old; consequently, fuel consumption is high and travel performance is low. The number of workers is insufficient for the waste loading work onto the tractor trolleys. Due to these causes, the low waste collection efficiency of tractor trolley has resulted in the difficulty to execute regular waste collection service in the designated service area.	In accordance with procurement of new vehicles, the use of tractor trolleys should be declined and shifted to arm-roll trucks and mini-dumpers. The retired trucks should be used for the other collection area that will be expanded outside of 64 UCs.

Problem	Description of Problem	Issues for Solving the Problems
5. Small haulage amount and cause of nuisance by mini-dumper	The work efficiency is low because the mini-dumpers could transport only small amounts of waste to the far landfill site and return again for the next collection service. In addition, wastes collected by mini-dumpers are unloaded at an open space beside the waste containers to be transported by arm-roll trucks, causing nuisance to the neighbouring residents.	GWMC is planning to deploy the mini-dumpers only for waste collection in surrounding areas with about 5-7 trips per shift and transfer the collected waste to large loading capacity trucks for transportation to the landfill site. For this purpose, two waste transfer stations for mini-dumpers that are located in the north-east side and the south-west side of the city have been planned, and one of them started the operation.
6. High risk of disease infection for sanitary workers	Sanitary workers are not provided any protective gear, such as masks, safety shoes and gloves in their operation. The sanitary workers pick up wastes and put them into their handcarts by hands. There is high risk of handling hazardous materials and infectious wastes directly.	It is essentially required to provide protective gear for all sanitary workers. It is also important to train them to handle the waste properly and to take a medical check on a regular basis.
7. A large number of illegal dumpsites	Many dumpsites exist illegally in the town area causing environmental degradation in the surrounding area. These illegal sites are located in areas adjacent to residential houses and have become a nuisance to the residents. In view of the situation, GWMC has started the programme of One Time Cleaning Activity since June 2014.	The One Time Cleaning Activity by QWMC and/or outsourcing should be accelerated to remove the cause of nuisance to residents, including execution of measures that shall not allow the sites to be used again as waste dumping site. Preparation of urgent project programmes for the clean-up operation and execution of well-planned work are indispensable.

2.4 Final Disposal Study

2.4.1 Overview of Final Disposal in Gujranwala

The old disposal site of approximately 4 ha utilised the lowlands along the Grand Trunk Road (G.T. Road) located in Chianwali at about 7 km south of Gujranwala City. Landfill operation, open dumping, started at the end of 2006 and finished at the end of February 2014. Landfill operation is no longer carried out but the site has not been closed properly to ensure safety and environmental degradation in the surrounding area.

The existing disposal site utilises the abandoned borrow pit in Gondlanwala at about 8 km north-northwest from the city centre of Gujranwala. The site is used as a temporary landfill site until the new sanitary landfill facilities become operational. Landfill operation started in March 2014 and this temporary disposal site currently receives domestic waste collected from the 64 urban union councils in Gujranwala City. The landfill operation carried out is the open dumping method and the landfill site has started to become a cause of environmental pollution in the surrounding area.

Engineered landfill facilities or sanitary landfill facilities have not yet been developed for the City of Gujranwala until now. In view of the situation of solid waste management (SWM) being practiced without an appropriate landfill site in Gujranwala, the Urban Unit (UU) and CDGG launched the project for development of new final disposal facilities in 2012. The UU, SWM team visited Gujranwala in September 2012 and carried out a site selection survey intensively to identify the suitable site for development of sanitary landfill facilities and prepared the report. Then the report was reviewed and revised in March 2014 by UU. According to the report entitled *"Landfill Site Identification & Evaluation Report"*, the site in Bhakhraywali is proposed as the candidate site for development of a new sanitary site for Gujranwala. The site selection procedures and the progress status of topographical and geotechnical surveys will be delineated later in **Subsections 2.4.6 and 2.4.7**, respectively.

Figure 2.4.1 shows the location of the closed disposal site in Chianwali, the existing disposal site in Gondlanwala and the candidate landfill site in Bhakhraywali. **Photo 2.4.1** shows the current status of these three disposal sites.

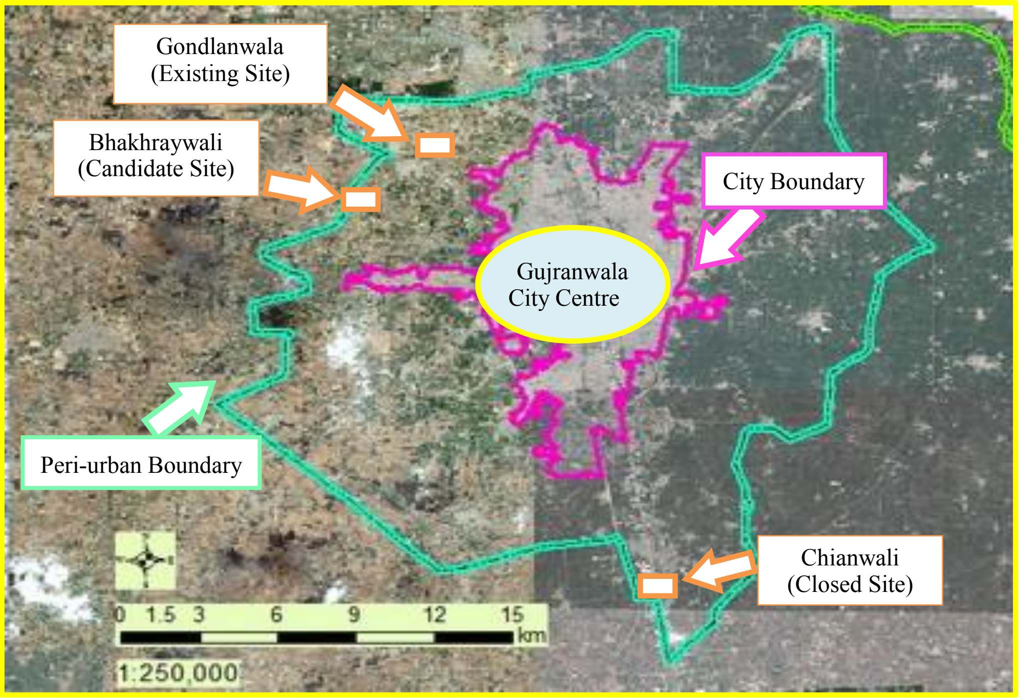


Figure 2.4.1 Location Map of Final Disposal Sites

Photo 2.4.1 Current Status of Final Disposal Sites

2.4.2 Final Disposal Operation

(1) Operation Status of Existing Final Disposal Site in Gondlanwala

The abandoned borrow pit in Gondlanwala site having the approximate area of 4.7 ha and the depth of 8-9 m is currently used as the temporary landfill site. Landfill operation started in March 2014. The site is expected to be used for 2 to 3 years for the estimated volume of about 400,000 m^3. Landfill work, open dumping, is carried out actively and the available landfill area is decreasing day by day. The loaded waste amount of each vehicle is weighed by the weighbridge installed by the Project in connection with the survey work of this project. As of September 2014, more or less 400 tons per day in average including the waste amount from the clean-up work of the illegal dumpsites in the town area is carried into the landfill site. In the records of the weighbridge, the maximum incoming waste amount up to now has become 665 tons per day on 30 September 2014. Then, the waste is unloaded onto the top of the landfill area and spread by two units of tractor shovels.

The landfill work is carried out by the open dumping method, so that environmental degradation especially groundwater contamination, breeding of pests such as flies, etc., have become significant problems. GWMC is taking measures for earth covering, draining contaminated water at the bottom of the landfill area and spraying insecticides for controlling waste dumping operation.

Waste pickers, most of them look like under 18 years old male, collect recyclable materials at the waste unloading area and in the slope where wastes slide down to the bottom of the landfill. The number of waste pickers was about 20 people, initially, but about 35-40 people divided into three groups in worked daily in September. Health hazards and risk of recovery operation is a matter of concern. The waste picker survey including the waste pickers working in town was conducted in December 2014 and the survey method and results are described in next **Section 2.5**.

Photo 2.4.2 shows the current operation status described above.

Disposal Site, March 2014 Unloading Waste, March 2014 Waste Pickers & Recyclables, Sept. 2014

Disposal Site, Sept. 2014 Weighbridge, Sept. 2014 Water Pollution, Sept., 2014

Photo 2.4.2 Operation Status of Gondlanwala Final Disposal Site as of September 2014

Surface water ponding at the bottom of the landfill is contaminated, causing groundwater contamination. There are three farmer houses within the distance of 500 m from the Gondlanwala disposal site as shown in **Figure 2.4.2**. The total number of people residing in the three houses is about 50. They live on breeding of about 150 livestock and agriculture in the area.

Every house uses groundwater for daily living, agriculture and livestock. Every house uses groundwater from shallow and deep aquifers by hand pump and tube well. Seasonal water quality tests have been conducted in this project and the first water sampling was done in September 2014, taking groundwater and surface water samples from 10 sampling points including the wells of these three houses.

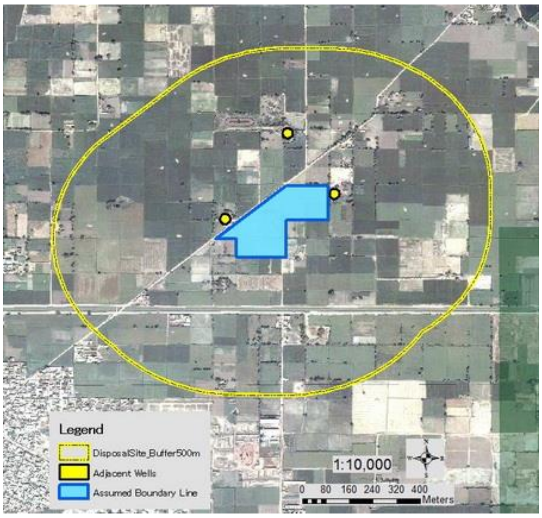


Figure 2.4.2 Location of Wells in and around the Gondlanwala Disposal Site

(2) Situation of Closed Chianwali Final Disposal Site

The Chianwali disposal site was used from the end of December 2006 to February 2014. The waste dumped during the period of approximately 7 years was left without any soil cover. The site is located just along the G.T. Road. Therefore, in addition to the risk of groundwater contamination, visual pollution to landscape and waste scattered by wind are causing the negative environmental impacts.

The record of the number of incoming vehicles to Chianwali available from CDGG was only for 4 months as shown in **Table 2.4.1**. Only arm-roll vehicles hauled waste to the disposal site and the tractor trolleys disposed waste at the open spaces in the town area due to long hauling distance problem, more than 15 km from the city centre, for this type of vehicle.

Table 2.4.1 Record of Incoming Vehicles (Arm-Roll Truck) to Chianwali Disposal Site

Vehicle Type	Arm-roll Truck			
Month/Year	November 2013	December 2013	January 2014	February 2014
Total No. of Trips per Year	2,600	2,137	2,062	2,001

Source: Record of SWM Section, CDGG

There were no incoming vehicle records available for the period before November 2013. However, the vehicle list from the fiscal year 2005/2007 is available and the data shown in **Table 2.4.2** was used for the estimation of waste disposal amount from the beginning of landfill operation in December 2006 to the end of landfill operation in February 2014. The average loading weight of arm-roll was obtained from the actual weighing of waste record at the private weighbridge in May 2014. Accordingly, the estimation of waste disposal amount was carried out by the factors of average loading weight of arm-roll truck, number of functional vehicles, and the annual operation ratio of the vehicles in each year.

Table 2.4.2 Number of Functional Vehicles in Fiscal Years 2006-2007 to 2012-2013

Fiscal Year	2006-2007	2007-2008	2008-2009	2009-2011	2011-2012	2012-2013
No. of Functional Arm-roll Truck	7	11	22	28	28	28
No. of Functional Tractor Trolley	43	43	43	37	37	37
Total No. of Functional Vehicles	50	54	65	65	65	65

Source: Processed data of Vehicle List of SWM Section, CDGG

Due to unavailability of operation days or the operation rate of vehicles in each year, the estimation was made on the assumption based on the interview to the GWMC operation section that the operation rate of vehicles is 70%.

The result of calculation of annual waste disposal amount at Chianwali is given in **Table 2.4.3** and the cumulative waste disposal amount is shown in **Figure 2.4.3**. The cumulative waste amount disposed at Chianwali had reached 341 thousand tons during the landfill operation of 7 years and 3 months. The accumulated waste volume is estimated at more or less 400 thousand cubic metres assuming that the bulk density of filled waste layer is within the range of 0.7 to 1.0 ton/m^3 obtained from the bulk density survey conducted in Chianwali and Gondlanwala disposal sites (see **Subsection 2.4.6** in detail). However, these figures are subject to change upon the availability of accurate data from the CDGG regarding the number of operation days of each vehicle in each year.

Table 2.4.3 Annual and Cumulative Waste Disposal Amounts at Chianwali

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Waste Disposal Amount (1,000 ton/year)	1.2	13.9	19.8	43.6	49.5	55.4	55.4	56.1	8.5
Cumulative Amount (1,000 ton)	1.2	15.1	34.9	78.5	128.0	183.4	238.8	294.9	303.4

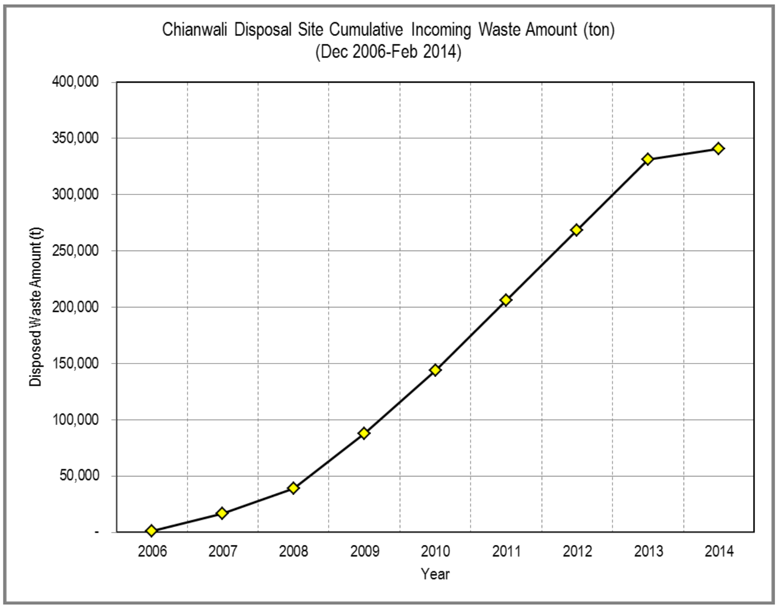


Figure 2.4.3 Cumulative Waste Disposal Amounts at Chianwali

(3) Waste Disposal Amount of Existing Gondlanwala Final Disposal Site

Landfill operation at Gondlanwala started in March 2014. Since then, the number of incoming vehicles had been recorded manually by the inspector until 8 May 2014. Recording of loading weight started from 9 May 2014 at a private weighbridge located along the way to Gondlanwala.

A weighbridge was later installed under the scheme of the Project at an area adjacent to the Gondlanwala landfill site. Weighing of incoming waste amount was then made continuously from 2 September 2014 at the weighbridge of Gondlanwala disposal site and digital recording is now available. Since 1 October 2014, the monthly weightbridge data has been processed and analysed through the he Incoming Waste Amount Survey during the Project activities. The incoming waste amount at Gondlanwala was estimated based on the data recorded from the sources mentioned above.

Monthly incoming waste amounts to the disposal site and the cumulative landfill waste amounts are shown in **Table 2.4.4** and the graphs in **Figure 2.4.4** and **Figure 2.4.5**. The monthly incoming waste amounts to the disposal site from March to June 2014 show less than 10,000 tons per month.

The incoming waste amount had increased from July at more than 20% due to the commencement of two-shift operation and clean-up of discarded wastes in the town area. In September, the incoming waste amount was more than 13,000 tons per month. In October 2014, the incoming waste amount transported to the disposal site jumped up to more than 16,000 tons/month due to additional Eid waste for about one week. Landfill waste amount has been accumulating day by day at the Gondlanwala disposal site and the filled waste in the past 12 months from March to February 2015 is estimated at 149,000 tons. Considering the result of the bulk density survey described in **Subsection 2.4.6** and the estimated lifetime of Gondlanwala disposal site, the bulk density is assumed at 0.9 ton/m^3. Consequently, with the assumed bulk density, the present cumulative landfill volume is estimated approximately at 166,000 m^3. The landfill area is secured at 4.7 ha at present. GWMC is planning to secure the adjacent land based on the offer of the landowner. After securing the adjacent land, the total landfill area will become 6.4 ha and available landfill volume will be 510,000 m^3. The balance volume of 344,000 m^3 will be filled up in in 22 months with the monthly incoming waste of 14,000 tons or 15,600 m^3 and the lifetime of the landfill site will end in December 2016.

Table 2.4.4 Monthly Annual and Cumulative Waste Disposal Amount at Chianwali

Month	Monthly Waste Disposal Amount at Gondlanwala Disposal Site (ton/month)	Cumulative Waste Disposal Amount at Gondlanwala Disposal Site (ton)
March 2014	9,980	9,980
April	9,894	19,874
May	9,628	29,502
June	9,588	39,090
July	12,693	51,783
August	11,767	63,550
September	13,159	76,708
October	16,734	93,442
November	12,688	106,130
December	12,976	119,106
January 2015	15,239	134,345
February	14,799	149,144

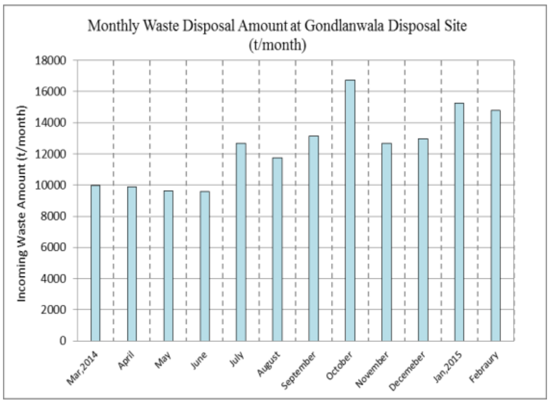


Figure 2.4.4 Monthly Waste Disposal Amount at Gondlanwala

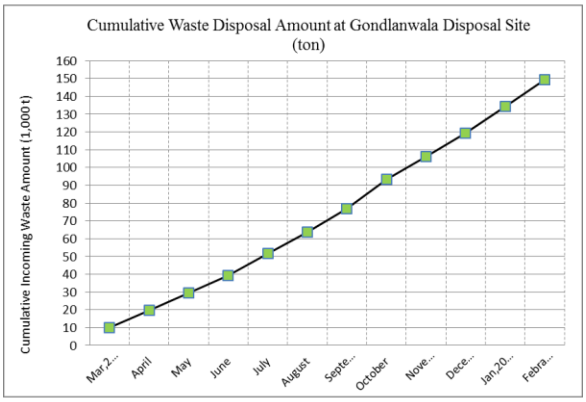


Figure 2.4.5 Cumulative Waste Disposal Amount at Gondlanwala

(4) Fluctuation of Incoming Waste Amount at Gondlanwala Final Disposal Site

Daily incoming waste amounts in September 2014 are shown in **Table 2.4.5** and the graph in **Figure 2.4.6**. The daily incoming waste fluctuates in the range of approximately 390-670 ton/day. On average, the incoming waste amounts on Mondays show more than the incoming waste of other days of the week since GWMC does not carry out waste collection on Sundays except for the requirement of special collection. The average incoming waste amount on Mondays reaches approximately 121% of the working-day average waste amount of the month followed by Wednesdays at 113%.

Table 2.4.5 Daily Incoming Waste Amount at Gondlanwala Disposal Site (September 2014)

Day of the Week	1st Week (1-7) (t/d)	2nd Week (8-14) (t/d)	3rd Week (15-21) (t/d)	4th Week (22-28) (t/d)	5th Week (29-30) (t/d)	Total (t/week)	Average Incoming Waste Amount by Day of the Week (t/d)	Ratio to the Working-day Average (%)
Monday	581	606	589	574	588	2,938	588	120.6
Tuesday	514	416	562	392	665	2,548	510	104.6
Wednesday	541	583	470	601		2,194	549	112.6
Thursday	248	469	496	484		1,697	424	87.0
Friday	303	420	497	556		1,776	444	91.1
Saturday	335	537	451	446		1,769	442	90.7
Sunday			236			236	236	48.5
Total	2,522	3,032	3,301	3,052	1,252	13,159	-	
Working-day Average Incoming Waste Amount by Day of the Week (t/d), 27days							487	
Daily Average Incoming Waste Amount (t/d), 30days							439	

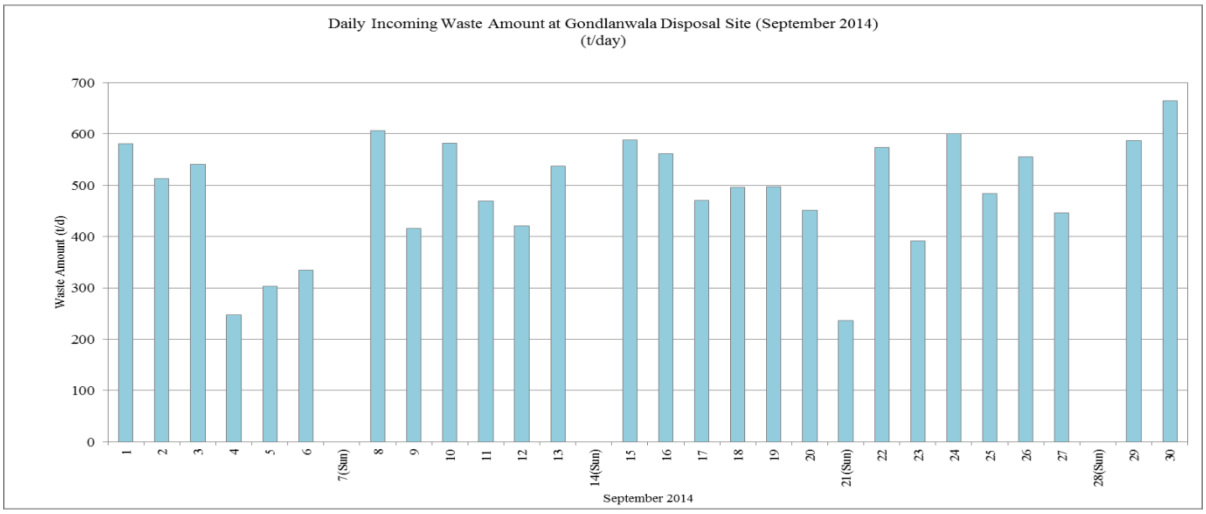


Figure 2.4.6 Daily Incoming Waste Amount at Gondlanwala Disposal Site (September 2014)

(5) Incoming Number of Vehicles per Day to the Gondlanwala Disposal Site

Collected waste is carried to the disposal site by tractor trolley and arm-roll trucks equipped with 5m^3 or 10m^3 containers. **Figure 2.4.7** shows the daily number of trips by arm-roll truck and tractor trolley recorded in February 2015. In total, the incoming number of vehicles to the disposal site reached approximately 5,100 trips. The incoming number of vehicles varied from the lowest recorded of 156 trips in 20 February to the highest recorded of 244 trips in 27 February. However, in average, the total number of 170 to 180 trips per day was performed by arm-roll trucks and the tractor trolleys. Among the total number of trips, about 75% of trips were performed by arm-roll trucks and the rest or 25% of trips was performed by tractor trolleys. As a matter of course, as well as the fluctuation of incoming waste amount described above, the number of trips of incoming vehicles increase on Mondays and Wednesdays. GWMC had started to dispatch 1m^3 mini-dumpers since December 2014 and the wastes collected by mini-dumpers were transported to the disposal site by arm roll trucks and/or trolley trucks.

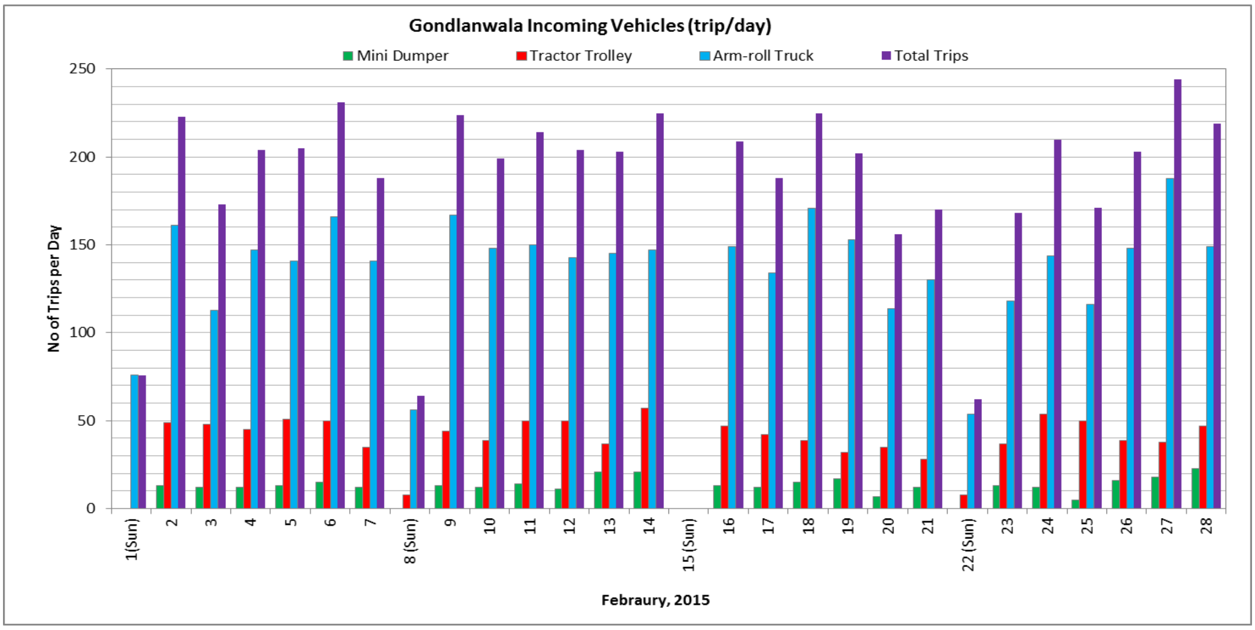


Figure 2.4.7 Daily Number of Incoming Waste by Arm-Roll Truck and Tractor Trolley to Gondlanwala Disposal Site (February 2015)

(6) Existing Landfill Machine

Two units of tractors with front end loading bucket are operated at the landfill site to push and spread waste unloaded from the incoming vehicles. The tractors, Model New Holland Diesel Agriculture Tractor, 105 HP, were procured in 2008. Due to aging of the vehicles after 7 years of operation, frequent maintenance and repair is required. Each vehicle consumes 30 litres of fuel daily and the annual operation cost is estimated at about Rs. 2 million. **Photo 2.4.3** shows an existing landfill tractor.

Photo 2.4.3 Landfill Tractor with Front Loading Bucket

The incoming vehicles unload waste on the top of the landfill layer in the public roadside, and then the waste is pushed away by two units of tractor shovel into the bottom of the landfill area. Earth covering on to the waste layer is carried out only intermittently. Soil covering work to the waste layer is carried out also intermittently. Environmental impacts such as odour problem and breeding of flies occur under the inappropriate practice of landfill work. In addition, leachate from the landfill layer ponding in the bottom of the landfill area during the monsoon season might be causing groundwater contamination.

(7) Landfill Operation Staff

Landfill operation is carried out by staff under the Senior Landfill Manager. The operators in the field are four persons as shown in **Figure 2.4.8**. The post of Operation General Manager is vacant as of end of September 2014.

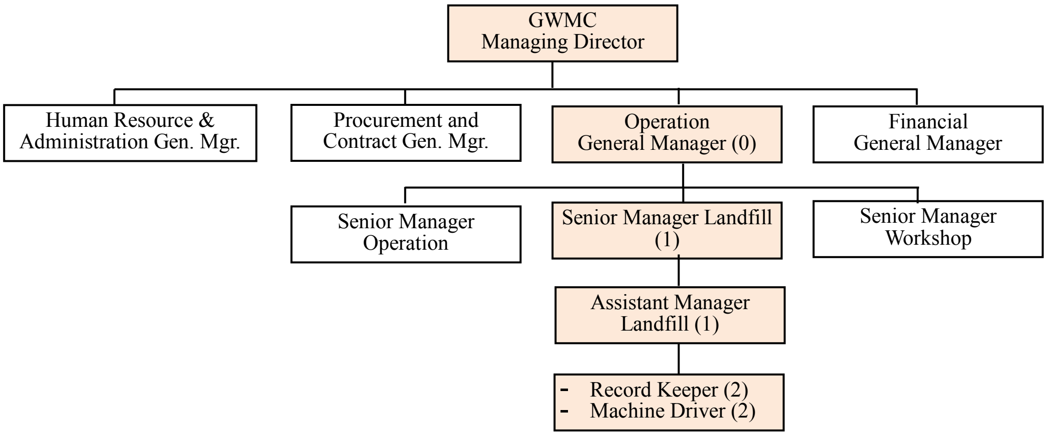


Figure 2.4.8 Organisational Structure for Landfill Operation

2.4.3 Topographic Survey of Closed and Existing Final Disposal Sites

The contract for the topographic survey was signed on 12 September 2014. The contractor has finished the field work and the mapping work is now underway. The final products of topographic map, profiles and cross sectional drawings were submitted to the JICA Project Team in December 2014. The topographic survey was carried out as shown in the following outline.

(1) Purpose of the Work

The purpose of the topographic survey is to provide the materials for the study, design and planning of the final disposal site of the Project envisaged under the solid waste management system for Gujranwala City.

(2) Location of the Survey Site and Survey Area

The locations of the topographic surveys and the survey area are the following two sites:

- Closed landfill site at Chianwali, Site Area: 6 ha (Survey Area: approximately 8 ha)
- Existing landfill site at Gondlanwala, Site Area: 5 ha (Survey Area: approximately 7 ha)

(3) Output of the Survey Work

The Contractor is to submit the following results of the survey work under the contract.

- One (1) set of original prints of topographic map(s) per site, which shall include all spot elevations, contour lines and all the surveyed items.
- One (1) set of original prints of profile and cross sections per site, which shall include major spot elevations and all the surveyed items. All original prints in ink shall be duly reviewed, dry-sealed and signed by a licensed Chief Geodetic Expert.
- Four (4) sets of copies of topographic map(s), profiles and sections per site.
- Two (2) sets of CD-ROM containing all the survey maps and records in digital form.
- All field books, worksheets, field notes, sketches, traverse and levelling computations.
- Preliminary design drawings and quantities of works of the closure plan at Chianwali site and the improvement plan of Gondlanwala as instructed and provided under the conceptual plan of the JICA Project Team.

2.4.4 Geotechnical Survey of Closed and Existing Final Disposal Sites

The contract for the geotechnical survey was signed on 6 September 2014. The contractor started the field work at the end of October 2014. The results of boring test and the laboratory test were submitted to the JICA Project Team in December 2014. The geotechnical survey is to be carried out as shown in the following outline.

(1) Purpose of the Work

The geotechnical survey shall be conducted for the boring tests, permeability tests, field reconnaissance and literature review. The objectives of the geotechnical survey are to examine the bearing capacity for the foundation design of structures, to examine the underground permeability for the measures against infiltration of leachate, and to grasp the geological conditions of the site and the surrounding area.

(2) Location of the Survey Site and Contents of the Survey Work

The locations of the geotechnical surveys and the contents of the survey work are described as follows:

- Survey of the closed landfill site at Chianwali and the existing landfill site at Gondlanwala;
- Number of Boreholes: 5 boreholes at the closed landfill site, and 5 boreholes at the existing landfill site;
- Boring Depth: 30m each (If N-values are more than 50 for consecutive 5m, boring shall be stopped.);
- Standard Penetration Test and N-value: every 1m at each borehole;
- Groundwater Table: at each borehole; and
- Permeability Test: 3 holes at the closed landfill site and 3 holes at the existing landfill site.

(3) Output of the Survey Work

The report to be submitted shall consist of one (1) original plus four (4)copies, digital files of the report and all the processing files in CD-ROM (2 sets). The report shall be described with the methodology, procedures, survey/test results, evaluation of the survey/test results including, but not limited to, the following contents:

- Date and location of boring tests (location map scale: 1:25,000 or 50,000), elevation & coordinate of boreholes, maps showing the locations of the boreholes (scale: 1:1,000), description of the geographical and geological conditions and sub-surface stratigraphy of the site and the surrounding area;
- Borehole logs, water table, profile and cross sections of borehole logs, soil classifications, N-values;
- Recommendations on foundation type for structures and impermeability;
- Photographs showing scenes of the work and soil samples in core boxes; and
- Copy of field book(s).

2.4.5 Water Quality Survey of Closed and Existing Final Disposal Sites

The contract for the water quality survey was signed on 6 September 2014. The water quality survey was to be carried out in three (3) seasons. The contractor conducted water sampling twice at the end of September 2014 for the monsoon season and at the end of January 2015 for the winter season. The third survey is scheduled in May 2015. The water quality survey is carried out as shown in the following outline.

(1) Purpose of the Work

The purpose of this survey work is to carry out water quality tests of groundwater and surface water samples in the surrounding area of the closed landfill site in Chianwali and the existing landfill site in Gondlanwala and assess the present status in view of water quality.

(2) Location of the Survey Site and the Contents of the Survey Work

The locations of the water quality surveys and the contents of the survey work are as shown below. The work shall include all works, such as mobilisation of manpower, vehicles, and instruments for sampling (e.g., sampling tool, analytical instrument, laboratory, etc.), implementation of water quality tests, and reporting of the work.

- Survey site at the closed landfill site at Chianwali and the existing landfill site at Gondlanwala including the surrounding area.
- Five (5) surface water samples and five (5) groundwater samples in and surrounding area of the landfill site per survey site per season. (The groundwater samples are taken from the shallow wells of 18 to 21m in depth and from the deep wells of 21 to 60m in depth. The sampling sites are indicated in the maps shown in **Section 2.8**.)
- Water quality parametres for testing: water temperature, pH, electric conductivity, turbidity, BOD_5, COD, SS, Total-N, and heavy metals (R-Hg, T-Hg, Cd, Pb, Cr^{6+}, As and Se).

(3) Output of the Survey Work

The report shall be prepared in English and submitted in one (1) original and four (4) sets of hard copies. Digital files of the report and all the processing files shall be saved in CD-ROM and submitted to the JICA Project Team. The report shall include, but not limited to, the following:

- Location map and survey area map;
- Work method;
- Work results; and
- Photographs.

(4) Result of First and Second Waste Quality Survey

The results of the first and second water quality tests for the sites in Gondlanwala and Chianwali are as summarised below. The detail is given in **Section 2.8**.

- As a whole, electric conductivity of most of the groundwater samples in Gondlanwala exceeds 1,000 μS/cm. The higher level of electric conductivity is caused of electrolyte most probably by the concentration of Chloride ion dissolved in water.
- Stagnant water in Gondlanwala disposal site is contaminated by leachate. The leachate has a possibility of groundwater contamination in the neighbouring area. However, the results of laboratory test conducted for groundwater samples of four (4) wells in the neighbouring area do not show distinctive groundwater contamination by the Gondlanwala disposal site.
- In Chianwali, electric conductivity of groundwater samples shows lower values as compared to those of the Gondlanwala groundwater samples although the groundwater quality is not preferable for drinking purpose judging from the level of electric conductivity.
- Three surface water samples taken from the drainage lying along the Chianwali disposal site show high COD (250~500 mg/L) and BOD (80-180 mg/L). Surface water in the drainage is contaminated with domestic and industrial wastewaters discharged from the neighbouring area. Water samples from the upstream and downstream sections of the drainage against the location of Chianwali disposal site do not show increase of concentration of water quality parametres, and the disposal site is not causing water contamination of the drainage at present.

2.4.6 Landfill Waste Bulk Density Survey

(1) Purpose of the Survey

The purpose of the survey is to find out the bulk density of landfill waste which will be used further for the Bhakhraywali landfill planning. Specific objective of the survey is as follows:

- To estimate the bulk density of solid waste at the dumping sites, i.e., the closed dumpsite in Chianwali and the existing dumpsite in Gondlanwala.

(2) Outline of the Survey

The survey was carried out on 10 February 2015. One excavator and three tractor trolleys were dispatched for the survey. In each site, landfill waste from three sampling pits, approximately 2m (Width) × 2m (Length) × 2m (Depth), were excavated and loaded onto the tractor trolleys. The net weights of the loaded wastes or the excavated weight were measured at the weighbridge installed by the Project. On the other hand, each excavated pit was measured as to width, length and depth to calculate the excavated volume.

(3) Calculation of the Bulk Density

The data were processed for both Chianwali and Gondlanwala sites. **Table 2.4.6** shows the calculated bulk density of both sites. The bulk density at Chianwali is higher than that of Gondlanwala.

Table 2.4.6 Calculated Bulk Density at Chianwali and Gondlanwala

Sr. No.	Sample	Volume (m^3)		Waste Amount (kg)		Bulk Density (kg/m^3)	
		Chianwali	Gondlanwala	Chianwali	Gondlanwala	Chianwali	Gondlanwala
1	Pit 1	4.0	4.5	4,880	3,100	1,211	693
2	Pit 2	2.2	4.9	2,200	3,680	999	756
3	Pit 3	3.7	4.9	4,040	2,760	1,095	559
Average		3.3	4.8	3.706	3,180	1,121	668

(4) Conclusions and Recommendations

The results of the survey revealed that the Chianwali waste layer is comparatively consolidated as compared to that of the Gondlanwala waste layer. Chianwali started operation in the end of December 2006 and closed in February 2014 while the site in Gondlanwala became operational in March 2014. This difference of elapsed time in each site brought the difference of bulk density of the landfill waste layer because of consolidation. In other words, the average bulk density of each site is depicted as follows:

Chianwali (1,121 kg/m^3) > Gondlanwala (668 kg/m^3)

From the results of this survey, it is recommendable to adopt the bulk density of 1.0 t/m^3 for the design of sanitary landfill facilities in Bhakhraywali while the bulk density of 0.9 t/m^3 is appropriate for the shorter time landfill period of about 3 years at Gondranwala disposal site.

2.4.7 Incoming Waste Survey

(1) Purpose of the Survey

The waste composition data plays a crucial role in planning and designing of solid waste system. The specific objectives of the incoming waste composition survey are as follows:

- To determine the composition of waste collected from Gujranwala waste collection area and hauled to Gondlanwala for disposal; and
- To estimate the potential of resource or recyclable materials mixed in the incoming waste at the existing disposal site in Gondlanwala.

The results of the survey are very beneficial in determining the quantity of material available for recovery from disposal site and determining the future needs for recycling facility(s) and intermediate treatment facilities.

(2) Outline of the Survey

(a) Period of the Survey

The incoming waste composition survey was conducted from 9-13 December 2014 (4 days). Drilling was conducted by the survey team at the disposal site on 8 December 2014. The survey was carried out only for once during the period of the project.

(b) Location of the Survey

The incoming waste composition survey was conducted at the Gondlanwala disposal site.

(c) Samples for Waste Composition Analysis

The whole city area (64 union councils) was considered for the survey since the SWM services are being provided currently by GWMC in this area. A total of 10 waste samples were taken from each vehicle coming from the subject areas. **Table 2.4.7** shows the total number of samples and sampling areas.

Table 2.4.7 Sampling Area and Number of Samples for Survey

Sampling Area	No. of Sampling Area	No. of Samples per Area	Total No. of Samples
	A	B	A × B
High Income Group Area	1	2	2
Middle Income Group Area	2	2	4
Low Income Group Area	2	2	4
Total			10

(d) Survey Team Composition

A team comprising of two waste managers, one research associate and nine (9) survey assistants conducted the incoming waste composition survey under the instruction of the JPT staff in charge.

(e) Survey Method

The incoming waste composition survey method was developed under the following the requirements in the Terms of Reference of the Waste Amount and Composition Survey (WACS) contract and the instructions of the JPT taking the site conditions into consideration . In total, the composition of 1,564 kg of waste from 10 areas was analysed in the course of the survey. The waste was sorted into 16 pre-determined different fractions. The procedure of the survey is as shown in **Figure 2.4.9.**

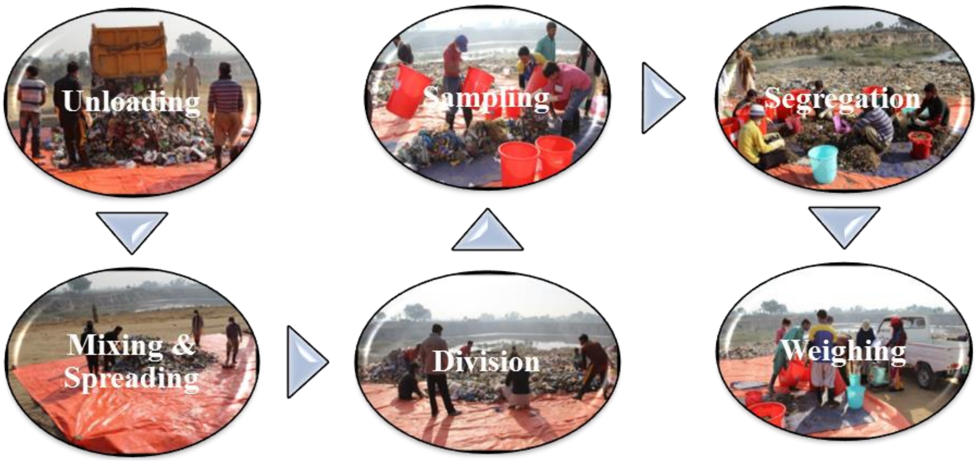


Figure 2.4.9 Incoming Waste Composition Survey Procedures

(3) Output of the Survey

The results of ten (10) samples subjected to the waste composition survey are summarised in **Table 2.4.8.**

Table 2.4.8 Results of the Incoming Waste Composition Survey at Gondlanwala

Sr. No.	Item	Average of Each Income Group Sample (%)			Weighted Averages (%)
		High Income (2 samples)	Middle Income (4 samples)	Low Income (4 samples)	
1.	Kitchen Waste	32.39	28.38	25.73	27.98
2.	Paper (recyclable)	1.07	0.94	1.88	1.24
3.	Paper (other paper)	13.72	9.18	8.04	9.29
4.	Textile	7.52	9.42	11.19	9.76
5.	Grass & Wood	3.32	2.45	6.98	3.90
6.	Plastic (recyclable)	2.12	1.18	1.62	1.41
7.	Plastic (non-recyclable)	10.06	8.11	6.45	7.80
8.	Leather & Rubber	0.56	0.32	2.50	1.00
9.	Metal (recyclable)	0.15	0.16	0.15	0.16
10.	Metal (non-recyclable)	-	-	-	-
11.	Bottle & Glass (recyclable)	0.07	0.50	0.63	0.49
12.	Bottle & Glass (non-recyclable)	0.29	0.00	0.00	0.03
13.	Ceramic, Stone & Soil, etc.	6.85	7.67	5.14	6.83
14.	Domestic Hazardous Waste	0.08	0.04	0.03	0.04
15.	Sieve Remainings	15.84	17.76	13.45	16.27
16.	Miscellaneous	5.95	13.89	16.22	13.80
TOTAL		100.00	100.00	100.00	100.00

(4) Findings from the Survey

The weighted average percent composition of Gujranwala waste being disposed is shown in **Figure 2.4.10**. At Gondlanwala, the kitchen waste account for 28% of total waste, thereby representing the largest fraction and followed by sieve remains with 16%, miscellaneous with 14% and non-recyclable paper with 9%. Only very small amounts of recyclables (paper 1.24%, plastic 1.41% and glass 0.49%) were found in waste at the Gondlanwala disposal site. The composition of domestic hazardous waste in the waste reaching Gondlanwala is almost negligible (0%). It shall be noted that most of the fraction of sieve remaining and miscellaneous is organic waste mixed with kitchen waste and animal droppings (donkey cart and horse cart) and kitchen waste.

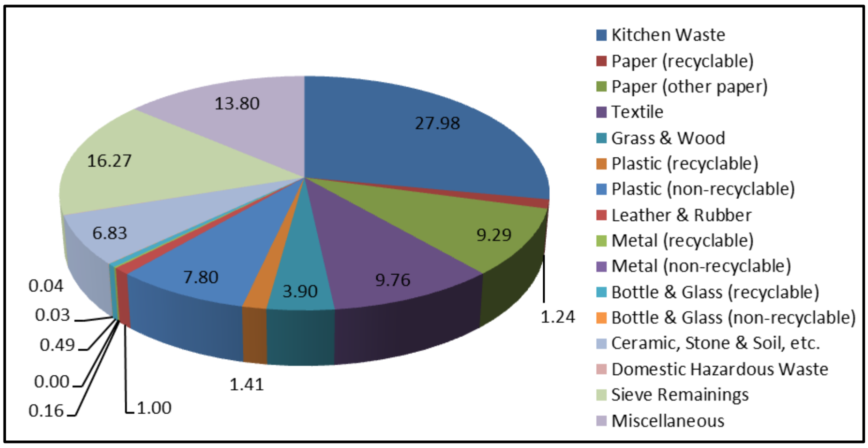


Figure 2.4.10 Average Waste Composition of Incoming Waste at Gondlanwala

(5) Conclusions and Recommendations

The following conclusions and recommendations can be drawn from the analysis of the incoming waste composition survey conducted at the Gondlanwala disposal site.

(a) Conclusions

- The waste for disposal at Gondlanwala has 32% of organic waste represented by kitchen waste and grass and wood. The organic waste ratio becomes more than 50% in case sieve remaining and miscellaneous wastes are included. These wastes are biodegradable waste having a high potential for bio-gasification and/or compost if GWMC manages to collect organic waste separately.
- The combustible waste ratio represented by plastics, paper, etc., account for almost 34%. Therefore, installation of incineration plant and/or Refuse Derived Fuels (RDF) plant can be a good option for the strategies for renewable energy projects.
- The amount of dry recyclables or resource materials hauled to Gondlanwala is considerably low at only 4%. Most of the recyclables have already been sorted at sources by dwellers and at the waste discharge points at waste containers by the waste pickers and sold in the recycling market. Consequently, the option for construction of centralised material recovery facilities of mixed waste is negative.

(b) Recommendations

- The material recovery and intermediate treatment options can be prioritised as follows on the basis of the results of the incoming waste composition survey:

  Small-scale MRF* < Composting and/or Bio-gasification < RDF and/or Incineration

  Note: *MRF: Material Recovery Facility
- The existing recovery system by households, waste pickers and recycling industry shall be maintained or strengthened with the support and/or assistance of GWMC.
- Incoming waste composition survey should be carried out at least once in a year to obtain the basic information for 3R activities and intermediate treatment facilities.

2.4.8 Implementation Status of Selection of Final Disposal Site

(1) Background of Landfill Site Selection

Gujranwala City has not developed engineered landfill facilities or sanitary landfill facilities until now. The city and districts are working for the collection and transportation of solid waste but unfortunately there is no proper way of final waste disposal. Waste is being disposed of indiscriminately in open plots and pits in and outside of the urban areas.

In order to secure a safe final disposal site, the Urban Unit (UU) in collaboration with CDGG conducted the study called *"Landfill Site Identification and Evaluation Report"* in Gujranwala. The UU SWM team visited Gujranwala in September 2012 to carry out the site selection survey intensively to identify the suitable site for sanitary landfill facilities and prepared the report. The report was reviewed and revised in March 2014 for the final report.

The report recommended four (4) suitable sites for developing the sanitary landfill facilities with the top rank given to the site in Bhakhraywali. The following paragraphs summarise the site selection report prepared by UU in March 2014.

(2) Summary of Landfill Site Identification and Evaluation Report, March 2014

(a) Basic Concept for Selection of Landfill Site

Landfill site selection is a very important process for the successful operation and final waste disposal without environment degradation. Landfill site selection involves an extensive evaluation process in order to identify the optimal available disposal location. The selected location must be in accordance with the basic government rules and regulations, and also take into cognizance how to cater the important factors like health, economic, environmental and social. In fact, many researchers have used different criteria for landfill site selection that varies with respect to region and facilities.

Following are the major factors considered during the landfill site selection:

- Airports: If a landfill is located within a specified distance, for example, 2km*, of an airport, the owner or operator must demonstrate that the landfill will not present a bird hazard to aircrafts. Note:* Punjab Waste Management Act 2013, Article (g), 26. Standard for Landfill.
- Flood plains: For landfills located on a 100-year flood plain, the owner or operator must demonstrate that the landfill will not restrict the flow of a 100-year flood, reduce the storage capacity of the flood plain, or result in the washout of solid waste.
- Wetlands: New landfill and lateral expansions cannot be located in wetlands except where there is no practical alternative.
- Fault zones: New landfills and lateral expansions must not be located within 200 feet of a fault zone.
- Seismic zones: New landfills and lateral expansions are restricted in areas susceptible to ground motion resulting from earthquakes.
- Unstable areas: Unless it can be demonstrated otherwise, landfill must not be located in areas susceptible to natural or human-induced events or forces capable of impairing the integrity of landfill components. Examples of unstable areas are those with poor foundation conditions, areas susceptible to mass movements (landslide, rock-fall, etc.), and areas with karst terrains (sinkholes).

Apart from the above, many other factors are also taken into consideration prior to the selection of potential site for the Landfill.

(b) Methodology

The identification and final selection of landfill site is a very complex task and requires qualified and trained personnel. Despite the various limitations, the Urban Unit devised a simple but effective methodology to select a suitable landfill from the proposed sites in Gujranwala. The following steps are applied:

(i) Negative Mapping

Unsuitable sites are eliminated from the selection list after further evaluation of all candidate sites.

(ii) Positive Mapping

The identification and selection of an appropriate site for a landfill depends upon several criteria. This selection according to the set criteria is called positive mapping. The positive mapping process includes the following two steps:

- Setting up of the site selection criteria; and
- Investigation of sites against the site selection criteria via site survey.

The above-mentioned steps can be explained as follows.

(iii) Setting of Scoring Criteria

The survey of the landfill site was commenced with a careful desk study leading to a specific sitting criteria presented in **Table 2.4.9**. The evaluation factors including geographical and environmental aspects are the basic factors in setting up the criteria along with other socio-economic limitations. Those factors are determined basically by UU in compliance with the requirements prescribed in Article 26, Standards for Landfill, Chapter- IX, Punjab Waste Management Act of 2013. The scoring of each factor was determined in consideration of the importance of the factor in technical and environmental aspects for the construction of disposal facility. Then, the field survey was carried out to verify the condition of each factor shown in the following table.

Table 2.4.9 Site Selection Scoring Criteria

Classification	Factors	Marks	Reference
Area	Size and capacity of the landfill	10	For factors having the total mark of 10: 10 = Most suitable for landfill site 5 and above = Suitable for landfill site Below 5 = Not suitable for a landfill
Location	Transfer distance	10	
	Access road to the landfill	10	
	Distance from Restricted Zone	10	
	Availability of onsite soil cover	5	
	Municipal facilities	5	
	Sub-Total	*50*	
Environment	Main Irrigation network 500 m	10	
	Nearby environmentally sensitive area (within 500 m)	10	
	Perennial Stream within 300 m	5	
	Impact to ecosystem	5	For factors having the total marks 5: 5 = most suitable for landfill site 3 and above = Suitable for landfill site Below 3 = Not suitable for landfill
	Sub-Total	*30*	
Society	Residential areas and other facilities	5	
	Historical and cultural heritage	5	
	Sub-Total	*10*	
Economy	Construction cost (including appurtenant facilities)	10	
	Sub-Total	*10*	
Total		100	

Source: The Urban Unit, *Landfill Site Identification and Evaluation Report, March 2014.*

(c) Site Survey

A detailed site selection survey was conducted by the Urban Unit team in Gujranwala through the site visit of all possible potential sites around the city at all 8 major roads connecting with Gujranwala bypass. A landfill sitting selection criteria was established considering the important factors and parametres on which all the sites were scrutinised and evaluated in subsequent steps. During the survey, the coordinate of each site was determined using Global Positioning System (GPS) as shown in **Figure 2.4.11**. Further, using the Geographic Information System (GIS) tool, sites were identified with measuring the distance from major road.

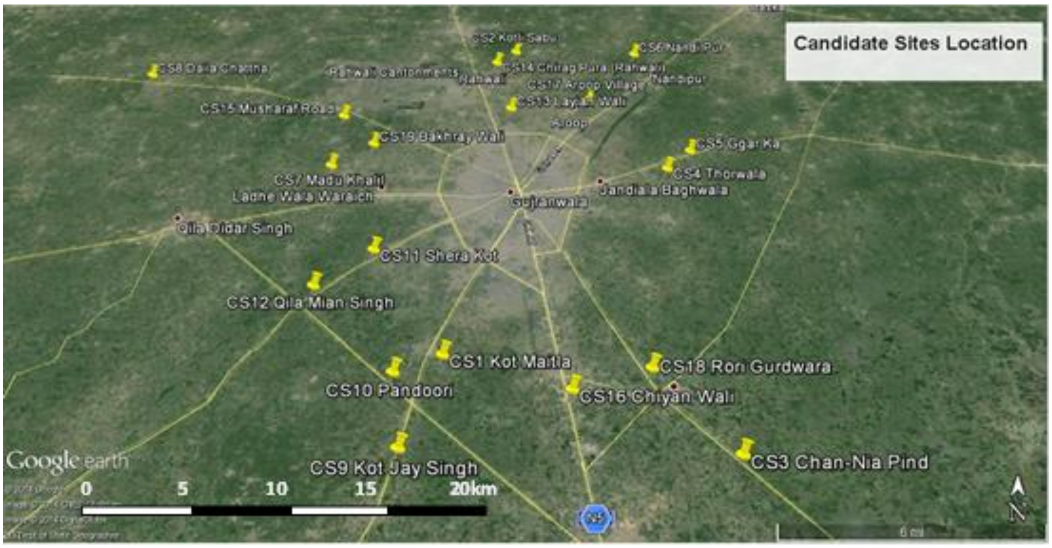


Figure 2.4.11 Location of Candidate Sites

(d) Evaluation of Candidate Site

Firstly, all the identified and potential candidate sites were analysed against the set criteria for selection. Secondly, each site was evaluated through the scoring system in **Table 2.4.10** and the result computed as presented in **Figure 2.4.12**. For example, if a site is available for the construction of a landfill or has lower groundwater table, it will have more marks as compared to availability of the site although it is not confirmed by the owner or having a considerably higher groundwater table leading to the chances of groundwater contamination. This process is called ranking system through which all the potential sites selected via negative mapping are ranked according to their own properties. The ranking system suggests that if a proposed site is used for agricultural purposes it will get lesser marks in the category of land use, in case of barren or any other suitable land is available. The total marks allocated to each site decide the final ranking. **Table 2.4.11** and **Table 2.4.12** show the details of scoring of each site.

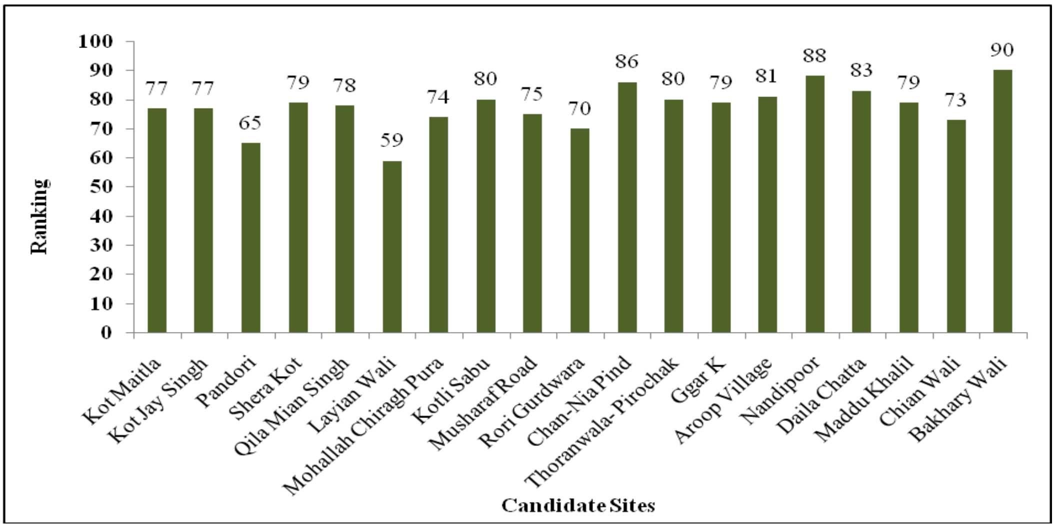


Figure 2.4.12 Ranking of Candidate Sites according to the Set Criteria

Source: The Urban Unit, Landfill Site Identification and Evaluation Report, March 2014.

(e) Conclusion and Recommendations of the Report

In Gujranwala, landfill site selection is very difficult because areas surrounding the city are densely populated and comprise very fertile agricultural land. That is why no barren land is available in the adjoining areas. Therefore, in the existing scenario, the four (4) top-ranked sites out of the 19 were selected after visiting, studying, evaluating and identifying according to the criteria set by the team of Urban Sector Planning & Management Services Unit (Pvt.) Ltd. in collaboration with the Urban Unit. The result of site selection study is deemed appropriate in terms of evaluation indicators and the scoring criteria. Basic information of the following four top-ranked sites is outlined below.

(i) Bhakhraywali
(ii) Nandipur
(iii) Chan-Nia Pind
(iv) Daila Chatta

Table 2.4.10 Outline of Top-Ranked Sites for Final Disposal of Waste in Gujranwala

Site Name	Bhakhraywali	Nandippur	Chan-Nia Pind	Daila Chatta
Land Ownership	Private	Private	Private	Private
Land Status	Borrow Pit and Agricultural Land	Agricultural Land	Agricultural Land	Agricultural Land
Land Area	25.3 ha	14.2 ha	10.1 ha	14.1 ha
Location (GPS Coordinates)	32011.150 N 74006.187 E	32016.098 N 74015.606 E	32000.682 N 74016.674 E	32014.902 N 73057.552 E
Direction from City Centre	North - West	North - East	West - South	North - West
Main road passing by the site	Alipur Chatha Road	Sialkot Road	Main Emanabad Road	Alipur Chattha Road
Distance from City Centre	11 km	18 km	14 km	22 km

All of these sites are recommended for further study, which shall include Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA).

Among the four sites, the site in Bhakhraywali obtained the highest comprehensive evaluation including environmental, social, economic aspects, etc. Especially, the condition of access road distance of 2km from the main road and the site area of approximately 25ha are advantageous against other selected sites.

Followed by the conclusion of the site final report of “Landfill Site Identification and Evaluation Report” in March 2014, CDGG announced the Bhakhraywali site as the candidate site of final disposal facilities. Then, CDGG through GWMC, proceeded with the procurement process. The draft EIA report was submitted to the UU in March 2015 and the summary of the draft EIA report is presented in **Section 2.8**.

Regarding the future landfill site at Bhakhraywali, the site was advertised as the proposed landfill site but the site has not been procured yet due to delay of payment from the government subsidies. If the start of construction work is delayed, the new landfill facilities will not be completed within the lifetime of the temporary disposal site in Gondlanwala. This will thus require other provisional landfill sites.

Table 2.4.11 Scoring Results of Each Candidate Site (1/2)

Comparison Matrix of Candidate Sites											
Classification	Factors	Marks									
		Total	Kot Maitla	Kot Jay Singh	Pandori	Shera Kot	Qila Mian Singh	Layian Wali	Mohallah Chiragh Pura	Kotli Sabu	Musharaf Road
Area	Size and capacity of the landfill	10	2	2	2	2	2	2	2	8	2
Location	Transfer distance	10	9	7	8	7	8	10	9	8	8
	Access road to the landfill	10	7	8	7	8	9	3	4	5	7
	Distance from restricted zone	10	10	10	10	10	10	10	10	10	10
	Availability of onsite soil cover	5	4	5	4	4	5	4	5	5	5
	Municipal facilities	5	5	5	5	5	5	5	5	5	5
	Sub-Total	50	37	37	36	36	39	34	35	41	37
Environment	Main Irrigation network 500 m	10	8	7	4	8	8	2	9	7	5
	Nearby environmentally sensitive area	10	8	8	3	8	6	6	7	8	8
	Perennial Stream within 300 m	5	4	4	3	4	4	3	4	5	4
	Impact to ecosystem	5	5	5	3	5	3	4	5	5	4
	Sub-Total	30	25	24	13	25	21	15	25	25	21
Society	Residential areas and other facilities	5	2	3	4	4	4	3	3	3	4
	Historical and cultural heritage	5	5	5	5	5	5	5	5	5	5
	Sub-Total	10	7	8	9	9	9	8	8	8	9
Economy	Construction cost incl. secondary infrastructure like access road	10	8	8	7	9	9	2	6	6	8
	Sub-Total	10	8	8	7	9	9	2	6	6	8
Total		100	77	77	65	79	78	59	74	80	75

Source: The Urban Unit, Landfill Site Identification and Evaluation Report, March 2014.

Table 2.4.12 Scoring Results of Each Candidate Site (2/2)

Comparison Matrix of Candidate Sites												
Classification	Factors	Marks										
		Total	Rori Gurdwara	Chan-Nia Pind	Thoranwala- Pirochak	Ggar K	Aroop Village	Nandipoor	Daila Chatta	Maddu Khalil	Chianwali	Bakharywali
Area	Size and capacity of the landfill	10	2	8	2	2	2	9	7	2	2	10
Location	Transfer distance	10	9	8	9	9	8	8	7	9	9	9
	Access road to the landfill	10	6	6	7	7	8	8	8	9	9	10
	Distance from restricted zone	10	10	10	10	10	10	10	10	10	10	10
	Availability of onsite soil cover	5	4	4	4	4	5	4	5	5	3	4
	Municipal facilities	5	5	5	5	5	5	5	5	5	5	5
	Sub-Total	50	36	41	37	37	38	44	42	40	38	48
Environment	Main Irrigation network 500m	10	8	9	9	9	9	8	8	5	5	8
	Nearby environmentally sensitive area (within 500 m)	10	8	10	10	9	8	10	8	8	5	9
	Perennial Stream within 300m	5	3	4	5	5	4	5	4	3	3	3
	Impact to ecosystem	5	5	5	5	5	5	5	5	4	4	4
	Sub-Total	30	24	28	29	28	26	28	25	20	17	24
Society	Residential areas and other facilities	5	3	5	3	3	3	3	3	5	3	3
	Historical and cultural heritage	5	1	5	5	5	5	5	5	5	5	5
	Sub-Total	10	4	10	8	8	8	8	8	10	8	8
Economy	Construction cost incl. secondary infrastructure like access road	10	6	7	6	6	9	8	9	9	10	10
	Sub-Total	10	6	7	6	6	9	8	9	9	10	10
Total		100	70	86	80	79	81	88	83	79	73	90

Source: The Urban Unit, Landfill Site Identification and Evaluation Report, March 2014.

2.4.9 Implementation Status of Topographic and Geotechnical Survey on a Candidate Final Disposal Site in Bhakhraywali

The contractor hired by the UU completed the field work for the topographic survey and geotechnical survey of Bhakhraywali in September 2014. Outputs of these surveys were submitted to the UU in February 2015. Then, the JICA Project Team proceeded to the preparation of conceptual design of sanitary landfill facilities, which will be incorporated as a part of the document for EIA study.

2.4.10 Relevant Laws, Regulations and Guidelines on Waste Disposal Plan

The Punjab Provincial Government has been preparing the institutional system of solid waste management through formulation of the policies and enactment of laws, rules and regulations, guidelines, manuals, etc. The major government policies, laws, guidelines, etc., are listed below:

- National Environmental Policy 2005;
- National Sanitation Policy 2006;
- Guidelines for Processing and using Refuse Derived Fuel (RDF) in Cement Industry, 2012, Pakistan Environmental Protection Agency, Ministry of Climate Change;
- Punjab Waste Management Act 2013 (Draft);
- Punjab Municipal Solid Waste Management Guidelines 2007 and 2011;
- Solid Waste Management Manual, The Urban Unit; and

Design and Operation of Sanitary Landfill, The Urban Unit.

Among others, the Punjab Municipal Solid Waste Management Guidelines of 2011 (hereinafter referred to as “Punjab MSWM Guidelines 2011”) describes the requirement for planning, design and operation of each system composing solid waste management. The major technical requirements of waste disposal are stipulated in Chapter 8, Disposal (Landfilling). There are several unclear provisions in the Punjab MSWM Guidelines 2011; however, the provisions for major items are summarised in the following subsections.

(1) General Requirements

The major general requirements for landfill planning stated in the Punjab MSWM Guidelines 2011 are summarised as follows:

- Preferably, landfills should be for non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing.
- Land-filling of mixed waste should be avoided unless the same is found unsuitable for waste processing.
- The landfill plan shall be prepared/described with the following:
- Collection and transport routes, collection area, transfer station if any, the number, types and capacities of the incoming vehicles;
- Design period of the landfill, all landfill machineries and equipment, sources of the covering materials, operating hours, number of working days, number of workers for each activity;
- Hydro-geological condition, highest water levels, water quality for groundwater and surface water, topography, public and private water wells within one kilometre radius of the landfill site;
- Subsurface conditions, soil permeability and landslide areas, sink holes, fault areas, foundation analysis to support the loads and stress from the landfill and sub-grade settlement after land-filling; and
- Design of the site plan with details for particular activities and other appurtenant facilities such as onsite roads and traffic system, office building, weighing scale house, staff house, maintenance shop, parking area, truck wash bay, entrance-exit gate, fence, landscaping, utilities, and specifies types and number of machinery and equipment.

- Landfill site selection shall follow the “Minimum Site Selection Criteria for Landfill Site” in Annex-V of the Guidelines.
- Separation distance considered as the factor for site selection or the site plan is stated as follows:
- The distance between the active disposal area and the nearest residential, institutional, commercial or industrial building is recommended to be a minimum of 1000 m;
- The distance between the active disposal area and the nearest property boundary should be a minimum of 100 m; or
- The distance between the active disposal area and the nearest bank top or any surface water course or to any off-site well should be a minimum of 100 m.
- All landfill sites should be provided with the designated areas for separation, handling and storage of recyclable, compostable or reusable materials, bulky metallic objects, white goods, tires, batteries, and, where applicable, source separated materials such as yard wastes, glass, metals, plastics, paper, cardboard, etc. Source separated hazardous waste shall be stored and managed in accordance with the Hazardous Waste Regulations.

(2) Classification of Landfill

The Punjab MSWM Guideline 2011 classifies a landfill based on the tonnage of incoming waste amount per day shown as follows:

- Class A: Receiving a daily municipal solid waste of more than 1000 tons
- Class B: Receiving a daily municipal solid waste of 500-999 tons
- Class C: Receiving a daily municipal solid waste of 100-499 tons
- Class D: Receiving a daily municipal solid waste of less than 100 tons

(3) Distance of Groundwater Table from the Bottom of Landfill

The Punjab MSWM Guidelines 2011 states the distance from the bottom of landfill to groundwater table as “The bottom of landfill trench shall be higher than the groundwater table and not less than 3 metres unless special design of the hydrostatic uplift control is provided, or consult the Punjab EPD for specific guidance”. On the other hand, the provision in a, (b), (2), 26, “Standards for Landfills” in Punjab Waste Management Act 2013 (draft) states that “the bottom of the landfill shall be at least ten metres above the ground water level“. This discrepancy shall be studied and clarified. In this connection, the final revision of the technical guideline for final disposal in Japan, Ministerial Ordinance No. 3, 21st of February, 2013, Ministry of the Environment, do not state the distance or separation of groundwater table from the bottom of the landfill. However, it states that firm and durable facilities such as water conduit to collect and discharge groundwater shall be installed if there is a risk of damage to groundwater shielding facilities.

(4) Landfill Liner System

The Punjab MSWM Guidelines 2011 states that all landfill liners shall consist of the following components:

- Sub-base (The lowest point of the excavated area upon which the liner system is to be placed.)
- Base (above the sub-base with a minimum 300 mm thickness)
- Bottom liner and leak detection system (The system shall provide for the detection and collection of a leak through the composite liner system. The flexible membrane must be manufactured of high density polyethylene (HDPE) of a minimum 60 mil thickness.)
- Soil liner component (The soil liner shall not be less than 1000 mm in depth. The soil liner shall be constructed to ensure that the minimum permeability of the compacted soil is 1×10^{-7} cm/sec or less; the soil may be amended, if required, with an admixture such as bentonite clay.)

- Flexible membrane liner [The Flexible Membrane Liner (FML) component of the liner must be manufactured of high density polyethylene (HDPE) of a minimum 60 mil thickness.]
- Leachate collection layer (The Leachate Collection Layer shall not exceed a leachate depth in this layer of 300 mm. A minimum 300 mm thickness cushion layer should be placed above the leachate collection layer.)

(5) Leachate Management System

The Punjab MSWM Guidelines 2011 states that leachate management system should be installed based on the following requirements:

- The leachate management system should consist of the facilities for collection, control, treatment, discharge and monitoring of leachate from the landfill site;
- The leachate management system should be separate from the storm water drainage system;
- The leachate management systems should be functional year round and effective during the lifespan of the landfill;
- Leachate flow, both instantaneous and total flows, must be recorded; and, the system should have the adequate storage capacity for discharge control; and
- All leachate which would be harmful if discharged into the surrounding environment shall be treated to remove pollutants and tested prior to discharge.

(6) Landfill Gas Management

The Punjab MSWM Guidelines 2011 states the requirements of landfill gas management as follows:

- Venting and/or gas collection systems must be installed to control and monitor gas generation in the landfill;
- All new landfills must be assessed for viability of energy recovery from gas generation; and
- Landfill gas management systems shall be evaluated on a case by case basis.

(7) Surface Water Management

The Punjab MSWM Guidelines 2011 states the requirements of surface water management as follows:

- Surface water management systems should be designed to:
- divert surface and storm water from the landfill area;
- control run-off discharge from the facility;
- control erosion, sedimentation, siltation, and flooding; and
- minimise the generation of leachate.
- All surface water management systems should be hydraulically separate from the leachate management system.

(8) Groundwater Management

The Punjab MSWM Guidelines 2011 states the requirements of groundwater management as follows:

- Groundwater must be carefully managed to avoid contamination by leachate or surface water discharges;
- The seasonal high groundwater table must be maintained at a minimum of 1000 mm below the bottom liner;
- Groundwater lowering system must be provided for positive drainage of groundwater or lowering of groundwater level;
- The distribution of groundwater monitoring wells should depend on the hydrogeological

conditions of the landfill for the installation of a sufficient number of wells and function to take potential contamination samples, background level samples and multilevel samples. At least three monitoring wells shall be installed at hydraulically lower reaches of groundwater flow direction; and

- The monitoring wells must be retained throughout the lifespan of the facility.

(9) Landfill Operation

The Punjab MSWM Guidelines 2011 states the requirements of landfill operation as follows:

- All new landfills shall have disposal waste monitoring systems through inspection and weighing of waste to be landfilled.
- General matters for landfill operation require that:
- Soil cover should be placed at least once per day or more often as required;
- Landfill should have constant supervision throughout the operation hour;
- All loads must be inspected prior to unloading;
- Landfill shall accept only the approved waste;
- Dust and litter must be controlled;
- Exposed areas must be stabilised to prevent erosion and sedimentation;
- Vectors must be controlled as required;
- Appropriate signage must be placed at the entrance to the landfill indicating the name of the landfill, hours of operation, emergency contact, and the waste type acceptable for disposal; and,
- Operation and maintenance manual shall be prepared including the document for approval of landfill, operational requirements, landfill method, contingency plan, records, report, etc.

(10) Environmental Pollution Control

The Punjab MSWM Guidelines 2011 include the following systems for environmental pollution control:

- Capping system;
- Landfill gas management system;
- Leachate management system; and
- Regular monitoring points for settlement, groundwater quality, leachate and gas sampling.

(11) Financial Provision

The Punjab MSWM Guidelines 2011 states the financial provision for various after use options for the cost of restoration, aftercare, maintenance, land, site development and environmental protection through the income sources, such as:

- Income from incoming waste and gas utilisation (if applicable); and
- Income from after use.

(12) Closure Plan

The Punjab MSWM Guidelines 2011 states the requirements for the closure plan specifically the following:

- Total waste volumes and tonnage, and life of the landfill (i.e., closure date);
- Closure layout plan showing the final elevation, contours of the landfill, surface water diversion and drainage controls;
- Final cover design including the depth and permeability of barrier layers and drainage layers, topsoil information, vegetation cover and erosion prevention controls;

- Procedures for notifying the public regarding the closure and the alternative waste disposal facilities;
- Procedures for the control of rodents, nuisance, and wildlife;
- Proposed land use after closure;
- Plan and accompanying design for the collection, storage and treatment/use of landfill gas for a minimum of 25 years;
- Plan for operation of required pollution control engineering works such as leachate collection and treatment systems, for a minimum post-closure period of 25 years;
- Monitoring plans for groundwater, surface water and landfill gas, erosion and settlement for a minimum post-closure period of 25 years; and
- Estimated cost, updated annually, to carry out closure and post-closure activities for a minimum period of 25 years.

2.4.11 Evaluation of Final Disposal Condition

The problems and issues in relation to final disposal activities under the current situation are summarised in **Table 2.4.13**. These items will be the basic elements to develop the plans, programmes and projects to comprise the final disposal plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table 2.4.13 Identification of Problems and Issues in Final Disposal

Problem	Description of Problem	Issues for Solving the Problems
1. Solid waste management without sanitary landfill facilities	Gujranwala City has never developed sanitary landfill facilities and the disposal sites tentatively used in the past have caused environmental degradation in the surrounding area. The existing landfill site in Gondlanwala procured for provisional use was not developed to function as an engineered sanitary landfill facility and with the continued inappropriate landfill operation by open dumping, the surrounding area is facing the problem of environmental degradation.	Urgent development of sanitary landfill facilities should be made so as not to cause secondary pollution from the landfill site. To solve this problem, a site selection study for new landfill facilities has been carried out by the Urban Unit, and the site in Bhakhraywali was selected for the proposed construction site. EIA study and obtaining approval is one of them and the EIA study is now underway.
2. Delay of procurement procedures for proposed landfill site in Bhakhraywali	The site in Bhakhraywali was advertised as the proposed landfill site but the site has not been procured yet due to delay of payment. This will cause the delay of construction work. If the start of construction work is delayed, the new landfill facilities will not be completed within the lifetime of the temporary disposal site in Gondlanwala. This will thus require other provisional landfill sites.	Procurement of the proposed landfill site through coordination among the relevant agencies of the government should be required for accelerating the procurement process. Immediate action by CDGG/GWMC is required to appeal the urgency of the project and the necessity to avoid further environmental degradation in order to increase the priority of subsidy payment by the provincial government agency(s).
3. No development work of landfill facilities of the existing landfill site in Gondlanwala	The existing landfill site in Gondlanwala utilises the abandoned borrow pit without facility development. Most of the troubles in landfill operation occur due to inappropriate site condition, which bring about environmental degradation especially groundwater contamination, breeding of pests such as flies, etc. to the surrounding area.	Implementation of rehabilitation work to install and/or construct the facilities should be carried out for mitigating environmental pollution.
4. Inappropriate landfill operation and management at the existing landfill site in Gondlanwala	Landfill management was not properly implemented at the existing landfill site in Gondlanwala. As a result, the existing landfill site might be causing a negative impact on the environment of the surrounding area.	Minimising the environmental impact of the existing landfill site should be implemented through emergency measures and introduction of landfill operation and maintenance manual, procurement of sufficient number of landfill machines, equipment, materials and deployment of staff.
5. Not proper closed/abandoned landfill site in Chianwali	The Chianwali landfill site was not closed properly and thus causing secondary pollution to the surrounding area. The site is located just along the G.T. Road. Therefore, in addition to the risk of groundwater contamination, visual pollution to landscape and waste scattered by wind are causing the negative environmental impacts.	Mitigating the environmental impacts should be required through implementation of safe closure work of the landfill site. According to Punjab Municipal Waste Management Guidelines 2011, "Closure Plan", Chapter 8, the post-closure maintenance and monitoring works shall be provided for a minimum period of 25 years.

2.5 Intermediate Treatment and 3R Promotion Study

2.5.1 Waste Picker Survey

The Waste Picker Survey is one of the field surveys within the framework of the Project carried out by JICA. Recycling of municipal solid waste in Pakistan relies largely on the informal recovery of resource materials by the waste pickers, junk shops and waste dealers, which render valuable services to society by recovering unusable wastes for productive resources. Nevertheless, little is known about the activities of waste pickers. One of the reasons is that waste traders are understandably very cautious in keeping their business confidential. Another reason is the difficulty in earning the trust of waste pickers and waste dealers.

There is an air of secrecy around waste pickers. Quantitative data on solid waste management in Gujranwala City has been scarce and the recycling rates are unreliable. The waste picker survey was focused on gathering information from the waste pickers in Gujranwala City and the existing disposal site with regard to their recycling activities.

(1) Objective of the Survey

The main objective of the survey was to collect information and to analyse the current activities of waste pickers in Gujranwala City and at the Gondlanwala disposal site.

(2) Method of the Survey

The questionnaire was structured based on the contents of the Inception Report of the JICA Project Team and included the following three (3) parts:

1) General information about the waste pickers;
2) Current recycling situation and recovery amount of recyclables by the waste pickers, and their health and safety issues; and
3) Future concerns of waste pickers regarding their job.

The survey was carried out in December 2014.

The breakdown of sample size for the waste picker interview survey is given in **Table 2.5.1**.

Table 2.5.1 Breakdown of Sample Size for Waste Picker Survey

Item No.	Location		No. of Samples	
1	Gondlanwala Disposal Site			20
2	Gujranwala City	Low Income Area	5	20
		Middle Income Area	10	
		High Income Area	5	
Total				40

Source: GWMC, JICA Project Team

(3) Results of the Survey

The survey data was evaluated as to the recovery amount and selling price of recyclables collected by the sample groups of waste pickers surveyed in Gujranwala City and at the Gondlanwala disposal site.

(a) Gujranwala Town Areas

Evaluated were the average amount of each kind of recyclable collected per waste picker per day, unit price of each recyclable, average selling price of each recyclable in the city, and the range of unit price and selling price of each kind of recyclable.

The waster pickers in Gujranwala City segregate the recyclables collected per day according to type and selling price. The recyclable easily collected from the waste is cardboard, i.e., 37 kg/day per waste picker on average. However, the selling amount of hair is the highest among the other types of recyclable, i.e., 800 Rs./day followed by metals at 400 Rs./day.

More cardboard, paper (others), plastics (PET and other), metals (steel and others) and hair are recovered in the town area as compared to the recyclables recovered at the Gondlanwala disposal site. Waste pickers in the town area do not segregate rubber and broken glasses, but they segregate or recover food waste.

(b) Gondlanwala Disposal Site

Evaluated were the average amount of each kind recyclable collected per waste picker per day at the Gondlanwala disposal site, the unit price of each recyclable, the average selling price of each recyclable, and the range of unit price and selling price of each recyclable. The amounts of recyclable collected from the waste at Gondlanwala disposal site are large. Recovered quantities of shoes and glass bottles amount to 53 kg/day and 52 kg/day, respectively, per waste picker on average, but the selling amount of hairs is the highest among the other recyclables, i.e., 772 Rs./day.

Recovery amount of glass bottles, shoes and bones at the Gondlanwala disposal site is more as compared to that in the town area while rubber and broken glasses are recovered only at the disposal site. None of the disposal site waste pickers is involved in food waste recovery.

Table 2.5.2 shows the results of comparison between survey samples in Gujranwala City and Gondlawala disposal site. Waste pickers at Gondlanwala sell recyclables at prices higher than the waste pickers in the city, and the recovery amount is more at the Gondlanwala disposal site.

Table 2.5.2 Results of Comparison between Survey Samples in Gujranwala City and Gondlanwala Dumping Site

Categories of Recyclables	Recovery Amount (kg/day)		Average Unit Price (Rs./kg)		Average Sold Amount (Rs./day)		Unit Price Range (Rs./kg)		Sold Amount Range (Rs./day)	
	GC*	GDS**	GC	GDS	GC	GDS	GC	GDS	GC	GDS
Cardboard	37	15	8	7	253	105	4-10	6-7	40-1,000	36-175
Paper (other)	13	2	8	30	83	60	5-15	30	75-100	60
Plastic (PET)	13	12	26	20	322	239	20-30	20-22	125-750	100-540
Plastic (other)	19	10	8	16	306	143	8-30	7-22	80-1200	80-240
Glass (bottles)	24	33	3	3	88	122	2-5	2-4	8-320	30-600
Glass (broken)	0	29	0	3.5	0	98	0	3-4	0	60-200
Metal (others)	11	1	44	80	400	80	30-80	80	60-750	80
Metal (steel)	3	2	25	35	75	70	25	35	75	70
Shoes	9	20	5	4	55	83	3-15	3-7	6-180	15-200
Rubber	0	6	0	5	0	29	0	3-7	0	15-42
Hair	0.2	0.2	3,800	4,000	800	772	3,000-4,000	4000	400-1,200	320-2,000
Bones	10	11	8	9	91	106	5-10	5-10	25-400	20-200
Food Waste	10	0	15	0	165	0	10 to 22	0	75-440	0
Total	149	141			2,638	1,907				

Note: * GC: Gujranwala City, ** GDS: Gondlanwala Dumping Site
Source: GWMC, JICA Project Team

(4) Conclusion

The total recovery amount by 20 waste pickers in Gujranwala City is 1,084 kg/day, which is greater than the recovery amount by 20 waste pickers at the Gondlanwala disposal site, i.e., 1,264 kg/day. The average recovery amount per waste picker in the city is 82 kg/day; whereas, at the Gondlanwala disposal site the recovery amount per waste picker is 55 kg/day. The average monthly income of waste pickers at the Gondlanwala disposal site is 30,000 Rs./month which is almost the same as that of the waste pickers in the city, i.e., 29,500 Rs./month.

The results of this survey reveal that the recovery of resource materials in waste is carried out actively with the involvement of waste pickers, junk shops and dealer. If the resource materials recovered directly from the large waste generators to the dealers or to the factories is added, the recovery amount in the current recycling market in Gujranwala is estimated at more than 70 ton/day. The amount recovered by the waste pickers in addition to the material recycling is contributing to the waste diversion or reduction of landfill amount.

Thousands of people are engaged in waste linked businesses throughout the city and elsewhere. The waste pickers play an important role in the segregation and recovery of resource materials from discarded waste and add to the promotion of recycling and reuse of recyclable waste. The survey showed that the majority of households discard hazardous wastes together with other wastes. Those hazardous wastes are corrosive, toxic, ignitable or reactive and may cause injury or poisoning, particularly, to children and people who sort the waste. The waste pickers never wear protective gears against injury or sickness.

2.5.2 Overview of Intermediate Treatment and 3R Promotion in Gujranwala

Activities related to the intermediate treatment and 3R in Gujranwala have been surveyed to collect related information through interview with concerned persons and exploratory investigations.

In Gujranwala, there is no formal intermediate system or 3R (Reduce, Reuse, Recycle) system. Informal activities take place at various steps from the source to the final disposal site through waste-related activities (See **Figure 2.5.1**). Recycling (resource recovery) has been widely done mostly through the residents, sanitary workers and waste pickers. Segregation at source and resource recovery by waste pickers has been discussed in the preceding **Subsection 2.5.1**, and private recycle shops and dealers are described in this **Subsection 2.5.2**.

(1) Segregation at Household

The segregation of recyclables such as plastics, newspaper, cardboard, food waste, cans and PET bottles is done mainly by the maids and children who sell them to street hawkers, private recycle shops or dealers for their supplementary income or snacks. Some private recycle shops hire workers to collect recyclables in residential areas by moving from one street to another with hand pulled carts, bicycles and motorcycles.

(2) Segregation at Commercial Area

Owners or employees of commercial shops segregate recyclables such as cardboard, paper, plastic and so on, and sell them to private recycle shops or dealers. In some areas, the private recycle shops go to these commercial shops to buy the recyclables.

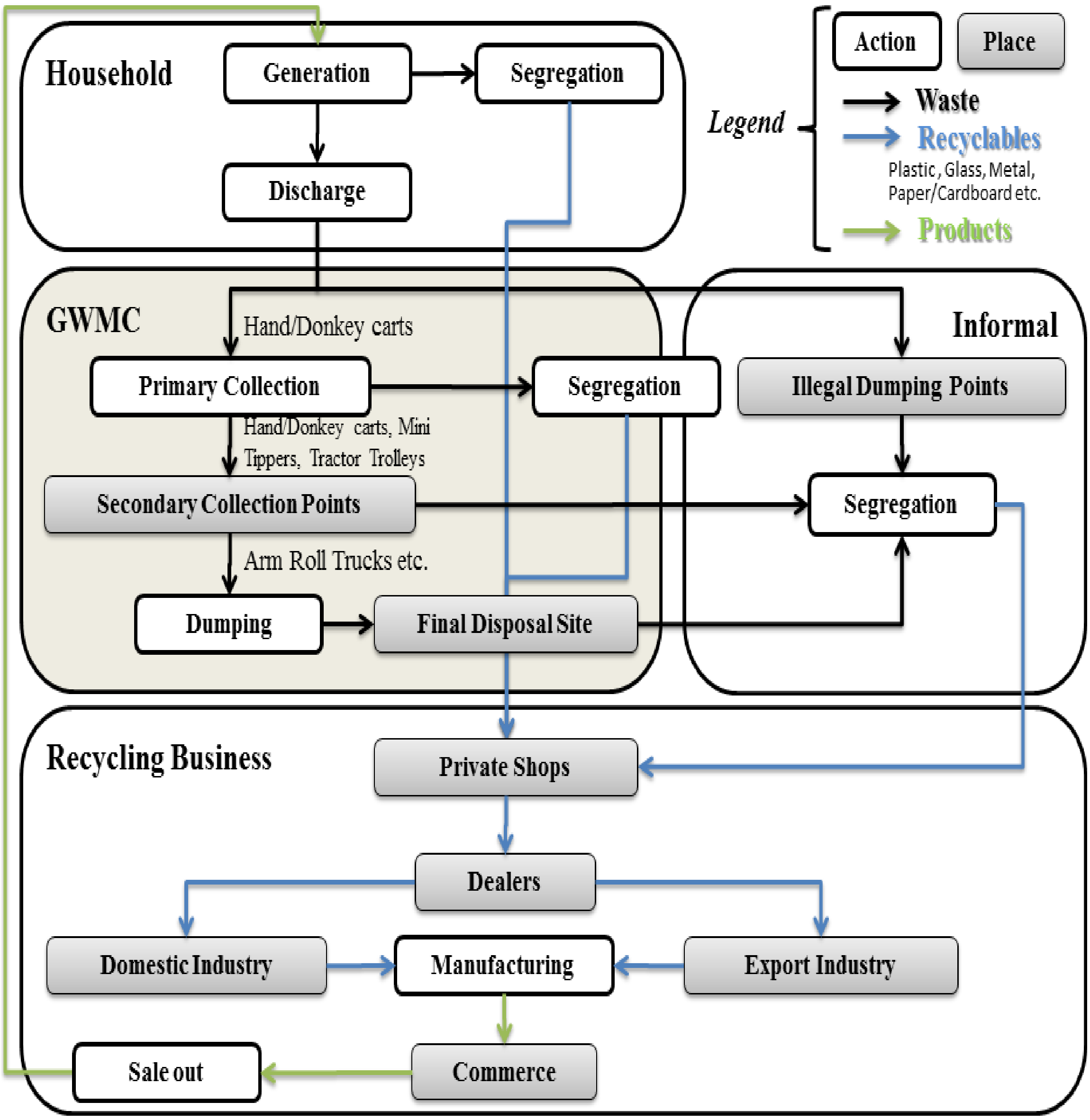


Figure 2.5.1 Material Flow of Recyclables in Gujranwala

(3) Waste Picking

There are two types of private waste pickers in Gujranwala. Most of the waste pickers are males of all ages. The first group works in the street, and near containers at collection points and transfer stations, move from street to street of the city as well as the open plots full of illegally-dumped waste in urban areas. The second group works at the final disposal sites.

The first group segregates and collects recyclables such as plastics, glass, cardboard, metals and so on, and sell them to private recycle shops or dealers. Since they have their own territories, the same waste pickers work at the same containers every day. In some areas, waste pickers sometimes collaborate with GWMC sanitary workers to transfer waste from hand carts or donkey carts to containers.

On the other hand, the second group segregates and collects the recyclables, carries them to the city and sell them to private recycle shops or dealers because there are no shops near the final disposal site. Since they gather the recyclables from trucks or trolleys full of waste, they interfere with GWMC's dumping work. In addition, they are at risk of being injured. In fact, almost all of them complain about not only the bad odour but also the danger of broken glasses and hospital wastes mixed in municipal solid waste. Since no one has protective equipment such as boots, gloves, masks, and so on, some of them have experienced getting injured by broken glasses. It is then necessary to consider possible methods to protect them from getting injured and to provide means of earning for their living. Waste picking activities are shown in **Photo 2.5.1, Photo 2.5.2** and **Photo 2.5.3,** and recyclables collected by waste picking are presented in **Photo 2.5.4**.

Photo 2.5.1 Waste Picking at a Container, UC No.41

Photo 2.5.2 Waste Picking in an Open Plot, UC No.6

Photo 2.5.3 Waste Picking at the Final Disposal Site and Collected Recyclables, UC No.131

Photo 2.5.4 Recyclables Collected by Waste Picking, UC No.131

Some GWMC sanitary workers also segregate and collect the recyclables directly from domestic waste and sell them to the private recycle shops or dealers as the waste pickers do. This is partially because GWMC does not prohibit the sanitary workers from collecting the recyclables during working hours.

Based on the results of hearing survey with waste pickers in April 2014, total number of waste pickers at containers and the final disposal site is estimated at 433 (See **Table 2.5.3**). In addition, there are many waste pickers moving around Gujranwala City. Therefore, the estimated number of waste pickers may exceed 800. Regarding the amount of recyclables treated by waste pickers, it can be presumed to be around 70 tons per day assuming that the average collection amount is 82 kg/day-waste picker and 55 kg/day-waste picker in Gujranwala City and Gondlanwala disposal site, respectively, based on the waste pickers survey conducted by GWMC and the JICA Project Team in December 2014.

Table 2.5.3 Number of Waste Pickers at Container and Final Disposal Sites

Town / Road / Place	Number of Containers*	Number of Waste Pickers
Aroop Town	48	89
Kshiali Town	57	114
Nandipur Town	51	95

Town / Road / Place	Number of Containers*	Number of Waste Pickers
Qila Didar Singh Town	40	68
G.T. Road	5	10
Chianwali Final Disposal Site	0	2
Gondlanwala Final Disposal Site	0	55**
Total	201	433

Note: * The number of containers was estimated in April 2014.
**The number of waste pickers of 55 is based on the Waste Picker Survey in January 2015.
Source: Results of interview survey with waste pickers, GWMC and JICA Project Team

(4) Other 3R Activities

Based on the interview with residents, the following facts regarding 3R were revealed:

- Almost all people get free plastic bags (mainly polyethylene) instead of bringing their bags when shopping.
- When people have troubles with their electronics or furniture, they tend to take actions based on 3R policy; that is, they firstly try to repair them, handover and/or then sell them out. In case of combustible materials, they stock and use them as fuel in winter.

2.5.3 Existing Recycling Firms in Gujranwala

In Gujranwala City, informal sector activities are very active as described in **Subsection 2.5.2**. In order to evaluate the system of segregation, collection and treatment/disposal of recyclables and abilities of related contractors, types of recyclable materials, degree of utilisation and penetration to residents, and presence or absence of markets in Gujranwala have been surveyed. Regarding the markets, size and operating structure related to firms and problems have also been examined.

(1) Recycle Private Shops and Dealers

There are more than 400 private recycle shops and dealers in Gujranwala City. Basically, private recycle shops (see **Photo 2.5.5**) collect recyclables from households, commercial establishments, waste pickers, street hawkers (see **Photo 2.5.6**) and sanitary workers. They collect all sorts of recyclables including paper/cardboard, all types of metal, glass, plastic, bread and shoes. They also sell the recyclables to specified recycle dealers after collecting a certain amount. On the other hand, recycle dealers purchase the recyclables from recyclable shops and industrial establishments, etc., located not only in Gujranwala City but also all over Pakistan or other countries, and sell them to industrial establishments. Most of them are specialised dealers but some are general ones. In addition, it is said that there are brokers called “middlemen” who play the role of mediator between dealers and factories without treating the recyclables directly.

Regarding the price of recyclables, although it depends not only on kind of recyclables but on quality, recyclables are sold at a small profit.

Photo 2.5.5 Recycle Private Shop, UC No.54

Photo 2.5.6 Street Hawkers in Peri-Urban Area, UC No.117

(a) Targeted Recyclables

Private recycle shops and dealers treat cardboard, food waste, glass, leather, metals (aluminium, brass, copper, iron, lead, silver, tin), paper, plastics, rubber, shoes, etc. Almost all of the private shops deal with cardboard/paper, plastics and metals. Approximately half of the shops deal with food waste and glass. In contrast, approximately 70% of dealers treat exclusively metals followed by plastics (ca. 20%) and paper (ca. 15%).

(b) Price of Recyclables

Purchase prices of private recycle shops and dealers are described in **Table 2.5.4**.

Table 2.5.4 Price of Recyclables

Unit: Rs./kg

Item	Price Range	Item	Price Range
Cardboard	7-17	Metal	25-650
Food waste	17-18	Aluminium	100-200
Glass	1-5	Brass	120-565
Leather	17	Copper	550-650
Paper	8-20	Iron	25-45
Plastic	11-80	Lead	105
Rubber	3-4	Silver	142-175
Shoe	5-38	Tin	30

Source: Interview with private recycles shops and dealers, GWMC and JICA Project Team

(c) Profit

Regarding profit of recycle private shops and dealers, there are few direct answers from them. Based on their answers about rough transaction amount and purchase/selling prices, their profit can be estimated at between 5,000 and 125,000 Rs./Month. Majority average profit is estimated at 30,000 Rs./Month.

(d) Number of Employees

Almost all recyclable dealers hire less than 10 people at a maximum. Some owners operate their shops by themselves.

(e) Site Location

The number of recycle private shops and dealers was counted by field survey. **Table 2.5.5** shows the minimum number because of the purpose and procedure of this survey. Regarding private shops, all urban UCs except No.4 and No.42 have at least one shop. On the other hand, dealers operate only in about 40% of urban UCs and tend to be located in UCs with many private shops. Regarding the peri-urban UCs, there are some recycle private shops in each UCs with few exceptions; there are no recycle private shops in UC No.114, UC No.117 and so on. However there are no recyclable dealers in the peri-urban UCs.

Table 2.5.5 Number of Recyclable Shop and Dealers by UCs

UC No.		Shop	Dealer	Total	UC No.		Shop	Dealer	Total
Aroop Town	4		1	1	Khiali Town	28	8		8
	5	6		6		29	7		7
	6	4	2	6		30	8		8
	7	3		3		31	10	1	11
	8	9	2	11		32	7		7
	9	11	2	13		33	8		8
	10	10	9	19		34	7	250	257
	11	6		6		35	11	1	12
	12	5		5		36	8		8
	13	8	2	10		37	6		6
	14	5		5		38	4	1	5
	56	2		2		47	13		13
	57	2		2		48	7	1	8
	61	9	2	11	Qiladidar Singh Town	3	2		2
	62	6		6		39	4		4
	63	5		5		40	9		9
	64	12		12		41	5		5
Nandipur Town	1	4		4		42		12	12
	2	6	1	7		43	8	10	18
	15	3		3		44	3		3
	16	1		1		45	4	1	5
	17	12		12		46	6	1	7
	18	9		9		49	10	2	12
	19	6		6		50	10	1	11
	20	7	1	8		51	3		3
	21	6		6		52	4		4
	22	6	1	7		53	5		5
	23	5		5		54	10	3	13
	24	6		6		55	1		1
	25	7	1	8		58	7	1	8
	26	3		3		59	5		5
	27	8		8		60	6	3	9
Total							398	312	710

Source: JICA Project Team

(f) Open Hours

Most of the shops and dealers open at around 8 a.m. and close at around 5 p.m. every day except on Fridays.

(g) Year of Operation

Year of operation depends on the shop and dealer such as 2 to 35 years. The average is estimated to be about 10 years. Since there are no necessary qualifications to start a business, it seems to be relatively easy to start operations.

(2) Scrap Market

It has been confirmed that a scrap market focusing on metals exists in UC No.34 in Gujranwala City. The market is a kind of association composed of about 250 recyclable dealers in UC No.34. The association has a board of directors, president, finance head, secretary and so on. Some of the dealers are registered with the Gujranwala Chamber of Commerce and Industry, even though it is not necessary. Although the transaction volume is not revealed, this market purchases metal scraps from all over the country and sell them to factories in Gujranwala City. Middlemen described above play the role of mediation between the scrap dealers and the factories.

(3) Factory

Recycle status in factories in Gujranwala City and surrounding areas were surveyed. Almost all of the factories sell or give their recyclable waste (metal scrap, slag, plastic scrap, plaster, etc.) to recycle dealers or applicants. Some factories recycle their generated recyclable waste in their factories or purchase recyclables from dealers or other factories in order to utilise as their feedstock. Typical industries and recyclables are enumerated in **Table 2.5.6** and metal scrap from factories is shown in **Photo 2.5.7**.

Table 2.5.6 Typical Industries, Recyclables, Destinations and Final Products

Industry Sector	Recyclables	Destination	Final Products
Chemicals	Plastic drum, Metal drum	Dealer	Reuse
Ceramics	Mould	Own factory	Filling material
Food	Plastic bag* (low density polyethylene (LDPE) bag, or polythene bag)	Dealer	Plastic crystals/pallets
Foundry Works	Combustion residue	Applicant	No use (waste)
Gas Appliances	Metal (Iron, Silver, Steel)	Dealer	Remoulding and rerolling
Marble	Small cuttings of marble	Dealer	Basement material
Paper	Paper	Dealer	Recycling
Plastic	Plastic*	Dealer	Plastic crystals/pallets
Sanitary Fittings	Metal (Brass)	Dealer	Remoulding
Spare Parts	Metal (Aluminium, Brass, Copper, Iron, Steel)	Dealer Other Factory	Spare parts e.g., nuts, bolts, etc.
Utensil	Metal (Iron, Brass, Steel) Metal (Aluminium) Plastic (Becolite)	Dealer Own furnace Factory workers	Kitchen ware and spare parts, sanitary fittings spare parts

Note:* According to the interview results with industrialists and recyclable manufactures, plastic bag and plastic in the above table is not made of poly-vinyl chloride in Gujranwala. However, there may be no act or protection to prohibit the use of poly-vinyl chloride in the country.

Regarding plastics, there are some notifications which may be called the prohibition of non-degradable plastic products (manufacturing, sale and usage) of polyethylene, polypropylene or polystyrene, Regulation 2013 ("Extraordinary Published by Authority, Part-II Statutory Notifications (S.R.O), Government of Pakistan Environmental Protection Agency, Islamabad, 2013", and "The Punjab Gazette published by Authority, Law & Parliamentary Affaires Department, 2002).

Photo 2.5.7 Metal Scraps from a Factory of Small Industrial Estate SIE (II)

(4) NGO

There are three (3) NGOs related to the environment sector in Gujranwala, namely; Organisation Pan Environment (OPE), Gujranwala Environmental Organisation (GEO) and Social Transmission & Environmental Protection Society (STEPS). One of them, OPE, carried out a pilot project for composting as part of a waste collection program financially supported by an international NGO named Water Aid. In particular, from May 2011 to January 2012, OPE had collected domestic waste and segregated organic waste from the waste in part of UC No.8. The number of covered households (HH) and population was about 1,800 and 15,000, respectively. After segregation, organic wastes were transported to UC No. 38 about 10km away from UC No.8 for composting. OPE adopted the pile method for composting under the technical cooperation of the University of Agriculture Faisalabad. The number of members related to this project was 13, i.e., 11 for sanitary workers and 2 for social mobilisers. During the first 6 months, OPE provided the door-to-door collection service for free and started to charge 50 Rs./month/HH after 6 months. Since the collection rate of waste discharge fee was only 25%, OPE could not continue to provide the service after funding stopped. With regard to composting, OPE collected organic waste of about 900 kg/day and produced compost with 25% of weight recovery rate. OPE gave compost free of charge and sometimes sold them at 20 Rs./kg. Reasons for the failure the marketing of compost were: (1) OPE does not have a licence for the sale of compost; and (2) Farmers want immediate results. While compost give results in 5-6 years, chemical fertilizers give more yield of crops and immediate results. Therefore, the demand of compost is not much at present.

GEO has been entrusted the project of installation of dust bins by the Environmental Protection Department (EPD). Dust bins were installed outside government offices, colleges and adjoining streets of UC 90/54 and small dust bins were distributed free of charge to shopkeepers. The project was completed in almost 2 months. GEO also printed awareness messages on 5m^3 waste containers placed in different UCs of the city. STEPS conducted an awareness campaign related to environment in a school of Gujranwala.

(5) Private Composting

In one of the largest parks in Gujranwala City named Gulshan Iqbal Park, composting has been practiced for more than 23 years. After establishment of the Parks and Horticulture Authority (PHA) on 11 April 2014, the administration of all parks was handed over by the Tehsil Municipal Administrations (TMA) to PHA.

Pit and open heap/pile method of composting is being practiced. In the open heap/pile method, cow dung, dry crushed leaves and earth are mixed at the ratio of 3:2:14. Periodic sprinkling of 5% DAP (Di-Ammonium Phosphate) solution is done on the pile. In the pit method of composting, 2 feet high layer of leaves of eucalyptus tree in the park are placed in the pit and periodic sprinkling of 5% DAP is also done.

The process is completed in 3 pits. After every 3 months, the material is transferred to the next pit. This type of compost gets prepared in 9 months. Compost prepared in this park is used only for horticulture and floriculture within the park. As many as 100,000 plants of 23 different varieties were grown using this compost in 2014. PHA has a plan to expand composting into the other parks in Gujranwala City. **Photo 2.5.8** shows the interview with the administrator of the Gulshan Iqbal Park regarding their composting activity.

Photo 2.5.8 Interview with Administrator at Gulshan Iqbal Park, Gujranwala

(6) Farmer

In Gujranwala District, large cultivated lands spread in the peri-urban UCs. **Table 2.5.7** shows the cultivated area of each crop in Gujranwala City and Sadar Tehsil. The major crop occupies approximately 95% with rice and wheat. On average, fertilizer consumption amount of wheat is 100 kg of urea, 75 kg of DAP (Di-Ammonium Phosphate) and 50 kg of potash per acre. On the other hand, the amount for rice is 100 kg of urea and 50 kg of DAP per acre. The total fertilizer consumption of crops is estimated to be approximately 50,307 tons per year in Gujranwala City and Sadar Tehsil. It was revealed through interview with the Managing Director (MD) of Lahore Compost Company that 6-7 bags of 50kg are required per acre. The total compost consumption for crops is estimated to be 110,291 tons per year in Gujranwala City and Sadar Tehsil. As shown in the table, for example, unit price per acre of chemical fertilizers application for wheat becomes 11,300 Rs./acre and unit price of compost application for wheat becomes 1,750 Rs./acre. Compost is cheaper than the chemical fertilizer.

However, it was revealed through some interviews with farmers that they do not want to start to utilise compost without verification test by authorised public institutions.

Table 2.5.7 Comparison of Cost and Consumption of Chemical Fertilizers and Compost Application on Crops in Gujranwala City and Sadar Tehsil (2013-2014)

Crop type	Cultivated Area		Quantity of Chemical Fertilizer Required (tons)	Estimated Cost of Chemical Fertilizers Application (Rs.)	Quantity of Compost Required (tons)	Estimated Cost of Compost Application (@ 7 bags / acre) (Rs.)
	(acres)	Ratio (%)				
Wheat	139,408	44.2	27,882	1,575,310,400	48,793	243,964,000
Rice	159,892	50.7	20,466	1,674,868,700	55,962	279,811,000
Vegetables	4,070	1.3	1,018	57,387,000	1,425	7,122,500
Sugarcane	180	0.1	45	2,506,500	63	315,000
Maize	189	0.1	43	2,475,900	66	330,750
Fodder	11,378	3.6	853	48,356,500	3,982	19,911,500
Total	315,117	100.0	50,307	3,360,905,000	110,291	551,454,750

Source: Agriculture Department Gujranwala

Although more precise recycle rate cannot be calculated at this stage without the whole result of WACS (Waste Amount and Composition Survey), it can be said that the recycle rate has already reached a certain figure and that there are less recyclables distributed in the informal recycle sector at the final disposal site.

Currently, there are no formal activities related to intermediate treatment and 3R although it was observed that an appreciable extent of informal activities regarding intermediate treatment and 3R are carried out. Therefore, it is important to design the manners of utilisation of non-recycled waste with minimising effect to the informal activities.

2.5.4 Evaluation of Intermediate Treatment and 3R Promotion Condition

The problems and issues in relation to intermediate treatment and 3R (Reduce, Reuse, Recycle) activities under the current situation are summarised in **Table 2.5.8**. These items will be the basic elements to develop the plans, programmes and projects to compose the intermediate treatment and 3R promotion plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table 2.5.8 Identification of Problems and Issues in Intermediate Treatment and 3R

Problems	Description of Problem	Issues for Solving the Problems
1. Absence of formal intermediate treatment and 3R facilities	Gujranwala City has not developed intermediate treatment or 3R facilities until now.	GWMC should introduce formal intermediate treatment and 3R facilities with consideration on not only budget but also the awareness of residents. To determine the necessary and sufficient facilities, the result of WACS shall be fully considered.

Problems	Description of Problem	Issues for Solving the Problems
2. Lack of awareness of residents on intermediate treatment and 3R	People who do not want to get little money from recyclables are not interested in the segregation of waste. In addition, almost all people neither bring bags for shopping nor conduct pre-treatment like pressing and dewatering. On the other hand, GWMC has not started educational programmes for intermediate treatment and 3R.	GWMC should raise the residents' awareness regarding the intermediate treatment and 3R. Even if there are enough facilities and systems related to the intermediate treatment and 3R, they will not be effective without the consciousness of the residents.
3. Health Risk of Waste Pickers	Waste pickers never wear protective equipment like shoes, masks, gloves and helmets to protect themselves from injury or sickness. Although they sometimes disturb operation like unloading and collecting, GWMC should not oversimplify this problem. It cannot be solved by prohibiting their activities since they do not have any other means to earn a living except waste picking at present.	Instead of imposing a limit on their work to improve operation efficiency, GWMC should provide alternative opportunities when they make a living. The countermeasure for Problem 1 in this table must be considered first to determine the countermeasure for this problem.
4. Ambiguous flow of recyclables	Although there are no formal facilities and systems for the intermediate treatment and 3R in Gujranwala City, there are so many people involved in the recovery of recyclables. There seem so many flows of recyclables, and the amount of recyclables in each flow or point cannot be identified at this moment.	In order to set reasonable goals of intermediate treatment and 3R plan, it is necessary to grasp the current situation quantitatively or the recovery rate. It is also needed to measure the effect of several plans related to intermediate treatment and 3R. Therefore, GWMC should take measures to calculate the recovery rate periodically.

2.6 Environmental Education and Public Awareness Raising Study

2.6.1 Public and Establishment Awareness Survey

(1) Objective of the Survey

Awareness survey was planned to identify the current status of waste management practices by key stakeholders including the following categories:

- Households (include households targeted in waste amount and composition survey); and
- Business entities (market, schools and universities, commercial establishment, restaurants, hotels, shops, factories, and hospitals).

(2) Survey Method

The interview survey is conducted by a private contractor while some key components, such as sample numbers and target entities, and questionnaire forms are developed with close cooperation between counterpart personnel and the JICA Project Team.

This survey covers the following areas in Gujranwala City:

- Aroop
- Nandi Pur
- Khiali
- Qila Didar Singh
- Rural (outside of 64 urban UCs)

Number of samples required for the household survey is determined using multistage sampling methods, in which approximately 400 samples are required giving 95 confident levels. These 400 samples are then distributed among target areas depending upon income level since income greatly influences the type and volume of waste. The number of samples per area per income level is listed in **Table 2.6.1** below.

Table 2.6.1 Number of Samples for Public Awareness Survey

Town	Areas	*Income Level*			Samples	Proportion of Samples
		Low	*Middle*	*High*		
Aroop	A	12	20	10	85	All the selected households in the Waste Amount and Composition Survey (WACS) shall be included in this survey.
	B	13	20	10		
Nandi Pur	C	12	20	10	85	
	D	13	20	10		
Khiali	E	40	5		85	
	F	35	5			
Qila Didar Singh	G	15	25		85	
	H	20	25			
Rural	I	30			60	
	J	30				
Sub Total		220	140	40	400 Households	

Likewise, the number of target commercial establishments is determined to represent the whole area of Gujranwala City as shown in **Table 2.6.2**.

Table 2.6.2 Number of Samples for Establishment Awareness Survey

Category	Samples	Establishment to be Surveyed
Market	5	Major markets, sales
School	5	Number of enrolled students (1 university, 1 government college & school, 1 private college & school)
Commercial Establishment	7	Large Scale, Number of Employees, Floor size
Restaurant	5	Number of customers
Hotel	5	Number of rooms
Store	10	Floor size
Factory	10	Large-Scale, based on production
Hospital	3	Number of beds
Sub-Total	50	

Although survey items differ considerably since each entity has its own unique characteristics, the items summarised in **Table 2.6.3** are determined to be included in the questionnaires. These questions would give a comprehensive picture of awareness in waste management in the City.

Table 2.6.3 Survey Items in the Questionnaires

Households	Commercial Establishments	
	General Establishments	Medical Institutions
Part 1: General Information		
- Location - General area description - Responsible entities for SWM - Existence of community groups, leadership	- Location - General area description - Responsible entities for SWM - Existence of community groups, leadership	- Location - General area description - Responsible entities for SWM - Existence of community groups, leadership
Part 2: Description of Interviewed Subject		
- Number of members - Type of dwelling - Unit rent or ownership - Household income	- Type of commercial activity - Number of employees - Floor area - Annual Sales	- Number of beds - Hospital specialisation

Households	Commercial Establishments	
Part 3: Solid Waste Conditions		
- Waste containers used - Waste discharge habits - Discharge location - Separation and recycling - Waste collection system - Charge paid - Self treatment	- Waste containers used - Waste discharge habits - Discharge location - Separation and recycling - Waste collection system - Charge paid - Self treatment	- Waste containers used - Hazardous and non-hazardous waste separation - Discharge location - Waste collection system - Treatment system within the institutions (Self-treatment)
Part 4: Awareness on SWM Issues		
- Concept of SWM in the city - Willingness to pay to improve SWM	- Concept of SWM in the city - Willingness to pay to improve SWM	- Concept of SWM in the city - Willingness to pay to improve SWM

(3) Result of the Survey

The survey was carried out from late September to November 2014 in which the results formed the basis in considering the following:

- Understanding the waste storage/discharge practices in planning the optimal waste collection system;
- Selecting target area for separate collection and implementation of awareness rising, public relations (PR), and environmental education to the public;
- Understanding the residents’ awareness in environment/hygiene to plan the appropriate awareness rising, PR, and environmental education activities; and
- Considering appropriate fee system for waste collection services.

(a) Households

(i) Accountability of the Result of the Survey

Table 2.6.4 gives a general information about the respondents in the survey depending upon income group. Across the income group, there is no gender bias, and a major portion of the answer come from the master, wife, or children who are familiar with household matters very well. This makes the result of the survey very accountable.

Table 2.6.5 shows the response rate for each question in the survey. It is found that most of the questions have been given answers so that the data acquired is very useful. On the other hand, however, respondents were very reluctant to give information about financial matters, such as how much they are willing to pay for a service. Therefore, the data on financial matters should be dealt as reference only and should not be used as definite illustration of the situation on the ground.

Table 2.6.4 Relation with Head of the House in the Survey

Group	Respondents	Male	Female	Relation with Master			Others
				Master	Wife	Children	
High Income	39	20 (51%)	19 (48%)	12	15	8	4
Middle Income	139	69* (50%)	69* (50%)	62	40	25	12
Low Income	157	85* (53%)	70* (43%)	75	53	21	8
Rural Area	60	31 (51%)	29 (48%)	22	17	20	1
Total	395	205* (52%)	187* (47%)	171	125	74	25

Note:* No gender was specified for one (1) respondent in middle income and two (2) respondents in low-urban income groups.

Table 2.6.5 Response Rate for Each Question (Households)

No.	Contents of the Question	High Income	Middle Income	Low Income	Rural Area
Q.No.1	General Information of Interviewee (Number of respondent)	39	139	157	60
Q.No.2	Waste Collection Services and Waste Discharge Behavior				
2.1	Do you have waste collection services?	100%	100%	83%	100%
2.2	What do you usually use when you discharge wastes?	95%	97%	99%	95%
2.3	How much waste do you discharge per week	92%	86%	90%	92%
Q.No.3	Recycling				
3.1	What do you do with used bottles?	100%	99%	100%	98%
3.2	What do you do with used cans?	82%	81%	96%	97%
3.3	What do you do with paper in your wastes?	92%	98%	99%	98%
3.4	In general, do you support the idea of recycling?	95%	81%	100%	100%
3.5	Do you use your kitchen wastes for any purpose?	100%	99%	100%	100%
3.6	Do you separate any other wastes? What do you do with them?	87%	99%	89%	98%
Q.No.4.	Financial Matters				
4.1	Do you give tips/fees to the collection crew?	97%	97%	100%	100%
4.2	[To those who have waste collection services] How much Rupee per month, at maximum, could you pay?	36%	21%	2%	20%
4.3	How much do you pay for water supply per month?	18%	13%	8%	20%
4.4	How much, at most, could you pay for water supply supposing that you would not get water supply without paying that amount?	3%	33%	10%	27%
4.5	How much do you pay for electricity per month?	64%	75%	83%	97%
4.6	How much, at most, could you pay for electricity supposing that you would not get electricity without paying that amount?	8%	29%	10%	33%
4.7	What is the order of priority of the following items for your living condition?	100%	100%	92%	100%
Q.No.5	Cleaning the city	97%	98%	96%	100%
5.1	Do you think public areas such as roads and parks are well kept clean?				
5.2	Who does clean the road in front of your premises and/or adjacent public area?	100%	100%	96%	100%
5.3	Keeping the city clean requires efforts of not only the city and the GWMC but also the general public. Are you willing to cooperate in some ways to keep the city clean?	100%	100%	96%	100%
5.4	Do you think a campaign to raise awareness of people for maintaining the city clean is effective?	100%	99%	96%	100%
5.5	Who do you think should have the initiative in keeping the city clean?	95%	98%	99%	100%
5.6	What problems do you find?	100%	100%	99%	100%

(ii) Waste Collection Services/Waste Discharge Behaviour

In urban area, more than half of households have waste collection services. Of course, households with higher income receive a higher level of waste collection services, namely; door-to-door collection. On the other hand, close to 70% of households do not have waste collection services in rural areas (see **Table 2.6.6**). It also shows that a majority of households have no issue about distance from waste collection point since most of them enjoy either door-to-door collection or curb-side collection.

Table 2.6.6 Coverage and Type of Waste Collection Services

	High (urban)	Middle (urban)	Low (urban)	Rural
Door-to-Door collection	87%	82%	50%	22%
Curb side collection	0%	7%	34%	12%
No Response	5%	0%	1%	0%
No Services	8%	11%	15%	67%

Figure 2.6.1 shows the frequency of waste collection. As expected, daily collection is observed in high income groups with more than 60% of households serviced every day.

The graph clearly shows the correlation with income level and frequency, i.e., the higher the income, the more frequent waste collection. It can be noted that most of the households across the income group have multiple collection days in a week.

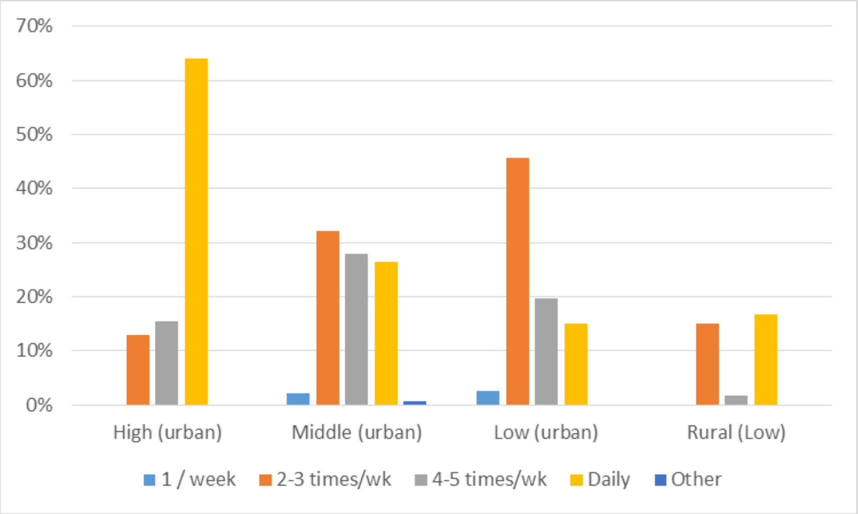


Figure 2.6.1 Frequency of Waste Collection

When a household encounters issues on waste collection services, such as insufficient waste collection (frequency) or waste collection at irregular time, A considerable number of households imply that they dispose their waste into public places (see **Table 2.6.7**). Seven percent (7%) of middle income people dispose their waste at nearby waste containers when no prompt waste collection is provided. In other words, regular waste collection and awareness rising activity for proper SWM is badly needed to attain a hygienic condition in the community.

Table 2.6.7 Behaviour when Issues are encountered on Waste Collection Service

	High (urban)	Middle (urban)	Low (urban)	Rural (Low)
Wait for next collection	60%	11%	3%	0%
Dispose at public places	40%	82%	97%	100%
Other (dispose at nearby container)	0%	7%	0%	0%

(iii) Willingness to Pay for Waste Collection Services

Table 2.6.8 gives a summary of the responses to two (2) questions: one is for the "willingness to pay" and the other is to find out if the residents are paying tips/fees in the current waste collection services.

Since the amount of money that one is willing to pay was asked from the respondents who want to avail of GWMCs' waste collection service, no figure was given by the respondents who gave a "no answer" or "no" to the questions. In other words, the results of the survey on WTP should be dealt with as reference only since a very limited number of people answered this question. Actually, nobody in high income group answered this question. High income residents might have feared that much higher fees would be imposed in the future when GWMC starts to collect waste with fees.

Interestingly, however, people are much more inclined to give out information about tips they are currently paying for waste collection workers. In urban settings, close to 70 to 80% of residents gave out the figure and approximately 30% in rural setting gave out the figure.

Although the WTP figure is based on very limited number of respondents, the general trend is same across the income groups when the WTP figure and the current tip is compared. In general, close to 35–40% of residents in urban middle and low income groups pay either 1-50 Rs. or 51-100 Rs. a month. Nonetheless, people willing to pay 51-100 Rs./month dropped considerably while 0 Rs./month emerged in the willingness to pay questions. A similar trend can be said also for the rural population.

If GWMC will pursue the collection of operation cost from the residents directly, it should be emphasised to PR such information as the objectives, operation, and other environmental related activities to the public to gain their confidence and make them realise that a certain cost is necessary to properly manage SWM and make the city environment hygienically clean.

Table 2.6.8 Behaviour when Issues Appear on the Waste Collection Service

Willingness-to-Pay		High (Urban)	Middle (Urban)	Low (Urban)	Rural (Low)
Wants waste collection service by GWMC	No Answer	36 (92%)	124 (89%)	131(83%)	21 (35%)
	Yes	0 (0%)	14 (10%)	26 (17%)	39 (65%)
	No	3 (8%)	1 (1%)	0 (0%)	0 (0%)
	Total	39 (100%)	139 (100%)	157 (100%)	60 (100%)

Current amount of tip paid for collection		High (Urban)	Middle (Urban)	Low (Urban)	Rural (Low)
If tip is given to collection worker	No Answer	1 (3%)	5 (4%)	0 (0%)	0 (0%)
	Yes	32 (82%)	96 (69%)	103 (66%)	17 (28%)
	No	6 (15%)	38 (27%)	54 (34%)	43 (72%)
	Total	39 (100%)	139 (100%)	157 (100%)	60 (100%)

The willingness to pay for each income group is shown in **Figure 2.6.2**, and the tip to collection workers by income group is presented in **Figure 2.6.3**.

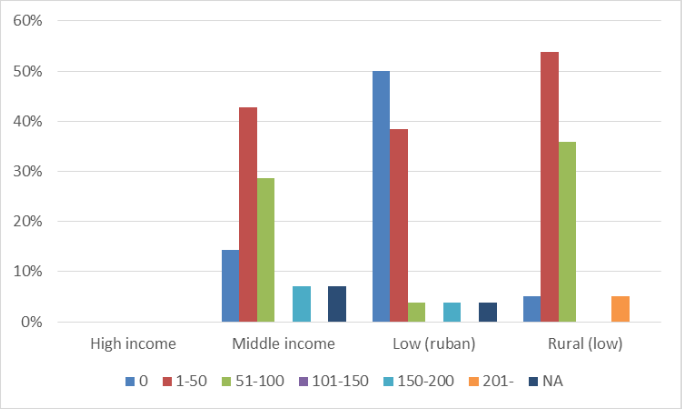


Figure 2.6.2 Willingness to Pay for Waste Collection Services by Income Group

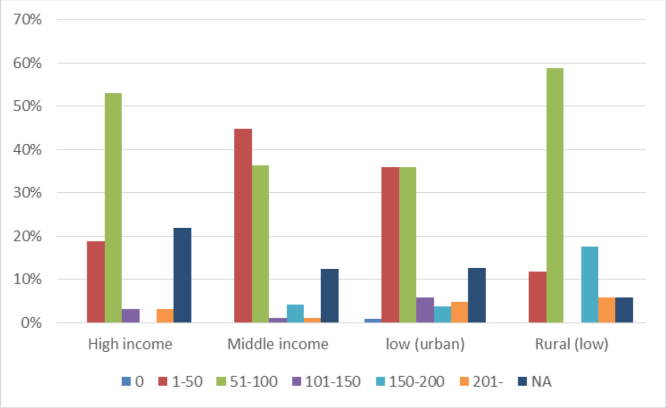


Figure 2.6.3 Current Tip Paid to Collection Workers per Month by Income Group

Incidentally, approximately 40 to 50% of residents in middle and low income groups in urban area indicated that they were not satisfied with the current waste collection service (See **Figure 2.6.4**.).

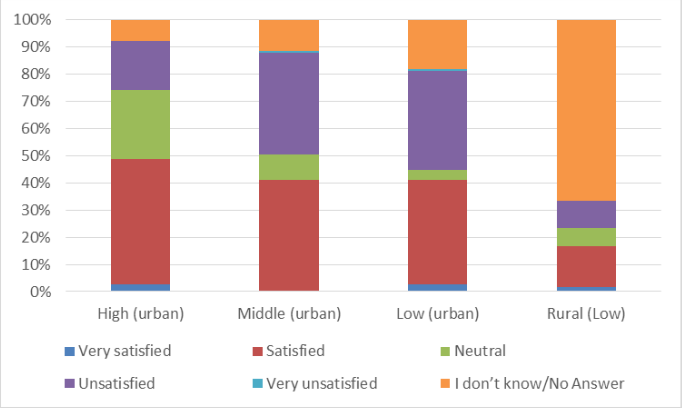


Figure 2.6.4 Satisfactory Rate of Current Waste Collection Service

(iv) Recycling Behaviour

Figure 2.6.5 to Figure 2.6.8 show residents' behaviour on recycling. These figures present the percentage of respondents who separate bottles, cans, and paper from other wastes. According to the result, bottles are relatively recognised worth separating from other waste across the income groups although more income seems to mean less interest in segregating bottles from other waste.

For the metal cans, middle income in urban area shows very little interest in separating them from other wastes, followed by the urban low income and rural low income. Paper, on the other hand, is fairly well segregated from the other wastes. Nonetheless, many of the segregated papers, like newspapers, are being used for other purposes such as wrapping material in shops.

Almost no one is separating kitchen waste from the other waste in all 4 groups. This suggests that much of the materials which can be used to make compost is going to landfill site and shortening its service life.

In all materials, one can say there are a lot of room to improve public to participate in recycling activities. Segregation of recyclables from general waste should be one of the focus of the topic in the environmental education.

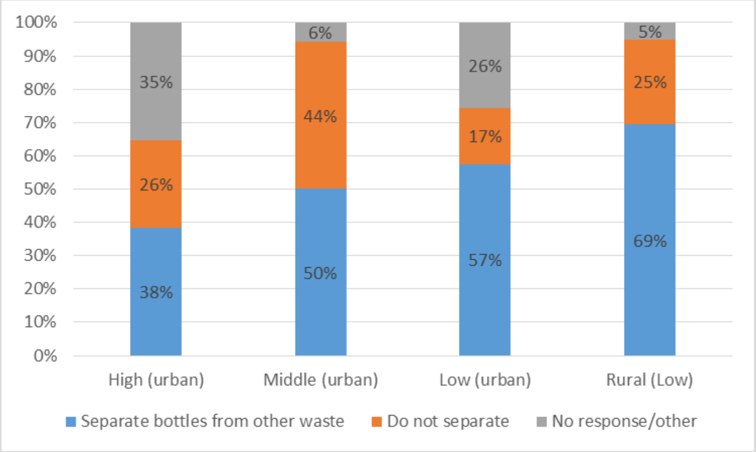


Figure 2.6.5 Recyclable Separation (Bottles) by Income Group

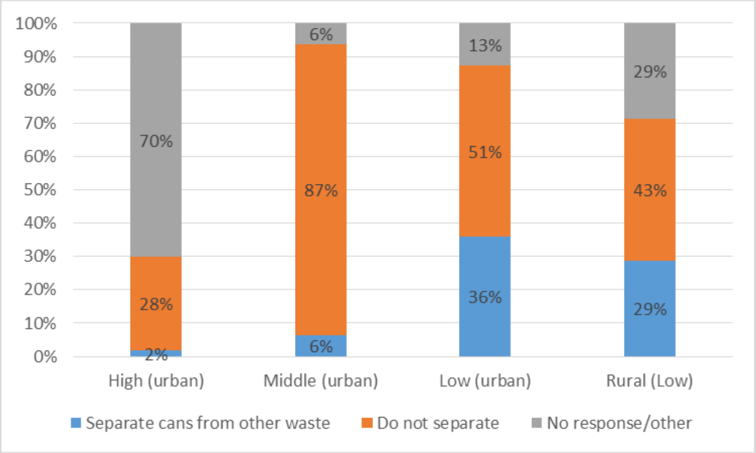


Figure 2.6.6 Recyclable Separation (Cans) by Income Group

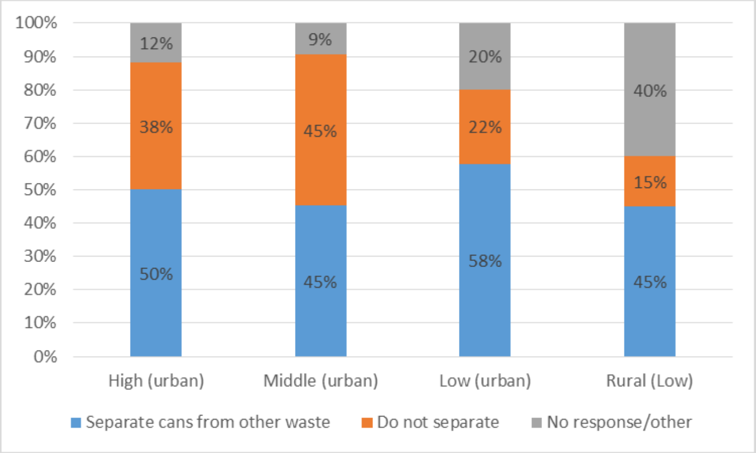


Figure 2.6.7 Recyclable Separation (Papers) by Income Group

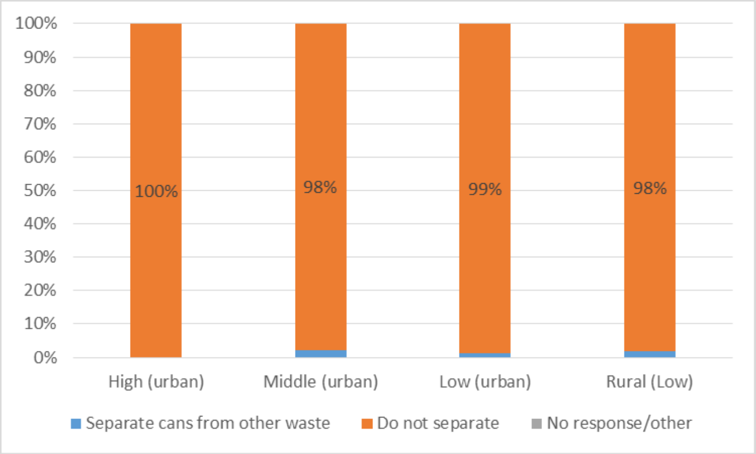


Figure 2.6.8 Recyclable Separation (Kitchen Waste) by Income Group

(v) Cleanness of the City

Approximately 40 to 50 percent of residents view the public spaces in the city as clean, but another 30 to 40 percent of people answered "not clean". (See **Figure 2.6.9.**)

When asked if they would cooperate in the effort to keep the city clean, almost all respondents answered "Yes." (See **Figure 2.6.10**.)

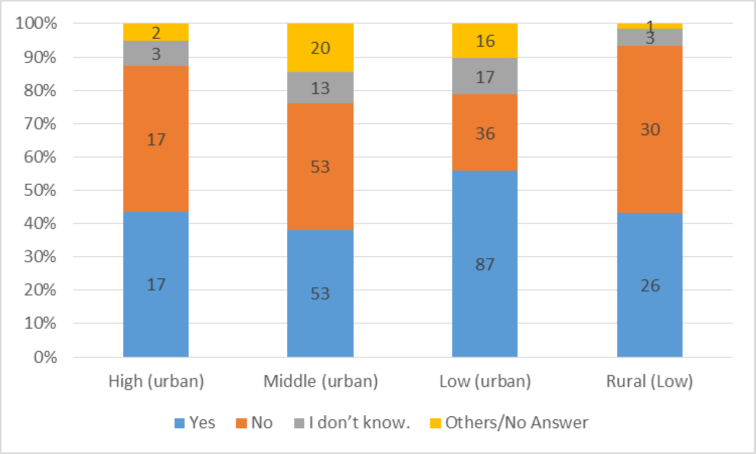


Figure 2.6.9 Residents View on Cleanness of Public Space

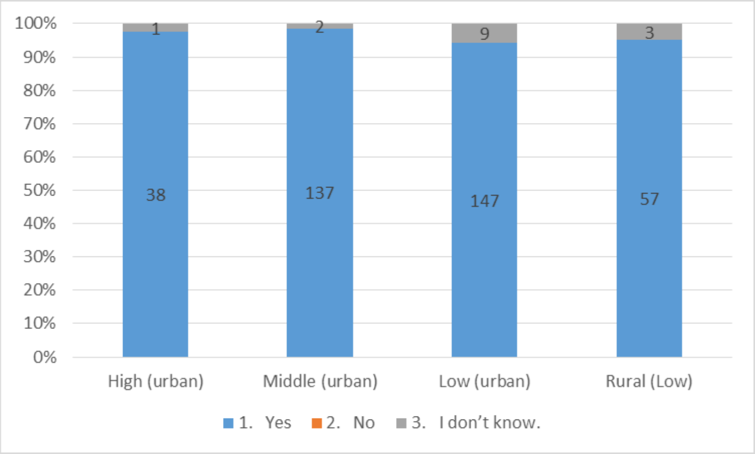


Figure 2.6.10 Residents' Willingness to Cooperate in Keeping City Clean

(b) Commercial Establishments (Business Establishments)

Interview surveys were also carried out for business establishments. The questionnaire includes the same or similar questions across the industry such as general information about the interviewees, recycling and financial matters. Some questions were, however, very different from industry to industry. For instance, additional questions for medical waste and general waste were asked for "hospitals" whereas generation of waste types were asked for "factories."

(i) Accountability on the Results of Survey

Table 2.6.9 shows the response rate for each question by category. Since interview survey was employed, most of the questions were given some answers even if the answer was simply "No." Therefore, given the condition of the survey, most of the results can be considered as valid results.

A majority of the questions in the business establishment survey received some answers, meaning that most of the questions received a 100% response rate. **Table 2.6.9** presents the questions which did NOT receive the 100% response rate. As one can see, questions and industry which did not give an answer in all categories are very limited, except for financial matters where all industries in one way or another were reluctant to answer the questions. In the following table, the shaded area represents the tendency of response.

Table 2.6.9 Response Rate that did not Received 100%

	Recycle			
	Number of Questions			Percentage of >100% Response
	Total	100% response	> 100% response	
Store/Shop	7	4	3	60 - 80%
Market	7	6	1	20%
Office	5	4	1	85%
Factory	5	3	2	70 - 90%

	Waste Collection and Discharge Behaviour			
	Number of Questions			Percentage of >100% Response
	Total	100% response	> 100% response	
Market	5	3	2	90%
Office	5	3	2	85%
Hotel	5	4	1	80%

	Financial Matters			
	Number of Questions			Percentage of >100% Response
	Total	100% response	> 100% response	
Store/shops	4	1	3	0%
Market	4	3	1	80%
Institute	6	4	2	85%
Office	3	1	5	0 - 85%
Hotel	4	0	4	0 - 80%
Restaurant	6	1	5	0 - 60%
Factory	9	5	4	0 - 40%
Hospital	10	2	8	0 - 66%

	Cooperation in Waste Management			
	Number of Questions			Percentage of >100% Response
	Total	100% response	> 100% response	
Store/Shop	4	0	4	50 - 90 %
Market	1	2	2	80 - 90 %

(ii) Waste Collection Services/Waste Discharge Behaviour

A large number of establishments have waste collection services. The establishments that do not have a waste collection service usually have their own disposal methods (See **Table 2.6.10**).

Satisfactory to the current waste collection service is shown in **Figure 2.6.11**. Result of this question varies depending on business types where restaurants and hospitals have good ratio of satisfaction of the services while 70% of factory says 'not satisfied.'

Table 2.6.10 Availability of Waste Collection Service

	Store/ Shop	Market	Institution	Restaurant	Office	Hotel	Factory	Hospital
Yes	90%	90%	57%	100%	100%	60%	100%	100%
No	0%	10%	29%	0%	0%	20%	0%	0%
Don't know	10%	0%	14%	0%	0%	20%	0%	0%

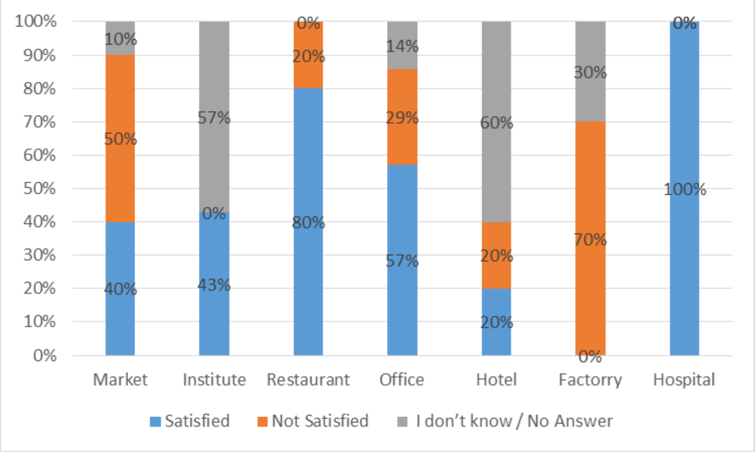


Figure 2.6.11 Satisfactory Rate for Current Waste Collection Service

(iii) Recycling Behaviour

Recycling practice among business establishments is very low. The only exception done at restaurants is bottle recycling (100%) and can (60%). (**Figure 2.6.12** and **Figure 2.6.13**). Many answered either they did not know or discharged with other types of waste. Especially for organic waste which can be used for animal feed or composting, a majority of the establishments discharge them with the other waste. (**Figure 2.6.14**)

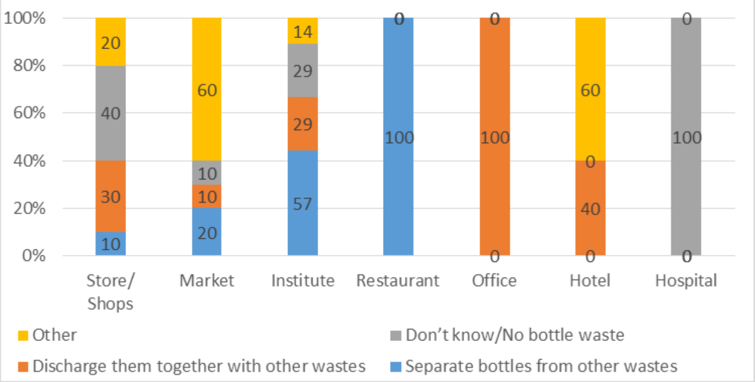


Figure 2.6.12 Recyclable Separation (Bottles) by Business Establishment Type

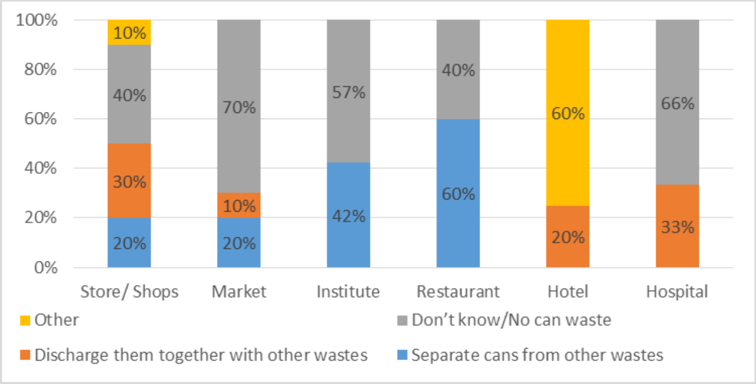


Figure 2.6.13 Recyclable Separation (Cans) by Business Establishment Type

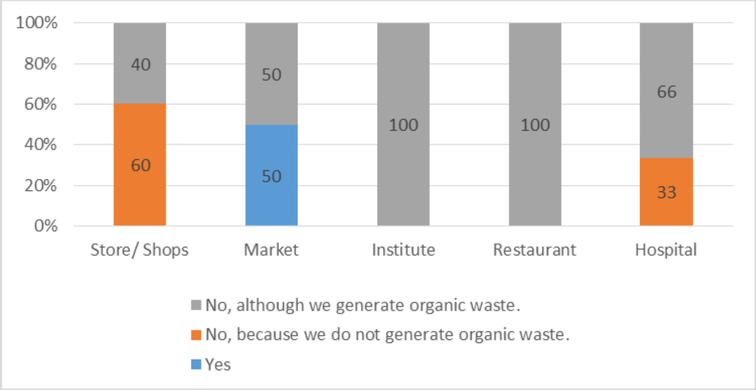


Figure 2.6.14 Recyclable Separation (Organic Waste) by Business Establishment Type

(4) Conclusion

In general, the public is not satisfied with the waste management services provided by GWMC, which resulted in the low awareness of SWM. Also, the limited data suggests that Resident's Willingness-to-Pay is very limited or even none.

Discharge behaviour has much room for improvement because the awareness on recycling is low. Although recycling and reusing bottles is somewhat much popular among the general public and restaurants, other recyclable materials show a considerably low recycling rate. This can be true for even the low-income group in rural areas.

Organic materials, which can be used to make compost and reduce the volume of waste sent to the final disposal site, are also not collected well.

Therefore, public relation activities should be carried out to disseminate the proper SWM practices expected to be performed by the public and the SWM practice carried out by GWMC. The activities should focus on proper waste management (for example, discharge practice), 3R (Reduce, Reuse, Recycle), and keeping the community environment clean (no littering).

2.6.2 Findings from the Interview with the District Officer Environment

There is a District Officer Environment in Gujranwala City who deals with environmental issues in general, such as nature/life, waste/resource, and energy and global warming. The interview with the District Officer revealed the following:

- There is no by-law, ordinance or directive for carrying out environmental education. However, a framework exists for higher education such as Doctor of Philosophy (Ph.D,), Master of Philosophy (M.Ph)/Master of Science (MS), and Bachelor of Science (BS) in Environmental Sciences.
- Collaboration with NGOs exists with, for example, Organisation Pan Environment (OPE), Nayab

Welfare Society, Gujranwala Environmental Organisation, etc.

- Various media including brochures/textbooks, TV/radio/commercial programs, signboards, school curriculum, and public meetings are utilised in environmental education.
- Walks, seminars, activities at educational institutions, e.g., speech competition, essay writing, printed material distribution, or environmental club, and other activities are employed for environmental education/awareness raising.
- Priority should be placed on (a) recycling of plastics, metals, glass, cardboard and others; (b) composting from kitchen waste; and (c) animal/donkey waste.
- Community meetings are the best strategy for awareness in Gujranwala along with school education programmes. For mass communication, local cable channels can be very effective. Workshops and seminars will not work for Gujranwala.
- In Gujranwala at community level, education can be delivered by mosques (Imam Masajid). Moreover, different community groups on the basis of income should be educated through multiple awareness programmes/media.
- Feminist groups/representatives from local community should be selected to address awareness at household level. The contents of educational network may include major waste types, 3R concept, at source segregation, waste and economy correlation and use of cloth bags rather than plastic bags.
- There is no coordination or consultation from the Education Department while setting the curriculum.

The Environment Department has conducted composting and recycling sessions in different schools on periodic basis. An awareness curriculum (books) in private schools under a project was also distributed. The awareness material includes story books regarding solid waste, composting, 3R concept, water conservation and solid waste management guidelines.

2.6.3 Evaluation of Environmental Education and Public Awareness Condition

Although the result of the awareness survey is not available yet, interviews with the District Officer and the Environment Officer indicate the lack of commitment in environmental education in the government, which appears to be the hindering issue. For instance, there is neither legal framework to carry out environmental education nor coordination among relevant bodies. The problems and issues under the current situation related to environmental education are as summarised in **Table 2.6.11**.

Table 2.6.11 Identification of Problems and Issues on Environmental Education and Public Awareness

Problem	Description of Problem	Issues for Solving the Problems
1. Poor coordination among government agencies and departments	There is a lack of coordination among departments including school education, GWMC and environment. Since awareness raising campaign or environmental education activities have been carried out without much coordination among relevant bodies, thus messages were not focused nor spread among target population.	Coordination among the relevant departments like environment, school education, etc., is necessary for the implementation of environmental education and public awareness raising activities. A mechanism to address environmental awareness should be developed among the agencies concerned to realise effective and coherent effort on environmental education. The relevant bodies may include Planning and Development, Education, Water and Sanitation, and Environment.
2. Inappropriate school curriculum on the environment	The curriculum is different for public and private schools. Inevitably, students in public schools, especially, primary schools, learn less about the environment.	It is necessary to increase the practical applications and classes regarding the environment in the school curriculum. Some environmental education packages for the kids as well as training for the teachers may also be implemented.
3. Lack of awareness among public	There is a tendency among the public that the government has the sole responsibility of taking care of the environment. Awareness programme and campaign can be developed through community groups which may be comprised of area representatives, religious persons and	Patient effort is necessary to edify the public on environment, especially, waste management. In this sense, collaboration with grassroots group or even religious body (mosque) needs to be considered in order to raise awareness among the public. In addition, feminist groups may pose

Problem	Description of Problem	Issues for Solving the Problems
	students.	strong influence to each household's waste management practices through a network of wives. The efforts can include waste reduction, reuse/recycle, source separation, and proper waste discharge.
4. Irregular informal education on the environment	There is no continuous informal education except once a year during such event as Earth Day. There is no strategy defined for the public information department regarding informal environmental education.	The government should initiate concrete efforts in highlighting the importance of environment through implementation of public information for the environment as well as cooperation with various groups working for environmental issues.

2.7 Economic and Financial Study

2.7.1 Demographic Situation

As indicated in **Table 2.7.1**, the estimated population of 64 Urban UCs of Gujranwala City is approximately 1.56 million as of 2012 and 1.65 million as of 2014. The estimation in 2014 is based on the latest population growth rate of 2.6 percent per annum applied to *"Situation Analysis of SWM Services in Gujranwala City"* conducted in 2012. Due to the rapid growth rate of population, the population density is higher as compared to the whole Punjab.

Table 2.7.1 Town-Wise Population in Project-Related Town in Gujranwala

Town	No. of Urban UCs	Estimated Population for Year 2012	Estimated Population for Year 2014
Nandi Pur Town	15	379,980	400,000
Khiali Shah Pur Town	13	339,930	357,840
Aroop Town	17	426,920	449,410
Qila Dedar Singh Town	19	417,680	439,680
Total	64	1,564,510	1,646,930

Note: Estimated from Socio-economic and Demographic Profile, 1998-2008 and Situation Analysis of SWM Services in Gujranwala City, 2012

2.7.2 Economic Situation

Gujranwala is one of the major industrial cities of Punjab, thereby contributing to the economy of Pakistan. Being an industrial city, it has a variety of manufacturers in industrial machinery, fan industry, motor pumps industry, washing machine industry, electric goods, poultry feed, soap, ballpoint, rubber tube, metal utensils, melamine utensils, cutlery, kitchenware, ceramic tiles, sanitary wares, sanitary fittings, agriculture implements, woollen textiles, steel pipe industries, etc.

The estimated and forecast of percentage of population by economic category and the industrial profiles are as indicated in **Table 2.7.2** and **Table 2.7.3**, respectively.

Table 2.7.2 Estimated and Forecast Percentage of Population by Economic Category in Gujranwala

(Unit: %)

Category			1998	2005	2008	2010	2015
1=2+3	Economically Active		21.64	23.33	24.09	24.60	25.92
2		Employed	16.39	17.68	18.25	18.64	19.64
3		Unemployed	5.24	5.65	5.84	5.96	6.28
4=5+6+7+8	Economically Inactive		78.36	76.67	75.91	75.40	74.08
5		Children under 10 years old	27.52	26.93	26.66	26.48	26.02
6		Students	9.74	9.53	9.43	9.37	9.20
7		Domestic Workers	34.60	33.85	33.51	33.29	32.71
8		Others	6.51	6.36	6.30	6.26	6.15
7=1+4	Total		100.00	100.00	100.00	100.00	100.00

Source: Estimated from Socio-economic and Demographic Profile1998-2008

Table 2.7.3 Industrial Profile of Gujranwala

Type of Industry	No. of Units
Power Looms	921
Utensils	504
Foundry Products	341
Fans/Coolers/Washing Machines	321
Sanitary Fittings	172
Motor Pumps	151
Hosiery Products	107
Textile Processing	52
Woven Textile Spinning/Weaving	48
Agricultural Implements	44
Total	2,661

Source: Estimated from Socio-economic and Demographic Profile1998-2008

2.7.3 Social Situation

The Government of the Punjab is committed to attain the Millennium Development Goals (MDGs) for education, health, water supply and sanitation, and poverty. Towards this end, the Government, with assistance of UNICEF, has been periodically carrying out the Multiple Indicator Cluster Surveys (hereinafter referred to as "MICS"). MICS provides provincial and district-wise social data.

MICS 2003-04 was based on 40 indicators and the usage of information generated by the survey pointed to the need of further improvements in the scope and coverage of selected indicators. Therefore, the scope of MICS 2007-08 was further expanded to more than 70 indicators and coverage level. The results of the 2007-08 survey do not only provide information on progress made in key social indicators since 2003-04 but also provide an excellent baseline for the key social indicators.

Currently, the results of the latest MICS 2011-2012 are being compiled. The results of the major social indicators for Punjab Province as well as Gujranwala are presented from **Table 2.7.4** to **Table 2.7.15** below. After obtaining the results of the district-wise MICS 2011-12 data, those data will be updated. These socio-economic indicators cover a wide range of socio-economic situation of the residents of Gujranwala, including literacy, education, water and sanitation, adult health and health care, child mortality, nutrition, child health, child protection, reproductive health, HIV knowledge and attitudes, employment, and housing and assets.

The results clearly prove that the social indicators of Gujranwala are better than the average of Punjab in almost all areas.

Table 2.7.4 Socio-economic Indicators (Literacy)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Literacy Rate 10+ years (%)	67.0	54.0	72.0	59.0
Adult Literacy Rate 15+ years (%)	61.0	52.0	68.0	56.0
Adult Literacy Rate 15-24 years (%)	82.0	68.0	87.0	73.0

Source: MICS 2007-08

Table 2.7.5 Socio-economic Indicators (Education)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Pre-school attendance (%)	n.a.	n.a.	27.0	14.0
Net intake rate in primary education (5 years) (%)	n.a.	n.a.	16.0	19.0
Net intake rate in primary education (6 years) (%)	n.a.	n.a.	41.0	38.0
Net primary attendance rate (5-9 years) (%)	66.0	51.0	60.0	53.0
Net primary school attendance rate (Government schools) (%)	n.a.	n.a.	34.0	56.0
Net primary school attendance rate (Private schools) (%)	n.a.	n.a.	65.0	43.0
Net middle/secondary attendance rate (%)	42.0	33.0	36.0	29.0
Primary educational facility within 2km (Government boys) (%)	n.a.	n.a.	98.0	93.0
Primary education facility within 2km (Government girls) (%)	n.a.	n.a.	99.0	91.0
Primary educational facility within 2km (Private boys) (%)	n.a.	n.a.	100.0	75.0
Primary educational facility within 2km (Private girls) (%)	n.a.	n.a.	100.0	74.0

Source: MICS 2007-08

Table 2.7.6 Socio-economic Indicators (Water and Sanitation)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Physical access to drinking water (within dwelling) (%)	100.0	92.0	99.0	92.0
Use of improved drinking water sources (%)	100.0	97.0	99.0	97.0
Use of properly treated water (%)	n.a.	n.a.	7.9	4.8
Safe drinking water without bacteria (%)	n.a.	n.a.	46.0	51.0
Use of sanitary means of excreta disposal (%)	84.0	58.0	95.0	70.0
Use of improved water sources and improved sanitation (%)	n.a.	n.a.	95.0	68.0
Proper disposal of waste water (%)	66.0	43.0	94.0	57.0
Proper disposal of solid waste (%)	24.0	15.0	20.0	14.0
Hand washing adequately before meal (%)	52.0	41.0	72.0	57.0
Hand washing adequately after using latrine (%)	77.0	55.0	85.0	66.0

Source: MICS 2007-08

Table 2.7.7 Socio-economic Indicators (Adult Health and Health Care)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Prevalence of chronic cough (%)	2.0	2.0	1.0	2.0
Reported tuberculosis (%)	0.3	0.5	0.4	0.3
Reported hepatitis (%)	n.a.	n.a.	0.7	0.7
Care provided by Lady Health Worker (LHW)	23.0	35.0	38.0	50.0
Physical access to health facility within half an hour's distance (%)	n.a.	n.a.	96.0	75.0

Source: MICS 2007-08

Table 2.7.8 Socio-economic Indicators (Child Mortality)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Under-five mortality rate (Death per 1000 births)	93	112	95	111
Infant mortality rate (Death per 1000 births)	61	77	67	77

Source: MICS 2007-08

Table 2.7.9 Socio-economic Indicators (Nutrition)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Underweight prevalence (moderate & severe) (%)	28.0	34.0	27.0	34.0
Underweight prevalence (severe) (%)	n.a.	n.a.	10.0	11.0
Stunting prevalence (moderate & severe) (%)	n.a.	n.a.	37.0	42.0
Stunting prevalence (severe) (%)	n.a.	n.a.	20.0	23.0
Wasting prevalence (moderate & severe) (%)	n.a.	n.a.	13.0	13.0
Wasting prevalence (severe) (%)	n.a.	n.a.	6.8	5.6
Exclusive breastfeeding rate (%)	n.a.	30.0	50.0	49.0
Continued breastfeeding rate at 12-15 months (%)	n.a.	79.0	67.0	74.0
Continued breastfeeding rate at 20-23 months (%)	n.a.	47.0	42.0	53.0
Timely complementary feeding rate (%)	44.0	64.0	39.0	42.0
Children receiving minimum recommended complementary feeding (%)	n.a.	n.a.	23.0	31.0
Adequately fed infants (%)	n.a.	n.a.	38.0	40.0
Adequately iodised salt consumption (%)	8.0	8.0	4.0	6.0
Vitamin A supplementation (under 5 years) (%)	89.0	87.0	76.0	79.0

Source: MICS 2007-08

Table 2.7.10 Socio-economic Indicators (Child Health)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Use of Oral Rehydration Therapy (ORT) (%)	48.0	43.0	37.0	47.0
Prevalence of diarrhea (%)	17.0	22.0	6.4	7.8
Home management of diarrhea (%)	n.a.	n.a.	21.0	15.0
Received ORT or increased fluids and continued feeding (%)	n.a.	n.a.	35.0	30.0
Care seeking for suspected pneumonia (%)	n.a.	n.a.	67.0	70.0
Knowledge of two danger signs of pneumonia (%)	n.a.	n.a.	10.0	10.0
Any illness during past 2 years (%)	n.a.	n.a.	n.a.	13.0
Solid fuels (%)	n.a.	n.a.	46.0	71.0

Source: MICS 2007-08

Table 2.7.11 Socio-economic Indicators (Child Protection)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Birth registration (%)	89.0	82.0	90.0	77.0
Child labour (%)	n.a.	n.a.	3.2	5.1
Labourer students (%)	n.a.	n.a.	2.3	3.4
Student labourers (%)	n.a.	n.a.	65.0	49.0
Child disability (2-9 years) (%)	n.a.	n.a.	3.7	5.2

Source: MICS 2007-08

Table 2.7.12 Socio-economic Indicators (Reproductive Health)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Total fertility rate (%)	5.9	4.7	n.a.	4.3
Use of contraceptives (%)	45.0	36.0	40.0	32.0
Contraceptive drop out (%)	n.a.	n.a.	8.0	4.3
Unwilling pregnancy (%)	n.a.	n.a.	24.0	26.0
Antenatal care (%)	53.0	44.0	69.0	53.0
Skilled attendant at delivery (%)	45.0	33.0	59.0	43.0
Institutional deliveries (%)	n.a.	n.a.	51.0	38.0
Postnatal care (%)	40.0	30.0	51.0	41.0
Currently married women aged 15-19 (%)	n.a.	n.a.	1.9	3.2

Source: MICS 2007-08

Table 2.7.13 Socio-economic Indicators (HIV Knowledge and Attitudes)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Knowledge of preventing HIV/AIDS (%)	n.a.	n.a.	18.0	18.0
Negative attitude towards people with HIV/AIDS (%)	n.a.	n.a.	53.0	43.0

Source: MICS 2007-08

Table 2.7.14 Socio-economic Indicators (Employment)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Unemployment rate (15+ years) (%)	n.a.	n.a.	7.6	6.8
Family member working outside village/town (persons per household)	9.6	11.0	11.0	12.0

Source: MICS 2007-08

Table 2.7.15 Socio-economic Indicators (Housing and Assets)

Indicator	MICS2003-04		MICS2007-08	
	Gujranwala	Punjab	Gujranwala	Punjab
Percent of Households who own three or more possessions (%)	77.0	56.0	99.0	89.0
Percent of household members who use at least one utility (%)	99.0	83.0	99.0	94.0
Household characteristics (finished floor) (%)	n.a.	n.a.	77.0	57.0
Household characteristics (finished roof) (%)	n.a.	n.a.	97.0	84.0
Household characteristics (finished wall) (%)	n.a.	n.a.	95.0	76.0
Ownership of assets (house) (%)	90.0	86.0	78.0	84.0
Ownership of assets (land) (%)	27.0	32.0	19.0	34.0
Ownership of assets (livestock) (%)	24.0	41.0	31.0	51.0
Mean household size (persons per household)	7.0	6.6	7.0	6.5
Mean number of persons per room (persons per household)	3.0	3.4	3.7	3.7

Source: MICS 2007-08

2.7.4 Infrastructure Situation

(1) Roads and Railways

The road network in Gujranwala has 9 primary roads, 13 secondary roads and 8 local roads connecting the city with other areas. In addition, the Grand Trunk Road (G.T. Road) and a motorway also pass through it. The inter-city railway infrastructure is also available, and helps to connect the city to other areas. The major road network in Gujranwala is as shown in **Table 2.7.16**.

Table 2.7.16 Major Road Network in Gujranwala

Classification	Length (km)
National Highway	69.52
Motorway	45.50
Provincial Roads	422.58
Farm to Market Roads	1,454.28
Sugar Cess Roads	16.66
Ex-District Council Roads	235.70
Intra-City Roads	115.51

Source: Socio-economic and Demographic Profile 1998-2008

(2) Educational Infrastructure

Educational facility is considered to be one of the most important social infrastructures. In Gujranwala, a large number of schools, colleges, and medical colleges provide educational services to the citizens. The number of educational institutions in Gujranwala and Punjab is as shown in **Table 2.7.17**.

Table 2.7.17 Number of Medical Institutions in Gujranwala and Punjab

Type of Institutions	Number of Institutions (As of 2012)	
	Gujranwala	Punjab
Mosque School	41	1,897
Primary School	1,470	42,048
Middle School	290	7,756
High School	193	5,589
Higher Secondary School	15	798
Arts and Science Intermediate College	17	212
Arts and Science Degree College	33	718

Source: Punjab Development Statistics 2013

(3) Health Facilities

Health facility is also considered to be one of the most important social infrastructures. In Gujranwala, a wide range of health institutions such as hospitals, dispensaries, clinics and health centres are available. The number of medical institutions in Gujranwala is separately shown in **Table 2.7.17**.

2.7.5 Economic and Financial Situation of GWMC

(1) Budget Allocation Mechanism of GWMC

The budget for GWMC is allocated from the budget of CDGG which almost depends on the subsidies from the Government of the Punjab (GOPb). For the financial year 2012-13, out of the budget for SWM services, 85.6 percent was allocated for salary-related expenses and the remaining 14.4 percent was earmarked for other operating costs. **Table 2.7.18** gives a snapshot of the budget for SWM services.

Table 2.7.18 Budget for SWM Services of GWMC

Expenditure Item	2012-13 Budget	
	Budget (Rs. 1,000)	Share (%)
Total Expenditure of CDGG	9,576,299	100.0
Total Public Health Services	458,280	4.8
Total SWM Services	447,824	100.0
Salaries and Allowances	383,160	85.6
Other Operating Costs	64,664	14.4

Source: Budget Estimates for 2013-2014, CDGG

In conclusion, GWMC is not in a position to meet their financial needs from the internal financial sources. They fall back on subsidies from the GOPb. This dependence on the budget of CDGG is not sustainable in the long term, and GWMC needs to increase their financial resources to meet their statutory obligations instead of solely depending on the budget of CDGG which is subsidised from the Provincial Government.

Direct cost recovery through user charges does not exist in Gujranwala although LWMC is planning to charge user fees in accordance with the income level. An important reason for this situation is the lack of willingness to pay and proper billing systems. Since there is no official tariff system for SWM services in Punjab, the tariff setting for SWM services is not controlled by an authorised organisation of the provincial government of Punjab.

The determination of tariff for electric power services is one of the primary responsibilities of NEPRA (National Electric Power Regulatory Authority). NEPRA determines electricity tariffs, keeping in view the principles of economic efficiency and service quality, according to the prescribed tariff standards and procedures of 1998. While the tariff setting/revision of the power sector is controlled by the federal government, the tariff setting/revision of the water and sanitation sector is controlled by the independent committee involved in each urban development authority such as LDA (Lahore Development Authority) and GDA (Gujranwala Development Authority).

Likewise, the tariff setting/revision of plans are subject to the approval of independent organisations for the price regulation of sanitation/water and electricity, thereby being finally approved by the provincial and federal governments, respectively. Both of the mechanisms do not require enactment by the assemblies.

(2) Cost Structure for SWM Services

GWMC is required to accurately identify how much is spent for the various components of SWM services in Gujranwala to establish strategies to minimise the cost of the services. However, at present, GWMC is not sufficiently capable of grasping the variable costs, the fixed costs and even the break-even point for the provision of SWM services.

Public services such as SWM services require cost accounting in order to financially track activities. Cost accounting is a process of collecting, analysing, summarising and evaluating various alternative public utility services. Cost accounting provides the detailed cost information required to control current operations of SWM services.

Cost accounting is used to help grasp the costs of operating SWM services. Most of the costs incurred by SWM services are what is called "variable costs" because they varied directly with the amount of wastes.

Some costs tend to remain the same even during busy periods, unlike variable costs, which rise and fall with the volume of work. These "fixed costs" should also be identified.

In order to efficiently provide SWM services, GWMC is required to adopt a strategy for minimising these costs. For this purposes, it is essential for GWMC to grasp the cost of services accurately.

(3) Pricing Mechanism

GWMC currently does not levy any SWM tax, nor does it impose user fees for SWM services. SWM tax is a tax whose specific objective is limited to the improvement of SWM services. Although the SWM tax is being adopted by some other countries, no city in Pakistan has introduced this purpose-specific tax system for the generation of funds required for SWM services. Financial sources for SWM services are covered by the budget of CDGG which almost depends on the budget of the GOPb. Inadequate cost recovery mechanisms by GWMC limit the extent of operation as well as new investments of SWM services. Therefore, the pricing mechanism such as charging user fees need to be considered and adopted.

Thus, in order to secure the budget for financially sustainable SWM services, GWMC needs to consider its revenue raising capabilities by introducing a proper user charging system for SWM services.

(4) Situation of Private Sector Involvement

GWMC should explore the possibilities of involving the private sector in SWM services to provide efficient services cost-effectively with minimum costs. The private sector has been involved in the SWM services in Punjab in formal as well as informal sectors. Waste Management contracts were given out on small-scale community areas especially in new developed housing schemes due to lack of such facilities.

Likewise, GWMC is not currently working with the private sector although it is exploring the possibilities to introduce the option of private sector participation. Due to the limited resources available, GWMC is looking towards improvement of its SWM services through outsourcing the service to the private sector. It is commonly believed that the private sector would perform significantly better than the public sector. This belief is based on assumptions that the private sector would be more efficient, cost effective and would bring in new technologies for the improvement of the SWM system. **Table 2.7.19** shows the recent experiences on private sector participation in Punjab.

Table 2.7.19 Recent Experiences of Private Sector Participation in Punjab

Project Name	Type of PSP	Collection	Transport	Recycling	Treatment	Final Disposal
Lahore Sanitation Programme	Franchise	X	X			X
Gujrat Sanitation Programme	Management Contract	X	X			X
Cantonment Board Lahore	Management Contract	X	X		X	X
Clifton Cantonment Board, Karachi	Management Contract	X	X			X
Awam Sanitation Programme, Fisalabad	Franchise	X	X			X
Chaklala Waste Management Programme, Rawalpindi	Service Contract	X	X	X		X
Solid Waste and Environment Enhancement Project	Management Contract	X	X		X	X
Lahore Compost Plant, Lahore	BOT/ Concession			X		X
Multan Composting Project, Multan	BOT			X		X
Metropolitan Corporation, Lahore	Franchise	X		X		X

Source: Punjab SWM Reform

2.7.6 Evaluation of Economic and Financial Condition

The problems and issues in relation to economic and financial management under the current situation are summarised in **Table 2.7.20**. These items will be the basic elements to develop the plans, programmes and projects to comprise the economic and financial management plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table 2.7.20 Identification of Problems and Issues on Economic and Financial Condition

Problem	Description of Problem	Issues for Solving the Problems
1. Insufficient financial independence in SWM services	GWMC is not in a position to meet its financial needs from the internal financial sources. It falls back on subsidies from the GOPb. This dependence on the budget of CDGG is not sustainable in the long term, and GWMC needs to increase its financial resources to meet its statutory obligations instead of solely depending on the budget of CDGG which is subsidised from the Provincial Government.	The proper revenue generation mechanism such as the introduction of tariff system by GWMC should be carefully studied. Transparency for setting the tariff level as well as a wide range of activities raising users' willingness to pay for SWM services is also required. The continuous financial monitoring mechanism for GWMC should be also established in the framework of the institutional strengthening the headquarters of GWMC.
2. Not well identified cost structure for SWM services	GWMC is required to accurately identify how much is spent for the various components of SWM services in Gujranwala to establish strategies to minimise the cost of the services. However, at present, GWMC is not sufficiently capable of grasping the variable costs, the fixed costs and even the break-even point for the provision of SWM services.	In order to set proper tariffs for users, all the costs associated in providing SWM services by GWMC should be reflected as accurately as possible and streamlined as fixed costs and variable costs.
3. Lack of pricing mechanism for SWM services	Currently, there is no substantial pricing mechanism for SWM services in Gujranwala. GWMC currently does not levy any SWM tax, nor does it impose user fees for SWM services. Inadequate cost recovery mechanisms by GWMC limits the extent of operation as well as new	To secure the budget for financially sustaining SWM services, GWMC needs to consider its revenue raising capabilities by introducing a proper user charging system for SWM services. The pricing mechanism such as charging user fees need to be considered and adopted.

Problem	Description of Problem	Issues for Solving the Problems
	investments of SWM services.	
4. Few involvement of the private sector	GWMC is not currently working with the private sector although it is exploring the possibilities to introduce the option of private sector participation. Due to the limited resources available, GWMC is looking towards improvement of its SWM services through outsourcing to the private sector.	GWMC should explore the possibilities of involving the private sector in SWM services to provide efficient services cost-effectively with minimum costs. The objectives of involving the private sector include 1) enhancing efficiency; and 2) mobilise the investment resources of the private sector.

2.8 Environmental and Social Considerations Study

2.8.1 Laws and Regulations Related to Environmental and Social Considerations

Pakistan laws related to comprehensive environmental issues are shown in **Table 2.8.1** and **Table 2.8.2** shows the policy, guidelines, and rules of solid waste management nationwide/provincial-wise.

Table 2.8.1 Environmental Laws in Pakistan

Title of the Law	Contents
Pakistan Environmental Protection Act	This act provides for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. EIA is mentioned in Section 12.
National Environmental Quality Standards (NEQS)	NEQS consists of two parts: • List of laws and regulations in 14 sectors such as Environmental Protection, Land Use, Water Quality and Resource, Solid Waste Management, and so on. • Description of National standards
Pakistan Environmental Protection Agency (Review of IEE & EIA) Regulations 2000	Process of IEE and EIA is described.
National Environmental Policy	The Policy provides an overarching framework for addressing the environmental issues facing Pakistan, particular pollution of fresh water bodies and coastal waters, air pollution, lack of proper waste management, deforestation, loss of biodiversity, desertification, natural disasters and climate change. Guidelines are shown in each sector, and one of such sector is “Waste Management”.

Table 2.8.2 Policy, Guideline, and Rules of Solid Waste Management National/Provincial-Wise

Name	Contents
National Sanitation Policy 2006	The policy stipulates that one of its objectives is to develop and implement strategies for integrated management of municipal, industrial, hazardous and hospital and clinical wastes of national, provincial and local level.
Punjab Municipal Solid Waste Management Guidelines 2011	Various issues in waste management are covered.
Hospital Waste Management Rules 2005	Rules for the management of medical waste generated in hospital are described.

2.8.2 Implementation Status of Environmental Impact Assessment (EIA) on a Candidate Final Disposal Site in Bhakhraywali

(1) Projects Requiring an EIA in Pakistan

The Environmental Protection Act of 1997 and the Pakistan Environmental Assessment Procedures of 1997 stipulate the conditions that would require EIA for the project site. The process of EIA is described in "Pakistan Environmental Protection Agency (Review of IEE & EIA) Regulations 2000." The case is filed in the Federal Agency, and the Agency decides whether the case is IEE (Initial Environmental Evaluation) or EIA. According to the Regulations, EIA is required in view of waste management as follows:

- Waste disposal and/or storage of hazardous or toxic wastes (including landfill state, incineration of hospital toxic waste)
- Waste disposal facilities for domestic or industrial wastes, with annual capacity more than 10,000 cubic metres

(2) EIA Process in Pakistan

Figure 2.8.1 shows the process of EIA in Pakistan. Once the report is submitted, within 10 working days of application for EIA, the Federal Agency proceeds to the "Preliminary Scrutiny." After "Public Participation" is done, the Federal Agency will carry out its "Review" within 90 days of application for EIA. Upon completion of the Review, the "Decision" of the Federal Agency shall be communicated to the proponent.

(3) EIA of this Project

The Urban Sector Planning and Management Services Unit Ltd. (The Urban Unit) in partnership with Gujranwala Waste Management Company (GWMC) conducted Environmental Impact Assessment (EIA) for the proposed Bhakhraywali landfill site. The actual survey was carried out by local consultants from 15 August 2014. The major contents are shown in **Figure 2.8.2**.

If the schedule is delayed, serious problem may ensue later. If the completion of EIA is delayed, construction and operation will also be delayed at the new Bhakhraywali landfill site. Since the existing landfill site, namely, Gondlanwara, will be full in two (2) years [see **Subsection 2.4.2, Item (3)**], illegal dumping will start again in case the new landfill site will not be ready at that time.

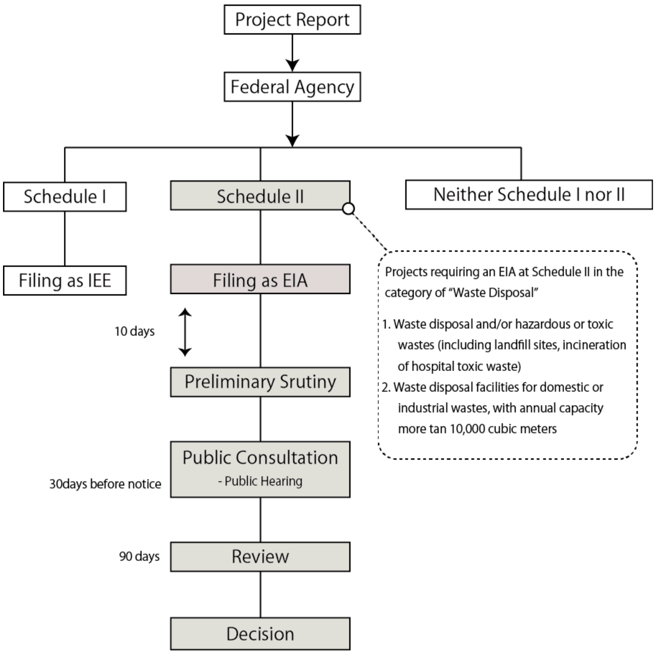


Figure 2.8.1 Process of EIA in Pakistan by the "Pakistan Environmental Protection Agency (Review of IEE & EIA) Regulations 2000"

- Governing Legislation and Statutory Requirements
- Project Alternatives
- Description of the Baseline Environmental Conditions (e.g. Fauna and Flora, Water Resource, Communities, Identification and Evaluation of Environmental Impacts)
- Public Consultation
- Identification and Evaluation of Potential Environmental Impacts
- Environmental Management Plan
- Laboratory Test
  - Water Quality: Aluminium, Antimony, Arsenic, Bacterial, Coliform, Boron, Barium, Cadmium, Chromium, Copper, Colour, Chloride, Cyanide, Fluoride, Lead, Manganese, Mercury, Nickel, Nitrate, Nitrite, Odour, Pesticides, pH, Phenols, Poly-nuclear Hydrocarbon, Radioactive, Residual; Chloride, Selenium, Taste, Total Hardness, Turbidity, TDS, and Zinc
  - Air Monitoring: PM 2.5, PM 10, SOx, NOx, CO (8 hour sampling), and Pb

Figure 2.8.2 Major Contents of EIA Report (Planned)

(4) Summary of EIA Report

The EIA report on the construction of a new final disposal site at Bhakhraywali was drafted in February 2015 and submitted to the Federal Agency in March 2015. After the submission, Public Hearing and Review is to be carried out between March and April 2015, and Decision will be made by the Federal Agency in May 2015 at the latest. The draft EIA report is summarised as follows:

(a) Natural Condition

(i) Climate

Gujranwala has a tropical hot dry climate with long summers when temperature rises to maximum up to 48 degrees Celsius in the months of June and July, and 4 degrees Celsius in the months of December and January. The summer season starts from April and continues until the end of September, the winter season starts from November and continues until February, and Monsoon starts from the later part of June and lasts over the period of two-and-a-half months.

(ii) Water

Surface water: The *Chenab* River is the only river in the district. The *Chenab* River forming the northern boundary has been described as a broad shallow stream. There are several *nullahs* (canals) in the district which form channels for floodwater in the rainy season. The most important of them are *Palkhu, Aik, Khot, Beghwala* and *Dekh*.

Groundwater: Groundwater is mainly used for drinking and irrigation in Gujranwala. For drinking, the local population is generally reliant on supply from the hand pumps in rural areas while in urban areas population use drinking water from the piped water supply scheme.

(iii) Fauna and Flora

Fauna: Due to the extensive cultivation, high population and human activities, there is little wildlife in the project area. However, the Wildlife Department has reported some fauna.

Flora: The project area, which is an agricultural land, is a habitat of several floral species. Common floral species with rooted vegetation are also present near most of the water bodies of the area.

(iv) Land-use

The project site of the proposed landfill is an agricultural land with 10-15% uneven land left after the exaction activities.

(v) Air and Noise

During the survey at the site, no air pollution or generation of noise was noted.

(b) Socio-economic Condition

(i) Population

The total population of Gujranwala District is 3,400,940 as estimated in March 1998. The 1998 Census show that the population of the district consists of Muslims (95%), Christians (4%), and Hindu and others (less than 1%).

(ii) Economic Activities

Gujranwala is a vibrant economic city of Punjab with palpable contribution in agriculture and the industrial sector. It is one of the major wheat and rice producers in the Punjab. In terms of industrial sector, Gujranwala is one of the important commercial and industrial nerve centres of Pakistan. Quality ceramic products are also one of the most important sectors in Gujranwala.

(iii) Sanitation

Thirty-five point three percent (35.3%) of households have no sanitation facility, and 42.8% have flush toilet in dwelling while 21.9% have flush toilet in premises. Infant morbidity rate is 67/1,000 live births.

(iv) Health Condition

Acute respiratory infection is the frequent health problem.

(c) Public Consultation

As a component of public consultation, 14 stakeholders have been interviewed.

Positive Perceptions: Stakeholders showed affirmative standpoint for the sanitary landfill in Bhakhlaiwali in terms of benefit of public health and environment.

Negative Perceptions: The common viewpoint is GMWC's negligence of required procedures and the guidelines create new environmental constraint and hazards. Lack of community inclusion and public disclosure is pointed out as well.

(d) Impact by the Project

Impact from the project in the construction phase and the operation phase has been evaluated in the report. Impact in the current situation and in the situation that possible measures implemented are considered. Major residual impacts of negative and positive aspects are summarised below.

Construction Phase: The most negative impacts are the dust problem, surface water contamination, natural vegetation (trees), traffic impact, and noise and vibration. On the other hand, increase of labour and employment opportunity, and community development and improvement in the infrastructure are counted as positive impact.

Operational Phase: Soil contamination due to solid waste is the most negative impact, and traffic impact because of garbage collection vehicles and noise and vibration generated from the operation of disposal site are assumed as major negative impact as well. On the other hand, labour opportunity is the positive impact.

(5) Delay of EIA

The EIA process is delayed compared to the first schedule. The delay of EIA approval signifies the delay of starting the service in the new landfill site. If the current disposal site at Gondlanwala becomes full of capacity before the start of new landfill site operation, there will be no place where the waste is thrown away. This situation will cause illegal dumping again. To avoid this situation, GWMC has been trying to complete all EIA processes as soon as possible.

Currently, the review of EIA is planned to be completed in 40 days to shorten the total process although it takes 90 days maximum. In case of further delay of approval of EIA, the start of construction work and operation of the new sanitary landfill facilities will also be delayed and this situation will cause extended use of the existing Gondlanwala disposal site. Since the Gondlanwala disposal site is the so called open dumping and the site is claimed by the neighbouring residents, immediate measures shall be taken to get approval of the EIA as soon as possible in order to shift the landfill operation to Bhakhraywali.

2.8.3 JICA Environmental Checklist for Waste Management

This project follows the JICA Guidelines for Environmental and Social Considerations as well as the Pakistani laws and regulations. This project is categorised as “Category B” based on the JICA Guidelines. Categorisation is made based on sector, scale, characteristics and location of the project, and “Category B” is defined as “Less adverse impact than “Category A” (significant adverse impact)”.

The JICA Environmental Checklist is issued under the JICA Guidelines, and the Checklist mentions detailed issues and items for avoiding negative impacts to community from the project. The JICA Checklist is a list of conditions which a JICA-funded project needs to follow so as to satisfy the desired quality of the project. For this project, the JICA Environmental Checklist for Waste Management is applied. The Checklist consists of six categories: Permits and Explanation, Pollution Control, Natural Environment, Social Environment, Others, and Note.

According to the comparison between the Pakistani laws and the JICA Environmental Checklist for Waste Management (see **Table 2.8.3**), some issues show that there is no conflict between the JICA Checklist and Pakistani laws; for example, both require EIA for project implementation. On the other hand, some differences are identified in the category; for example, “Social Condition” of the JICA Checklist. “Social Conditions” in the JICA Checklist requires consideration of living and livelihood of stakeholders and working condition at the project site. These issues are not clearly mentioned in Pakistani laws.

Application of the JICA Checklist to the project will make a better situation for the future waste management in Gujranwala. The Checklist will contribute especially in the field of social consideration.

Table 2.8.3 Comparison of Pakistani Laws and Regulations Related to Environmental Protection and Waste Management and JICA Environmental Checklist for Waste Management

Category Environmental Item in JICA Environmental Checklist for Waste Management	Comparison with Pakistan Laws and Regulations
1. Permits and Explanation 1) EIA and Environmental Permits 2) Explanation to the Local Stakeholders 3) Examination of Alternatives	**[Result of Comparison]** ･ No Major Conflict between the JICA Checklist and Pakistan laws and regulations **[Related Laws/Regulations]** ･ Guidelines for the Preparation and Review of Environmental Reports (1997) ･ Pakistan Environmental Protection Agency (Review of IEE & EIA) regulations 2000 ･ National Environmental Quality Standards (NEQS) ･ Building Regulation (2007) ･ Punjab Municipal Solid Waste Management Guidelines 2011 ･ Guidelines for Public Consultation (1997)
2. Pollution Control 1) Air Quality 2) Water Quality 3) Wastes 4) Soil Contamination 5) Noise and Vibration 6) Odour	**[Result of Comparison]** ･ Treatment and disposal process of other hazardous and dangerous waste may not be defined. ･ Noise generated by vehicles shall comply with the National Environmental Quality Standard. Noise generated by Facility operation may not be defined. Vibration level by vehicles or facility operation may not be defined. **[Related Laws/Regulation]** ･ National Environmental Quality Standards (NEQS) ･ Punjab Municipal Solid Waste Management Guidelines 2011 ･ Hospital Waste Management Rules (2005)
3. Natural Environment 1) Protected Areas 2) Ecosystem 3) Management of Abandoned Site	**[Result of Comparison]** ･ No Major Conflict between the JICA Checklist and Pakistan laws and regulations **[Related Laws/Regulation]** ･ Guidelines for Sensitive and Critical Area (1997) ･ Punjab Municipal Solid Waste Management Guidelines 2011
4. Social Environment 1) Resettlement 2) Living and Livelihood 3) Heritage 4) Landscape 5) Ethnic Minorities and Indigenous People 6) Working Conditions	**[Result of Comparison]** ･ No conflict, basically, but social and environmental considerations shall be accorded to waste pickers in the existing system in accordance with the JICA guidelines. ･ Measures for local landscape protection are not defined in Pakistani laws and regulation. ･ Working condition and environment is not clearly defined in Pakistan laws and regulations although the Labour Policy (2010) mentions labourers' human rights, health and social welfare. **[Related Laws/Regulation]** ･ Guidelines for the Preparation and Review of Environmental Reports (1997) ･ Labour Policy (2010) ･ Antique Act (1975) ･ Punjab Special Premises (Preservation) Ordinance (1985) ･ Guidelines for Sensitive and Critical Area (1997) ･ Punjab Municipal Solid Waste Management Guidelines 2011 ･ National Environmental Policy ･ The World Bank Environmental Assessment Sourcebook Volume I
5. Others 1) Impacts during Construction 2) Monitoring	**[Result of Comparison]** ･ No Major Conflict between the JICA Checklist and Pakistani laws and regulations **[Related Laws/Regulations]** ･ Guidelines for the Preparation and Review of Environmental Reports (1997) ･ Punjab Municipal Solid Waste Management Guidelines 2011
6. Note 1) Reference to Checklist of Other Sectors 2) Note on Using Environmental Checklist	**[Situation]** ･ This issue is not mentioned in Pakistani laws, therefore, The World Bank Environmental Assessment Sourcebook, Volume I, shall be applied, if necessary. **[Related Laws/Regulations]** ･ Guidelines for the preparation and review of Environmental Reports (1997) ･ The World Bank Environmental Assessment Sourcebook, Volume I

2.8.4 Environmental and Social Considerations Survey for Closed and Existing Final Disposal Sites

This survey is planned to start in November 2014. The objective of the Environmental and Social Consideration Survey (E&S Survey) for closed and existing final disposal sites is to figure out environmental and social problems in the current situation. Some measures shall be taken to avoid future environmental pollution using the survey result. Interview surveys shall be carried out with local stakeholders to identify the problems in addition to environmental measures. Contents of the surveys for each landfill site are summarised below.

(1) Existing Landfill Site (Gondlanwala)

The survey is to focus on problems caused by usual operation of landfill site and affect normal life (e.g., bad odour, flies and vectors, traffic jam caused by garbage collection vehicles, garbage falling down from collection vehicles without cover on the way to the landfill site) and environmental issues (e.g., water quality, air quality, hydrogeological situation, soil contamination, noise and vibration). In addition to environmental measures, the opinion of neighbouring residents shall be collected. The situation of waste pickers shall be surveyed as well because waste pickers are among the “key stakeholders” in the waste management system.

(2) Closed Landfill Site (Chianwali)

The survey is to focus on past issues, such as leachate and bad scenery of garbage heaped without final soil cover, because the site was abandoned without any environmental protective measure. This open dumping type of site is environmentally harmful as well; that is, the examination of rainwater reveals hazardous leachate which will cause serious environmental pollution in future. In addition to environmental measures, the opinion of neighbouring residents shall be collected. Environmental measures including measures for water quality, air quality, hydrogeological situation, soil contamination, odour, noise and vibration. The results will contribute to the implementation of the closure plan, which is included in the master plan.

(3) Result of the Survey

Baseline Information: Since EIA was not carried out at the current disposal site (Gondlanwala) and closed disposal site (Chianwali), most of baseline information is not available. No secondary data about air quality, noise and vibration, and offensive odour level is available as well.

Water quality should be described since the main source of drinking water is groundwater in the city. Current water quality data is available referring to the water sampling test carried out in Gondlanwala and Chianwali by the JICA Project Team. Detailed result is shown in **Subsection 2.8.5**.

Opinion of Stakeholders: Opinions of stakeholders are similar in both Gondlanwala and Chianwali. All stakeholders in both sites answered that they have experienced problems related to the disposal site. Dirty streets, smell and flies, and environmental pollution especially on water quality were the common responses.

In terms of benefit of waste collection system, a majority of them recognised that the disposal site is beneficial for Gujranwala, and the benefit is “Collection system keeps avoiding the waste from spreading around” and “Waste does not have to be treated or carried to any disposal point by each household separately.” On the other hand, some negative opinions are also recorded such as “It (disposal site) creates environmental problems.”

About the management of GWMC, the major opinion was addressed to the current situation that no soil-cover to the site makes the landscape deteriorated, and the bad quality of spray (for avoiding insects and vectors). Improper garbage collection system is also mentioned, that is, waste is already around everywhere in the city, and the illegal dumping in the city is pointed out as evidence of poor collection system.

Difference of Opinion between Chianwali and Gondlanwala: More respondents in Chianwali worried about health problems and pollution compared to the respondents in Gondlanwala. In addition, half of respondents consider that a disposal site is beneficial for future Gujranwala while all respondents recognised so in Gondlanwala.

2.8.5 Water Quality Survey in Gondlanwala and Chianwali

Water quality survey is planned to be carried out in three seasons in Chianwali and Gondlanwala. The first season survey was conducted in September 2014, the second season was made between January and February 2015, and the third season is planned in May 2015. As many as 14 parametres were checked in the first water quality test, such as Temperature, Turbidity, Electric Conductivity, pH, Nitrogen, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Suspended Solid, Cadmium, Lead, Chromium, Selenium, Arsenic, and Total Mercury. Ten samples were taken in each site: 5 surface water samples and 5 groundwater samples in Chianwali, and 3 surface water samples and 7 groundwater samples in Gondlanwala. Locations of sampling are shown in **Figure 2.8.3** to **Figure 2.8.6**, and samples were analysed in SGS Pakistan Private Limited, a private laboratory in Lahore. Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial and the Pakistan National Standards for Drinking Water Quality were used as reference to surface water and groundwater respectively.

(1) Water Quality Survey in the First Season (September 2014)

The first water sampling was conducted on 28 September 2014 at the pre-determined sites in Gondlanwala and Chianwali. The detailed analysis of water quality parametres shall be carried out after collection of the results of three seasons. The findings from the first survey result are summarised as follows.

In Gondlanwala, the ponding surface water in the bottom of the landfill area is polluted by leachate but the water pollution level is still lower than that of leachate from the landfill site used for years. Most of the water samples of wells are high in Electric Conductivity probably caused of soluble substances dissolved in groundwater. In Chianwali, similar to the results of well water analysis of Gondlanwala, the Electrical Conductivity of well water shows higher value. One of the hand pump wells shows very high Arsenic contamination. Reference shall be made to the following **Table 2.8.4** and **Table 2.8.5** for the laboratory test results and the location of sampling points.

(2) Water Quality Survey in the Second Season (January and February 2015)

The second sampling was carried out in 29 January 2015 at Chianwali and 12 February 2015 at Gondlanwala. All samples were collected at the same locations of the first sampling (see **Figure 2.8.3** to **Figure 2.8.6**). The results of the second season water quality test are shown in **Table 2.8.6** and **Table 2.8.7.** Two new parametres, Phosphorous and Chlorides, were added to the laboratory analysis to search for the reason of high electric conductivity in the result of the first sampling. Analysis was made in the same laboratory as the first sampling. A summary of the second water sampling test is described below.

Gondlanwala

- Surface water in the disposal site is contaminated by the influence of leachate (refer to Sampling ID: GSW-1).
- Groundwater samples near the disposal site, which are GGW-1, GGW-2, GGW-3 and GGW-4, are under the standard except Turbidity and no serious water contamination is found so far. However, since the Electric Conductivity is high, some kind of ion must be dissolved. It is not sure whether this situation (High Electric Conductivity) is because of the disposal site or not according to the first and second sampling.

Chianwali

- The result of three surface water samples around the disposal site, which are CSW-1, CSW-2, and CDW-3, shows high BOD and COD compared to the standard. It may be because the sampling points are drainage of neighbourhood area, and discharged water may inflow.

- Less possibility that surface water is polluted because of leachate from the disposal site because the result of BOD and COD of downstream water (CSW-2) is not significantly high compared to the result of upstream water (CSW-1).
- Electric Conductivity is relatively high in Chianwali, such as over 1,800µS/cm in CGW-2. The reason is not sure but hypothetically some kind of ion must be dissolved.
- Less possibility that groundwater is polluted because of leachate from the disposal site since the results of the nearest groundwater sample of disposal site, CGW-3, are all under the standard.

(3) Comparison of the Results of the First and Second Seasons

- **Gondlanwala**: In the groundwater sampling of GGW-3, the results of Nitrogen and Turbidity became high in the second season compared to the first season. Since animal husbandry is active around the sampling point, the situation may imply that animal excreta inflow to the groundwater.
- **Chianwali**: In the surface water sampling of CGW-2, some kind of groundwater contamination was observed since the results of Suspended Solid, COD and Turbidity are high in the second sampling compared to the first sampling. The reason is not sure, but the result of high electric conductivity in CGW-2 may not be caused by the disposal site. If the high electric conductivity in CGW-2 is caused by the Chianwali site, the result of CGW-5 would show a high value as well since GGW-5 and CGW-2 have the same depths of well, and probably both water samples came from the same depths.

Table 2.8.4 Water Quality Test Result in the Surrounding Area of the Existing Landfill Site in Gondlanwala (First Sampling)

(Water Sampling Date: 30 September 2014)

Sampling Point ID				GSW-1	GSW-2	GSW-3	GGW-1	GGW-2
Sample water source	Units	Standard		Landfill Site	Irrigation Tributary	Irrigation Main Canal	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				N/A	N/A	N/A	90	65
Temperature	°C	40	-	30.0	29.0	28.0	30.0	30.0
Turbidity	NTU	-	<5	39.0	19.0	27.0	1.0	*11.0*
Electric Conductivity	μS/cm	-	-	3,870.0	271.0	218.0	1165.0	1,216.0
pH	-	6-10	6.5-8.5	8.59	6.59	6.73	6.87	7.12
Kjldahal Nitrogen (TKN)	mg/L	-	3	15.93	0.28	0.58	0.58	0.58
COD	mg/L	150	-	*607.0*	10.0	13.0	<5.0	17.0
BOD$_5$	mg/L	80	-	*152.0*	<3.0	4.0	<3.0	<3.0
Suspended Solids (TSS)	mg/L	150	-	65.0	26.0	21.0	<5.0	35.0
Cadmium (Cd)	mg/L	0.1	0.01	<0.003	<0.003	<0.003	<0.003	<0.003
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (Cr)	mg/L	1.0	≤ 0.05	0.013	<0.005	<0.005	<0.005	<0.005
Selenium (Se)	mg/L	0.5	0.01	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic (As)	mg/L	1.0	≤ 0.05	0.038	<0.005	<0.005	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sampling Point ID				GGW-3	GGW-4	GGW-5	GGW-6	GGW-7
Sample water source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Hand Pump Well	Tube Well
		SW*	GW**					
Depth of Well (Feet)				65	65	150	70	125
Temperature	°C	40	-	29.0	28.0	28.0	28.0	28.0
Turbidity	NTU	-	<5	1.0	1.0	<0.20	*14.0*	2.0
Electric Conductivity	μS/cm	-	-	1408.0	966.0	1317.0	1114.0	115.0
pH	-	6-10	6.5-8.5	7.69	7.02	6.85	7.61	7.23
Kjldahal Nitrogen (TKN)	mg/L	-	3	0.28	0.28	0.28	0.28	0.28
COD	mg/L	150	-	<5.0	<5.0	<5.0	9.0	<5.0
BOD5	mg/L	80	-	<3.0	<3.0	<3.0	<3.0	<3.0
Suspended Solids (TSS)	mg/L	150	-	<5.0	<5.0	<5.0	7.0	<5.0
Cadmium (Cd)	mg/L	0.1	0.01	<0.003	<0.003	<0.003	<0.003	<0.003
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Selenium (Se)	mg/L	0.5	0.01	0.006	0.005	<0.005	<0.005	<0.005
Arsenic (As)	mg/L	1.0	≤ 0.05	<0.005	<0.005	0.007	<0.005	0.008
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Note: The italic figures in a grey coloured cell indicate over the standard.

*Pakistan National Standards for Drinking Water Quality are used as reference to surface water.

** The standard for groundwater samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

Table 2.8.5 Water Quality Test Result in the Surrounding Area of Closed Landfill Site in Chianwali (First Sampling)

(Water Sampling Date: 30 September 2014)

Sampling Point ID				CSW-1	CSW-2	CSW-3	CSW-4	CSW-5
Sample water source	Units	Standard		Drainage	Drainage	Drainage from landfill site	Irrigation Canal	Irrigation Canal
		SW*	GW**					
Temperature	°C	40	-	30.0	29.0	30.0	24.0	26.0
Turbidity	NTU	<5	<5	16.0	89.0	19.0	12.0	21.0
Electric Conductivity	µS/cm	-	-	1639.0	1530.0	1608.0	111.0	185.0
pH	-	6-10	6.5-8.5	6.87	7.27	7.27	6.97	6.51
Kjldahal Nitrogen (TKN)	mg/L	-	3	8.40	9.85	5.50	0.28	0.28
COD	mg/L	150	-	*341.0*	*508.0*	*292.0*	<5.0	27.0
BOD5	mg/L	80	-	*165.0*	*178.0*	*151.0*	<3.0	7.0
Suspended Solids (TSS)	mg/L	150	-	39.0	45.0	18.0	17.0	*185.0*
Cadmium (Cd)	mg/L	0.1	0.01	<0.003	<0.003	<0.003	<0.003	<0.003
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.005	<0.005	<0.005	0.011	<0.005
Selenium (Se)	mg/L	0.5	0.01	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic (As)	mg/L	1.0	≤ 0.05	0.009	0.012	0.008	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sampling Point ID				CGW-1	CGW-2	CGW-3	CGW-4	CGW-5
Sample water source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				200	65		80	60
Temperature	°C	40	-	24.0	28.0	24.0	26.0	26.0
Turbidity	NTU	<5	<5	2.0	<0.20	1.0	1.0	<0.20
Electric Conductivity	µS/cm	-	-	564.0	1854.0	330.0	798.0	332.0
pH	-	6-10	6.5-8.5	7.05	6.92	6.73	7.02	6.89
Kjldahal Nitrogen (TKN)	mg/L	-	3	0.28	0.28	0.28	0.28	0.28
COD	mg/L	150	-	<5.0	<5.0	<5.0	<5.0	<5.0
BOD5	mg/L	80	-	<3.0	<3.0	<3.0	<3.0	<3.0
Suspended Solids (TSS)	mg/L	150	-	<5.0	<5.0	<5.0	<5.0	<5.0
Cadmium (Cd)	mg/L	0.1	0.01	<0.003	<0.003	<0.003	<0.003	<0.003
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.005	<0.005	<0.005	<0.005	<0.005
Selenium (Se)	mg/L	0.5	0.01	0.005	<0.005	<0.005	0.007	<0.005
Arsenic (As)	mg/L	1.0	≤ 0.05	0.014	*0.190*	<0.005	<0.005	0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Note: The italic figures in a grey coloured cell indicate over the standard.

*Pakistan National Standards for Drinking Water Quality are used as reference to surface water.

** The standard for groundwater samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

Table 2.8.6 Water Quality Test Result in the Surrounding Area of the Existing Landfill Site in Gondlanwala (Second Sampling)

(Water Sampling Date: 30 January 2015)

Sampling Point ID				GSW-1	GSW-2	GSW-3	GGW-1	GGW-2
Sample water source	Units	Standard		Landfill Site	Irrigation Tributary	Irrigation Main Canal	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				N/A	N/A	N/A	90	65
Temperature	°C	40	-	18.1	18.1	17.9	18.3	18.4
Turbidity	NTU	-	<5	202	71	108	*13*	*11.2*
Electric Conductivity	µS/cm	-	-	4440	1919	380	1302	1745
pH	-	6-10	6.5-8.5	7.84	7.89	7.25	7.43	7.51
Kjldahal Nitrogen (TKN)	mg/L	-	3	91.11	41.55	1.78	0.29	0.59
COD	mg/L	150	-	*361*	139	149	<5.0	9
BOD_5	mg/L	80	-	129	37	44	<3.0	3
Suspended Solids (TSS)	mg/L	150	-	93	39	64	7	7
Cadmium (Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium (Se)	mg/L	0.5	0.01	0.008	0.009	0.012	0.008	0.022
Arsenic (As)	mg/L	1.0	≤ 0.05	0.012	0.006	<0.005	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	4.3	3.82	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	428.9	130.99	23.24	82.39	109.86
Sampling Point ID				GGW-3	GGW-4	GGW-5	GGW-6	GGW-7
Sample water source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Hand Pump Well	Tube Well
		SW*	GW**					
Depth of Well (Feet)				65	65	150	70	125
Temperature	°C	40	-	18.1	18.5	19.3	18.5	18.8
Turbidity	NTU	-	<5	*7*	*7*	1.9	*15*	2.1
Electric Conductivity	µS/cm	-	-	1336	1655	1436	1128	1098
pH	-	6-10	6.5-8.5	7.67	7.43	7.47	7.65	7.51
Kjldahal Nitrogen(TKN)	mg/L	-	3	0.59	0.89	<0.1	0.59	<0.1
COD	mg/L	150	-	<5.0	<5.0	<5.0	8	<5.0
BOD5	mg/L	80	-	<3.0	<3.0	<3.0	<3.0	<3.0
Suspended Solids(TSS)	mg/L	150	-	<5.0	<5.0	<5.0	7	<5.0
Cadmium(Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead(Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium(Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium(Se)	mg/L	0.5	0.01	0.01	<0.005	<0.005	<0.005	<0.005
Arsenic(As)	mg/L	1.0	≤ 0.05	<0.005	0.006	<0.005	<0.005	0.011
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	80.28	139.02	95.71	82.39	68.91

Note: The italic figures in a grey coloured cell indicate over the standard.
*Pakistan National Standards for Drinking Water Quality are used as reference to surface water.
** The standard for groundwater samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

Table 2.8.7 Water Quality Test Result in the Surrounding Area of the Closed Landfill Site in Chianwali (Second Sampling)

(Water Sampling Date: 12 February 2015)

Sampling Point ID				CSW-1	CSW-2	CSW-3	CSW-4	CSW-5
Sample water source	Units	Standard		Drainage	Drainage	Drainage from landfill site	Irrigation Canal	Irrigation Canal
		SW*	GW**					
Temperature	°C	40	-	18.6	18.4	18.2	18.3	18.1
Turbidity	NTU	<5	<5	85	93	243	11	10
Electric Conductivity	µS/cm	-	-	2080	2140	180	548	492
pH	-	6-10	6.5-8.5	7.19	7.24	7.91	7.6	8.47
Kjldahal Nitrogen (TKN)	mg/L	-	3	36.2	18.4	15.13	1.78	0.29
COD	mg/L	150	-	*276*	*255*	*257*	15	11
BOD5	mg/L	80	-	*83*	79	*112*	4	5
Suspended Solids (TSS)	mg/L	150	-	34	61	121	29	7
Cadmium (Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.002	<0.002	<0.02	<0.02	<0.02
Selenium (Se)	mg/L	0.5	0.01	0.017	0.012	0.01	0.009	0.008
Arsenic (As)	mg/L	1.0	≤ 0.05	0.005	<0.005	<0.005	<0.005	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	0.56	0.67	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	228.18	230.29	179.58	8.45	8.45
Sampling Point ID				CGW-1	CGW-2	CGW-3	CGW-4	CGW-5
Sample water source	Units	Standard		Tube Well	Hand Pump Well	Tube Well	Tube Well	Hand Pump Well
		SW*	GW**					
Depth of Well (Feet)				200	65		80	60
Temperature	°C	40	-	18.9	18.1	19.1	18.4	18.2
Turbidity	NTU	-	<5	3.3	*13*	1.7	2	2.9
Electric Conductivity	µS/cm	-	-	573	1806	317	851	304
pH	-	6-10	6.5-8.5	7.89	7.23	8.1	7.63	8.02
Kjldahal Nitrogen (TKN)	mg/L	-	3	<0.1	0.59	<0.1	0.59	0.89
COD	mg/L	150	-	<5.0	6	<5.0	<5.0	<5.0
BOD5	mg/L	80	-	<3.0	<3.0	<3.0	<3.0	<3.0
Suspended Solids (TSS)	mg/L	150	-	<5.0	7	<5.0	<5.0	<5.0
Cadmium (Cd)	mg/L	0.1	0.01	<0.002	<0.002	<0.002	<0.002	<0.002
Lead (Pb)	mg/L	0.5	≤ 0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium (Cr)	mg/L	1.0	≤ 0.05	<0.02	<0.02	<0.02	<0.02	<0.02
Selenium (Se)	mg/L	0.5	0.01	<0.005	0.021	<0.005	0.017	0.015
Arsenic (As)	mg/L	1.0	≤ 0.05	0.024	<0.005	<0.005	21.12	<0.005
Mercury (Hg)	mg/L	0.01	≤ 0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Phosphorous (P)	mg/L	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
Chlorides (Cl^-)	mg/L	1000	250	9.57	145.78	3.82	21.12	6.33

Note: The italic figures in a grey coloured cell indicate over the standard.

*Pakistan National Standards for Drinking Water Quality are used as reference to surface water.

** The standard for groundwater samples: Pakistan National Environmental Quality Standard (NEQS) for municipal and liquid industrial effluents.

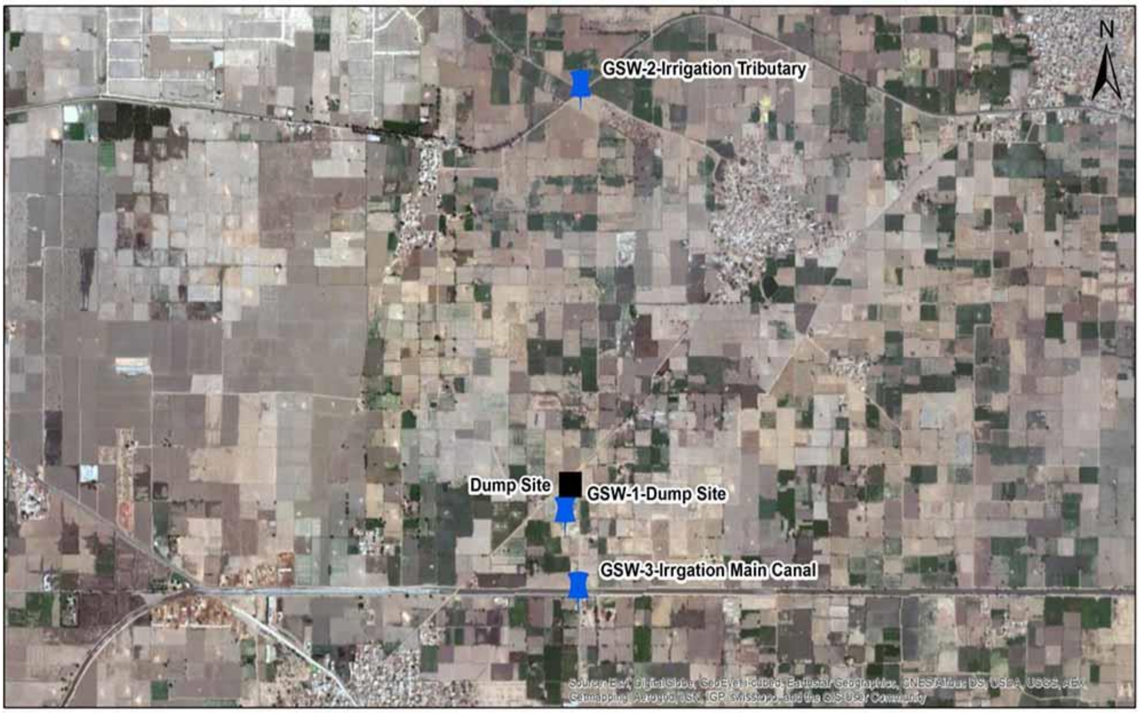


Figure 2.8.3 Location of Water Quality Sampling Points in Gondlanwala (Surface Water)

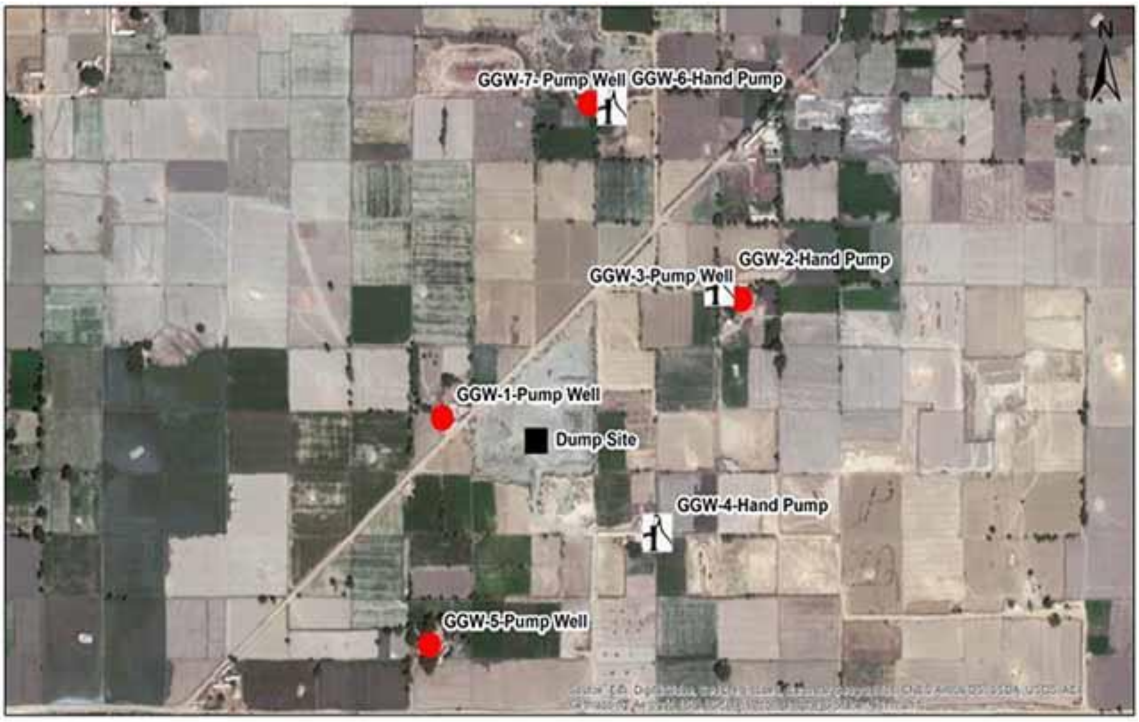


Figure 2.8.4 Location of Water Quality Sampling Points in Gondlanwala (Groundwater)

Figure 2.8.5 Location of Water Quality Sampling Points in Chianwali (Surface Water)

Figure 2.8.6 Location of Water Quality Sampling Points in Chianwali (Groundwater)

2.8.6 First Stakeholder Meeting

The first stakeholder meeting was held on 23 September 2014 at Mugal Mahal Hotel in Gujranwala (**Photo 2.8.1**). A summary of the meeting is shown in **Table 2.8.8**. In addition to the major stakeholders who are landowners and residents in the project site, related organisations participated in the meeting. Contents of the Project, current situation of waste management in Gujranwala, and point of environmental and social considerations in the Project were discussed at the meeting. According to the discussions, stakeholders are interested in the direction of waste management in Gujranwala.

Photo 2.8.1 First Stakeholder Meeting

Table 2.8.8 Summary of the First Stakeholders Meeting

Date and Venue	23 September 2014 Mugal Mahal Hotel, Gujranwala
Type of Participants (Participating Organisations)	Residents/Landowners in the project site, Gujranwala Waste Management Company (GWMC), JICA Pakistan Office, City District Government Gujranwala (CDGG), Local NGOs
Number of Participants	32 persons
Presentation Title	- Project Introduction by the Managing Director of GWMC (Dr. Haq, Managing Director of Gujranwala Waste Management Company) - Brief Overview of the JICA Project for Integrated Solid Waste Management in Gujranwala (Mr. Takasugi, JICA Expert for Final Disposal Plan) - Applying JICA Environmental Checklist for Waste Management (Ms. Tsutsui, JICA Expert for Environmental and Social Considerations)
Discussion/List of questions from the participants (selected)	- Will GWMC implement the JICA Master Plan & what can be the constraints for its implementation? - What is the status of dump sites? - How will GWMC utilise waste in future? - What is the plan of GWMC for at source separation? - Which step has GWMC taken for better unloading of waste by handcarts into the waste containers? - What is GWMC’s strategy to avoid waste littering during its transportation and to guide the sanitary workers at their assigned duty place? - What are the plans to monitor sanitary workers by operational staff?

2.8.7 Inclusion of Waste Pickers

The issue on Waste Pickesr is a common issue in solid waste management in developing countries*. It is estimated that 35 to 40 waste pickers are regularly working in the current disposal site at Gondlanwala. Their working environment is dangerous: They do not have protective gear, such as gloves and proper shoes, and dirty environment increases their health risk. (Note:* World Bank (1999) *What a Waste: Solid Waste Management in Asia.* http://web.mit.edu/urbanupgrading/urbanenvironment/resources/references/pdfs/WhatAWasteAsia.pdf [Last visit: March 14, 2015])

Since waste pickers do not have an alternative way to earn, they would come back to work in the disposal site although the authorities prohibit their activity. Many efforts trying to drive them away without giving alternative income sources had resulted in failure in other developing countries. Therefore, to consider long-term comprehensive solid waste management, it is better to take into account measures to cope with the waste pickers issue instead of just trying to drive them away from the project site.

2.8.8 Evaluation of Environmental and Social Consideration Condition

Problems on environmental and social consideration are classified into six (6) categories, namely; Laws and Regulations, EIA, SEA, Improper management of GWMC, Insufficient public disclosure, and Environmental Monitoring. The discussion point for each category is presented below and the problems and issues are summarised in **Table 2.8.9**.

Table 2.8.9 Identification of Problems and Issues on Environmental and Social Considerations

Problem	Description of Problem	Issues for Solving the Problems
1. Lack of enforcement of laws and regulations	Ignorance of social issues can be seen in the landfill site and its vicinity.	Execution of analysis and evaluation based on the JICA Guidelines for Environmental and Social Considerations, version 2010, should be required.
2. Delay of EIA	Delay of EIA for the new landfill site would attract illegal dumping again.	GWMC should continue making efforts to the completion of EIA process in cooperation with the Urban Unit as soon as possible.
3. No legal requirement of SEA (Strategic Environmental Assessment)	There is risk of no comprehensive perspective in formulating a master plan since Strategic Environmental Assessment (SEA) is not a legal requirement in Pakistan.	Introduction of SEA approach, as described in the JICA Guidelines for Environmental and Social Considerations, should be made in the process of formulation of the Master Plan. SEA must apply for a master plan project funded by JICA according to the Guidelines.
4. Insufficient public disclosure	Since lack of community inclusion and information sharing is pointed out in the EIA public consultation and the opinion survey, public disclosure is required in two types of information: health risk and environmental pollution from the disposal site, and operation policy of GWMC.	According to the result of opinion survey, residents are anxious about the health risk and environmental pollution. This situation implies that information for these issues is not provided sufficiently. Since most of the questions in the first stakeholder meeting were related to operation policy and solution to the current problems by GWMC, information sharing is indispensable.
5. Lack of environmental monitoring	No EIA was implemented in the current and closed disposal sites, i.e., Gondlanwala and Chianwali. In addition, no regular monitoring was carried out in the current and closed disposal sites. Environmental pollution, therefore, may accrue in future since both disposal sites are not sanitary landfills.	Post-closure process of Chianwali should be included in the Master Plan and regular monitoring in Gondlanwala and Chanwali shall be included in the Master Plan.
6. High risk of occupational health and safety environment	Unsanitary and dangerous working environment of waste pickers in the existing landfill site, such as working without any protective gear. Life support of waste pickers will also collapse after the landfill site is closed, i.e., waste pickers will lose their source of income once Gondlanwala landfill site is closed.	Waste pickers could be involved in an official recycling system, such as sorting recyclable materials at controlled area or composting of organic waste. Instead of ignoring or outlawing the waste pickers, CDGG and GWMC could involve them in the waste management system, and provide protective equipment to them.

2.9 Institutional Strengthening and Organisational Study

2.9.1 Laws and Regulations Related to Solid Waste Management

This section deals with laws and regulations related to solid waste management especially focusing on the important ones in Punjab Province.

(1) Overview of Environmental Laws in Pakistan

The Pakistan Environmental Protection Ordinance of 1983 was the first federal legislation aiming to improve the environment especially in the matter of waste. As a federal legislation, the Ordinance established the Pakistan Environmental Protection Council (hereinafter referred to as "PEPC") as the supreme environmental policy-making body in the country and the Pakistan Environmental Protection Agency (hereinafter referred to as "Pak-EPA") at the federal level and Environmental Protection Agencies at provincial level in all four provinces of the State, including the Province of Punjab, to administer and implement the provisions of the Ordinance. In 1997, the improved Ordinance was enacted after approval by the Parliament as the Pakistan Environmental Protection Act (hereinafter referred to as "PEPA").

The 1997 PEPA retained the institutional framework of the 1983 Ordinance and provides for the protection, conservation and improvement of environment, for prevention and control of pollution, and for the promotion of sustainable development.

The PEPA defines waste as any substance or object which has been, is being or is intended to be, discarded or disposed, and includes liquid waste, solid waste, waste gases, suspended waste, industrial waste, agricultural waste, nuclear waste, municipal waste, hospital waste, used polyethylene bags, and residues from the incineration of all types of waste (PEPA Section 2 (xiv). Other federal legislations related to solid waste management are summarised in **Table 2.9.1**.

Table 2.9.1 Other Federal Legislations Related to Solid Waste Management

Name of Regulation	Year	Major Issues related to Solid Waste Management
The Factories Act	1935	・Regulations on labour factories ・Disposal of waste and effluents has to be arranged.
Pakistan Penal Code	1960	・Penal Law ・Handling and negligent conduct with respect to poisonous, toxic and hazardous waste is an offence. The code is to be monitored by the provincial government.
Constitution	1973	・Basic rights and duties of the citizens and the Government of Pakistan ・Acquiring land for public interest
Pakistan Environment Protection Act (PEPA)	1997	・Protection, conservation, rehabilitation and improvement of environment, prevention and control of pollution ・Defines municipal waste, hazardous waste, hospital waste, industrial waste, agricultural waste, organic and inorganic matters and living organisms, buildings. ・Prohibits discharge of waste in a concentration that violates the National Environmental Quality Standards (NEQS) ・EPAs that are satisfied that the discharge of any kind of waste in violation of the provisions of the Act is likely to occur or occurring are empowered to direct the responsible person to take necessary measures. ・Penalties for contraventions against the provisions of the Act.
Pollution Charge for Industry Rules	1998	・Calculation and collection of charges
Provincial Sustainable Development Fund Board Rules	1998	・Rules on constitution and meetings of the Board
Environmental Tribunal Rules	1999	・Organisation and procedures/rules
Review of IEE/EIA Regulations	2000	・Regulation on Environmental Impact Assessment (EIA) ・Projects requiring an Initial Environmental Examination (IEE)/EIA ・Waste disposal projects require IEE/EIA
National Environmental Quality Standards (NEQS)	2000	Quality Standards for: ・Municipal and liquid industrial effluents ・Industrial gaseous emissions ・Motor vehicle exhaust and noise
NEQS Regulations	2000	・Certification of environmental laboratories
NEQS Rules	2001	・Self-monitoring and reporting by industrial units

Name of Regulation	Year	Major Issues related to Solid Waste Management
		・Categories of industrial units ・Monitoring report in addition to EIA approval
Environmental Sample Rules	2001	・Procedure of inspection and taking samples
Hazardous Substance Rules	2003	・Management of hazardous substances ・Waste management plan pertaining to hazardous waste
Hospital Waste Management Rules	2005	・Management of waste generated by healthcare institutions

(2) Important Laws and Regulations Concerning Solid Waste Management in Punjab Province

Among the environmental laws related to solid waste management, the following five laws and regulations are most noteworthy in the Province of Punjab.

(a) Punjab Environmental Protection Act (2012)

Following the enactment of Pakistan Environmental Protection Act (PEPA, 1997), the Punjab Environmental Protection Act was approved in 1997 and subsequently amended in 2012. Similar to PEPA, the Punjab Environmental Protection Act defines several types of waste and stipulates powers and functions of the Council and Agency at the provincial level. The major amendment made in 2012 could be said that, in general, powers and functions of the Provincial Government were slightly weakened compared to the Federal Government. For example, the previous Act (1997) allowed both Federal and Provincial Government to delegate any of their powers or functions under the Act, the rules or the regulations to any Government Agency, local council or local authority. However, the amended Act allows only the Federal Government to do so.

(b) Hazardous Substance Rules (2003)

These Rules were formulated to deal with hazardous substances listed in Schedule I (242 chemicals and any other prescribed by Pak-EPA) of these Rules. Only the licence holder personnel can import, handle transport, treat and dispose of the hazardous waste and the proprietor has to submit and follow a safety management plan.

Issues related to solid waste management and addressed in these Rules are as follows:

- Instructions regarding return or disposal of an empty container (Section 9(2)(f));
- Safety precautions to deal with containers (Section 11(1)(b)); and
- Waste management plan (Section 19).

(c) Hospital Waste Management Rules (2005)

These Rules were formulated to deal with hospital waste in response to Section 31 of PEPA 1997. These Rules define chemical waste, genotoxic waste, infectious waste, non-risk waste, pathological waste, pharmaceutical waste, radioactive waste, risk waste and sharp objects. The rules clearly state that hospitals are responsible for the management of waste generated within their premises and thus each hospital has a waste management team responsible for preparation of the waste management plan, its implementation and periodic review and revision. In addition, the detailed procedures are described in the Rules for waste segregation, transportation, storage, disposal, and minimisation and reuse.

(d) Punjab Municipal Solid Waste Management Guidelines (2011)

The Guidelines attempt to address all important elements of waste management systems as a general guidance to the provincial government departments, local governments, private operators and other agencies that initiate or operate any solid waste management activity in urban areas. Various components of solid waste management such as waste collection, waste transfer, recovery of useful components, waste incineration, composting, bio-gas generation and land-filling are covered in these guidelines giving a technical guidance to do these operations with minimal impacts to the environment.

(e) Punjab Municipal Solid Waste Management Act (Draft) (2013)

The objective of the Act is to provide a system for the generation, storage, transport, collection, recovery, treatment and disposal of waste which regulates and mitigates the adverse impacts associated with the uncontrolled generation and disposal of waste in a manner that promotes sustainable economic growth, social development and environmental protection.

The Act obligates persons desirous of being engaged in waste management to apply for a licence and prohibits certain activities relating to waste such as littering in any public place and burning of waste. It also provides instructions for dealing with specific types of wastes including horticultural waste, hazardous waste and bio-medical waste.

The Act had established the Punjab Waste Management Commission which is responsible for the following fields:

- Preparation of a Provincial Waste Management Plan;
- Giving general or specific directions to a Local Government or Local Governments or Authorised Officers regarding this Act;
- Proposal to the Government such as tariffs, rates, fees, charges and penalties if it is deemed necessary to carry out the purposes of this Act;
- Meeting no less than once in every calendar year to review implementation of this Act and to make such recommendations as may be necessary for the implementation of this Act;
- Ensuring that this Act and Rules and Regulations framed thereunder are enforced;
- Monitoring areas where this Act has been applied through Monitoring and Evaluation Reports and Waste Management Plans;
- Hearing appeals against decision taken by Authorised Officers;
- Preparation and presentation of the key performance indicators to the Government once in each calendar year;
- Proposal to the Government such Guidelines, Rules, Policies, Schemes, Programmes and Strategies in order to carry out the purposes of the Act;
- Delegation, with the approval of the Government, of such functions to an Authorised Officer as may be determined; and
- Performance of such other functions as may be prescribed or is incidental to the above functions or assigned by the Government from time to time.

In addition to the Provincial Waste Management Plan, the Act establishes that every local government is responsible to prepare a Waste Management Plan provided that the Waste Management Plan shall contain details on prevention, minimisation, collection, recovery and disposal of waste within the area.

Although this Act is still in the process of legislation, it can be said that it is the most comprehensive law to deal with solid waste management in the Punjab Province since it also mentions recovery of waste and landfills.

(f) Solid Waste Management By-Laws, City District Government Lahore (2005)

The By-Laws was formulated to create provision for healthy improvement of the environmental standard in Lahore contemplating many innovative ideas and proposals by the members of civic body which cannot be materialised because of lack of necessary legal and regulatory framework.

These By-Laws hold responsible for the sanitation of the area within its jurisdiction the City District Government Lahore (CDG Lahore SWM By-Laws Section 3). The City District Government shall therefore arrange for sweeping and cleaning of public streets (CDG Lahore SWM By-Laws Section 3). The City District Government may arrange for the removal and carriage of refuse and for this purpose will provide receptacles and vehicles (CDG Lahore SWM By-Laws Section 6). Furthermore, the City District Government will provide landfills and other facilities for the disposal of waste (CDG Lahore SWM By-Laws Section 7). The local by-laws also contain the prohibition against depositing refuse, building materials, etc., in any public place (CDG Lahore SWM Section 16) and sets out fines for the violation of these rules (CDG Lahore SWM By-Laws Section 34).

Although there are several laws and regulations related to solid waste management in the Punjab Province, they are very much fragmented or not well integrated. It means there is no single law on solid waste management which is precise and comprehensive. This makes it more difficult for government officials to understand their work and responsibilities.

In addition, the general public is unaware of those laws and regulations partially because of illiteracy in English. Thus, the by-law being drafted by UU and LWMC should be precise and comprehensive enough for government officials and residents to understand and comply with it. This means the by-law should be written not only in English but also in Urdu.

Another issue concerning laws and regulations is their insufficient implementation. This is due to lack of enforcement. Thus it is necessary to equip GWMC with more effective and efficient enforcement measures. Another cause is the ignorance of the public. The general public even does not know what is written in the laws and regulations and it seems that most of them do not know their existence. This should be rectified by interpretation and/or translation of important laws and regulations in Urdu and also by raising public awareness on the general issues related to solid waste management.

As overviewed above, there are many laws, regulations and policies related to solid waste management but they are fragmented and insufficiently enforced. Another challenge in terms of legislation is the lack of coordination among different government agencies. Whether national or provincial, environmental issues tend to be overlooked in the political arena, resulting in the lack of funds and personnel compared to other urgent issues of more importance. In order to ensure compliance with the related legislations, it is also important to mainstream the environmental issues, especially, solid waste management in the political agenda.

2.9.2 Policies Related to Solid Waste Management

(1) Overview of National/Provincial Development Plan

There are three major development policies at national and provincial level. Though none of them deals with solid waste management as a separate issue from sanitation/environment, all of them briefly touch the issue. Thus, it can be said that improvement of solid waste management is in line with the national and provincial governments’ policy.

(a) Vision 2030

Vision 2030 is the policy document that depicts the vision of the Pakistan Government to realise Pakistan in 2030 in the world context. Its main objectives are as below:

- To realise industrialised, prosperous, just and developed Pakistan through sustainable development in a resource constrained economy by knowledge inputs; and
- To be a middle income country with a GDP of around USD 4,000 by 2030.

Vision 2030 deals with solid waste management in the context of refuse recovery and electricity generation strategies. In addition, it aims at strengthening urban management and municipal services in universities including solid waste management.

(b) Vision 2020

Vision 2020 is the policy document that depicts the vision of Punjab Government. It aims at making Punjab Province fully literate, employed, skilled, tolerant, culturally sophisticated, with world class infrastructure and modern centres, internationally connected and a healthy society by 2030.

Its development plan encompasses the following areas:

- Agriculture sector
- Manufacturing sector
- Poverty reduction
- Improvement of public services delivery
- Public private partnership strategies
- Governance reforms
- Reforms in civil services
- Improvement of infrastructure
- Educational reforms

Solid waste management is not considered as a separate issue; however, it is discussed under the subsection of water supply and sanitation. Water supply and sanitation is discussed under public health. It mentions that in order to improve public health condition it is important to improve water and sanitation condition of the Province.

(c) Punjab Development of Cities Act 1976

This Act was provided for the development of cities in the Punjab Province. Its objectives are listed as follows:

- To establish a comprehensive system of planning and development in order to improve the quality of life in the cities of the Punjab;
- To establish an integrated development approach and a continuing process of planning and development;
- To ensure optimum utilisation of resources, economical and effective utilisation of land; and
- To evolve policies and programmes, relating to education, water supply, sewerage, drainage, solid waste disposal and matters connected therewith and incidental thereto.

The Act makes the City Development Authority responsible for preparing and implementing environmental improvement schemes including solid waste disposal in cities. Solid waste management is considered as a compulsory part of cities development of this act. The Authority has the power to remove sources of pollution such as cattle, tongas (carts pulled by horses), horses, other animals, solid waste, industrial waste, etc., from the cities after providing alternate accommodation or compensation. The Authority also has the power to impose fines or imprisonment on the person involved in the deviation from this Act.

(d) National Policy

There are five (5) national policies related to solid waste management.

(i) National Environmental Policy (2005)

The National Environmental Policy (hereinafter referred to as "NEP") was adopted in 2005 by the Federal Government driven from the National Environment Action Plan (approved in 2001 by Pakistan Environmental Protection Council). The NEP provides an overarching framework for addressing the environmental issues facing Pakistan, particularly, pollution of freshwater bodies and coastal waters, air pollution, lack of proper waste management, deforestation, loss of biodiversity, desertification, natural disasters and climate change. It also gives directions for addressing the cross-sector issues as well as the underlying causes of environmental degradation and meeting international obligations.

The NEP aims to protect, conserve and restore Pakistan's environment in order to improve the quality of life of citizens through sustainable development. The following guiding principles shall be applied to achieve the objectives of the Policy:

- Principles of sustainable development;
- Principles of equitable access to environmental resources;
- Integration of environment into planning and implementation of policies, programmes and project;
- Changing personal attitudes and behaviours;
- Precautionary principles;
- Polluter pays principle;
- Improving efficiency with which environmental resources are used;
- Cradle to grave management;
- Best available technology;
- Decentralisation and empowerment;
- Extensive participation of communities, stakeholders and the public;
- Accountability and transparency; and
- Increased coordination and cooperation among federal and provincial governments.

NEP addresses solid waste management under Section 3.3, Waste Management. The purpose is to prevent and reduce pollution caused by liquid and solid waste. Among others, subsequent principles are mentioned as follows:

- Encourage reduction, recycling and reuse of municipal and industrial solid and liquid wastes;
- Develop and enforce rules and regulations for integrated management of municipal, industrial, hazardous and hospital wastes; and
- Develop and implement strategies for integrated management of municipal, industrial, hazardous and hospital waste at national, provincial and local levels.

(ii) Guideline for Solid Waste Management (2005)

The Guideline addresses the management of municipal solid waste and hazardous waste, i.e., above all hospital waste. The focus is on municipal waste.

According to the Guideline, the overall aim of the solid waste management strategy for Pakistan is "to provide an effective, efficient, affordable, safe and sustainable solid waste management system for all the urban and rural settlements in Pakistan." The Guideline suggests different options on different operational levels right from generation, primary collection to disposal including capacity building of concerned department.

Within the Guideline, a strategy for solid waste management in Pakistan is proposed (Part A, Chapter 7). The Guideline forms part of a package of regulations and guidelines which includes the following:

- The Pakistan Environmental Protection Act of 1997;
- Policy and procedures for filing, review and approval of environmental assessments;
- Guidelines for the preparation and review of Environmental Reports; and
- Pakistan environmental legislation and the National Environmental Quality Standards (NEQS) as amended from time to time.

(iii) National Sanitation Policy (2006)

The National Sanitation Policy of Pakistan provides a broad framework and policy guidance to the Federal Government, Provincial Governments, federally administered territories and the local governments to enhance and support sanitation coverage in the country through formulation of their sanitation strategies, plans and programmes at all respective levels for improving the quality of life of the people of Pakistan and the physical environment necessary for healthy life. The Policy envisions creation of an open defecation free environment with safe disposal of liquid and solid waste and the promotion of health and hygiene practices in the county.

The National Sanitation Policy states 10 objectives. The ones relating to solid waste management are as follows:

- To ensure open defecation free environment; the safe disposal of liquids, solids, municipal, industrial and agricultural wastes; and the promotion of health and hygiene practices;
- To promote community-led total sanitation (CLTS);
- To develop and implement strategies for integrated management of municipal, industrial, hazardous, and hospital and clinical wastes of national, provincial and local levels; and
- To increase mass awareness on sanitation and community mobilisation.

According to the Policy, the guiding principles for solid waste management (scenario of sanitation options) are described as follows:

- Integrated solid waste management will be promoted and practiced by selection and application of appropriate measures, technologies and management programmes;
- Government at all levels will promote the principle of 3R's of waste management (i.e., reduce, reuse and recycle) and encourage waste separation to maximise resource use and conservation;
- Fines will be imposed on citizens, businessmen, factory owners and government institutions for any violation of the laws relating to solid waste management;
- Appropriate solid and liquid waste treatment facilities will be made integral part of all development projects;
- Solid waste in large and intermediate cities will be disposed of into properly designed landfill sites. In case of smaller settlements, area specific solutions will be developed in line with the National Environmental Quality Standards (NEQS); and
- Bio-gas projects will be introduced to generate energy from wastes.

(iv) National Drinking Water Policy (2009)

The National Drinking Water Policy was approved in order to improve the quality of life of people of Pakistan by reducing incidence of death and illness caused by waterborne diseases through ensuring provision of adequate quantity of safe drinking water to the entire population at an affordable cost and in an equitable, efficient and sustainable manner.

While the Policy does not address issues related to waste management, its policy guidelines can be applicable for provision of waste management services. The policy guidelines which can be applied include the following:

- Increasing access;
- Appropriate technologies and standardisation;
- Community participation and empowerment;
- Public awareness;
- Capacity development;
- Public private partnership;
- Research and development;
- Coordinated planning and implementation; and
- Legislation.

(v) National Climate Change Policy (2012)

The National Climate Change Policy was established in 2012 to ensure that climate change is mainstreamed in the economically and socially vulnerable sectors of the economy and to steer Pakistan towards climate resilient development.

The Policy addresses issues related to waste management in the context of climate change mitigation in the energy field. The policy measures raised by the Policy are as follows:

- Promote the development of renewable energy resources and technologies such as solar, wind, geothermal and bio-energy;
- Install plants to generate power from municipal waste; and
- Promote and provide incentives for activities required for increasing the energy-mix and switching to low-carbon fossil fuels, and develop indigenous technology for CO_2 Capture and Storage (CCS); Waste Heat Recovery, Co-generation; Coal Bed Methane Capture; and Combined Cycle Power Generation.

(e) Provincial Level

There are two provincial policies related to solid waste management.

(i) Punjab Urban Water Sanitation Policy (2007)

The Punjab Urban Water Sanitation Policy was approved in 2007 with the vision of “sustainable water and sanitation for all” to provide optimum quantity of water and sanitation services on a sustainable bases. The objectives of the Policy are mentioned below:

- Provide a legal, regulatory framework and efficient institutional arrangements for sustainable water supply, sanitation and wastewater treatment services; and
- Sustainable financing arrangements including community participation and public private partnership.

In the same manner as the National Drinking Water Strategies, the Punjab Urban Water Sanitation Policy does not directly deal with waste management issues. However, its policy principles are applicable to solid waste management. The applicable principles are as follows:

- Community participation;
- Social and environmental considerations;
- Capacity building;
- Public Private Partnership (hereinafter referred to as “PPP”); and

- Environmental education.

In addition, the following socio-economic instruments could serve as useful reference in light of private sector involvement in solid waste management:

- Performance-Based Financing: The Government of the Punjab and the cities will fund water utilities based on performance-based incentive financing from its own resources and from private sectors, which are sustainable and invested in sustainable systems;
- Component Sharing: Water and sanitation projects will use internal and external component sharing model for financing of community based interventions;
- Need-Based Financing: The Government of the Punjab will fund water and sanitation projects based on the accessibility to services and the condition of infrastructure in the city;
- PPP Contract: PPP mode of financing and management shall be used as an instrument to facilitate capital investment, enhance efficiencies, expand the service areas and improve accountability & quality of service delivery;
- User charges: The tariff for provision should be linked to the actual cost of service provision to ensure financial sustainability; and
- Subsidies: Subsidies will be provided through lifeline tariff in the low income areas. To enhance provision of water and sanitation services in low income areas, the differential cost will be met through targeted subsidies.

(ii) Punjab Landfill Sites Policy (Draft) (2008)

The Punjab Landfill Sites Policy was adopted in order to facilitate, guide and support local governments in establishing proper landfill sites in the province based on the concept of waste hierarchy that is waste reuse, reduction, recycling and recovery in the province. The Policy provides an overarching framework that would address the legal, regulatory, institutional, administrative, environmental issues and challenges faced by stakeholders.

The goal of the Policy is to protect environment, improve public health and to make cities clean with the following objectives:

- To minimise negative externalities associated with unregulated waste dumping;
- To establish and strengthen the institutional arrangements for landfill site selection, development, operation, maintenance and post closure; and
- To improve the overall solid waste management system in the cities by providing well managed sanitary landfill sites.

In line with other policies, the Punjab Landfill Site Policy of 2011 sets its policy principles such as sustainable development, private sector participation and polluter pays principle. In addition, attention is paid to economies of scale so that the Policy suggests various policy measures to share the responsibility among the government of Punjab and local governments.

2.9.3 Organisations Related to Solid Waste Management

There are several organisations related to solid waste management at national, provincial, and local government levels.

(1) Federal Government

The Planning and Devolution Division at federal level and Planning and Development Departments at provincial level are responsible for the preparation of development plans and allocation of financial resources. At the federal level the Ministry of Environment is responsible for the development of policies and programmes under the environmental scheme (Rules of Business 1973 Schedule II).

The Federal Government may, by notification in the official Gazette, make rules for carrying out the purposes of the PEPA including rules for implementing the provisions of the international environmental agreements, specified in the Schedule to the Act (PEPA Section 31). Making use of this power, the Federal Government of Pakistan has enacted several rules in connection with waste management and enforcement. The federal government has been empowered to levy pollution charge on persons not complying with the NEQS.

The Pakistan Environmental Protection Agency (Pak-EPA) was established in 1984 under the Environmental Protection Ordinance. Pak-EPA and the provincial EPAs are the main regulatory bodies for the implementation of PEPA. In 1997 the Parliament passed the Environmental Protection Act that repealed the Ordinance. The additional waste management related functions and responsibilities of Pak-ETA are summarised as follows:

- Preparation of national environmental policies for approval by the Council [PEPA Section 6(1)(b)];
- Implementation of national environmental policies [PEPA Section 6(1)(c)];
- Formulation of ambient air and water standards [PEPA Section 6(1)(g)];
- Render Advice and assistance in environmental protection matters [PEPA Section 6(1)(m)];
- Assistance to local authorities to implement schemes for the proper disposal of wastes [PEPA Section 6(1)(n)];
- Promote public education and awareness policies [PEPA Section 6(1)(q)]; and
- Undertake inquiries and investigations into environmental issues [PEPA Section 6(1)(i)].

For carrying out the purposes of the PEPA, the EPA may, with the approval of the Federal Government, make regulations according to the enumeration in Section 33 of PEPA. Regulation of hazardous substances/wastes and introduction of public participation in EIA reviews are the topics relevant to waste management.

(2) Provincial Government

(a) Provincial EPA

Every provincial government established a Provincial Environmental Protection Agency and delegates powers and functions to them. Punjab EPA was established by Notification No. S.R.O. 2151 (1) 98 to the Punjab EPA. The following is their responsibility concerning waste management:

- The powers and functions of review and approval of IEE/EIA and those on handling of hazardous substances.

Provincial EPAs have been given statutory cover. Provincial EPAs can exercise powers delegated to them by the respective provincial governments or the Pak-EPA. According to PEPA Section 26, the Federal Government may delegate any of its or of the Federal Agency’s powers and functions to any government agency of such Provincial Government or any local council or local authority in the Province.

Under Section 16 of the 1997 PEPA, the Federal Agency or any Provincial Agency that is satisfied that the discharge of any waste in violation of the provisions of the Act is likely to occur or occurring are empowered to direct the responsible person to take necessary measures. Pak-EPA and the provincial EPAs have been empowered to issue Environmental Protection Orders to deal with an actual or potential adverse environmental effect following a violation of the provisions of the Act. This may include immediate stoppage of pollution, installation of pollution control devices and action for disposal of waste and restoration of environment.

(b) Urban Unit

The Urban Unit was established in 2006 as a Project Management Unit of the Planning and Development Department, Government of the Punjab. In 2012, it was transformed into a wholly government-owned company registered with the Securities and Exchange Commission of Pakistan (SECP). The fields of operations mainly include urban planning, urban transport, solid waste management, urban water and sanitation, geographic information systems (GIS), urban property tax and land records as well as municipal finance.

The Solid Waste Management (SWM) Sector of the Urban Unit envisions developing and formulating provincial policies, and legal and regulatory framework for solid waste management in the cities of Punjab. It aims at providing technical assistance to various local governments and building their institutional capacity by imparting trainings and recruiting professionals in the field of SWM. The sector on the whole, is committed to improving the solid waste management practices in Punjab to make its cities the engines of growth and sustainable development according to the Chief Minister’s vision.

Its scope of work includes the following:

- Formulation of provincial policies, legal and regulatory framework for SWM;
- Strategy planning for proper waste management for towns, cities and regions;
- Capacity building of the relevant stakeholders;
- Technical assistance to various local governments in development of SWM action plans, landfill sites, improvement in existing SWM system and overall capacity building of departments;
- Facilitate foreign agencies working in Pakistan in the SWM Sector; and
- Training to government officers, professionals, researchers and students to enhance their technical skills of managing solid waste.

(3) City District Government Gujranwala (CDGG)

The Gujranwala District Government was established under the devolution process that took place in 2001 as the City District Government in 2005. The district comprises the following five areas and Tehsils:

- City area (64 union councils)
- Sadar area (39 union councils)
- Noshehra Virkan Tehsil
- Wazaribad Tehsil
- Kamoke Tehsil

Besides, the City and Sadar area is administratively divided into the following four towns:

- Aroop Town
- Kahiali Shanhpur Town
- Nandipur Town
- Qila Didar Singh Town

City District Government Gujranwala (CDGG) is responsible for providing solid waste management in the four Towns (City area and Sadar area). However, due to the budget constraint, it is capable to provide the service in only 64 Union Councils (UCs) of the City. In the three Tehsils, each Tehsil Municipal Administration is in charge of solid waste management.

The City District of Nazim, assisted by the District Coordination Officer and the District Police Officer, heads the CDGG. The District Coordination Officer (DCO), the highest ranking civil servant in the City District Government, heads the executive branch of the district government. The executive branch is divided into 7 departments and an Executive District Officer (EDO) heads each department to carry out its function (see **Figure 2.9.1**). Before the declaration of the District as City District, all functions under the Municipal Services category including solid waste management were performed by the Teshil Municipal Administrations (TMAs). In 2005 when the District Government Gujranwala declared a City District Government, solid waste management function together with the staff became the responsibility of the CDGG.

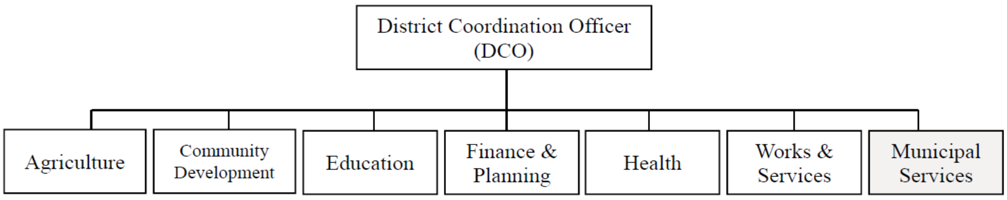


Figure 2.9.1 Organisational Chart of CDGG as of March 2015

The solid waste management comes under the Municipal Services (MS) function in the City District Government Gujranwala. The other functions of the MS department include Environment, Spatial Planning and Commercialisation, and Transport. The MS department is headed by the Executive District Officer (EDO) and the District Officer (DO) heads the sub-departments. The Solid Waste Management sub-department is responsible for solid waste collection, transportation and disposal of the municipal waste to the final disposal site in four towns of Gujranwala (Aroop, Khiali Shahpur, Nandipur and Qila Didar Singh). In other three outer teshils, solid waste is managed by the respective TMAs.

Figure 2.9.2 below illustrates the organisational structure of the MS department. The shaded parts show the Solid Waste Management Department. The District Officer is supported by the chief sanitary inspectors and assistant sanitary inspectors for primary and secondary collection of solid waste. Sanitary supervisors supervise sanitary workers in the field.

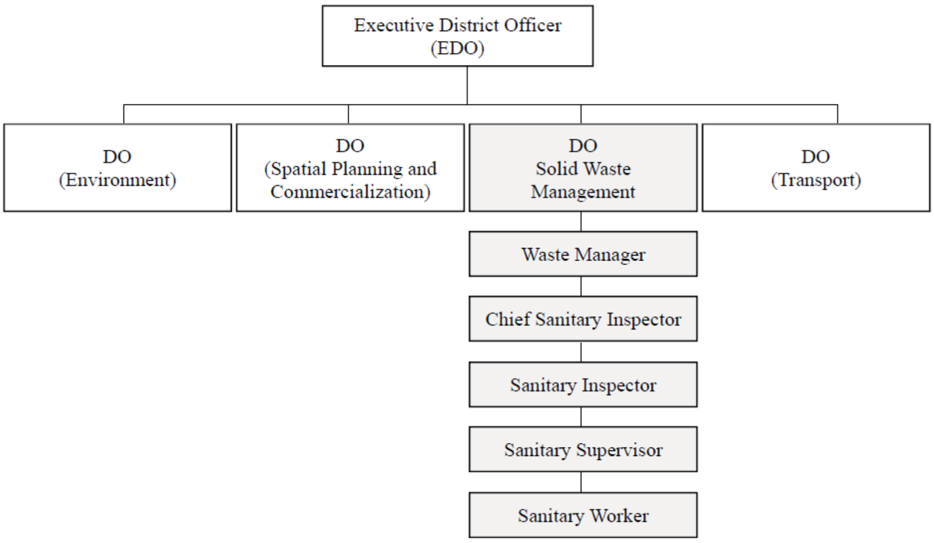


Figure 2.9.2 Organisational Structure of the Municipal Services of CDGG as of March 2015

As for capacity development of staff of CDGG, only 6 waste managers received training programme by the Urban Unit specific to solid waste management while Even EDO (MS) and DO (SWM) have never attended such programme. This shows the lack of technical expertise of CDGG.

(4) Gujranwala Waste Management Company (GWMC)

Due to rapid urbanisation, waste management has become a major challenge and the Government including CDGG, realised it could not manage it by itself. In case of Lahore, the City District Government Lahore outsourced sweeping, collection and transportation three years ago in order to make it more efficient. Following the success of Lahore Waste Management Company (LWMC), the Chief Minister of the Province of Punjab decided that this model is to be replicated in the other major six cities of the Punjab Province; namely, Sialkot, Faisalabad, Rawalpindi, Multan, Bahawalpur and Gujranwala. In this way, the Gujranwala Waste Management Company (GWMC) was formed under the Company's Ordinance Section 42 and registered in July 2013. Actual Operation started in January 2014 as the Managing Director (MD) was selected.

Figure 2.9.3 below illustrates the organisational structure of GWMC. Operational staff still belongs to CDGG but under the supervision of MD of GWMC. Management staff of 45 personnel is going to be hired to supervise 1,604 sanitary workers who are transferred from CDGG.

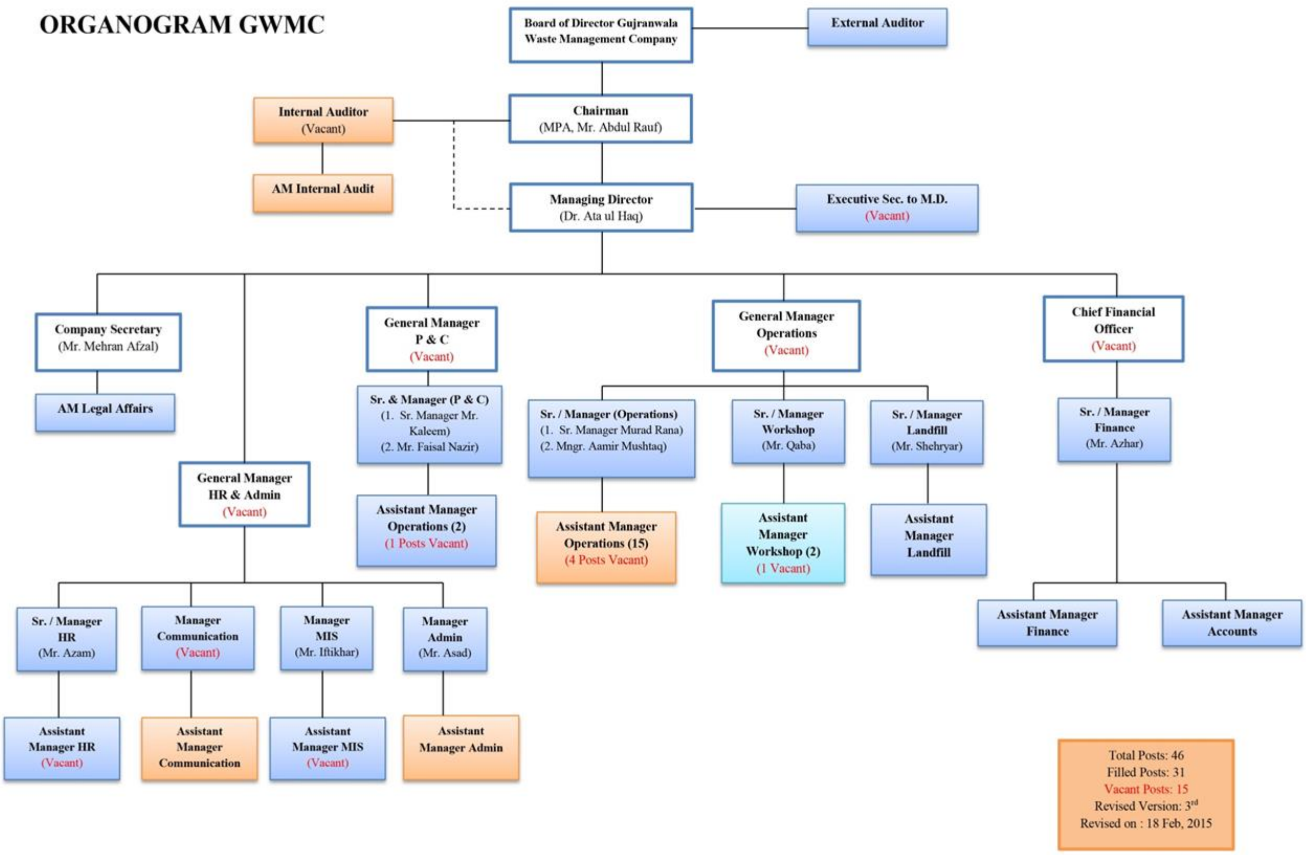


Figure 2.9.3 Organogram of Gujranwala Waste Management Company as of February 2015

According to the Service and Asset Management Agreement (SAAMA), GWMC is responsible for field work (actual provision of solid waste management service) in 64 UCs while CDGG is responsible for monitoring of GWMC's work as well as enforcement and enactment of rules and regulations. In addition, CDGG aims at provision of solid waste management service in the remaining 34 UCs in 4 towns if its budget allows.

The Contract between CDGG and GWMC is a service contract where:

- Equipment is transferred from CDGG to GWMC and owned by GWMC.
- Staff belonging to CDGG is placed at the disposal of GWMC.

- Additional staff is hired directly by GWMC.
- GWMC budget (including staff salary) is covered by CDGG.

Since GWMC is a new organisation, it has several challenges to address. The first challenge is lack of human resources. Since the establishment of GWMC, the hiring of management staff has been ongoing. However, the first level of hierarchy has not been filled up yet; for example, general managers and chief financial officer. This is because of: (a) lack of experts in SWM; and (b) strict criteria of selection. These make it quite difficult to find qualified and/or capable staff in the market at affordable compensation. Currently, MD is considering to fill the positions by developing the capacity of existing staff and promoting them to the higher positions. For this purpose, an appropriate training system should be established.

Another challenge is lack of training system. The Management and Profession Development Department of the Punjab Province is in charge of the provision of training. However, the training course is only about general administrative issues and not specifically about solid waste management. As a result, even the management staffs of GWMC and CDGG have not received any training on solid waste management (only 6 waste managers have received training by UU). To develop their human/institutional capacity, it is essential to provide such training especially for management level staff. At the moment, GWMC is planning to have its own training programme and has started needs assessment of each department.

The third challenge is lack of performance monitoring system. Although it is supposed to be defined according to the SAAMA agreement, there is no performance indicator (KPI) to monitor the performance of individual staff. CDGG as well as GWMC should start to work on setting KPI as soon as possible. Together with performance monitoring system, it is also essential to introduce incentive measures for staff based on their performance.

The final challenge is lack of financial independence from CDGG. For now, GWMC does not collect any fee for collection of wastes, meaning there is no waste management related revenue. Thus, CDGG transfers its budget from the Provincial government to GWMC. In order to establish financial independence of GWMC from CDGG, it is required to secure its own budget by imposing waste collection fees and tipping fees as currently discussed by UU and LWMC. Otherwise, one of the advantages of private sector involvement, which is relative freedom from political interference cannot be assured.

Table 2.9.2 summarises the capacity of CDGG and GWMC under the status quo.

Table 2.9.2 Capacity of CDGG and GWMC

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Feb, 2015
Generation	Solid Waste Generation	• 860 tons/day generation in 2012 (based on situational analysis report of Gujranwala City by UU)	• Lack of reliable data.	• 910 tons/day in 2014 at the rate of 0.55kg/ capita/day (based on observations and work done by Mr. Sami Ullah). • Office and weighbridge are under construction at Gondlanwala dump site.	• 1262 tons/day at the rate of 0.43 kg/capita/day (Based on First WACS survey result). • Second WACS Survey was conducted in February 2015. Results are awaited.
Transportation & Collectio	Service Provision	• Service is not provided in the whole city.	• Lack of resources proper planning and skilled personnel.	• Planning to start pilot project of new SWM system in two UCs.	• GWMC is currently providing services in 64 union councils further divided into zones. (8 zones for UC's, main roads are divided into 2 parts). • Plan to start pilot project in

	Components of SWM	**Baseline Capacity of CDGG as of May 2014**	**Identified Problems of CDGG as of May 2014**	**Target / Planned Capacity of GWMC**	**Update till Feb, 2015**
			• Some of the areas are impartially served.		union councils after procurement of 10 compactors. • 7 Zonal offices are operational. • One zonal office will be operational next month.
	Primary Collection	• Handcarts: 378/385 • Donkey carts: 102	• Lack of primary collection equipment and devices.	• 500 new handcarts are introduced into the system of which 400 are in the field and 100 stored in the workshop • 20 wheelie bins are introduced in the system for trial run.	• Almost 850 Handcarts are in the field. • 37 wheelie bins were used on trial basis but they were not effective since wheelie bins cannot bear much weight and are difficult to handle.
	Primary Transportation	• Through tractor trolleys	• Lack of up-to-date vehicles and equipment	• 37 tractor trolleys are engaged in primary collection. • Plan to introduce 35 mini-dumpers in the system to increase efficiency of work and up-date the system.	• 35 mini-dumpers and 37 tractor trolleys are operational in the field for primary collection and transportation.
	Secondary Collection	• Secondary collection is done by $5m^3$ and $10m^3$ capacity containers. • 191 containers of $5m^3$ capacity are in the field, transfer stations, masonry and iron enclosures, 22 on arm-roll trucks, 7 in workshop and 5 at contractor's end. • 5 containers of $10m^3$ capacity are in the field, 6 in workshop, 2 on arm-roll trucks.	• Lack of proper planning for use of operational vehicles	• Plan to purchase and introduce $0.8m^3$ skips in the system to increase primary as well as secondary collection. • Identification of almost 800 illegal dump sites within the city and process to clear those sites is ongoing. • Plan to construct transfer stations in the city to improve collection services.	• Plan to purchase 400 containers ($0.8m^3$) for the compactors to be introduced in the system. • 2 Transfer stations are operational currently at: 1) Sialkot Road 2) Near Siddique Sadiq Hospital. • Due to complaints from the residents there is a possibility to shift these transfer stations somewhere else. • Plan to rent another site for transfer station near Alam Chowk .In process of negotiation and will be operational from 16 March w.r.t. Manager Operations.
	Secondary Transportation	• Arm-roll trucks of $5m^3$ and $10m^3$ capacity are used for secondary transportation.	• Almost 40% of SWM vehicles and equipment are out of order most of the time.	• Same vehicles, i.e., arm roll trucks of $5m^3$ and $10m^3$ capacity are used for secondary transportation. Only 7% of the vehicles are out of order at present.	• Almost all of the vehicles are in working condition. • Second shift by 8 arm rolls is operational. • Second shift with 29 Sanitary Workers & 5 Mini Tippers will be operational w.e.f 10-03-2015 • Plan to procure 10 compactors of $7m^3$.

	Components of SWM	**Baseline Capacity of CDGG as of May 2014**	**Identified Problems of CDGG as of May 2014**	**Target / Planned Capacity of GWMC**	**Update till Feb, 2015**
				• 22 out of 24 arm roll trucks of $5m^3$ capacity and 2 out of 4 arm roll trucks of $10m^3$ capacity are in operation at present. • Second shift by 6 arm roll trucks was started on trial basis to increase the collection efficiency and maximum utilisation of available resources. • Plan to introduce compactors of $7m^3$ and $13m^3$ capacity and $7m^3$ dump trucks.	
	Waste Quantity (Collection Efficiency)	• 500 tons/day collection in 2012 i.e. 55% collection efficiency (based on situational analysis report of Gujranwala City by UU)	• Lack of reliable data	• 400-450 tons per day collection, i.e., 44-49% collection efficiency (based on observations and work done by Mr. Sami Ullah)	• 565 tons on average per day i.e. 59 % collection efficiency w.r.t Manager Landfill.
	Workshop	• Workshop is situated at Sheikhupura Morr near mini stadium.	• Improper planning at workshop • Lack of security system • Lack of repair and maintenance works • Lack of technical expert was the reason of improper maintenance of machinery, equipment and vehicles. • Lack Of Inventory • Practise of corrective maintenance rather than preventive maintenance • Improper and poor parking • Complete	• Cost saving through engine oil change, local repair and maintenance, battery repair cost. • Sorting and storage of scrap. • 3' steel fencing of workshop. • Renovation of waste enclosures • Capacity enhancement of $3.5m^3$ tractor trolley to $6m^3$ for transportation of waste on trial basis. • Improvement in service station of workshop in progress and be operational soon. • Use of scrap engine of tractor trolley as generator. • Proper records-keeping of	• Cost saving through engine oil change, in this sense that now only branded engine oil is used which lasts for longer time. • Recycling of waste batteries. • Durable Renovation of existing 7 waste enclosures. • 81 out of 84 vehicles are operational at present. • 35 new mini-dumpers added in system for greater waste collection. • Implementation of Japanese TPM 5S standard at workshop. • Prevention of Dengue hazard in workshop by regular anti dengue spray at workshop. • Functionalisation of mobile workshop. • Complete electrical wiring and lighting at workshop premises /Activation of WAPDA connection.

	Components of SWM	**Baseline Capacity of CDGG as of May 2014**	**Identified Problems of CDGG as of May 2014**	**Target / Planned Capacity of GWMC**	**Update till Feb, 2015**
			outsourcing and no in-house repair and maintenance facility.	newly purchased and replaced parts of vehicles. • Only 7% of SWM vehicles are out of order; the rest are functional. • 78 out of 84 vehicles are operational at present.	
Disposal	Disposal	• At Chianwali dump site at approximately 14.4km from the city centre.	• Poor management of the Chianwali dump site resulted in closure of the site before expected lifetime; according to UU studies, it should be utilised until 2016. • Lack of expert staff at dumpsite. • Lack of planning.	• Shifting of the dump site to Gondlanwala at approximately 7km from the city centre. • Chianwali dump site closure and heap management from the roadside. Rehabilitation of the site will be according to the plan devised by JICA. • 360-415 tons of waste are transported to the disposal site, i.e., 39.5% to 46% is disposed. • Fuel consumption is cut down to 10-12 lacs/month for transportation of waste.	• Weighbridge installed at Gondalawala. • Maintaining record of tonnage • Proper soil cover over waste along with compaction. • Dewatering stagnant water through peter pump. • Office construction at Gondalawala disposal site. • Fumigation on daily basis. • Plan to cap Chianwali and to complete boundary wall construction. • Land Acquisition of Bakherywala PC 1 formation in process. • Average 565 tons/day Routine collection. • Average 54 tons/day one time collection.
Special Waste	Industrial Waste	• Industrial waste though not in jurisdiction of SWM department but is carried and disposed of by it. • Some industries reuse and recycle their waste.	• Industrial waste management is not the responsibility of the SWM Department but no other system of industrial waste management exists.	• Only municipal waste management is under the responsibility of GWMC.	• Same
	Construction and Demolition Waste (C & D Waste)	• SWM Department takes C & D waste to the Chianwali dump site without charging fee from the generator.	• C & D waste management is out of the scope of municipal waste.	• GWMC yet has not devised any strategy of C & D waste.	• Currently GWMC is lifting the C & D waste but hasn't devised any strategy yet as C & D isn't the responsibility of GWMC.

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Feb, 2015
	Hospital Waste	• 36 hospitals and clinics were registered with Shalimar hospital for incineration of waste.	• Hospital waste is being mixed with municipal waste.	• Hospital waste is treated by AT traders.	• Same
	Drainage Waste	• Drainage de-silting and removing up to 2' width drains and the removal of silt from the drains of WASA are the responsibility of CDGG. • No record is maintained.	• Lack of proper machinery and vehicles for transport of de-silted material.	• GWMC has not devised any strategy about handling and transportation of de-silted material. • Till now same procedures are adopted by CDGG.	• For handling of de-silted material one gang with 10 Sanitary Workers is working in each zone. • Mini tippers, Tractor Trolleys and handcarts are used for transportation of de-silted waste.
3R	Recovery	• Informal scavenging activity of about 600 waste pickers involved in the activity (based on situational analysis report of Gujranwala City by UU).	• Lack of reliable data.	• About 700 waste pickers are involved in informal scavenging activity at disposal points and dumping site (based on field observation and interview with waste pickers/scavengers by Waste Manager Hina Aslam).	• About 800 waste pickers are involved in informal scavenging activity in the city and dumping site (based on field observation and interview with waste pickers/scavengers by Waste Manager Hina Aslam).
	Composting	• Yard trimmings and waste from fruits and vegetable markets is disposed into the dump site. • Composting is not practiced.	• Lack of market for composting. • There should be separate collection vehicles for organic waste in order to make compost.	• GWMC has not devised any strategy about composting yet.	• Same

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Feb, 2015
Institution	Legislative Framework	• No by-law of SWM for CDGG.	• Lack of a single comprehensive law about MSWM. • Laws are fragmented and hence their implementation is questionable since implementing bodies are more than one. • Lack of clear policy on municipal waste. • Weak enforcement of existing laws and regulations. • Lack of policy to promote 3R. • Inadequate planning. • Ineffective regulations • Lack of good governance.	• UU and LWMC are drafting a by-law.	• Same
	Human Resource	• DO (SWM), CSI, SI, SS, SW and office staff • Unskilled work force: 1,604	• Lack of technical experts • Shortage of sanitary workers • 1,604 sanitary workers were hired upon establishment of the SWM Department. Updated data is not available about dead, retired and left-over personnel out of the 1,604 workers.	• Recruitment of experts of each field like company secretary, HR, Administration, Finance, Operations, Procurement, Workshop, Landfill site, Communication. • Hiring of 345 unskilled labourers • Hiring of one more CSI on trial basis for supervision of cleaning activity on roads. • Deputation of staff (almost 60 sanitary workers) on roads. • Group insurance policies are in hand. • 1,420 (1,003 regular, 417 contract) workers of CDGG were	• Recruitment of CFO, & Manager Comm. • Finalisation of Organogram of GWMC with the coordination of LWMC as per consultancy agreement. • Plan to obtain the ISO 9001:2008 certification for GWMC, aiming to continue on yearly basis. • Plan to complete with strong coordination and obtain the necessary HR related software, trainings, census, PMS, etc., from LWMC as per the consultancy agreement & executions with true letter & spirit. • To identify the weak areas of employees through using/implementing effective system of TNA & provide necessary trainings for improvements/ to overcome the shortfalls. Accordingly, we need the assistance by the experts in this regard. • Preparation of HR Manual for GWMC • Hiring of 125 sanitary workers

	Components of SWM	Baseline Capacity of CDGG as of May 2014	Identified Problems of CDGG as of May 2014	Target / Planned Capacity of GWMC	Update till Feb, 2015
				transferred to GWMC 325 daily waged employees; 345 new contract workers hired by GWMC.	& 109 Drivers for state of art vehicles on third party labour for more improvement/collection/cleanliness efforts are in hand. • Plan to liaison with DHQ & Social Security Hospital regarding the screening test of Hepatitis/Tuberculosis, etc., for field staff as a part of health & safety along with the procurement of required/necessary gadgets (i.e., Musk , Gloves , Gumshoe, etc.) • Procurement of android system of attendance for field staff alongwith monitoring (tender in process). • Procurement & execution of HRIS & Payroll system for making & maintaining transparency & accuracy • To provide medical coverage of all the GWMC staff (direct) alongwith Group Life Insurance (efforts are in hand). as the Group Life Insurance coverage of Permanent workers of Solid Waste with State Life has been continued/resumed w.e.f February,2015 • To create/develop a mechanise system for employee database/getting the complete information of employee (i.e., Permanent , Contractual, Daily Wager & third party labour employees)
	Training	• Local training and workshop of waste managers by urban unit (Sept. to Oct. 2013)	• Lack of training of employees	• Foreign training of the waste managers and MD in June 2014. • Training of all the managers of GWMC by LWMC is proposed in consultancy service document.	• LWMC plan to train the concerned employees accordingly as per of agreement.
	Finance	• For the fiscal year 2012-2013 budget of SWM was 4% of the total CDGG budget. • Out of SWM budget, 88% budget is utilised for salaries of SWM staff	• Improper file management and data handling system. • Lack of revenue collection system from SWM services. • Lack of financial expert in the	• Capital investment for purchase of up-to-date vehicles, skips and landfill site is proposed in current budget. • Conversion of documents and old record of CDGG data in soft form. • No revenue generation plan.	• Proposed budget is approved and items to be procured are in process. Requisition is sent to the procurement department.

	Components of SWM	**Baseline Capacity of CDGG as of May 2014**	**Identified Problems of CDGG as of May 2014**	**Target / Planned Capacity of GWMC**	**Update till Feb, 2015**
		while remaining 12% is non-salary expenses.	department. • Limited budget		
Public Communication	Education and Awareness	• Awareness of SWM effects on wetlands to the school children and teachers on world wetland day (collaboration of GWMC and CDGG)	• Lack of awareness programmes • Lack of participation and coordination among stakeholders, e.g., inter-agency collaboration at national/local level.	• One week awareness campaign of cleanliness celebrated with joint venture of WWF Pakistan and GCCI involving schools, colleges, communities, influential personalities. • Plan to raise awareness among citizens on Independence Day, 14th day of August. • Process of awareness will boost up after recruitment of communication manager.	• Assistant Communication Manager is recruited by GWMC. • Awareness Campaign on Eid ul-Azha along with provision of shopping bags. • 14 August celebration with a programme on FM Radio and shopping bags distribution. • Awareness campaign in Sanitation Week (16 March to 21 March 2015)
	Management Information System (MIS)	• Facebook page of SWM has been created but not updated daily due to non-availability of the internet facility and MIS manager.	• Lack of technical expert and MIS system	• GWMC domain name registered as gwmc.com.pk. • Official email accounts of GWMC employees are active. • Toll free telephone service activated to facilitate complaint registration by citizens/residents. • GPS based tracker system installed in two vehicles as a pilot activity. • GWMC facebook page created and updated. • Tender floated for security & surveillance system for mechanical workshop & office premises.	• Work order issued for server machine and its allied equipment • Dedicated ether network cable spreader in head office • Laptops and mobile sets procured • Tender for Desktop computers, multimedia floated. • Work order for network photocopier cum printer and digital telephone exchange issued • Work order for vehicle tracking and management system for 100 vehicles issued • Work order for vehicle trip counting system in pipeline • Tender floated for digital android based monitoring • Tender floated for CCTV equipment and its installation in head office and mechanical workshop • Tender for GWMC website in process • GWMC activities are being updated on facebook page.

2.9.4 Review of Past and Present Plans and Projects Related to Solid Waste Management

(1) Review of Past Foreign Aided Projects Related to Solid Waste Management

Past and present plans and projects related to solid waste management in Punjab Province are summarised according to donor, namely; the Government of Japan, the Asian Development Bank and the World Bank.

(a) Governmental of Japan

(i) Improvement of Garbage Collection and Disposal in Rawalpindi City (1996)

Under the scheme of Grant Aid, container trucks for waste collection, containers and heavy machinery have been provided to improve waste collection efficiency.

(ii) Dispatch of Short-Term Expert on Solid Waste Management (2002)

A short-term expert has dispatched aiming at evaluation of the above-mentioned project, including similar projects in Karachi and Quetta, as well as at identification of challenges. As the result, the necessity of development of laws and guidelines was noted.

(iii) Dispatch of Long-Term Expert on Municipal Waste Management (2003-2005)

No report was available. Thus it is unclear whether or not an expert was dispatched to Punjab Province.

(iv) Project for Solid Waste Management in Pakistan (2005-2006)

District officers in charge of solid waste management in major cities were trained on solid waste management in Japan. As a result of the training, the Punjab Municipal Solid Waste Management Guidelines was developed in collaboration with United Nations Development Programme in 2007.

(v) Capacity Building for Solid Waste Management (2006-2009)

The technical cooperation project was implemented to enhance the output of the above-mentioned project and to further improve the solid waste management system. Main activities were the training in the eight major cities for the purpose of capacity development in solid waste management.

(vi) Data Collection Survey on Solid Waste Management in Punjab Province (2009-2010)

Data on budget allocation, staffing, assistance from other donors in the field of solid waste management in seven major cities in the Punjab Province, namely Lahore, Faisalabad, Rawalpindi, Multan, Gujranwala, Sargodha and Sialkot was collected and surveyed. Consequently, it was confirmed that there was high need for assistance in solid waste management in those cities.

(b) Asian Development Bank (ADB)

(i) Southern Punjab Basic Services Project (2005-2009)

This project aimed at basic infrastructure development, including not only waste management but also water supply, sewerage, drainage and roads in 26 cities having the population of more than 50,000 people in Punjab Province. Approximate project cost was 55-60 million US dollars. The implementing agencies were the Water and Sanitation Agency (WASA) and the Development Authority (DA). The project covered hard components such as construction, as well as soft components; i.e., financial capacity development and institutional improvement of the implementing agencies. Although this project had overarching coverage, activities for each city were chosen according to prioritisation based on its needs. Out of the 26 landfills constructed, 13 were for cities including Multan.

(ii) Rawalpindi Environment Improvement Project (2006-2011)

Aiming at improvement of living environment in Rawalpindi, this Project intended to develop water supply, sewerage and waste management. Total project cost was 5,142.6 million rupees, out of which ADB bore 3600 million rupees and the Government of the Punjab, 1,542.6 million rupees. The project included the construction of wells and water drainage, development of sewerage and drainage system, procurement of waste collection vehicles and construction of a final disposal site. In addition, the project provided the capacity development programme of implementing agencies and the public awareness raising programme.

(c) The World Bank (WB)

(i) Punjab Municipal Services Improvement Project (2006-2010)

The purpose of this project was to develop capacity in terms of planning and finance for municipal services of Teshil Municipal Administration (TMA) in the Punjab Province. Total project cost was 58.9 million US dollars, out of which WB incurred 50 million US dollars and the Government of the Punjab 8.9 million US dollars. Target area of municipal services included water supply and sewerage system, drainage system, waste management, road/transportation and fire-fighting measures.

(ii) KOICA-World Bank Joint Study on Solid Waste Management in Punjab (2006-2007)

The Korean International Cooperation Agency (KOICA) in collaboration with WB conducted a study on current status of waste management in nine major cities of the Punjab Province. Out of the nine cities, the Study developed master plans of waste management for the cities of Lahore and Sialkot targeting the year 2021. The WB consultants conducted a study and made recommendations on the legal framework, private sector involvement, technology and planning, while the KOICA consultants conducted the study on finance, institution and stakeholders.

(2) Institutions for Private Sector Involvement in Solid Waste Management

Although currently there is no private service provider of solid waste management in Gujranwala, the provincial government has taken initiative of private sector involvement. This is mainly because of the lack of capacity of local governments to catch up with the dramatic urbanisation and drastic increase of waste volume of cities. This section first briefly overviews laws and regulations related to private sector involvement, then analysis examples of private sector involvement in the Punjab Province.

(a) Laws and Regulations Related to Private Sector Involvement

Table 2.9.3 below summarises major laws and regulations related to private sector involvement in Pakistan.

Table 2.9.3 Summary of Laws and Regulations Related to Private Sector Involvement

Laws and Regulations	Related Issues	Remarks
Pakistan Policy on Public-Private Partnership (2010)	・ In the early 1990's, Pakistan established a policy and regulatory framework for Public-Private Partnership (PPP) in the telecom and power sectors. Unregulated sectors like transport and logistics, water supply, sanitation, solid waste management, real estate and social sectors including education, healthcare and housing have yet to benefit from such a framework. ・ A PPP may include an equity joint venture between GOP and the private sector. ・ **Benefits:** - Development of more infrastructure on time and within budget. - Encouraging the private sector in innovative design, technology and financing structures and including increased international and domestic investment. - Risk sharing by GOP with private sector partners. - Ensuring good quality public services and their wider availability. - Real financial benefits, and a better utilisation and allocation of public funds. - Economic growth and increased and wider employment opportunities. ・ **Objectives:** - Promote inclusive social and economic development through the provision of infrastructure. - Leverage public funds with private financing from local and international markets. - Encourage and facilitate investment by the private sector by creating an enabling environment in PPP in infrastructure. - Protect the interests of all stakeholders including end users, affected people, government and the private sector. - Set up efficient and transparent institutional arrangements for identification, structuring and competitive tendering of projects. - Develop efficient risk sharing mechanisms in such that the party best equipped bears the appropriate level of risk. - Provide viability gap funding where the projects' viability is insufficient to attract private sector funding.	・ These policies are specifically related to Partnership between public and private sectors. ・ These policies are developed to establish a clear financial, legal and administrative framework and also eliminate undesirable obstacles confronting private investments in infrastructure facilities and in order to facilitate public-private partnerships. ・ These policies are most suitable for understanding the PPP project approval and process, PPP structure and legal framework.
Protection of Economic Reforms Ordinance (1999)	・ Related to privatisation of public sector enterprises. ・ Fiscal incentives for setting-up of industries. ・ Transfer of ownership to private sector. ・ Foreign and Pakistani Investment. ・ Financial obligation.	This Ordinance is about banking, finance, exchange and payments systems, holding and transfer of currencies between public and private or 2 different countries and about "Foreign Currency Accounts".
Companies Ordinance (1984)		Specifically related to formulation of companies and about how to windup, Liquidation and so on (memorandum of association, Association Not for Profit, Companies Limited by Guarantee, Services and Authentication of Documents, Certificate of Share and

Laws and Regulations	Related Issues	Remarks
		Debentures, Regulation of deposits, Classes and kinds of shares, etc.).
Labour Policy (2010)	・Workers' right to form unions. ・Equitable adjustment of rights between workers and employers. ・Consultations between workers and employers. ・Adequate security of jobs. ・Conditions should be created that workers and employers are committed in enhancing the labour productivity. ・Promotion to higher jobs on suitability and merit. ・Social insurance schemes. ・Just and humane conditions of work be guaranteed to all workers. ・Forced labour in all its forms to be eliminated. ・The minimum wage was raised from Rs. 4600/- to Rs. 6000/- in the year 2008, which will be further enhanced to Rs.7000/- there is increase of about 17%. (Now According to the Budget of 2014-15, minimum wage is 12,000/-) ・All industrial, commercial and other establishments registered under any law shall pay wages to the employees through cheque/bank transfer. ・Points related to women, young, mine and child labours. ・Health safety and so on. ・Expansion in scope of workers' welfare fund. ・Social security. ・Employees' Old-Age benefits scheme. ・Different strategies of skill development and employment.	This policy stipulate rules related to wages and women workers; Eradication of Bonded Labour, Construction Labour, Contractual Employees, Child Labour, Informal Economy Workers, etc. It has nothing related to PPP.
Punjab Procurement Rules (2014)		These rules are related to procurement (like bid and bidding documents)

(b) Examples of Private Sector Involvement in Solid Waste Management in Punjab Province

Table 2.9.4 gives an overview of private sector involvement projects/programmes in the Punjab Province.

Table 2.9.4 Overview of Private Sector Involvement Project/Programme in the Punjab Province

Project	Mechanisms	Project Overview		Comments
Tehsil Municipal Administration Gujrat	Management Contract	Contract Parties	Tehsil Municipal Administration (TMA) Gujrat and Waste Management Pakistan (Pvt.) Ltd.	> one year contract with automatic renewal up to 2 years. > due to lack of experience and several management lapses the project failed as a Private Sector Participation (PSP) model. Comments are given below*1.
		Description of Services	Integrated Solid Waste Management Services for the entire urban area of Gujrat City. Primary and secondary collection, transportation and final disposal of solid waste. Municipal solid waste, construction waste, healthcare waste, industrial waste, and sewage sludge.	
		Description of	Urban population mix of low-middle	

Project	Mechanisms	Project Overview		Comments
		Area Served	income groups.	
		Size of Collection Zone	15 Union Councils comprising of 30,000 households.	
		Description of Staff Involved	1 Project Director, 2 Project Managers, 3 Administrative Managers, 18 Supervisors, 36 Drivers, 64 Loaders, 480 Sanitary Workers and 30 Social Motivators.	
		Description of Equipment	2 Mazda Trucks, 14 Tractor Trolleys, 3 Front End Loaders, 2 Mechanical Sweepers, 2 Blades, 1 Excavator, 1 Gully Sucker and 1 Jetting Machine.	
		Put into Operation	February 2004	
		Present Status	Contract Dissolved.	
Lahore Sanitation Programme	Franchise Contract	Contract Parties	Cantonment Board Lahore, Waste Busters, Residents	Comments are given below*2.
		Description of Services	Door to door collection of household waste daily Delivery of 30 garbage bags per month Transportation of waste to disposal site.	
		Description of Area Served	High Middle income urban areas of Lahore Cantonment.	
		Size of Collection Zone	10,000 households	
		Description of Staff Involved	Social Motivators, Supervisors, Drivers and Labour Mostly new staff was hired from within the community.	
		Description of Equipment	Suzuki Pick up vans, Hand carts, Uniforms.	
		Put into Operation	December 1996	
		Present Status	In Operation.	
Cantonment Board Lahore	Management Contract	Contract Parties	Cantonment Board Walton & M/s. Babar & Umer (Pvt.) Ltd. , GHS (Pvt.) Ltd., Waste Management Pakistan (Pvt.) Ltd.	Comments are given below*3.
		Description of Services	Solid Waste Conservancy including waste collection, street sweeping, drain cleaning, garden waste collection and commercial areas cleaning.	
		Description of Area Served	Urban areas falling under Lahore Cantonment within the administrative control of the Cantonment Board Walton, Lahore	
		Size of Collection Zone	50,000 households	
		Description of Staff Involved	Project Manager, Chief Sanitary Inspector, Supervisors, Administrative Staff, Sanitary Workers.	
		Description of Equipment	Mazda Dump Trucks (3 MT), Tractor Trolleys, Front End Loader, Mechanical Sweeper, Refuse Collection Vehicles (RCV), Suzuki Pickups.	
		Put into Operation	April 1999	
		Present Status	In operation	

Project	Mechanisms	Project Overview		Comments
Chaklala Waste Management, Rawalpindi	Service Contract	Contract Parties	Union Council 97, Shell Pakistan Ltd. and Green Management (Pvt.) Ltd.	Comments are given below*4.
		Description of Services	Clean-up of waste dumps, Community Awareness Programme Capacity building of Union Council Introduction of door to door waste collection.	
		Description of Area Served	Low Income Urban population. Living in Dhok Munshi, Chaklala, and Rawalpindi.	
		Size of Collection Zone	1 Union Council, 4500 Households.	
		Description of Staff Involved	Social Organisers, Project Manager, Sanitary Workers, Drivers.	
		Description of Equipment	Handcarts, Tractor Trolley, Pick-up Truck, Suzuki Pick-ups, Garbage Bags	
		Put into Operation	April 2005	
		Present Status	Project period ended October 2005	
Lahore Compost Plant	BOT Contract	Contract Parties	City District Government Lahore and Lahore Compost (Pvt.) Ltd.	Comments are given below*5.
		Description of Services	Establishment of a compost plant	
		Description of Area Served	Municipal solid waste collected in Lahore	
		Size of Collection Zone	1000 MT/day	
		Description of Staff Involved	Project Manager, Supervisor, Labour, Mechanics, Engineers, Biochemist, Marketing Representatives.	
		Description of Equipment	Compost plant comprising of sorting conveyor, sieving screens, trammel screen, shredder, turner and bagging unit.	
		Put into Operation	March 2005	
		Present Status	In operation	
Metropolitan Corporation Lahore (MCL)	Franchise	Contract Parties	Metropolitan Corporation Lahore (MCL) and Waste Collection & Sweeping (Pvt.) Ltd.	Comments are given below*6.
		Description of Services	Solid Waste Management of Ward No. 79, MCL, Lahore.	
		Description of Area Served	Urban area comprising of one ward in Metropolitan City	
		Size of Collection Zone	1000 households	
		Description of Staff Involved	Supervisor, 10 labour	
		Description of Equipment	Hand Carts, Transfer station, Suzuki Pickup	
		Put into Operation	April 2001	
		Present Status	Aborted	

(i) Tehsil Municipal Administration Gujrat[*1]

There are different steps of private sector participation (hereinafter referred to as “PSP”) in the Gujrat Project which has some positive and negative impacts.

Steps which makes negative impact:

- Too big area for primary and secondary collection;
- It is very difficult to perform many tasks at one time;
- Too many waste categories to be managed by private party;
- Initial time period for contract is too short to purchase equipment and investments (for private party);
- Variable costs not covered (Fuel & Salaries);
- Inexperienced private company;
- Bad monitoring of drivers during transportation of waste;
- Private company did not focus on unforeseen breakdown and repair costs;
- Only one time awareness campaign and less communication with local public;
- Key stakeholders were not involved;
- The first opposition came from the labour union that was sceptical about the new private contractor. There were genuine concerns since the labour union was not involved in deciding privatisation and thus lack of trust had developed naturally;
- The local media also sought opportunity to comment on the private contractor. There were 26 reporters on the sanitation beat and all had demands which needed to be addressed; otherwise, the press would release negative news everyday against the sanitation project. This was also an unforeseen expense which needed to be dealt with;
- No political backing of private company;
- Less monitoring and control of sanitary workers; and
- Political influence.

Steps which make positive impact:

- Cristal clear process of selection of a private company;
- Counting the number of trips to dumping site;
- Procurement of new equipment and handcarts.
- Awareness campaign before launching the project;
- Bit sport of newly elected Nazim (Mayor); and
- Social motivation.

(ii) Lahore Sanitation Programme[*2]

There are different steps of PSP Lahore Sanitation Programme with some positive and negative impacts.

Steps which make negative impact:

- No formal agreement and tendering process;
- No competition among service providers;
- No tariff system on the bases of no profit no loss; and
- No handling system of waste pickers.

Steps which make positive impact:

- Limited and manageable area;
- Fully designed and planned project area;
- Monitoring through the local committee;
- Door to door collection system;

- Awareness campaigns;
- Social motivators;
- Time decided for door to door collection;
- Uniform for sanitary workers;
- Baskets installed outside each house;
- 30 garbage bags for each house/month.
- Suzuki pickups for waste collection;
- Support from local media; and
- Cooperation of Cantonment Board and local public.

(iii) Cantonment Board Lahore[*3]

There are different steps of PSP Cantonment Board Lahore with some positive and negative impacts.

Steps which make negative impact:

- No proper disposal of waste;
- No sharing of Extra Costs among Contractors; and
- Heavy machinery required for dumpsite.

Steps which make positive impact:

- Detail design of the project;
- More than one contractor for the project;
- Open tender;
- Prequalification of contractors;
- Long-term contract (3 years);
- No political interference;
- Strict penalty clauses;
- Manpower and machinery are provided according to requirement;
- Sweeping and lifting of waste on daily bases;
- Door-to-door collection;
- Decided key performance indicators;
- Chief sanitary inspector and sanitary inspectors to monitor the programme;
- Machinery (waste trucks, Suzuki pickups, frontend roller and tractor trolleys);
- Awareness campaigns; and
- Support of stakeholders.

(iv) Chaklala Waste Management, Rawalpindi[*4]

There are different steps of PSP Chaklala Waste Management, Rawalpindi with some positive and negative impacts.

Steps which make negative impact:

- Large population and project area;
- The area legally falls under the Municipal Administration of the City District Government Rawalpindi. However, physically, the Union Council lies in the Cantonment Board area;
- No tendering process;
- Short-term service contract (6 months);

- No clause on the extension in the contract period;
- As soon as the project was handed over to the Union Council, politics took over and a debate over the ownership of the project came up. (Political differences among local leaders);
- Overhead costs of transportation of the waste from the collection point to the waste disposal site; and
- No sustainability of project without corporate support.

Steps which make positive impact:

- Shell Pakistan Ltd. undertook this venture as part of its Corporate Social Responsibility;
- Procured services from private contractor;
- Tasks for cleaning garbage dumps;
- The private contractor (Green Management) hired 20 female social organisers and trained them on aspects of community mobilisation;
- Well-designed plan;
- Planned cleaning of plots and dump sites;
- Handcarts and safety gears distributed among workers;
- Excavators, Bulldozers, Tractor Trolleys, Pickup Trucks, Handcarts, Garbage Bags.
- Support from local government; and
- Motivated workers with good salaries.

(v) Lahore Compost Plant[*5]

There are different steps of PSP Lahore Compost Plant with some positive and negative impacts.

Steps which make negative impact:

- Negotiations took more than one year;
- Stay order taken by local residents against the agreement;
- No experience in composting or solid waste management;
- Hired local consultants for advising the company;
- Slow sales of compost material due to inexperience; and
- Few companies participated due to inexperience.

Steps which make positive impact:

- First Build-Operate-Transfer (BOT) Project in solid waste management sector;
- Land and waste given free of cost to private contractor;
- Private contractor to invest in capital cost and operational cost;
- Recycling of organic waste;
- 30 years concession given to private contractor;
- 25 Acres land & 1000 ton/day or organic waste;
- Sharing of 10% profit with city government;
- Well reputed and established business house;
- Strong financial support from banks;
- Modern compost plant imported from Belgium; and
- Organic waste being delivered by City District Government Lahore.

(vi) Metropolitan Corporation Lahore (MCL) [*6]

There are different steps of PSP Lahore Compost Plant with some positive and negative impacts.

Steps which make negative impact:

- Lack of competition;
- Tariffs not negotiated;
- No administration support;
- Low skill level;
- Lack of training of franchise;
- Lack of monitoring skills of MCL;
- Lack of cooperation from community;
- Waste pickers, gypsy families involved; and
- Lack of support by MCL.

Steps which make positive impact:

- Well planned design;
- Economic solution;
- Door-to-door collection;
- Segregation of waste;
- Income generation (Rs.50/month);
- Proper tender solicitation;
- Pre-tender conference;
- Transfer stations provided;
- Handcarts; and
- Containers.

(vii) Lahore Waste Management Company (LWMC)

Another example of private sector involvement can be seen in the City District Government Lahore (CDGL). CDGL established LWMC under Section 42 of the Companies Ordinance of 1984 on 19 March 2010. The company is limited by guarantee having no share capital and is formed not for profit within the context of Section 42 of the Companies Ordinance. The LMWC is governed by a Board of Directors, headed by a Chairman. The organogram of LWMC is given in **Figure 2.9.4.** (The budgetary status is not yet provided by LWMC.). The company was formed in order to meet the demand of institutional innovation such as:

- To have financial and administrative autonomy for quick decision-making;
- To exercise corporate governance and professional approach;
- To improve human resource and financial management; and
- To ensure transparency, accountability and public disclosure.

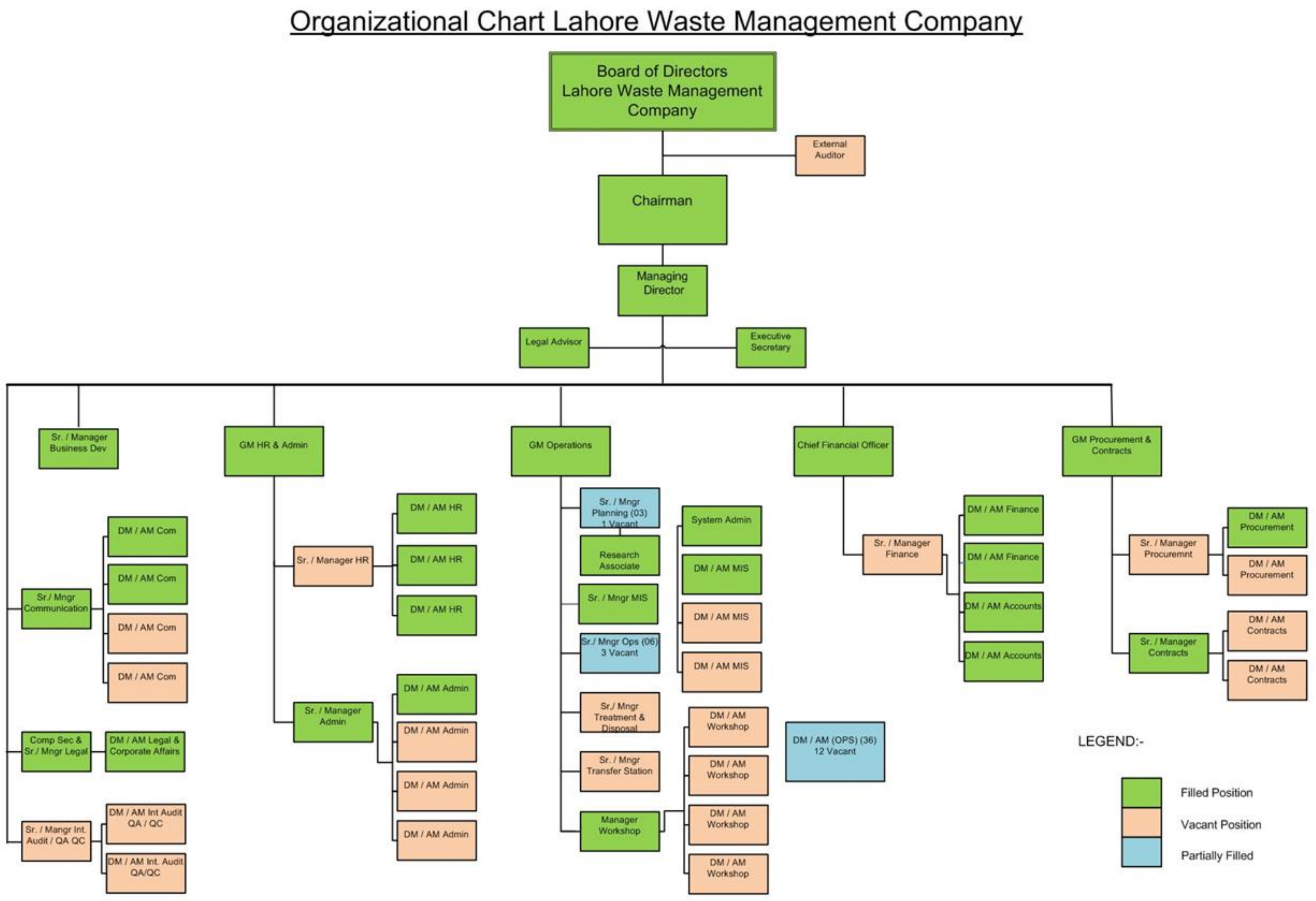


Figure 2.9.4 Organogram of Lahore Waste Management Company as of March 2015

According to the Services and Asset Management Agreement (SAMA) between CDGL and LWMC, all the functions and assets of the SWM department of CDGL and the TMAs have been entrusted to LWMC. LWMC aims to develop an integrated system of solid waste management to ensure efficient collection, transportation, recovery, treatment and disposal of wastes generated in Lahore.

LWMC's vision was the transformation of Lahore as one of the cleanest cities in the world by providing costomised solutions in the consultation with citizens and private partners to ensure sustainable, safe, clean and green environment. Following the vision, LWMC had the mission to provide a waste management programme that contributes to the maintenance of health of the residents by ensuring that waste is removed from the city and disposed in an environmentally acceptable manner.

Since the inception of LWMC, M/s ISTAC, a company in the Municipality of Istanbul, had provided technical support to LWMC through a consultancy agreement for the period from December 2010 to December 2013. ISTAC has assisted LWMC in improving its institutional structure. It conducted waste characterisation studies, prepared waste management plans, design of outsourcing of SWM system for Lahore, design of sanitary landfill and conducted training of LWMC's professional staff. ISTAC is currently engaged in the preparation of the integrated SWM plan of hospital, industrial and packaging waste management plans.

LWMC designed a new SWM System with the assistance of M/s ISTAC, which will outsource the SWM services in the city of Lahore to international companies. This outsourcing has been done through transparent international bidding and various internal firms were considered before awarding the contract to the two (2) Turkish companies, i.e., Albayrak and Ozpak against an amount of USD320 million for 7 years. The new Solid Waste Management Operations by Turkish companies were inaugurated jointly by His Excellency Kadir Tapas, the Mayor of Istanbul and Chief Minister Punjab Mian Muhammad Shahbaz Sharif on 11 March 2012.

The contracts include the following:

- Door-to-door collection of waste;
- Collection and removal of waste to the approved disposal sites;
- Mechanical/Manual sweeping of main and arterial roads, streets and squares with vacuum vehicles;
- Mechanical washing; and
- Health insurance and safety measures and standards.

The Turkish contracts have brought international expertise along with modern equipment and vehicles for carrying out SWM operations.

The workshops have been upgraded and M/s Ozpak has also started manufacture of 0.8 m^3 containers. The contractors have brought in additional vehicles like hauler dumper, mini-dumpers and chain arm rolls to address the SWM issue on the ground. Presently, about 1,500 km of roads are mechanically swept along with washing of about 100 km of area daily. More than 80% waste collection efficiency has been achieved by the contractors in their respective zones which was only 60% at the onset of the project.

From the above-mentioned examples, factors for success and failure of private sector involvement can be summarised as shown in **Table 2.9.5**.

Table 2.9.5 Factors for Success and Failure of Private Sector Involvement

Success	Failure
• Capacity of the private sector partner must be compatible to undertake the proposed project. • Proper planning and design of the project is the key to success of any PSP model. • Appropriate machinery and manpower. • Strict and vigilant monitoring. • Time Management. • A motivated team of workers. • Involvement of key stakeholders. • Community support. • Support of the local government. • A good customer service system with a complaint cell. • Public Awareness Campaigns.	• Lack of capacity. • Lack of Standard Operation Procedures (SOPs). • Contracts are drawn out without any legal or regulatory bindings. • There is no penalty clause in PSP Model. • Weak political support. • Resistance and non-cooperation from the community. • No implementation of Local Government ordinances/laws. • Appropriate and efficient technologies are required to bring about positive changes. Whereas expensive machinery causes financial burden in terms of costs and maintenance of such machines. • Corrupt practices in all local governments. • Lack of transparency.

From the above analysis, the following recommendation could be drawn:

Collection

- Door-to- door collection is the most efficient and effective method for the collection of waste. For this purpose, handcarts, mini-dumpers and even donkey carts can be used to bring the waste to transfer points.
- Garbage bags can be distributed if the community is willing to pay for them, or they can use any shopping bag for the disposal of daily waste.
- The door-to-door collection can be privatised to a private sector partner under the management. Waste collection areas where a private sector could operate may be contracted or franchised and be allowed to collect fees negotiated with the community.
- The door-to-door collection should be limited to not more than 200 households per vehicle.

Transportation

- Once the waste reaches the designated transfer point, the private sector may again be contracted for the transportation of waste from the transfer station to the disposal point.
- The private sector could enhance its capacity by using larger vehicles.

Disposal

- Alternate solutions are now in vogue such as Material Recovery Facility (MRF) where recyclable materials are sorted out before the waste is transported to the landfills.
- Composting plants can cater for the organic component of the waste by recycling into compost.
- Some studies are being conducted into biomass energy, Refuse Derived Fuels (RDF) and bio mechanisations on the same principles as that being conducted in India.
- Use 3R approach to minimise the amount of waste being transported to the landfill sites.

(3) Institutions for Community Participation in Solid Waste Management

(a) Types of Organisation

In Gujranwala, there are two types of civil organisations; namely, Community-Based Organisation (hereinafter referred to as "CBO") and Non-Governmental Organisation (hereinafter referred to as "NGO". CBO is a group of volunteers for specific purposes while NGO is a group with common interest registered under the Social Welfare Act. Both are also called generally as Civil Society Organisation. There used to be another type of group called Citizen Community Board (hereinafter referred to as "CCB"). CCB is defined under the Punjab Local Government Ordinances of 2011 and is a coordination group between government and residents. Eighty percent (80%) of its budget is from government and 20% is from the residents. There used to be about 750 CCBs but they were abolished due to budgetary constraints of the government.

(b) Door-to-Door Collection of Solid Waste Management Project, Union Council No. 8, Shahinabad, Gujranwala

Currently there is no CBO or NGO working in the area of solid waste management. However, there used to be the pilot project implemented by a CCB called the OPE Development Citizen Community Board, which was registered under the Social Welfare Department with the aim to improve solid waste collection in UC No. 8. Its project area was UC No.8 with the population of 22,000 people. The UC includes the following areas:

- Samnabad
- Gatoshala
- Block B, C, D
- Muhalla Insariyan
- Javed Town
- Mirza Colony, etc.

CDGG aimed at providing people with basic health and sanitation facilities. Thus CDGG in collaboration with OPE started the door-to-door collection project with the main purpose of making UC No.8 a model of clean UC where waste is collected on daily basis from the households.

The responsibilities of each party, CDGG and OPE, are as follows:

CDGG

- To provide containers for waste collection in UC No.8;
- To provide secondary collection on daily basis to disposal site;
- To provide door-to-door collection and to ensure cleanliness of drains and streets; and
- To provide technical assistance to OPE during the project.

OPE

- To inspect the project on daily, weekly and monthly basis;
- To provide 12 private sanitary workers for UC No.8.
- To ensure attendance of sanitary workers;
- To supervise the work performed by the sanitary workers to ensure door-to-door collection;
- To procure 6 motorbike carts for the collection of waste;

- To prepare and submit monthly inspection reports of cleanliness to EDO (MS) and DO (SWM);
- To make arrangements with the involvement of residents of UC No. 8 on the mobilisation of UC NO. 8 seminars and group discussions (community, schools, mosques);
- To be responsible for the printing of all materials necessary for the project;
- To address any and all complaints regarding the project in UC No.8.
- To bear the maintenance and petrol charges of motorbike carts
- To be able to charge Rs.50 per household only after 6 months of free service period;

Although this was the first and the last project which involved public participation in solid waste management, the project was considered as a failure since only 25% of the population paid the collection fee. In addition, the DCO at that time forced OPE to collect waste from households whether or not the households pay the collection fee. This action was unfair to the 25% of households that paid the collection fee. The reason of the failure can be summarised as follows:

- People were unwilling to pay for the SWM services;
- CCB did not have enforcement power;
- Mechanism of collection might not have been effective; and
- Policy was not consistent enough to support CCB activities.

2.9.5 Evaluation of Institutional Strengthening and Organisational Condition

The problems and issues in relation to institutional strengthening and organisational study under the current situation are summarised in **Table 2.9.6**. These items will be the basic elements to develop the plans, programmes and projects to comprise the institutional strengthening and organisational plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table 2.9.6 Identification of Problems and Issues on Institutional Strengthening and Organisational Condition

Problem	Description of Problem	Issues for Solving the Problems
1. Difficulty to understand and comply with laws and regulations	There is no comprehensive law on Solid Waste Management in Gujranwala that is understandable to officials and residents. In addition, regulations are written only in English so that most of the residents cannot read them. CDGG/GWCM has not implemented any awareness raising activity on SWM rules that residents should follow.	Currently, the committee concerned in the Punjab Province is drafting a by-law, referring to the Indian Municipal Solid Waste Management Rules (Draft) (2013). This by-law should integrate the latest version of laws and regulations related to SWM in the Punjab Province, so that it becomes one single comprehensive by-law to comply with. In order to make residents understand and comply with the by-law, it is advisable to translate and interpret it in Urdu and implement awareness raising activity on SWM rules.
2. Lack of management staff (especially managers)	There is a high vacancy rate in managerial level. 3 manager positions out of 4 are still vacant due to difficulty to recruit suitable persons. As a result., there is too much burden on MD and the Company Secretary.	In order to attract human resources with adequate expertise on solid waste management, the working environment must be attractive enough. Therefore, it is advisable to introduce the following systems: • Performance Based Salary; • Provision of Incentives such as monthly award for outstanding performance; • Gifts and incentives on Eid and Christmas holidays; • Rationalisation of working hours: work in three shifts without extra burden; • Provision of social welfare and old age benefits to secure the minimum quality of life of workers; and
3. Lack of expertise of technical staff	Technical staff does not have enough expertise and are not required to have any qualification. As a result, there is a lack of reliable data and improper management and maintenance of vehicles and equipment. Therefore, GWMC cannot provide efficient waste management services. In addition, there is no institutional arrangement among technical staff, resulting in ambiguous reporting line.	

Problem	Description of Problem	Issues for Solving the Problems
		• Health screening and other facilities. In addition, in order to develop the capacity of CDGG/GWMC staff continuously, it is essential to provide training regularly. Training modules are further discussed in Chapter 5.
4. Lack of financial independence of GWMC from the government	Since the GWMC budget (including staff salary) is covered by CDGG, it is difficult to get funds at the right time. In addition, technical staff such as sanitary workers still belong to CDGG and impossible to lay-off as GWMC needs. This means that GWMC cannot allocate staff flexibly	In order to achieve financial independence from CDGG, it is necessary to introduce user charge. For this purpose, it is quite important to raise awareness of residents and to increase the willingness to pay. As for the technical staff transfer, it is usually difficult to simply transfer them from the public sector (CDGG) to the private sector (GWMC) due to several reasons such as social welfare. Thus, it is recommended to decrease CDGG technical staff gradually as they retire and outsource the service to the contractor.
5. Too high cost of outsourcing compared to direct service	It is difficult to involve the private sector due to the small market size and immature local private sector. In Gujranwala, direct service (GWMC service) cost is much cheaper than outsourcing cost (800PKR/3500PKR). This is because the market is too small for economy of scale to function. It is also because the local private sector in SWM is still immature and results in outsourcing to Lahore/international contractor.	In order to improve efficiency, it is also advisable to introduce outsourcing of collection and transportation service. In 2025, the population of Gujranwala is estimated to be big enough for economy of scale to work and for the private sector to make profit. By this time, outsourcing cost will decrease as the technologies are localised such as production of machinery and equipment.
6. Extremely low acceptance of new SWM system	There is a quite serious lack of understanding of residents on SWM. Most of them take SWM service as free of charge. This leads to quite low willingness to pay and possible strong resistance to introduce user charge.	It is necessary to raise awareness of residents on a long-term basis. The emphasis should be given to the financial aspect in order to raise understanding on SWM cost and responsibility of each stakeholder. In order to facilitate the process, GWM should provide good service enough for residents to appreciate the service.

2.10 Hospital, Industrial, and Construction and Demolition Waste Study

2.10.1 Current Situation of Hospital Waste

(1) Category of Hospital Waste

According to the Punjab Environmental Protection Act (PEPA) of 2012 Clause 2. Definitions, (xxi), “hospital waste”, includes waste medical supplies and materials of all kinds, and waste blood, tissue, organs and other parts of human and animal bodies from hospitals, clinics and laboratories. The difference between “hospitals” and “clinics” in Pakistan is generally thought to be as follows:

A **clinic** is a health care facility that is primarily devoted to the care of outpatients. Clinics can be privately operated or publicly managed and funded, and typically cover the primary health care needs of populations in local communities. Clinics usually do not have the facility to admit the patients for overnight stays in contrast to **hospitals** which offer specialised treatments and admit inpatients for overnight stays.

“Hospital waste” used in this report, however, means waste generated from both “hospitals” and “clinics”, and other medical facilities as clearly described in the preceding PEPA, and this term is generally used in the rules and regulations in Pakistan. On the other hand, “municipal waste” includes sewage, refuse, garbage, waste from abattoirs, sludge and human excreta and the like (Clause 2. Definitions, (xxviii), PEPA, 2012).

According to the Hospital Waste Management Rules of 2005, “infectious waste” means waste contaminated by any type of pathogens such as bacteria, viruses, parasite or fungi and includes cultures from laboratory works, waste from surgeries, autopsies, and waste from infected patients, discarded or disposable materials and equipment which have been in contact with such patients and infected animals from laboratories. Also, in Hospital Waste Management Rules 2005, Section 3; every hospital shall be responsible for the proper management of waste generated by it till its final disposal in accordance with the provisions of the Act and Rules 16 to 22.

Hospital waste includes both risk and non-risk waste. Risk waste means infectious waste, pathological waste, sharps, pharmaceutical waste, genotoxic waste, chemical waste and radioactive waste. Sharps includes whether infected or not, needles, syringes, scalpels, infusion sets, saws, knives, blades, broken glass and any other item that could cut or puncture. Non-risk waste includes paper and cardboard, packaging, food waste and aerosols and like. **Figure 2.10.1** shows the flow diagram of hospital waste.

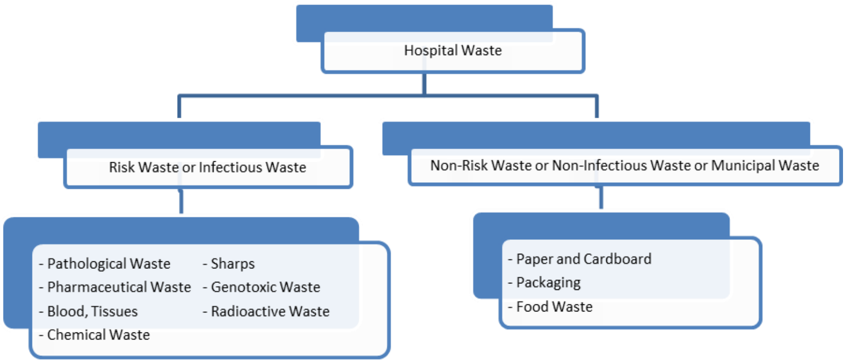


Figure 2.10.1 Flow Diagram of Hospital Waste

(2) Current Situation

There is the District Headquarters (hereinafter referred to as “DHQ”) in Gujranwala and it is the main medical centre of the Government. Instead of DHQ, government dispensaries, basic health units (hereinafter referred to as “BHUs”), rural health centres (hereinafter referred to as “RHCs”) and mother care health (hereinafter referred to as “MCH”) are present in urban and peri-urban union councils of Gujranwala (government side). In peri-urban areas, private hospitals are few as compared to clinics. Unfortunately DHQ does not even have up to date data regarding the number of clinics and hospitals at present in Gujranwala City and in the peri-urban area especially for the private medical facilities. The JICA Project Team visited every UC of the urban and peri-urban areas and updated the database regarding the number of medical facilities. **Table 2.10.1** and **Figure 2.10.2** show the number of medical facilities in Gujranwala based on the field survey.

Table 2.10.1 Number of Medical Facilities

Area	Town	Clinic	Hospital	Dispensary	BHU	RHC	MCH	Total
Urban		**719**	**101**	**24**	**0**	**0**	**0**	**844**
	Aroop	188	40	7	0	0	0	235
	Khiali Shah Pur	156	16	8	0	0	0	180
	Nandipur	173	29	2	0	0	0	204
	Qila Dedar Singh	202	16	7	0	0	0	225
Peri-Urban		**450**	**29**	**17**	**28**	**3**	**1**	**528**
	Aroop	127	9	5	7	0	0	148
	Khiali Shah Pur	131	10	5	10	1	0	157
	Nandipur	116	8	4	7	1	1	137
	Qila Dedar Singh	76	2	3	4	1	0	86
Total		**1,169**	**130**	**41**	**28**	**3**	**1**	**1,372**

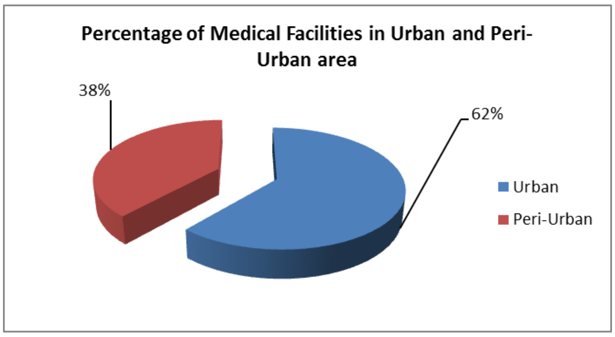


Figure 2.10.2 Percentage of Medical Facilities in Urban and Peri-Urban Area of Gujranwala

Since hospital waste (risk and non-risk) is not the responsibility of GWMC, the medical facilities adopted the self-collection and disposal systems. Currently the DHQ give their waste to A.T. Waste Management, a Lahore based private company, which had installed an incinerator at Kasur City located 120km south of Gujranwala City. A.T. Waste Management has signed a contract with hospitals and clinics, and charges them in accordance with the waste produced. Only the large scaled private hospitals have signed a contract with A.T. Waste Management. The hospitals that have signed a contract with A.T. Waste Management have dust bins with different colour-coded bags and separate boxes (for sharps) in each room (See **Photo 2.10.1**). A.T. Waste Management' struck visits with the Gujranwala twice a week. Therefore, in all the hospitals a store room is present where they store the medical waste for 3 days since collection trucks come only on Tuesdays and Fridays in Gujranwala (See **Photo 2.10.2**).

Photo 2.10.1 Colour-coded Bags and a Separate Box for Waste at a Hospital

Photo 2.10.2 Storeroom for Waste at a Hospital (Left: outside view, Right: inside view)

The unit fee under the contract with A.T. Waste Management is different among the hospitals and it ranges between 7 and 100 Rs./kg of medical waste. It neither depends on the number of beds nor kilogram of waste produced but perhaps on the hospital size and popularity. If the hospital is large in scale, it pays higher than the small scale hospitals.

There is no planning or set mechanism for the management of risk waste at the city or district level; for example, even in the District Head Quarter Hospital with 455 beds, which leads to huge quantity of risk waste per month. This hospital is one of the major hospitals in the whole district but still does not have any incineration or sterilisation unit.

All other government medical facilities like RHCs and BHUs, government dispensaries and MCH dig a pit, dispose all the risk wastes into the pit and burn them (See **Photo 2.10.3**). This practice is modified every 3 or 4 days. They give the non-risk waste to the municipal corporation workers since GWMC does not provide services in peri-urban areas.

Representatives of BHU informed the JICA Project Team during the survey that the District Health Office does not provide any budget for the collection of waste (e.g., separate collection in different coloured bags) and disposal of risk waste. Although a few clinics signed an agreement with the A.T. Waste Company, all wastes generated from small and large clinics and also some of the hospitals, are mixed with municipal waste which is a major risk to sanitary workers. This mixture of waste is further mixed with the contents of GWMC containers and in peri-urban areas and thrown into low-lying areas or open plots where they are picked up by the waste pickers and treated as recyclable material. It was also observed that in some hospitals and clinics, sanitation staff is involved in the selling of risk waste to the recyclable dealers. Sanitary staff of medical facilities does not have enough training about the hazardous nature of risk waste and they do not bother to use any personal protective equipment while sweeping wastes.

The JICA Project Team has visited all the urban and peri-urban UCs to make a comprehensive and updated database regarding the number of medical facilities in each UC and then further visited 32 medical facilities, DHQ, 13 private hospitals, 10 clinics, 4 BHUs (1 in each town), 2 dispensaries, 1 RHC and 1 MCH in all towns of Gujranwala to know about the current waste generation, collection and disposal practices. The results of interviews are summarised in **Table 2.10.2**.

Photo 2.10.3 Pit for Risk Waste at BHU

From BHUs, the risk waste (also called infectious waste) generated is approximately 30-60 kg/month, from RHC 75 kg/month and from MCH 30 kg/month. On the other hand, infectious waste from clinics is 15-225 kg/month. The DHQ produces infectious waste of approximately 1,000 kg/month. The other private hospitals produce infectious waste in the range of 15 to 1,230 kg/month. The hospitals located in peri-urban areas produce less infectious waste since the number of patients visiting peri-urban hospitals are less.

Roughly, the overall risk waste produced by all 32 medical facilities is estimated at more than 6,000 kg/month and non-risk waste is more than 7,000 kg/month. Based on the survey, the total generated amount of hospital waste in Gujranwala could be roughly estimated at 200 tons/month. The breakdown is that 120 tons/month is for risk waste and 80 tons/month is for non-risk waste.

Table 2.10.2 Interview Results about Hospital Waste

General Information							Infectious								Non-infectious	
Name	Category	Speciality	Bed	Employee	Infectious Waste [kg/Month]	Non-infectious Waste[kg/Month]	Outsourcing	Sharps	Bandages	Drips	Bloods	Tissues	Radioactive	Pharmaceuticals	MSW	Yard Trimmings
BHU Attawa	Basic Health Unit	General	2	17	60	90		x	x	x	x				x	
BHU Pupnakha	Basic Health Unit	General	2	16	30	60		x	x	x	x	x			x	x
BHU Gondlanwala	Basic Health Unit	General	2	7	30	45		x	x	x	x				x	x
BHU Mokalsandhwan	Basic Health Unit	General	0	16	60	105		x	x	x	x	x			x	x
Al Asad Clinic	Clinic	Physiotherapy	4	2	30	30				x		x			x	
Afshan Clinic	Clinic	Gyeanacology	7	12	21	30	x	x	x	x	x	x			x	
Farah Clinic	Clinic	Gyenacology	7	4	225	60	x	x	x	x	x	x			x	
Firdous Clinic	Clinic	General	4	7	60	45		x	x	x	x	x			x	
Ghuman Clinic	Clinic	General	0	4	15	30		x	x	x					x	
Imran clinic	Clinic	General	0	2	15	15		x	x						x	
Iqbal Clinic	Clinic	General	0	2	30	30		x	x						x	
Kamal clinic	Clinic	Surgical	6	4	45	60		x	x	x					x	
Nida Clinic	Clinic	Medicine	0	2	15	30		x	x	x	x				x	
Rehman Clinic	Clinic	Gyenacology	1	3	120	30		x	x	x	x	x			x	
Municipal Dipensary Garjakh	Dispensary	General	0	3	45	60		x	x	x					x	
Dispensary Satellite Town	Dispensary	General	0	3	75	75		x	x	x					x	x
Al-Fareed Hospital	Hospital	General	3	5	30	60		x	x	x					x	
Cheema Heart Complex	Hospital	Heart	25	15	105	375	x	x	x	x	x				x	
Gondal Medical Complex Hospital	Hospital	General	40	30	600	750	x	x	x	x	x	x			x	
Jinnah Memeorial Hospital	Hospital	General	120	105	480	600	x	x	x	x	x	x			x	
Medcare Hospital	Hospital	General	55	50	99	135	x	x	x	x	x				x	
Siddique Sadiq Hospital	Hospital	Cardiac	200	145	630	570	x	x		x	x	x			x	
Allama Iqbal memorial Trust Hospital	Hospital	General	150	150	450	150	x	x	x	x	x	x			x	x
Social Security Hospital	Hospital	General	150	275	600	300	x	x	x	x	x	x			x	
Al Raee Hospital	Hospital	General	150	160	1,230	360	x	x	x	x	x	x			x	
Al-Noor Hospital	Hospital	Gyenacology	4	5	45	120		x	x	x	x				x	
Fatima Memorial Medical Complex	Hospital	Gyenacology	6	7	90	60		x	x	x	x				x	
Zainab Memorial hospital	Hospital	General	5	10	15	30	x	x	x	x					x	
Chaudary Hospital	Hospital	General	20	20	100	270	x	x	x	x	x				x	
District Headquarters Hospital	Hospital (DHQ)	General	455	1,200	1,000	2,400	x	x	x	x	x	x			x	x
MCH JhandialaBagh wala	Mother Care Health	Mother Care	0	3	30	60		x	x	x	x	x			x	
Rural Health Center Eminabad	Rural Health Center	General	10	25	75	270		x	x	x					x	x

2.10.2 Current Situation of Industrial Waste

(1) Category of Industrial Waste

According to the Punjab Environmental Protection Act (PEPA) of 2012 Clause 2. Definitions, (xxiii), "Industrial Waste" means waste resulting from an industrial activity.

"Industrial Activity" means any operation or process for manufacturing, making, formulating, synthesising, altering, repairing, ornamenting, finishing, packing or otherwise treating any article or substance with a view to its use, sale, transport, delivery or disposal, or for mining, for oil and gas exploration and development, or for pumping water or sewage or for generating, transforming or transmitting power or for any other industrial or commercial purpose. (Clause 2. Definitions, (xxii), PEPA, 2012)

"Municipal waste" includes sewage, refuse, garbage, waste from abattoirs, sludge and human excreta and the like (Clause 2. Definitions, (xxviii), PEPA, 2012).

Industrial entities are responsible for disposing their waste properly. According to PEPA Clause 11, no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollutant or noise in an amount, concentration or level which is in excess of the National Environmental Quality Standards. The Federal Government may levy pollution charges on any person who contravenes or fails to comply with the provisions.

In Pakistan, construction and demolition waste (hereinafter referred to as C&D waste) is not under the category of industrial waste. In other countries construction is done by private construction companies but in Gujranwala no such trend of construction companies is seen. Mostly, people construct their houses on their own or hire workers. Legally, GWMC is not bound to deal with C&D waste but the general trend in Gujranwala is that people throw C&D waste in the streets and roadsides and as its mandate, GWMC is to clean the city. Therefore, GWMC collects the C&D waste as well. Detail discussion on C&D waste is in **Subsection 2.10.3**.

Industrial waste may be toxic or not depending on the nature of waste. **Figure 2.10.3** shows the flow diagram of industrial waste.

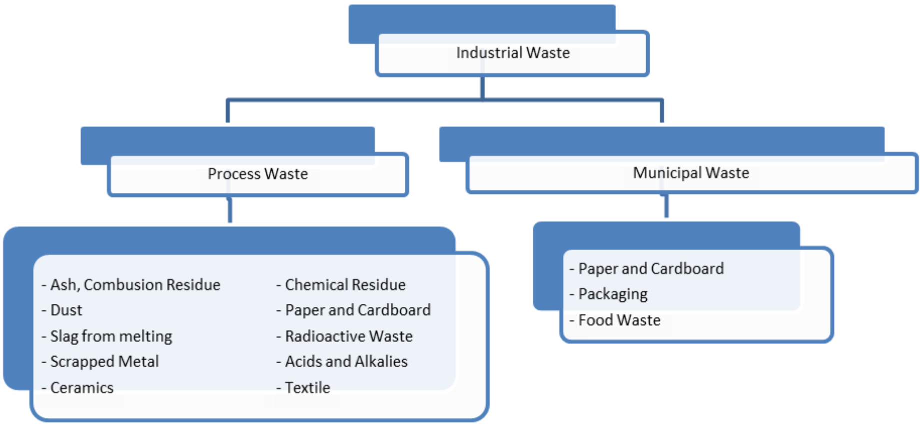


Figure 2.10.3 Flow Diagram of Industrial Waste

(2) Current Situation

Gujranwala is the commercial and industrial centre of Pakistan. It is playing a major role in supporting Pakistan's economy. Gujranwala is the main centre of electrical and engineering goods manufacturing industries in Pakistan, including domestic utensils, home appliances, gas appliances, and various types of electrical/industrial machinery.

According to the Gujranwala Chamber of Commerce and Industry (GCCI) report, almost 15,000 units are operating as cottage industry (small-scaled home-based units); however, waste generated from this industry can be negligible because the amount is minimal and mostly discharged mixed with the other municipal waste. Apart from the cottage industry, therefore, the site survey for industrial waste was conducted by JICA Project Team by focusing on much larger scale industries. As a result of the survey, although about 75% of the industries did not cooperate at all despite the letter-request for cooperation from GCCI, it is identified that approximately 4,000 units are located in 64 urban union councils of Gujranwala and approximately 240 industries are situated in peri-urban area of Gujranwala as shown in **Table 2.10.3**. Industries that are registered with GCCI have a National Tax Number (NTN) and are taxpayers to FBR (Federal Board of Revenue).

There are three Small Industrial Estates (hereinafter referred to as "SIE") in Gujranwala. SIE is defined as a piece of land notified as industrial area by the government. The government allots plots in the industrial estate. All the industries in this SIE are taxpayers. **Figure 2.10.4** shows the locations of SIEs.

Table 2.10.3 Number of Industries in Gujranwala City

Area	Town	Number of Industries*
Urban		**4,074**
	Aroop	998
	Khiyali Shah Pur	1,243
	Nandipur	505
	Qila Dedar Singh	1,328
Peri-Urban		**243**
	Aroop	45
	Khiyali Shah Pur	100
	Nandipur	48
	Qila Dedar Singh	50
SIE		**520**
	SIE I	179
	SIE II	327
	SIE III	14

Note:*Cottage industry is not included.

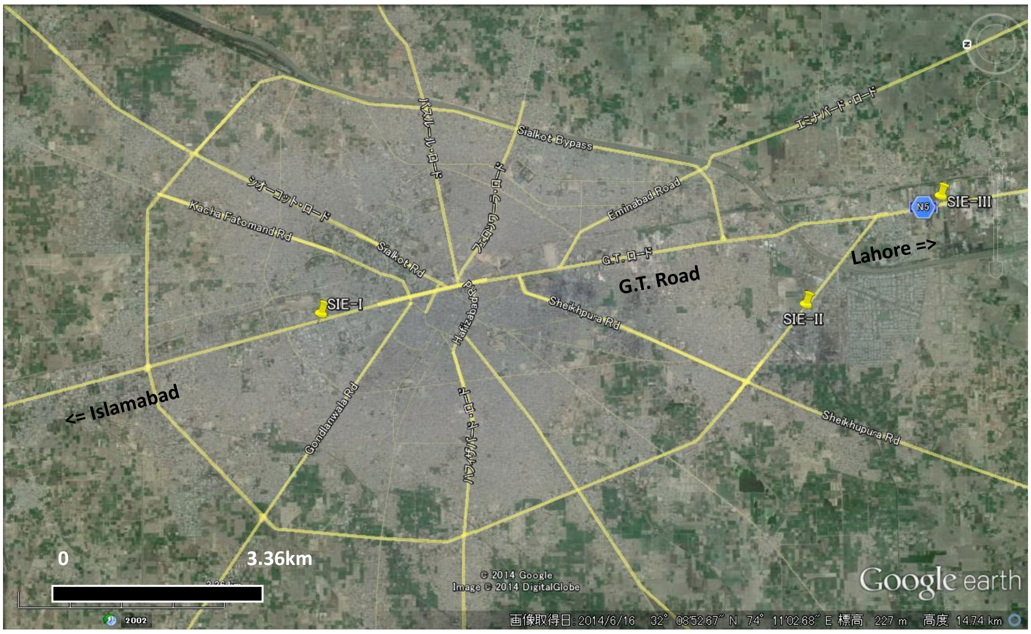


Figure 2.10.4 Location Map of Small Industrial Estates (SIEs)

Major factories surveyed are from 20 different lines of production; namely, Ceramics, Chemicals, Crushing, Food, Foundry works, Furniture, Gas appliances, Home appliances, Marble, Medicine, Metal works, Packaging, Plastic products, Recycling of metals, Rubber works, Sanitary works, Soap making, Spare parts making, Textile and Utensil manufacturing. In Gujranwala the practice of recycling is very common in industries. All of the scrap is reused or recycled within the same industry or in another industry as described in **Subsection 2.5.1, Item (3)** (See **Photo 2.10.4**). The results of the interviews are as shown in **Table 2.10.4**.

Plastic Scraps

Rubber Scraps

Slag

Metal Scraps

Marble Scraps

Photo 2.10.4 Recyclable Waste in Industries

Table 2.10.4 Interview Results about Industrial Waste

General Information							Industrial Waste													Dump Procedures			
Name	Production Type	Employee	Site Area (m^2)	Top Products	Production [per Month]	Industrial Waste [per Month]	Ash, Combustion Residu	Slag from melting	Dust	Glass and ceramics	Paper & Cardboard	Scrap rubber	Textile	Scrapped Metal	Mould	Plastics	Powder waste	Waste water	Food Waste	Open Dumping	Burn in Open Place	Incineration	GWMC Container
Dawn Ceramics	Ceramics	50	2,125	Tea Mugs	300,000 Piece	300,000 kg			x						x					x			
Bright Chemicals	Chemicals	6	128	Zinc Sulphate Chemical	3,000 kg	120 kg		x												x			
Khuram Brothers.	Chemicals	4	128	Textile Dyes	40,000 L	150 pieces of drums								x		x				x			
Mughal Pottery Works	Crushing	3	1,062	Ceramics Powder	86,400 kg	-			x											x			
Noubahar Bottling Pvt. Ltd.	Food	2,000	8,499	Pepsi, Mountain Dew, 7 up	9,000,000 Piece	-					x			x		x				x			
Tariq Bakery	Food	6	126	Rusk, Bunn	-	240 kg					x								x				x
LD Steel Furnace	Foundry Works	17	9,030	Steel Billets	900,000 kg	60,000 kg	x													x			
Mushtaq Foundary	Foundry Works	12	1,062	Spare Parts	60,000 kg	10% of raw material	x													x			
Indus Industry	Furniture	45	2,000	Plastic Furniture	-	-										x				x			
Al-hammad Industry	Gas appliances	15	2,000	Cooking range,Geyser,Heater	1,300 kg	2,000 kg								x						x			
Welcome Industry	Gas appliances	70	1,593	Cooking range,Geyser,Heater	2,250 kg	-								x						x			
Ameen Enterprises	Marble	10	126	Grinding of marble	-	-			x											x			
Kaleem Marble	Marble	1	531	Marble tiles	12,000 kg	-			x								x			x			
Makkah Marble	Marble	20	2,124	Marble tiles	45,000 kg	30-40 kg											x			x			
Batala Pharmaceuticals	Medicine	80	2,124	Tablets	1,500,000 kg	2,000 kg					x					x		x			x		
M. Zaib Brothers	Metal Works	5	531	Medical Instruments	6,000 kg	240 kg								x						x			
Khiali Paper mill	Packaging	31	4,249	Paper	300,000 kg	20% of raw material					x							x					x
Saad Abdullah Paper Mill	Packaging	16	4,249	Paper	5,100,000 kg	20% of raw material					x							x					x
Minhas Industry	Plastic Products	200	2,124	PPRC pipe,Sanitary Fitting	-	450 kg								x		x				x			
Munawar Battery	Recycling of metals	1	531	Lead	-	90 kg		x						x		x				x			
S.K rubber works	Rubber Works	22	101	Rubber Sole	90,000 kg	3,000 kg						x								x			
Golden Engineering	Sanitary Works	20	1,062	Sanitay fittings	12,000 kg	8,000 kg	x	x						x						x			
Sonex Sanitary Fittings	Sanitary Works	700	-	Sanitary fittings	-	108,000 kg								x		x							x
Prime Soap	Soap Making	35	4,249	Soap	15,000 kg	-				x								x		x			
Gujranwala Steel Industry	Spare Parts Making	60	1,060	Steel bars and flats	9,000,000 kg	10,500 kg	x							x								x	
Ittehad Industry	Spare Parts Making	20	1,060	Spare Parts	9,015 kg	19,500 kg								x						x			
Popular Engineering Industry	Spare Parts Making	35	2,124	Spare Parts,Kitchen ware	-	4,000 kg								x						x			
Chaudary Silk Factory	Textile	150	1,060	Silk Cloth	2,250 kg	1.5 kg					x		x					x		x			
Anas Melamine Industry	Utensil Manufacturing	25	2,124	Dinner Sets	900 kg	-										x				x			
Sonex cooking ware	Utensil Manufacturing	500	31,872	Non stick Utensils	-	-								x		x							x
Minhas Industry	Utensil Manufacturing	75	2,124	Steel Utensils	-	-								x						x			

Some industries prefer to buy their raw materials from third parties instead of the scrap dealers because the cost is cheaper, although they know that third parties also gain from the sale.

There is no separate collection, storage, and disposal for hazardous waste. The industrial waste is mostly in the form of combustion residue produced from foundries, ceramics industries and sanitary works; slag is produced from chemical manufacturing, battery recycling and sanitary works; dust is produced from stone grinding, marble industry, ceramics industry and pottery works; paper and cardboard is produced from food industry, pharmaceuticals, paper mills and textiles. Scrapped metal is produced from gas appliances industry, metal works, utensils, sanitary works and spare parts making industry, and this scrapped waste is recycled and reused not wasted. Wastewater mostly is from packaging industries, soap mills, chemical-making, textile, and marble industry (See **Photo 2.10.5**). Currently, both industrial and municipal wastes are disposed by the industrial establishments by themselves. There is no treatment of solid waste in industries; even wastewater is discharged into main drains without treatment.

It was noted that industries take their raw materials either from dealer shops present in Gujranwala or import them from other nearby cities as it depends upon their demand. During the survey it was observed that a majority of the waste from industries is either recycled, reused or sold and only a small portion of combustible residues are wasted. The common practice of disposing their waste is open dumping along the road and in vacant spaces. Only few industries dispose heir waste to the GWMC containers as mentioned in **Table 2.10.4**.

In addition to the above result, the following facts were revealed through the interviews.

- PRTR (Pollutant Release and Transfer Register) has not yet been established in Pakistan although the Pakistan Environmental Protection Act of 1997 prohibits unlicensed persons from handling hazardous substances (Clause 14) that are defined in a list of prescribed hazardous substances (Hazardous Substances Rules 2003, Clause 3). However, this Act is not well complied in any industry in Gujranwala.
- Most labourers in industries are young boys of age 14 to 25. No personal protective equipment is provided to the workers.
- Industries are willing to pay service charges if GWMC provides the service to them.

Ash Waste

Ceramic Waste

Wastewater

Plaster Waste

Photo 2.10.5 Industrial Waste from Various Sources

2.10.3 Construction and Demolition Waste

(1) General

The management plan of construction and demolition waste (C&D waste) is not a part of the components of this Master Plan formulation because C&D waste is categorised into industrial waste in general and the Gujranwala Waste Management Company (GWMC) is legally not bound to deal with the C&D waste. In order to improve the cleanliness of Gujranwala City, however, GWMC is actually collecting C&D waste from its jurisdiction (i.e., 64 Union Councils). GWMC signed an agreement with the Lahore Waste Management Company (LWMC) for providing consultancy to GWMC in June 2014. The C&D waste management plan is also a part of that agreement. This subsection summarises the present situation of C&D waste based on the report of LWMC.

(2) Source of C&D Waste

According to the C&D waste management plan provided by LWMC to GWMC, definition and sources of C&D waste are listed in **Table 2.10.5**

C&D waste is generated whenever any construction and demolition activity takes place such as construction of roads, underpass, flyover, bridges, plaza, remodelling, etc. It consists of inert and bio-degradable material such as concrete, plaster, metal, plastics, bricks, etc. A part of this waste goes to the municipal streams.

Table 2.10.5 Sources of C&D Waste Generated in Gujranwala

Activities	Sources
Construction Activities	Renovation/construction of residential flats, homes, villas and compounds
	Public development projects by Town Municipal Administration (TMA), Highway Department, Construction & Work Department, Gujranwala Development Authority, etc.
	Private construction projects by private housing authorities
Demolition Activities	Commercial buildings, plazas, shopping centres
	Government anti encroachment drives
	Renovation of private homes

Source: Lahore Waste Management Company, Final Report on Construction and Demolition Waste Management Plan for Gujranwala, November 2014, page 10.

(3) Source of C&D Waste

Gujranwala City is experiencing rapid urbanisation and industrialisation that results in increase of construction activities. C&D waste due to uncontrolled and unregulated civil works is thrown usually on roadsides, footpaths, vacant plots, parks, around waste storage containers etc.

According to the LWMC C&D waste plan, percentage of C&D waste generated is mentioned as, excavated soil/rubber waste generated is about 49 tons per day (35%), concrete waste as 44 tons per day (31%), bricks/ masonry pieces as 30 tons per day (21%), road scrap material as 13 tons (9%), ceramic tiles as 6 tons per day (4%), metals as 0.14 tons per day each (0.1%) and no wood component is found in C&D waste. However, this estimation made a fatal mistake because the percentage using estimation of the total C&D waste amounts comes from the ratio of non-combustible waste as a result of the waste amount and composition survey in this Project. There is obvious difference between C&D waste and non-combustible waste. To estimate the C&D waste generation in Gujranwala, another special survey exclusively for this purpose is required.

(4) Quantification of C&D Waste

According to field surveys conducted by the LWMC team, 46 sites were identified in Gujranwala City containing C&D waste with estimated quantity of 3,555 tons. It seems to be accumulated amount on roads and vacant plots estimated based on a visual observation at the sites.

(5) Collection and Transportation, and Disposal of C&D Waste

Currently there is no proper system for C&D waste collection and transportation in Gujranwala. C&D collection arrangements are made by the generator. C&D waste generator hires the services of donkey carts or tractor trolleys depending on quantum of waste. The contractor simply collects the waste and unloads into vacant plots, low lying areas or in waste storage container placed in the vicinity and get mixed with municipal solid waste.

C&D waste is collected by GWMC and is openly dumped at Gondlanwala site along with municipal solid waste. The waste collected by private contractor is dumped in depression/low lying areas located in the vicinity of the city.

(6) Legal Situation Analysis

There is no regulation in place that directly concerns construction and demolition waste in Pakistan. Even District Government has not drafted/notified any by-laws for solid waste management in Gujranwala. Current regulations covering C&D waste are “Building and Zoning” Regulations, 2008 of Gujranwala Development Authority (GDA). These regulations only define demolition activity. According to GDA regulations-2008, Chapter 8 and 9 dealt with “Builder’s Obligation” and “Role and Responsibility” as shown in the following clauses:

- **Clause 8.1.3, Written Permission for Use of Street:** No construction material or debris shall be deposited in any street without the written permission of GDA and on the condition that the builder will be responsible for clearing the street as and when required by the authority or immediately after completion of the work, whichever is earlier.
- **Clause 8.1.7, Removal of Obstructions and Debris after Completion of Work:** All debris, obstructions and erection in any street/road shall be removed within 7 days of the completion of work and the streets/road, all drains and public utility installations shall be kept in clean, tidy and serviceable conditions.
- **Clause 8.1.12, Permit to Demolish Building:** No building shall be demolished without a written permission from the Development Authority.
- **Clause 9.2.1 (iii) f.:** The builder shall be responsible for the disposal of debris/waste from construction site to the waste disposal site, as prescribed by the District Government.
- **Clause 9.2.1 (iii) g.:** The builder shall be responsible to restore the area in front of his/her plot after construction.

Cost recovery method for the lifting of demolition waste is mentioned in Punjab Local Government Ordinance 2001 (PLGO, 2001). Concerned clause is as follows:

- **Clause 64.4, Lease and Licenses for Land and Building:** The cost of demolition and removal of structure shall be payable to the local government by the lessee or licensee, as the case may be, and if the cost is not paid on demand, the local government may cause the material of the structures demolished and removed to be sold in auction, and if the proceeds of the sale are not sufficient to cover the cost, the balance shall be recoverable as arrears of land revenue, but if such proceeds exceed the cost, the excess shall be paid to the lessee or the licensee as the case may be.

Anti-Encroachment activities (immoveable) are major source of C&D waste generation in our cities. Anti-encroachment activities generates large quantum of demolition waste. Following clause of PLGO, 2001 is dealt with encroachment:

- **Clause 47, Encroachment and subsisting lease and licenses:** (1) No person shall make an encroachment movable or immoveable on an open space or land vested in or managed, maintained or controlled by a local government, or on over or under a street, road, graveyard, within its local area or a drain; (2) The local government may, after such notice as may be considered reasonable, remove the encroachment mentioned in sub-paragraph (1) with such force as may be necessary.

2.10.4 Evaluation of Hospital, Industrial, and Construction and Demolition Waste Condition

The problems and issues in relation to hospital, industrial, and construction and demolition waste management under the current situation are summarised in **Table 2.10.6.** These items will be the basic elements to develop the plans, programmes and projects to comprise the recommendation on hospital, industrial, and construction and demolition waste management in the Integrated Solid Waste Master Plan in Gujranwala.

Table 2.10.6 Identification of Problems and Issues on Hospital, Industrial, and Construction and Demolition Waste Management

Problem	Description of Problem	Issues for Solving the Problems
Hospital Waste		
1. Lack of data on medical facilities	The District Health Office does not even have up to date data regarding the number of clinics and hospitals at present in the Gujranwala District.	Updated database should be required regarding the number of medical facilities including government and private owned for the quantification of waste generated.
2. No check and balance mechanism on private contractors	Major hospitals and clinics have a contract with the A.T. Waste Management, a private company, for the waste collection. However, no such information and check and balance mechanism exists regarding safely disposal of the hazardous risk waste by private contractors.	Private sector does not provide any quality and environmental compliance certification to the clients. The government office also should monitor the performance of the public sector.
3. No enforcement mechanism	Hospital Waste Management Rules address only large scale hospitals and does not address small scale clinics nor regulate enforcement mechanism for the implementation of rules and regulations especially in terms of waste from private medical facilities.	In connection with the problem mentioned above, reinforcement of the current rules and regulations, and their implementation are key issues.
4. Mixing of risk waste with non-risk waste	It was observed that risk waste from smaller medical facilities is mixed with municipal waste, resulting in a major risk to sanitary workers.	No separate collection system from the smaller medical facilities form urban and peri-urban area by any government agency.
5. Risk waste as a recyclable material	It was also observed that risk waste is collected and sold by waste pickers and some of the sanitary staff of medical facilities, and finally reaches the recyclers. This is a very hazardous and alarming situation and leads to the high possibility of infection of various diseases to waste pickers, sanitary staff and recyclers.	Waste pickers and recyclers are not being regulated by any government agencies. At least disposal of the risk waste should be strictly regulated and monitored by legislation.
6. Budget constraints	The District Health Office does not have any budget to provide BHU for hospital waste management.	No allowance of budget for the waste at BHU level comes from higher management. However, appropriate waste management needs a certain amount of money.
7. Lack of awareness	Sanitary staff of medical facilities is not aware of the hazardous nature of e risk waste and they do not bother to use any personal protective equipment at the time of sweeping.	Training for sanitary staff should be carried out to handle risk waste with special care.

Problem	Description of Problem	Issues for Solving the Problems
Industrial Waste		
1. Unavailability of industrial data	Industrial data of the entire city is not available from any government or private department. Only the list of industries that have membership with GCCI is available. Most industries are reluctant to cooperate with surveys that are going to try to clarify their activities. They normally reject disclosure of any information regarding their types and sales of production, number of employees, disposal of industrial waste, etc., to avoid payment of taxes.	It is the duty of industrial departments to collect the data and updat the inventory of industries based on cooperation from them. It is essential to obtain the data for estimating the amount of waste produced from industries and formulating the waste management plan.
2. No proper enforcement of laws and regulations	There is no proper enforcement of laws, by-laws and regulations in Pakistan dealing with management of the waste discharged from industries. Although PEPA 2012 includes some clause related to industrial waste, it does not clearly demonstrate the responsibilities of industries regarding the solid waste management.	Rules and regulations that clearly mention the responsibility with strict enforcement are necessary.
3. Mixing of industrial waste with municipal waste	Most of the small scaled industries are in the residential area and waste is mixed with municipal waste. Due to no service by any company in the industrial area, waste of industrial estates is also mixed with the waste generated from households.	A separate collection system for industries and households is important to establish the proper solid waste management system in the city.
Construction and Demolition (C&D) Waste		
1. Ambiguity of classification and responsibility for C&D waste	Although C&D waste is categorised into municipal waste under the Punjab Municipal Solid Waste Management Guidelines 2011, the amount is too large to deal with municipal waste collected from households and commercial entities in general. The other laws and regulations do not clearly define the classification and responsibility for C&D waste.	The provincial government should firstly make some by-laws or regulations for C&D waste management in which rules and responsibilities should be clearly defined. Simultaneously, GWMC should consider introduction of tariff for C&D waste collection and propose it to the provincial government or city district government.
2. No reliable data on C&D waste generation amount and composition	The estimation by LWMC in terms of C&D waste amount and composition in Gujranwala is wrong so that no reliable data exists. Special surveys at the sites are indispensable for obtaining the data and will take a lot of time and resources.	The waste amount and composition data are basis of development of the management plan. Without the data, any plan covering the waste collection method and required number of vehicles and personnel cannot be prepared accurately.
3. Many illegal dumping of C&D waste	C&D wastes are piled up in front of houses, vacant plots, along the roadsides, etc., and accumulate day by day. According to the LWMC report, there are 46 of such sites in Gujranwala and the total amount is estimated at 3,555 tons.	GWMC has started the One-Time Cleaning Activity to remove the accumulated waste including C&D waste in the city area. This activity should be conducted continuously until all the illegal dumpsites are cleared by the allocation of suitable sets of vehicles and machinery.

CHAPTER 3. PLANNING POLICIES OF SOLID WASTE MANAGEMENT IN GUJRANWALA AND FRAMEWORK OF THE MASTER PLAN

3.1 Introduction

The responsibility, duty, authority, regulations, etc., of the local government as mandated by legislation will be the key elements to formulate the Integrated Solid Waste Management (ISWM) Plan. This chapter thus proposes the planning policies and strategies for establishing the framework of the ISWM for Gujranwala City based upon clarification and identification of problems and issues raised from the findings and data analysis presented in **Chapter 2**.

3.2 Establishment of Principles and Planning Policies for ISWM in Gujranwala

Although more discussions and consensus between the JICA Project Team and the Pakistani side are required, principles and planning policies for ISWM of the Gujranwala Waste Management Company (GWMC) are as prepared and presented in the following sections. These principles and planning policies are the basis on which the planning strategies of the SWM for GWMC and CDGG, as well as the Government of the Punjab and framework of the Master Plan, shall be formulated hereinafter.

3.2.1 Categories of Waste

(1) Clarification of Definition of Municipal Solid Waste

CDGG is primarily responsible for the management of municipal solid waste within the jurisdictional area of Gujranwala. In terms of the SWM in Gujranwala, CDGG executed a service contract with GWMC and the responsibility for handling municipal waste has been transferred to GWMC since January 2014. Before discussing the setting up of planning policies for the ISWM in Gujranwala, the definition of municipal solid waste and the demarcation between municipal solid waste and non-municipal solid waste should be clarified.

“Municipal waste” is defined in the Punjab Environmental Protection Act (PEPA) 2012 as “sewage, refuse, garbage, waste from abattoirs, sludge and human excreta and the like” (Clause 2. Definitions, [xxviii]). Another definition in the Punjab Municipal Solid Waste Management Guidelines 2011 sets out in more detail that “municipal solid waste” for the purpose of these Guidelines means solid waste generated within the jurisdiction of a local government except slaughterhouse, hazardous hospitals, or hazardous industrial waste but includes:

(a) Domestic waste (exclusive of hazardous waste) consisting of garbage and rubbish such as bottles, cans, clothing, plastic disposables, off packaging and food scraps, newspaper and magazines, plastics and yard trimming that originates from a household;
(b) Commercial waste (Market waste);
(c) Institutional waste (schools, hospitals (non-hazardous), public offices, etc.);
(d) Street sweeping waste;
(e) Garden waste (Tree trimming and grass cutting wastes);
(f) Solid wastes collected from drains and water courses in urban areas*;
(g) Construction/demolition waste;
(h) Industrial waste (except waste generated in designated industrial Estates); and
(i) Agricultural waste from farm and agricultural activities including poultry, cattle farming, animal husbandry, residues from the use of fertilizer, pesticides and other farm chemicals

Note:* Demarcation of the responsibility for sweeping and clearing drains between GWMC and WASA is presented in Subsection 2.3.2.

From the viewpoint of responsibility for handling wastes as a local government in general, the above categories of municipal waste seem to be too broad to be borne solely by a local government. Considering the "Polluter Pays Principle" as PEPA 2012 also states some of the articles based on this concept (e.g., Clause 11, Prohibition of certain discharges or emissions), the generators should be responsible, at least, for bulky or special wastes that are not discharged from residents' ordinary daily life. In this sense, categories (g), (h) and (i) above should be excluded in the list of municipal solid waste. In case that GWMC collects the waste including these categories, GWMC should charge the cost covering collection, transportation and disposal directly from the generators.

(2) Proposed Management Responsibility for Municipal Solid Waste

Non-municipal solid waste is waste that is not under GWMC's responsibility but the responsibility of waste generators. Since the Punjab Municipal Solid Waste Management Guidelines of 2011 do not have a legally binding force, based on the above argument, waste categories and their management responsibilities are proposed as summarised in the table below.

Table 3.2.1 Waste Category and Management Responsibility

Kinds of Waste	Management Responsibility	Remarks
1. Municipal Solid Waste 1-1 Domestic waste 1-2 Commercial waste 1-3 Institutional waste 1-4 Street sweeping waste (including carcasses) 1-5 Garden waste 1-6 Drain waste (Drain width: less than 2 feet)	GWMC	GWMC may collect bulky waste upon receipt of a request from residents by charging a special tariff.
2. Non Municipal Solid Waste 2-1 Non-hazardous industrial waste 2-2 Commercial waste of large amount 2-3 Construction & Demolition waste 2-4 Agricultural waste 2-5 Discarded vehicles & machinery 2-6 Hazardous waste including infectious hospital waste	Generators of waste (GWMC and CDGG should monitor generators' management of non-municipal waste until they establish a proper management system for these wastes.)	GWMC may collect non-municipal waste except waste item 2-6 upon receipt of a request from the generator by charging a special tariff. GWMC may also accept these categories of waste except waste item 2-6 at its disposal site on full cost recovery basis. The central government should establish hazardous waste management (treatment) facilities.

3.2.2 Responsibility of Federal Government, Local Government, Business Waste Generators and Residents

GWMC must have the power and responsibility for organising integrated solid waste management (ISWM). As shown below, there are other stakeholders involved in ISWM.

- Federal Government
- Government of the Punjab
- CDGG
- GWMC
- Business (Industrial and Commercial) Waste Generators
- Residents

The proposed principal responsibilities of respective stakeholders are given in the **Table 3.2.2**.

Table 3.2.2 Parties Involved in Solid Waste Management and Their Responsibilities

Involved Parties	Responsibilities
1. Federal Government	1) To formulate a national policy with respect to waste reduction, recycling and solid waste management. 2) To formulate and pass a national SWM law. 3) To set technical standards. 4) To research on solid waste management. 5) To ensure that the laws and regulations are applied. 6) To provide guidance to local governments.
2. Government of the Punjab	1) To formulate a provincial policy and prepare provincial strategies and plans (short and long term). 2) To enact Acts, Ordinances, Guidelines, etc. related to SWM. 3) To finance the district governments. 4) To levy a waste tax or tariff. 5) To formulate regulations. 6) To formulate guidelines with respect to: a) Methods of discharging waste (types of containers to be used); b) Waste reporting requirements of business waste generators; and, c) Recycling (types of waste to be recycled).
3. CDGG	1) To formulate a local policy and prepare local strategies and plans (short and long term). 2) To finance SWM. 3) To supervise performance of GWMC. 4) To enforce bye-laws and regulations.
4. GWMC	1) To provide waste collection, haulage, treatment, disposal and street sweeping services under contractual arrangements.
5. Business (Industrial and Commercial) Waste Generators	1) To manage (collection, treatment and disposal) their waste except those accepted by the local government as municipal solid waste. 2) To submit reports on their waste (types, quantity, pre-treatment and other information) as required by the municipal regulations.
6. Residents	1) To reduce generation of waste. 2) To recycle. 3) To comply with the local government's waste collection procedure. 4) To avoid littering waste. 5) To dispose of discarded vehicles by using commercial enterprises.

3.2.3 Vision, Mission and Goals of Integrated Solid Waste Management in Gujranwala

(1) Vision of Integrated Solid Waste Management in Gujranwala

The vision of integrated solid waste management in Gujranwala is proposed, as follows:

"Pursuing the cleanest and most beautiful city of Pakistan"

Alternatively, the following statement is proposed:

"Pursuing the cleanest city of Pakistan"

The words "most beautiful" can be eliminated from the statement because Gujranwala is not a tourist or recreational area. In addition, two options can be considered as follows:

"Transformation of Gujranwala from the dirtiest to the cleanest City of Pakistan"

"Clean & Tidy: A new face of Gujranwala"

The best statement suitable for Gujranwala will be discussed in the next stage of the Project.

(2) Mission of Integrated Solid Waste Management in Gujranwala

The mission of integrated solid waste management in Gujranwala is proposed, as follows:

(a) To improve and protect the public health of Gujranwala residents and visitors;

(b) To deliver efficient and effective waste collection and disposal services to the residents of Gujranwala;

(c) To maximise resource recovery and recycling through the participatory approach; and

(d) To ensure greener and safer environment at final disposal sites.

(3) Goals of Integrated Solid Waste Management in Gujranwala

The goals of integrated solid waste management in Gujranwala are proposed, as follows:

(a) To significantly extend and formalise resource recovery activities, including but going beyond the creation of enabling environments and the development of markets and industries for recyclables;

(b) To develop awareness and capacity for waste handling and source separation as essential components of sustainable waste management;

(c) To restructure and extend efficient and equitable collection of source-separated waste streams with the view of protection of public health and the environment;

(d) To build environmentally sound infrastructure and systems for safe disposal of residual waste, replacing the current disposal site and transfer station which must be rehabilitated; and

(e) To reduce the burden on the disposal site and increase its life span by using intermediate treatment and 3R approach.

3.3 Planning Strategy for ISWM in Gujranwala

3.3.1 Problem Identification on ISWM in Gujranwala

As stated in **Chapter 2**, based on the results of site reconnaissance, field surveys and analyses, there are many causes preventing GWMC from conducting better services of waste collection and disposal. Identification of the current problems is indispensable for establishment of the planning directions to solve these problems. The major problems enumerated below are considered to be the key issues on master plan formulation, and low level of waste collection service coverage and lack of public awareness are identified as the two core problems that shall be sorted out.

- Low level of waste collection service coverage
- A large number of illegal dumpsites
- Inappropriate landfill operation at the existing final disposal site
- No proper closed landfill site
- Absence of formal intermediate treatment and 3R facilities
- Lack of awareness of residents on intermediate treatment and 3R, and other SWM problems
- Health risk of sanitary workers and waste pickers

- Lack of management staff and technical expertise of GWMC
- Lack of financial independence and pricing mechanism in SWM services
- Few involvement of the private sector

3.3.2 Planning Strategy

To solve the problems and achieve the goals, the strategic approach to formulate the ISWM Master Plan for Gujranwala are proposed with the following six items in consideration of solving the implicated constraints of the city towards improvement of technical and institutional deficiencies:

- Heightening of public awareness and participation
- Development of SWM operational capacity of GWMC
- Financial strengthening of SWM
- Maximisation of public sector involvement in SWM
- Promotion of 3R (Reduce, Reuse, Recycle)

3.4 Planning Direction of the Master Plan

3.4.1 Components of the Master Plan

The ISWM Master Plan for Gujranwala is formulated in three implementation stages, namely; the first implementation stage (Short-Term Plan covering the period from 2016 to 2018); the second implementation stage (Mid-Term Plan covering the period from 2019 to 2024); and the third implementation stage (Long-Term Plan covering the period from 2025 to 2030). The action plans covered in the first implementation stage are formulated through two approaches: (1) technical approach, and (2) institutional and financial approach. The major planning items of the Master Plan are summarised as the following seven programmes:

Technical Approach of the Master Plan

Programme 1: Waste Collection and Transportation Plan

Programme 2: Final Disposal Plan

Programme 3: Intermediate Treatment and 3R Promotion Plan

Institutional and Financial Approach of the Master Plan

Programme 4: Environmental Education and Public Awareness Raising Plan

Programme 5: Economic and Financial Plan

Programme 6: Environmental and Social Considerations

Programme 7: Institutional Strengthening and Organisational Plan

3.4.2 Objectives, Planning Policies and Strategies of Each Component of the Master Plan

(1) Waste Collection and Transportation Plan

(a) Objective

The overall objective of the Waste Collection and Transportation Plan is to improve the existing collection service activities and expand the coverage area in Gujranwala City in order to maintain public sanitation and cleanliness of the city.

(b) Planning Policy

- The development plan of the waste collection and transportation plan shall be cover 64 UCs in the year 2018, and the planning area shall start expanding to 34 UCs in the year 2019.
- Targeted waste in the master plan shall be municipal waste.
- Construction and demolition (C&D) waste shall be handled in a different operation from the ordinary waste collection and transportation work.
- Separate collection system shall be adopted in the master plan.

(c) Planning Strategy

- Type of municipal solid waste shall be defined for the objective waste for the waste collection and transportation plan.
- Technical alternatives on waste collection and transportation system shall be studied by evaluating the most efficient result in terms of waste collection and transportation from generation source to final disposal site, as well as evaluation from the viewpoint of less impact to society and the environment.
- Separate collection system shall be established under the conditions with involvement of all the waste generators in the future.
- Implementation of waste collection and transportation is carried out based on the phased procurement of a sufficient number of waste containers and waste collection vehicles and containers. The procurement plan for waste collection vehicles and containers on waste collection and transportation plan shall be determined as the most optimum system of collection and transportation.
- Urgent clean-up work shall be promoted for illegal dumping sites in the city.
- Street cleaning work shall be conducted.
- Collection of bulky waste shall be conducted.
- Construction of necessary parking areas shall be conducted.

(2) Final Disposal Plan

(a) Objective

Waste disposal shall be provided as the last process of solid waste management to dispose waste for storing eternally and for stabilising the waste of no value for resource materials and/or waste conversion for further use and protect the surrounding area from secondary pollution.

(b) Planning Policy

- The development plan of final disposal facilities shall have been formulated in 2030 as the final target year of the master plan.
- Only treated or residual municipal solid waste shall be the objective waste acceptable to the final disposal facility of Gujranwala.
- Among the several types of final disposal facilities, the sanitary landfill facility is superior to any other type for disposal of municipal solid waste from technical, economic and environmental viewpoints. Hence the final disposal plan shall formulate the development plan for construction and operation of new sanitary landfill facilities in Bhakhraywali.
- The improvement plan of the existing landfill in Gondlanwala and the safety closure plan

of the old landfill site in Chianwali shall be involved as integral parts of the final disposal plan.

(c) Planning Strategy

- The development work of new sanitary landfill shall be carried out by stage-wise construction work in consideration of the financial capacity of the project proponent.
- The improvement plan of the existing landfill site and the safety closure of the old landfill site shall be carried out to the satisfactory level to mitigate the current negative impacts in consideration of economic efficiency.

(3) Intermediate Treatment and 3R Promotion Plan

(a) Objective

The objective of the Intermediate Treatment and 3R Promotion Plan is for reduction of domestic waste generation, recovery of resources, reuse, recycling, intermediate treatment and resource circulation.

(b) Planning Policy

- The development plan of intermediate treatment and 3R promotion activities shall have been formulated in 2030 as the final target year of the master plan.
- The plans should be implemented with consideration for not only limited budget but also informal activities related to intermediate treatment and 3R.
- The intermediate treatment plan shall be implemented through privatisation while the municipal solid waste management in collection, transportation and disposal shall be carried out and managed by the GWMC.

(c) Planning Strategy

- The development plan should be carried through parallel components, both “hard” and “soft”. Since it needs continuity, ”soft” measures should be emphasised by utilising existing facilities and systems to prevent interruption due to lack of funds.

(4) Environmental Education and Public Awareness Raising Plan

(a) Objective

The objective of the Environmental Education is to raise awareness of the general public as well as selected target groups (e.g., elected officials/representatives, religious scholars) at the Union Council, Tehsil and District levels of SWM.

(b) Planning Policy

- The plan should be formulated to promote better understanding of the resident through public and school environmental education by establishing coordination mechanisms in GWMC.
- The plan should be continuous and formulated to promote more involvement of public and selected target groups’ participation by providing opportunities to actively participate.

(c) Planning Strategy

- Capacity of communication unit of GWMC should be strengthened to facilitate and coordinate numerous education routes, i.e., facilitating educational materials and coordinating relevant bodies.

- GWMC needs to inform the public of the measures to be taken to improve SWM in the city. A properly structured communication strategy should be developed.
- A public environmental education and awareness programme should be carried out to raise awareness and involve the public in the initiatives for better SWM in the city.
- The introduction of SWM in the primary education curriculum should be considered to make school children more aware on solid waste issues. In addition, the development of educational materials for teachers and students should be considered essential as a tool to promote environmental education and create awareness among educational community.

(5) Economic and Financial Plan

(a) Objective

The objective of the Economic and Financial Plan is to establish the optimum cost recovery in the SWM operations of GWMC, thereby achieving the long-term financial sustainability of providing SWM services to be planned in the Master Plan.

(b) Planning Policy

- Cost recovery for the provision of SWM services should be achieved through the ample generation of stable revenues from users and taxation.
- Current operating costs required for SWM services should be accurately and continuously reviewed and estimated.
- Revenues required for the cost recovery should be mainly generated from the tariff charging system which reflects the cost of SWM services.
- Outsourcing of part of SWM services should be introduced for the purpose of utilising the efficient private sector.

(c) Planning Strategy

(i) Optimum cost recovery to cover the operation and maintenance cost for SWM services should be achieved for the long-term financial sustainability based on the following strategies:

- Establishment of the long-term road map for the full recovery of the operation and maintenance cost by user charges and subsidies from the provincial government;
- Establishment of a wide range of financial monitoring indicators together with the standard procedures for monitoring the cost recovery; and
- Preparation of manual and training of GWMC’s staff for the management of the cost recovery.

(ii) Operation and maintenance cost for SWM services should be accurately estimated based on the following strategies:

- Establishment of an independent accounting system for the financial autonomy of GWMC;
- Establishment of organisational setting such as a focal point inside GWMC in charge of accurately managing and estimating the operation and maintenance cost for SWM services; and

- Establishment of proper monitoring of the operation and maintenance cost for SWM services together with the minimisation of operation and maintenance cost to attain the operational efficiency of SWM services.

(iii) Revenue generation through the proper tariff charging system should be introduced based on the following strategies:

- Selection and introduction of proper user charge system to cover the operation and maintenance cost for SWM services;
- Selection and introduction of stable financial resources to cover the financial shortages from the provincial government through subsidies or taxation;
- Preparation of official tariff table for the selected user charge system;
- Establishment of a wide range of financial monitoring indicators together with the standard procedures for setting and revising the tariff level; and
- Improvement of users' willingness to pay through raising of public awareness for the payment of user charges.

(iv) Efficient private sector involvement should be introduced by outsourcing part of SWM services to private service operators as the following strategies:

- Selection and introduction of an efficient service contract for collection and transport services; and
- Establishment of a wide range of performance monitoring indicators together with the standard procedures for monitoring the financial performance of private service operators.

(6) Environmental and Social Considerations

(a) Objective

The objective of Environmental and Social Consideration is to propose measures to avoid new negative impacts which might be caused by the disposal sites, and mitigate current negative impacts of the disposal sites to social and natural environment in Gujranwala.

(b) Planning Policy

- Environmental and Social Consideration shall be applied for not only the proposed landfill site at Bhakhlaywali but also the current disposal site at Gondlanwala and the closed disposal site at Chianwali.
- Environmental Monitoring shall be carried out in long-term perspective.

(c) Planning Strategy

- A system of environmental monitoring should be established and implemented.
- Practical and initial solid waste recycling activities should be carried out with inclusion of waste pickers' activities.

(7) Institutional Strengthening and Organisational Plan

(a) Objective

The Organisational Restructuring and Human Resources Development Plan have three objectives as follows:

- To comprehensively reorganise the functions of the GWMC so that the responsibilities and services on solid waste management could be effectively and efficiently managed;
- To comprehensively strengthen human resources capacities of the managerial and technical staff of the GWMC to support its functions; and
- To establish a comprehensive Solid Waste By-Law for Gujranwala.

(b) Planning Policy

For the establishment of the new organisation in charge of solid waste management services, the function of the GWMC should be comprehensively reviewed in terms of organisational and individual capacity assessment, as follows:

- Responsibilities and obligations of the new organisation should not be fragmented or overlapping among the staff and workers;
- Linkages and coordination arrangements between different departments in the new organisation should be efficient and effective;
- The organisational structure should be optimised in line with the selected structure for Public-Private Partnership;
- Human resources development for providing solid waste management services shall be comprehensively designed and implemented based on the results of the capacity assessment;
- All rules and regulations related to SWM should be integrated;
- Integrated By-Law should be translated in Urdu; and

(c) Strategy

The organisation of GWMC shall be restructured comprehensively for effective and efficient service provision based on the following concepts:

- An efficient and rationalised organisational structure with clear reporting lines, reasonable spans of control and number of levels of managerial and technical staff, and the appropriate vertical structure to attain the operational efficiency of the solid waste management;
- A clear assignment and delegation of responsibilities and adequate authority to managers and supervisors with accountability for individual performance as well as a simple workflow for a quick decision process;
- A streamlined workflow based on the practical basis to avoid the overlapping of organisational structure;
- Clear-cut directing functions from the strategic level down to middle management and supervisors;
- Effective and appropriate management information systems and other procedures;
- Periodic assessment and feedback of management systems and other procedures based on agreed performance targets and criteria;
- A department or unit in charge of managing and regulating the proper Public-Private Partnership scheme;
- More practical human resources development including on-the-job training programme based on the capacity assessment and feedback system to share job skills among staff and workers should be implemented; and
- Raising public awareness on best practices in solid waste management such as rules and regulations, recycling, segregation, e-use, and recovery as well as inculcating the culture of waste reduction and proper storage among producers and consumers.

3.5 Goals of the Master Plan

3.5.1 Waste Collection and Transportation Plan

(1) Short-Term Plan (2016-2018)

- Increase of collection rate in 64UCs from the current 43% to 100% in 2018.
- Improvement of City's sanitary environment through the clean-up of illegal dumping sites in the 64 UCs.
- Improvement of collection and transport system through procurement of collection vehicles and introduction of the container system in the 64 UCs.
- Conduct of street cleaning through procurement of collection vehicles.
- Conduct of collection of bulky waste through procurement of collection vehicles.
- Conduct of necessary parking areas for procured vehicles.

(2) Mid-Term Plan (2019-2024)

- Increase of the collection rate in 34 UCs from 0% to 60% in 2024.
- Sustenance of collection rate in 64UCs with 100% in 2019.
- Improvement of collection and transport system through procurement of collection vehicles and introduction of the container system in 98UCs.
- Conduct of street cleaning through procurement of collection vehicles.
- Conduct of collection of bulky waste through procurement of collection vehicles.
- Conduct of necessary parking areas for procured vehicles.

(3) Long-Term Plan (2025-2030)

- Increase of collection rate in 98UCs to 100% in 2030.
- Sustenance of collection rate in 64UCs from the present with 100% in 2018.
- Improvement of collection and transport system through procurement of collection vehicles and introduction of the container system in 98UCs.
- Conduct of street cleaning through procurement of collection vehicles.
- Conduct of collection of bulky waste through procurement of collection vehicles.
- Conduct of necessary parking areas for procured vehicles.

3.5.2 Final Disposal Plan

(1) Short-Term Plan (2016-2018)

- Construction of sanitary landfill facilities (Stage 1) in Bhakhraywali
- Operation and maintenance of sanitary landfill facilities in Bhakhraywali
- Improvement of the existing landfill in Gondlanwala
- Safety closure of the landfill site in Gondlanwala
- Safety closure of the landfill site in Chianwali
- Monitoring of final disposal in Bhakhraywali and post-closure monitoring of Gondlanwala and Chianwali

(2) Mid-Term Plan (2019-2024)

- Operation and maintenance of new sanitary landfill facilities in Bhakhraywali

- Monitoring of final disposal in Bhakhraywali and post-closure monitoring of Gondlanwala and Chianwali
- Design of sanitary landfill facilities (Stage 2 Section) in Bhakhraywali
- Construction of sanitary landfill facilities (Stage 2) in Bhakhraywali

(3) Long-Term Plan (2025-2030)

- Operation and maintenance of sanitary landfill facilities in Bhakhraywali
- Monitoring of final disposal in Bhakhraywali and post-closure monitoring of Gondlanwala and Chianwali
- Site selection and EIA of future final disposal facilities
- Design of future sanitary landfill facilities
- Construction of future sanitary landfill facilities (Stage 1)

3.5.3 Intermediate Treatment and 3R Promotion Plan

(1) Short-Term Plan (2016-2018)

- Implementation of IEC (Information, Education and Communication) campaign on intermediate treatment and 3R at source.
- Piloting of IEC campaign on resource recovery at transfer stations by GWMC.
- Implementation of simplified WACS periodically.

(2) Mid-Term Plan (2019-2024)

- Establishment of the proposed Gujranwala Central Compost Company (GCCC) and start of operation of the Central Compost Plant for composting in 2020
- Piloting IEC campaign for the resource recovery at source in some urban UCs
- Registration of waste pickers and recycling industries

(3) Long-Term Plan (2025-2030)

- Enlargement of construction works for the Gujranwala Central Compost Plant (GCCP) for compost and additionally RDF production in 2029 and start of the plant operation from 2030
- Piloting IEC campaign on the resource recovery at source in some peri-urban UCs

3.5.4 Environmental Education and Public Awareness Raising Plan

(1) Short-Term Plan (2016-2018)

- Strengthening of coordination among relevant bodies, i.e., education board, school officials, area representatives and other relevant bodies
- Enhancement of the knowledge/awareness of teachers and students in primary schools on SWM and 3R.
- Enhancement of the knowledge/awareness of general public on SWM and promotion of 3R
- Start of operation of environmental education facility

(2) Mid-Term Plan (2019-2024)

- Maintenance and expansion of the coordination capacity among relevant bodies, i.e., education board, school officials, area representatives, and other relevant bodies.
- Continuance and expansion of knowledge and awareness raising among teachers and students

in primary schools in SWM and 3Rs.

- Continuation and expansion of knowledge and awareness raising efforts of general public on SWM and 3Rs.
- Continuation and enhancement of the environmental education facility.

(3) Long-Term Plan (2025-2030)

- Attainment of proper coordination through the establishment
- Attainment of proper training system
- Attainment of proper awareness creation system

3.5.5 Economic and Financial Plan

(1) Short-Term Plan (2016-2018)

- Preparation of the cost recovery strategies for sustainable SWM services by partially recovering the operation and maintenance cost together with subsidies or financial support from stable financial resources of the provincial government.
- Establishment of the short-term financial performance monitoring system through a wide range of financial key performance indicators to monitor costs, revenues and cost recovery rates during the short-term period.
- Accurate identification of the operation and maintenance cost for SWM services for the planned cost recovery strategies.
- Preparation for the future introduction of the proper tariff charging system to secure the stable revenue to cover the operation and maintenance cost for SWM services based on the survey results of the willingness to pay of users.
- Preparation for the partial involvement of the private sector through the service contract for the collection and transportation services in limited service areas.

(2) Mid-Term Plan (2019-2024)

- Updating of the cost recovery strategies for sustainable SWM services by partially recovering the operation and maintenance cost together with subsidies or financial support from stable financial resources of the provincial government.
- Commencement of negotiations for requesting the provincial government to provide subsidies or revenues from the property tax to fund the gap between the collected user charges and the required operation and maintenance cost.
- Establishment of the financial mid-term performance monitoring system through a wide range of financial key performance indicators to monitor costs, revenues and cost recovery rates during the mid-term period.
- Establishment of the independent cost accounting system and accurate updating of the operation and maintenance cost for SWM services for the planned cost recovery strategies.
- Preparation for the future introduction of the proper tariff charging system by various activities for raising the public awareness of users, thereby increasing the willingness to pay for the tariff.
- Preparation for the partial involvement of the private sector through the service contract for the collection and transportation services in limited service areas.

(3) Long-Term Plan (2025-2030)

- Achievement of the partial self-cost recovery for the operation and maintenance cost of SWM services by actually collected user charges from 2025.

- Establishment of the financial long-term performance monitoring system through a wide range of financial key performance indicators to monitor costs, revenues and the cost recovery rates during the long-term period.
- Accurate updating of the operating cost and maintenance cost for SWM services for the planned cost recovery strategies.
- Partial and test introduction of the selected new user charge system in limited service areas in addition to the stable financial sources from the property taxation system of the provincial government from 2025.
- Full-scale introduction of the selected new user charge system in all service areas in addition to the stable financial sources from the property taxation of the provincial government from 2028.
- Partial involvement of the private sector through the service contract for the collection and transportation services in limited service areas from 2028.

3.5.6 Environmental and Social Considerations

(1) Short-Term Plan (2016-2018)

- Commencement of environmental monitoring for waste collection and transport work.
- Commencement of environmental monitoring in Bhakhlaywali.
- Commencement of environmental monitoring including post-closure monitoring in Gondlanwala and Chianwali disposal sites.

(2) Mid-Term Plan (2019-2024)

- Continuation of environmental monitoring of waste collection and transport work.
- Continuation of environmental monitoring in Bhakhlaywali, Gondlanwala and Chianwali disposal sites.
- Commencement of environmental monitoring for the composting facility.

(3) Long-Term Plan (2025-2030)

- Continuation of environmental monitoring for waste collection and transport work.
- Continuation of environmental monitoring in Bhakhlaywali, Gondlanwala and Chianwali disposal sites.
- Continuation of environmental monitoring for the composting facility.

3.5.7 Institutional Strengthening and Organisational Plan

(1) Short-Term Plan (2016-2018)

- Restructuring of GWMC in order to enhance its capacity in Complaint Management, Awareness Raising, Intermediate by the end of 2016.
- Strengthening of the technical and managerial capacities of the candidate staff of the new public-owned corporation with the support of external technical cooperation through implementation of a comprehensive capacity development programme during the 3-year period from 2016 to 2018.
- Establishment of Gujranwala Solid Waste Management By-Law in English as well as in Urdu.
- Establishment of efficient and reliable private sector involvement scheme for the collection and transportation services, and the construction and management of sanitary landfill sites and intermediate treatment facilities through the new public corporation for SWM.

(2) Mid-Term Plan (2019-2024)

- Improvement of the organisational structure of GWMC based on feedback of results of the mid-term performance monitoring and assessment.
- Improvement of staff capacities of GWMC based on feedback of results of the mid-term performance monitoring and assessment of the capacity development programme.
- Implementation of public awareness raising activities in terms of the Gujranwala Solid Waste Management By-law especially with emphasis on rules residents must follow and cost of solid waste management.

(3) Long-Term Plan (2025-2030)

- Improvement of the organisational structure of GWMC based on the feedback of results of the long-term performance monitoring and assessment.
- Improvement of staff capacities of GWMC based on the feedback of results of the long-term performance monitoring and assessment on the capacity development programme.
- Implementation of public awareness raising activities in terms of the Gujranwala Solid Waste Management By-law especially with emphasis on rules residents must follow and cost of solid waste management.

CHAPTER 4. FORMULATION OF THE MASTER PLAN

4.1 Introduction

This **Chapter** presents the formulation of the Integrated Solid Waste Management (ISWM) Master Plan together with the technical options and institutional and financial arrangements. The first two sections, **Section 4.2** and **Section 4.3,** present the socioeconomic aspects such as population and economic projection including social conditions, and the conditions of waste generation and composition from the present situation to the target year 2030. Based on these basic conditions, master plan alternatives are developed based on combination of some of preferable options for the four (4) strategic components of the ISWM Master Plan, namely; (1) the waste collection and transportation plan; (2) the final disposal plans; (3) the intermediate treatment and 3R promotion plan; and (4) the environmental education and public awareness raising plan, as discussed in **Section 4.4**. The evaluation of these alternatives is then carried out and the optimum master plan is selected in **Section 4.5**. Finally, the optimum master plan is evaluated by technical points of view, economic and financial analysis, institutional and organisational aspects, and environmental and social considerations, are explained in **Section 4.6**.

4.2 Socioeconomic Aspect

4.2.1 Population Projection

(1) Past Spatial Development and Population in Gujranwala

Information of the past spatial development and population of Gujranwala were obtained from the Proposed Peri Urban Structure Plan Gujranwala City. **Figure 4.2.1** shows the pictorial developed area from 1914 to 2009. The early stage development occurred in the west side of the city. Development of east side of the city took place after 1950s. Nowadays, the built-up area is expanded in the north-west side of the city and the north and south areas along the G.T. Road. The Proposed Peri Urban Structure Plan Gujranwala City shows the past population as shown in **Figure 4.2.2.** This graph shows a rapid growth of population from 224 thousand in 1971 to 1.13 million in 1998.

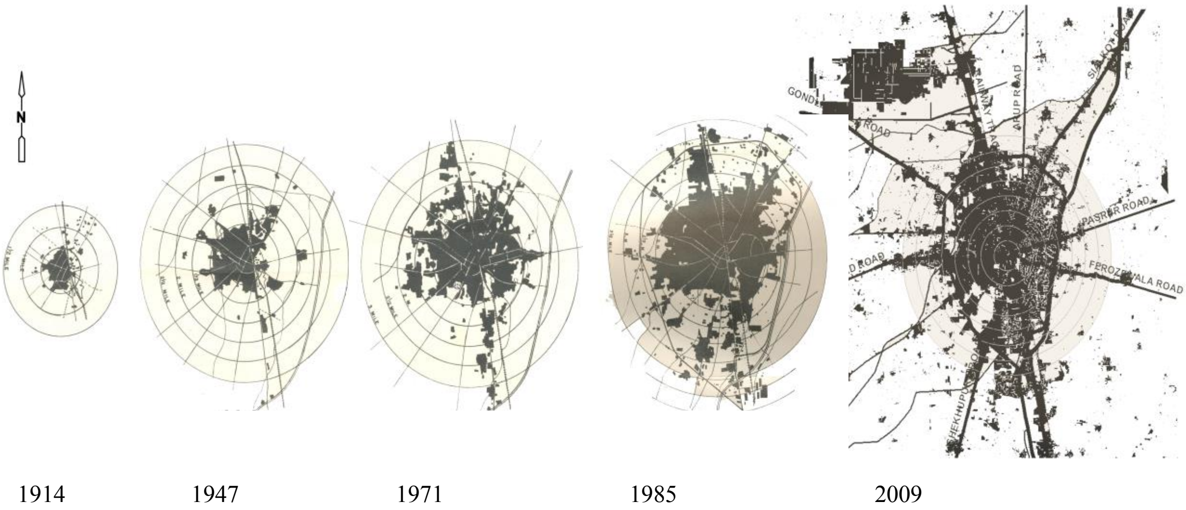


Figure 4.2.1 Gujranwala Historical Growth (Built-up Area)

Source: Proposed Peri-Urban Structure Plan Gujranwala City (Modified by JICA Project Team)

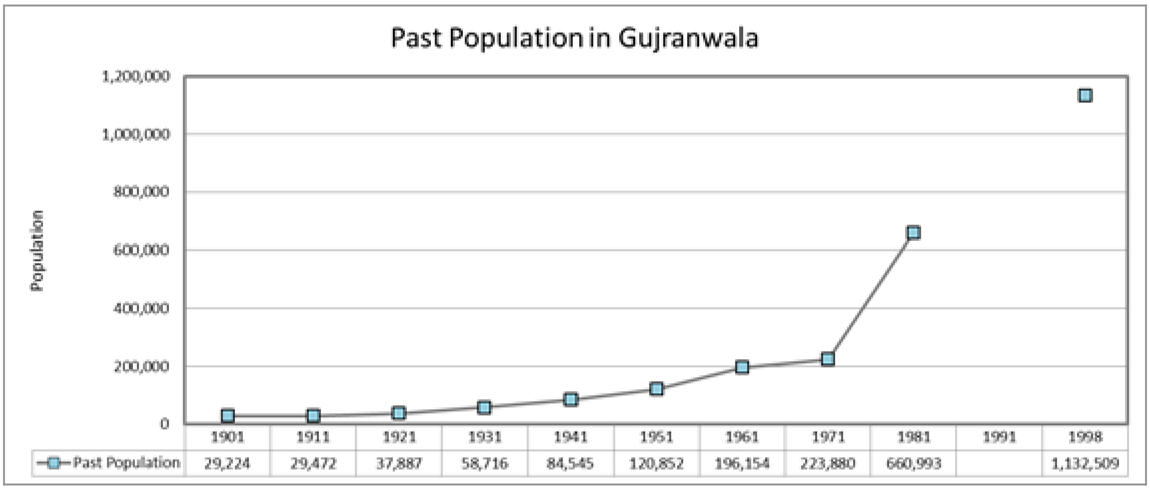


Figure 4.2.2 Past Population in Gujranwala (1901-1998)

Source: Proposed Peri-Urban Structure Plan Gujranwala City (Modified by JICA Project Team)

(2) Population Census in 1998

The available latest population statistics is only those of the national census conducted in 1998. According to the population census 1998, the population of 64 urban UCs and peri-urban UCs is approximately 1.13 million and 0.61 million, which cover the area of the ISWM Master Plan, as shown in **Table 4.2.1** and the total population is 1.74 million in 1998.

Table 4.2.1 Town-wise Population in the Area of ISWM Master Plan (1998 Census)

Type of Area	Town	Number of Union Councils	Census Population in 1998
Urban	Qila Dedar Singh	19	337,348
	Aroop	17	254,329
	Khiali Shah Pur	13	276,132
	Nandi Pur	15	264,700
Total of 64UCs		64	1,132,509
Peri-Urban	Qila Dedar Singh	6	101,488
	Aroop	8	217,500
	Khiali Shah Pur	12	154,715
	Nandi Pur	8	138,391
Total of 34UCs		34	612,094
Total of 98 Ucs		**98**	**1,744,603**

Source: Population Census 1998

(3) Projection of Future Population in 98 UCs

According to the population growth rate obtained from the CDGG, the population growth rate in 1981-1998 is estimated at 3.79 % per year. Meanwhile, the population growth rate in the Punjab Province during the same period is estimated at 2.64%.[*1] UU and LWMC carried out population projection in connection with formulation of the outsourcing plan of waste collection services in 64 UCs of Gujranwala.[*2]. The population projection in the report is carried out for the city area in 64 UCs for the period of 2012-2019. By analysing the projected population, the annual growth rate is obtained at 3.2%. Considering the rapid growth of the city in the recent years, the annual population growth rate at 3.79% is adopted for estimation of future population for the Project. Population projection is carried out based on the population census in 1998 for the base year.

Table 4.2.2 shows the summary of the population projection. As a result of population projection, the total population in 64 uban UCs and 34 peri-urban UCs increase from 3.2 million in 2014 to 5.7 million in 2030. **Figure 4.2.3** shows the projected population in comparison with the said projected population by UU.

Note: [*1]Demographic Indicators-1998 Census
http://www.pbs.gov.pk/sites/default/files/tables/DEMOGRAPHIC%20INDICATORS%20-%201998%20CENSUS.pdf
[*2]LWMC, Planning & Design of Proposed SWM System in Gujranwala City, Draft Report, pp. 50-53.

Table 4.2.2 Projected Population in the Area of ISWM Master Plan in Gujranwala

Urban UC Peri-Urban UC	Census Population in 1998	Estimated Population in 2014	Estimated Population in 2018	Estimated Population in 2020	Estimated Population in 2024	Estimated Population in 2030
Urban UC						
Qila Dedar Singh	337,348	611,739	709,886	764,715	887,404	1,109,314
Aroop	254,329	461,194	535,188	576,524	669,020	836,320
Khiali Shah Pur	276,132	500,732	581,068	625,948	726,374	908,015
Nandi Pur	264,700	480,001	557,012	600,033	696,301	870,423
Total-64 UCs	*1,132,509*	*2,053,666*	*2,383,153*	*2,567,219*	*2,979,099*	*3,724,072*
Peri-Urban UC						
Qila Dedar Singh	101,488	184,036	213,562	230,057	266,967	333,727
Aroop	217,500	394,410	457,688	493,038	572,140	715,213
Khiali Shah Pur	154,715	280,557	325,569	350,714	406,982	508,755
Nandi Pur	138,391	250,955	291,218	313,711	364,042	455,076
Total-34 UCs	*612,094*	*1,109,957*	*1,288,037*	*1,387,520*	*1,610,132*	*2,012,772*
Total-98 UCs	**1,744,603**	**3,163,624**	**3,671,190**	**3,954,739**	**4,589,231**	**5,736,843**

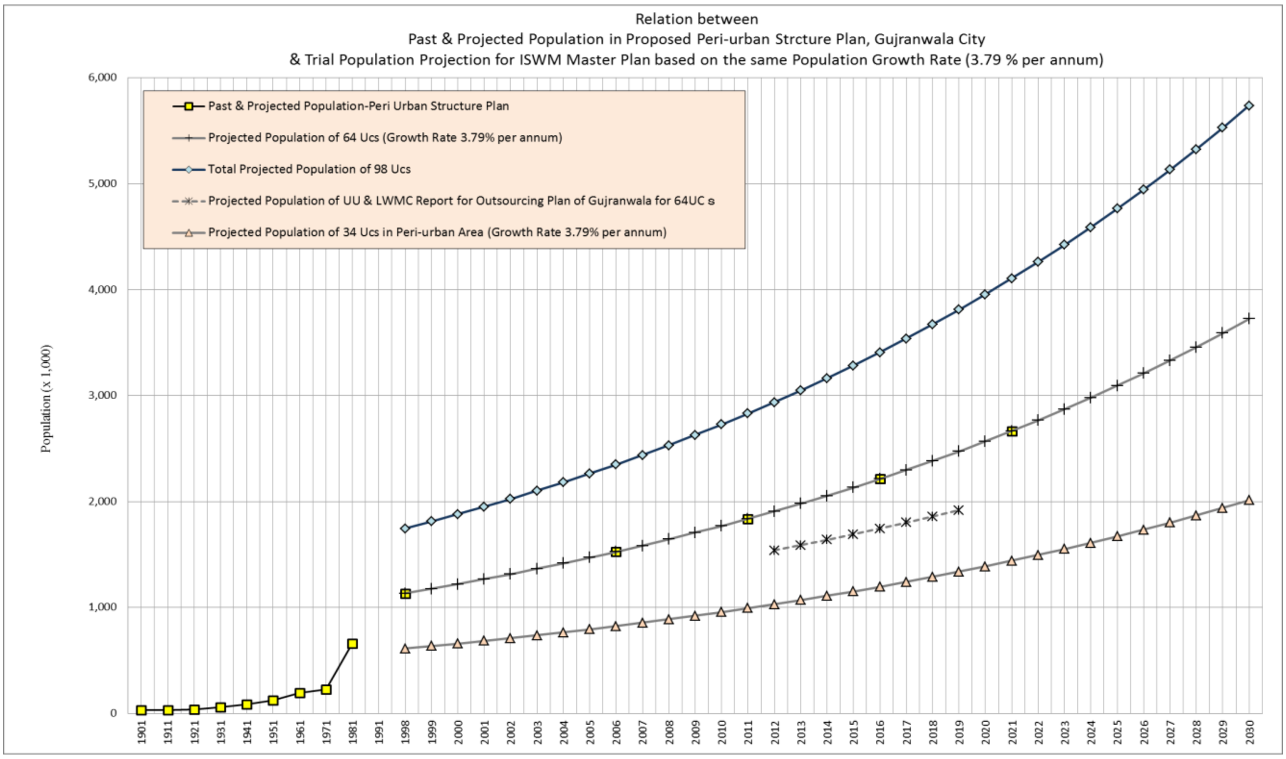


Figure 4.2.3 Past Population (1901-1998) and Projected Population (1999-2030)

(4) Adjustment of Future Population in the Project Area of 98 UCs

Peri-urban boundary line crosses the areas of 18 Peri-urban UCs and splits each UC area into inside/outside of the Project Area as shown in **Figure 4.2.4.** Adjustment was made with the projected population of the whole area of each UC by proportion of inside/outside areas. **Table 4.2.3** shows the adjusted population in the Project Area. As shown in the table, the total population of 3.0 million in 2014 increase up to 5.3 million in 2030, which is 1.8 times of the population after 16 years.

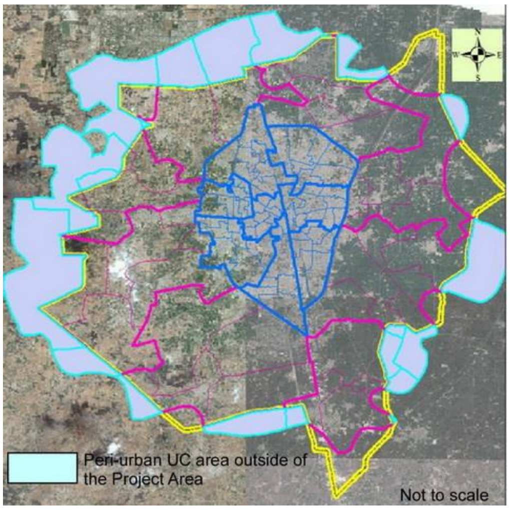


Figure 4.2.4 Peri-urban UCs Split into Inside and Outside of the Project Area

Table 4.2.3 Estimated Population in the Project Area for ISWM Plan (unit: 1,000 persons)

UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Urban UCs	2,054	2,132	2,212	2,296	2,383	2,473	2,567	2,665	2,766	2,870	2,979	3,092	3,209	3,331	3,457	3,588	3,724
Peri-urban UCs	910	944	944	980	1,017	1,056	1,096	1,137	1,180	1,225	1,272	1,320	1,370	1,422	1,476	1,531	1,589
Total Project Area	**2,964**	**3,076**	**3,157**	**3,276**	**3,400**	**3,529**	**3,663**	**3,802**	**3,946**	**4,095**	**4,251**	**4,412**	**4,579**	**4,752**	**4,933**	**5,120**	**5,313**

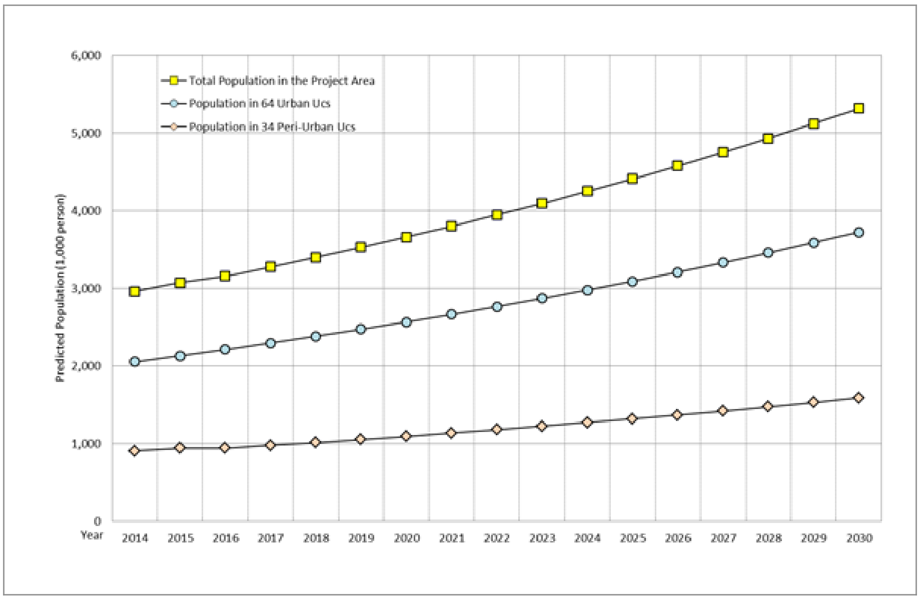


Figure 4.2.5 Trend of Estimated Population in the Project Area for ISWM Plan

4.2.2 Economic Projection

Pakistan's economic record during 2009-2013 was stagnant. The GDP real growth rate appeared to have been the slowest of any five-year period in the last century. Inflation had clearly accelerated during the same period. **Table 4.2.4** shows the real GDP growth rate, the inflation rate and the nominal GDP growth rate of Pakistan, respectively. Meanwhile, Punjab's regional economy had increased at a much slower pace than the rest of Pakistan over the period from 2007 to 2011, according to the estimates of the Institute of Public Policy. Punjab's average real GDP growth rate of 2.5 per cent between 2007 and 2011 lags far behind 3.4 per cent for the rest of Pakistan. The shortfall experienced in Punjab during the same period compared with the rest of Pakistan is mainly due to the irregular agricultural production which is the major sector of Punjab. Nevertheless, for the long-term perspective, the real GDP growth rates for the nation-wide Pakistan and Punjab have been growing at the almost same pace. **Table 4.2.5** and **Table 4.2.6** indicate the comparison of the long-term past GDP real growth rate record among Punjab, the rest of Pakistan and Pakistan during 1973-2000 and 2000-2011, respectively. It was revealed that the GDP real growth rates of Punjab and the nation-wide Pakistan are almost same during the past long-term record during 1973-2000 and the recent record during 2000-2011.

Table 4.2.4 GDP Real Growth Rate, Inflation Rate and Nominal GDP Growth Rate per Annum of Pakistan during 2009-2013

Indicator	2009	2010	2011	2012	2013 (Provisional)
Real GDP Growth Rate per Annum (%)	0.4	2.6	3.7	4.4	3.6
Inflation Rate per Annum (%)	17.0	10.1	13.7	11.0	7.4
Nominal GDP Growth Rate per Annum (%)	17.4	12.7	17.4	15.4	11.0

Source: Seventh Annual Report, the State of the Economy: Challenges and Response by Institute of Public Policy (2014)

Table 4.2.5 Comparison of GDP Real Growth Rate Record among Punjab, Rest of Pakistan and Pakistan during 1973-2000

Year	Punjab (%)	Rest of Pakistan (%)	Pakistan (%)
1973-1980	4.3	3.8	4.1
1980-1990	6.0	6.3	6.1
1990-2000	4.8	3.9	4.4
1973-2000	5.1	4.8	5.0

Source: Fifth Annual Report, the State of the Economy: Punjab Story by Institute of Public Policy (2012)

Table 4.2.6 Comparison of GDP Real Growth Rate Record among Punjab, Rest of Pakistan and Pakistan during 2000-2011

Year	Punjab (%)	Rest of Pakistan (%)	Pakistan (%)
2000-2006	6.9	7.8	7.4
2007-2011	3.3	1.6	2.3
2000-2011	5.6	5.5	5.5

Source: Fifth Annual Report, the State of the Economy: Punjab Story by Institute of Public Policy (2012)

Based on the above presumption, the IMF's macroeconomic medium-term projections are employed to provide the economic growth perspective which is the basis for the population projection of the master plan, as discussed in the preceding **Subsection 4.2.1**. **Table 4.2.7** indicates the IMF's mid-term macroeconomic framework for Pakistan. The annual GDP real growth rates for the long-term period are estimated at 5.0 per cent per annum. These real GDP growth rates per annum starting from 2016 are employed to estimate the projection of the population used for the master plan.

Table 4.2.7 IMF's Medium-Term Macroeconomic Framework

Indicator	2014	2015	2016	2017	2018	2019-
Real GDP Growth Rate per Annum (%)	3.1	3.7	3.9	4.7	5.0	5.0
Inflation Rate per Annum (%)	8.8	9.0	7.0	6.0	6.0	6.0
Nominal GDP Growth Rate per Annum (%)	11.9	12.7	10.9	10.7	11.0	11.0

Source: Seventh Annual Report, the State of the Economy: Challenges and Response by Institute of Public Policy (2014)

4.2.3 Social Consideration

According to **Chapter 2**, six categories of problems are summarised in terms of Environmental and Social Consideration, such as Law and Regulation, EIA Process, SEA, Public Disclosure, Environmental Monitoring, and Workers in Risk. These six issues must be considered for formulation of Master Plan and implementation of the Action Plan.

Laws and Regulations: There are some possibilities of ignorance of social issues in the landfill site and its vicinity because only limited issues related with social environment are mentioned in Pakistan laws and regulation in terms of waste management. Loss of ignorance of social issues, such as ignorance of stakeholders' opinion, will reveal no cooperation from stakeholders. The situation could be negative impact to the whole progress of formulation the master plan. To consider social issues, the JICA Guidelines for Environmental and Social Considerations will be referred.

EIA Process: Construction of new landfill site can be started only if its EIA report is approved. Delay of EIA approval will reveal illegal dumping. Some effort is already made to make the EIA approval process shorter. However, since delay of EIA approval is obvious, some measures should be carried out to avoid illegal dumping.

SEA: Since Strategic Environmental Assessment (SEA) is not a legal requirement in Pakistan, the JICA Guidelines for Environmental and Social Considerations will be referred to in the formulation of the Master Plan.

Public Disclosure: Public disclosure should be one of the important components in the formulation of the Master Plan. According to opinions of stakeholders, most of the respondents recognise that having a disposal site is beneficial for future Gujranwala. However, they are anxious about adverse impact such as health risk and environmental pollution. The information must be explained sufficiently. If complaints and anxiousness were not solved, it reveals that residents had built a sense of distrust to GWMC, and finally they will become reluctant to cooperate with GWMC. Programmes of public inclusion such as public meetings and awareness programmes shall be considered in the formulation of the Master Plan.

Environmental Monitoring: For long-term environmental and friendly waste management, establishment of a monitoring system is one of the important components of the Master Plan. Attention and effort should be paid for implementation of regular environmental monitoring in the formulation of the Master Plan. The result of Environmental and Social Consideration Survey in Gondlanwala and Chianwali (see **Subsection 2.8.4**) shows that no regular environmental monitoring had been carried out.

Environmental monitoring is applied not only in the operational stage but also after closure of the disposal site, since the Punjab Municipal Solid Waste Management Guideline of 2011 shows "A plan for monitoring groundwater, surface water and landfill gas, erosion and settlement for a minimum post-closure period of 25 years."

Workers in Risk: Waste pickers should be involved in the official process of solid waste management. Currently, they are working in severe condition with dangerous environment and health risk, and their activities sometimes hinder management of GWMC. In the Master Plan, it is proposed that waste pickers are involved in the official process of solid waste management. They can be involved in the various programmes for sorting recyclable materials at the controlled area or in organic waste composting. Trying to get rid of waste pickers will result in failure according to the past examples in many developing countries. Waste pickers should be involved as a part of the waste management system. It would be benefit both Gujranwala and themselves.

4.3 Present and Future Waste Composition and Composition

Future waste generation amount will be predicted based on the various factors and waste management stream including service population, collection service ratio, per capita waste generation amount, recovery amount of recyclable materials, etc. This section presents the study about those factors for prediction of future waste generation amount to provide basic data and solid waste management flow to formulate the ISWM Master Plan comprised of collection and transportation plan, intermediate and 3R promotion plan, final disposal plan and other soft components.

4.3.1 Relation between Waste Collection Amount and Waste Generation Amount

The relation between current waste collection amount and waste generation amount is examined based on the results of waste amount and composition survey and incoming waste amount and composition survey which were carried out in the course of the Project. The step-wise study is carried out in accordance with the flow chart shown in **Figure 4.3.1** and described in the following subsections.

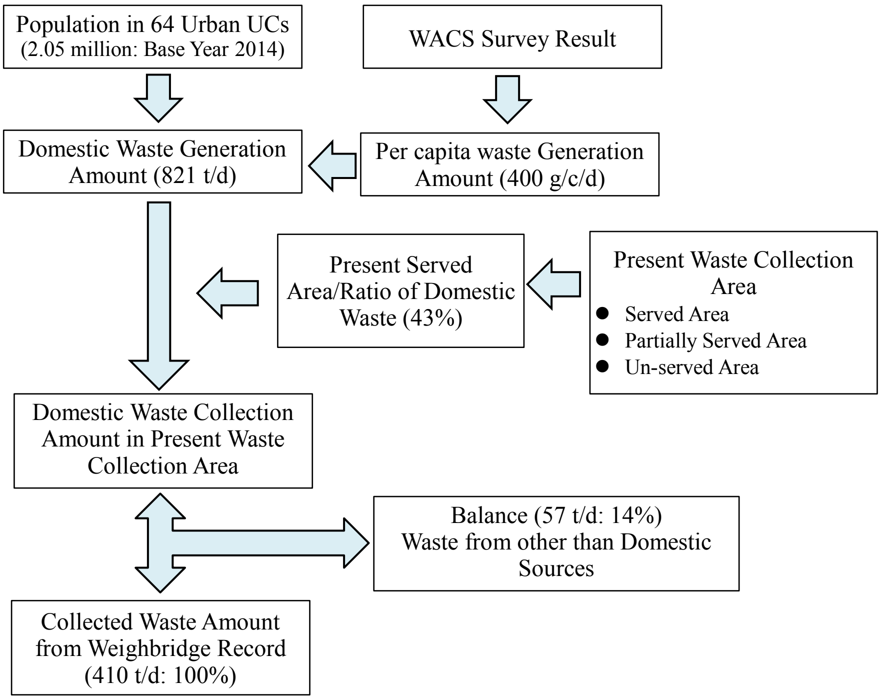


Figure 4.3.1 Flowchart for Confirmation of Present Waste Amount (2014)

(1) Per Capita Waste Generation Rate in 2014

WACS survey was carried out at the areas categorised as high income group area, middle income group area and low income group area in 64 urban UCs and rural area in peri-urban UCs. Weight of the samples discharged from 20 households of each income group for 7 days were processed and converted by the family size of each household to obtain the per capita waste generation amount. The information on the population of each income groups was not available. Therefore the survey was conducted together with the sanitary supervisor of each UC to categorise the 64 urban UCs into each income group areas. **Table 4.3.1** summarises the survey result for the numbers of UCs categorised into three income groups. From this result, the ratio of 10%, 60% and 30% were set for the high income group, middle income group and low income group, respectively.

Table 4.3.1 Income Group Ration in 64 Urban UCs

Income Level	No. of UCs	Ratio (%)	Adopted Ratio (%)
High Income Group UCs	6	9.4	10
Middle Income Group UCs	36	56.2	60
Low Income UCs	22	34.4	30
Total	64	100.0	100

The domestic waste generation ratio of each income group was processed by the weight of the number of UCs to obtain the average per capita waste generation rate of 64 urban UCs. **Table 4.3.2** summarises the domestic waste per capita waste generation rate of the first and second waste amount survey for each income group and the weighted average. As a result, the per capita waste generation rate for 64 urban UCs is adopted at 0.40 kilogram per capita per day (kg/c/d) and 0.35 kg/c/d for the peri-urban UCs for estimating waste generation amount for the base year 2014.

Table 4.3.2 Adopted Per Capita Domestic Waste Generation Rate in 2014

Area Category	Per Capita Waste Generation Amount from WACS Survey (kg/capita/day)				
	Result of 1st WACS Survey	Result of 2nd WACS Survey	Average	Income Group Ratio	Weighted Average
High income area	0.46	0.45	0.46	10%	0.40
Middle income area	0.41	0.36	0.39	60%	
Low income area	0.40	0.40	0.40	30%	
Rural area	0.33	0.36	0.35	100%	0.35

(2) Daily Average Waste Collection Amount at Gondlanwala Temporary Disposal Site

GWMC carries out waste collection services within the area of 64 urban UCs and collection service in 34 peri-urban UCs is basically not carried out at present. GWMC started weighing incoming waste amount at Gondlanwala temporary disposal site since September 2014 by the weighbridge equipment installed by the Project. According to the analysis of daily incoming waste amount tabulated in **Table 4.3.3**, the average daily incoming waste amount during the last 6 months are obtained at 410 tons per day, which are collected from domestic (households), commercial, business, institutional and other waste generation sources.

Table 4.3.3 Daily Average Regular Time Waste Collection Amount (Sep.2014 - Feb.2015)

Month-Year	Breakdown of Incoming Waste Amount at Gondlanwala Disposal Temporary Site (t/d)		
	Total Waste Amount	Regular Collection Service	One Time Collection Service
September - 2014	439	428	11
October - 2014	540	373	167
November - 2014	423	371	52
December - 2014	419	368	51
January - 2015	493	451	42
February - 2015	517	469	48
Average	472	410	62

(3) Waste Collection Area and Service Population

As discussed previously in **Subsection 2.3.2**, GWMC demarcated the entire area of 64 urban UCs into served area, partially served area and unserved area through the field survey and the interview to the sanitary supervisors of each UC. The result of demarcation work in town-wise area and ratio is as shown is **Table 4.3.4.** In order to determine the regular waste collection service area, assumption was made based on the current operation condition that the collection service has been carried out once in a week (1 time per 7 days) more or less in the partial collection service area and adjusted the regular collection service area. As a result, the served area adjusted by conversion of the partially served area to served area for every 4 towns, i.e., Qila Deedar Singh, Khaiali Shahpur, Aroop and Nandipur is calculated at 35%, 27%, 40% and 69%, respectively. Consequently, the present waste collection area or served population is estimated at 43% for domestic waste for the average of these percentages.

Table 4.3.4 Demarcation of Waste Collection Service Area (March 2014)

Name of Town	Served Area (km^2) (1)	Partially Served Area (km^2) (2)	Unserved Area (km^2) (3)	Total Area (km^2) (4)	Converted Served Area (km^2) (5) = (2) / 7	Adjusted Served Area (km^2) (6) = (1) + (5)
Qila Deedar Singh	2.5	6.1	1.0	9.6	0.9	3.4
(%)	(25.9)	(63.6)	(10.5)	(100.0)	(9)	(35)
Khiali Shahpur	3.5	13.4	3.0	19.8	1.9	5.4
(%)	(17.5)	(67.4)	(15.0)	(100.0)	(10)	(27)
Aroop	8.6	4.6	10.1	23.4	0.7	9.3
(%)	(37.0)	(20.0)	(43.0)	(100.0)	(3)	(40)
Nandipur	8.0	2.5	1.7	12.2	0.4	8.4
(%)	(65.6)	(20.8)	(13.6)	(100.0)	(3)	(69)

Note: Totals may neither become 100% nor always be equal to the sum of the subjected column or row due to rounding off to the first decimal point.

(4) Estimation of Present Waste Generation Amount, Domestic and Commercial Wastes

The population in 64 urban UCs is estimated at 2.05 million, approximately. Assuming that the collection service ratio is 43% as mentioned above, the served population is calculated at 882 thousand. The domestic waste amount deemed collected is estimated at 353 t/d with the relation between the said service population and the per capita waste generation rate at 400 g/c/d. On the other hand, as mentioned before, the collected and transported waste amount carried into the final disposal site is determined at 410 t/d. Accordingly, the balance between the collected domestic waste amount of 353 t/d and the total waste disposal amount of 410 t/d is considered as the waste from other than domestic source such as commercial, business and institutional waste generators. Based on this result, the present domestic waste ratio and commercial and institutional waste ratio is determined at 86% and 14%, respectively, to the total waste collection and transportation amount for further analysis to predict the future waste amount.

4.3.2 Estimation of Future Waste Generation Amount

Waste generation amount in the Project Area is carried out separately for domestic waste, and commercial and institutional waste in 64 urban UCs and peri-urban UCs based on the step-wise works as shown in **Figure 4.3.2**.

Estimation of domestic waste generation amount is carried out based on the estimated future population in the Project Area presented in **Section 4.1,** Population Projection and the per capita waste generation rate. The per capita waste generation rate tends to increase depending on the economic development and increase of disposal income of each individual. On the other hand, the per capita waste generation rate decrease depending on the implementing status of 3R programmes proposed in the ISWM Master Plan. In fact, the present waste generation rate per capita per day at 400 g/c/d in 64 Urban UCs and 350 g/c/d in the peri-urban UCs are still low level as compared with that of the neighbouring developing countries. Considering the said situations, the minimum increase ratio of 1 % per annum is assumed for the per capita waste generation rate. As a result, the per capita waste generation rate in 64 urban UCs and 34 peri-urban UCs are as summarised in **Table 4.3.5**.

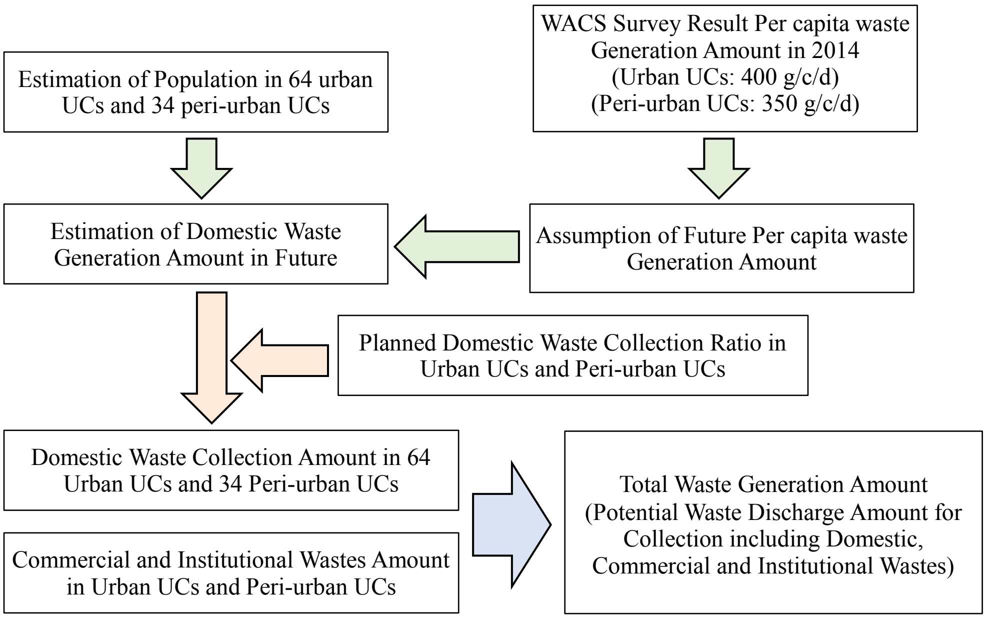


Figure 4.3.2 Flowchart for Estimating Future Waste Generation Amount

Table 4.3.5 Per Capita Domestic Waste Generation Rate

(Unit: g/c/d)

UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Urban UCs	400	404	408	412	416	420	424	428	432	436	440	444	448	452	457	462	467
Peri-urban UCs	350	354	358	362	366	370	374	400	404	386	390	394	398	402	406	410	414

Under this Project, the waste amount of commercial, business, institutional and other sources are estimated in the relation of collection amount and the ratio to the domestic waste. **Table 4.3.6** shows the planned domestic waste collection ratio which was determined after several discussions among the parties concerned. The waste collection ratio of 64 urban UCs was set at 100% in 2018 and the collection ratio of 34 peri-urban UCs was determined to start with 10% in 2019 and set the target to reach 100% in 2030. Meanwhile, the mixed ratio of commercial and institutional wastes to domestic waste collection amount is determined at 14% in 2014 for the area of 64 urban UCs. With regard to the mixed ratio of 34 peri-urban UCs at 12%, it was determined by the relation of per capita waste generation ratio in each area and the said mixed ratio in the area of 64 urban UCs. In addition, the economic growth in the area brings about more discharge amount of commercial and business wastes. It is assumed that the growth of mixed ratio of commercial waste will become double in the final target year of the Project in 2030 as summarised the mixed ratio of commercial and institutional waste in **Table 4.3.7.**

Table 4.3.6 Planned Domestic Waste Collection Ratio

(Unit: %)

UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Urban UCs	43	57	71	85	100	100	100	100	100	100	100	100	100	100	100	100	100
Peri-urban UCs	0	0	0	0	0	10	20	30	40	50	60	67	73	80	87	93	100

Table 4.3.7 Commercial and Institutional Waste Ratio to Domestic Waste Amount for Collection

(Unit: %)

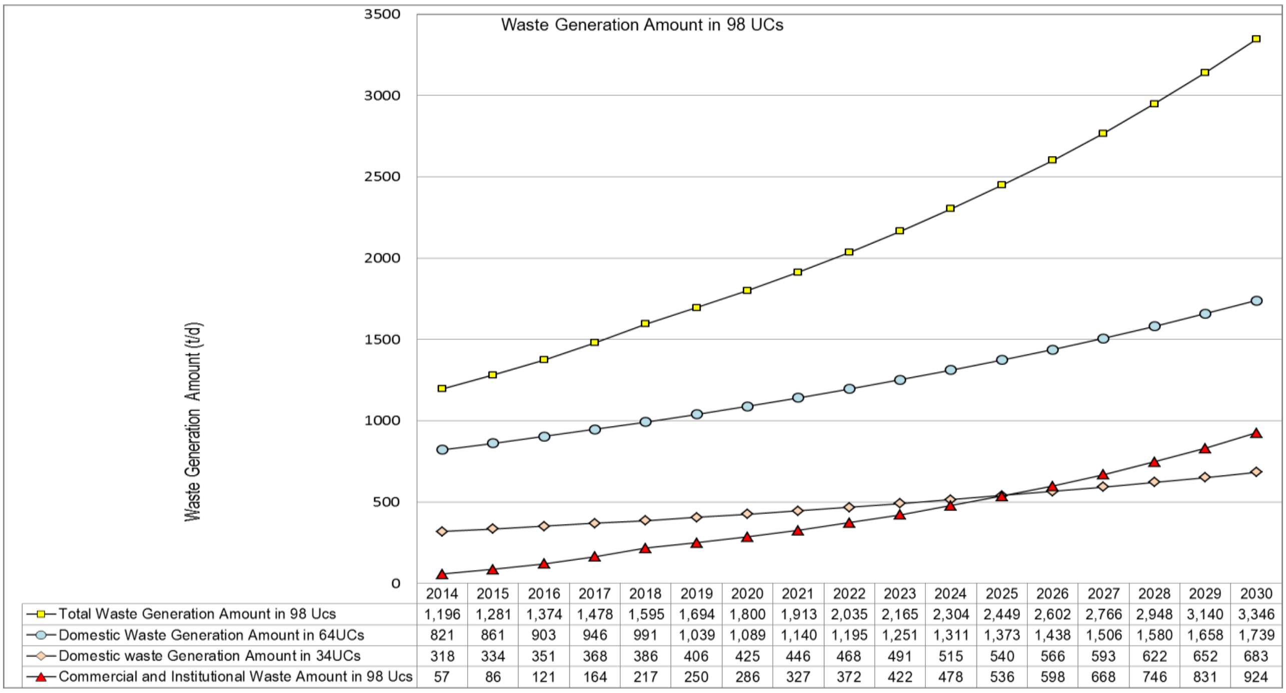
UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Urban UCs	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Peri-urban UCs	12	13	14	15	16	17	17	18	19	20	21	22	23	24	24	25	26

The future waste generation amount is estimated by the factors mentioned above, and summarised in **Table 4.3.8** and in **Figure 4.3.3**. As a result of the estimation of future waste generation amount in the Project Area, the present waste amount of 1,196 t/d in 2014 will increase up to 3,346 t/d in 2030 which is approximately 2.8 times of the present waste amount.

Table 4.3.8 Estimated Waste Generation Amount in the Project Area

(Unit: t/d)

UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Domestic 64 UCs	821	861	903	946	991	1,039	1,089	1,140	1,195	1,251	1,311	1,373	1,438	1,506	1,580	1,658	1,739
Domestic 34 UCs	318	334	351	368	386	406	425	446	468	491	515	540	566	593	622	652	683
Commercial	57	86	121	164	217	250	286	327	372	422	478	536	598	668	746	831	924
Total Project Area	1,196	1,281	1,374	1,478	1,595	1,694	1,800	1,913	2,035	2,165	2,304	2,449	2,602	2,766	2,948	3,140	3,346



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total Waste Generation Amount in 98 Ucs	1,196	1,281	1,374	1,478	1,595	1,694	1,800	1,913	2,035	2,165	2,304	2,449	2,602	2,766	2,948	3,140	3,346
Domestic Waste Generation Amount in 64UCs	821	861	903	946	991	1,039	1,089	1,140	1,195	1,251	1,311	1,373	1,438	1,506	1,580	1,658	1,739
Domestic waste Generation Amount in 34UCs	318	334	351	368	386	406	425	446	468	491	515	540	566	593	622	652	683
Commercial and Institutional Waste Amount in 98 Ucs	57	86	121	164	217	250	286	327	372	422	478	536	598	668	746	831	924

Figure 4.3.3 Trend of Estimated Waste Generation Amount in the Project Area (unit: t/d)

4.3.3 Domestic Waste Composition

The following **Table 4.3.8** shows the domestic waste composition of the second WACS. The values are obtained by processing the waste composition result of high income group, middle income group and low income group by the weight of each population size as well as the method adapted to the calculation of the average waste generation rate per capita per day. These values are studied to consider 3R and intermediate treatment as described in the following paragraph.

Each component of domestic waste composition was categorised for consideration material recovery, composting and RDF treatment as shown in **Table 4.3.9.** The total recyclable materials ratio is 26.5% and the clean recyclable takes 5.6% which accounts for only 20% of the total recyclable materials. The ratio of biodegradable wastes, total of kitchen waste and grass and wood, accounts for 61 % which shows higher composting potential from the results of the WACS survey. The total of combustible waste takes 31 % of the domestic waste for consideration of RDF and incineration treatment as well. From the WACS survey results, the mixed ratio of resource materials for planning is proposed at 30% for material recycling, 60% for composting and 30% for RDF.

Table 4.3.9 Weighted Average of Domestic Waste Composition

Waste Composition	Ratio (%)
Kitchen waste	59.37
Paper (recyclable)	2.63
Paper (non-recyclable)	13.46
Textile	4.80
Grass and wood	1.64
Plastic (recyclable)	0.89
Plastic (non-recyclable)	7.26
Leather and rubber	0.79
Metal (recyclable)	0.21
Metal (non-recyclable)	0.01
Bottle and glass (recyclable)	1.12
Bottle and glass (non-recyclable)	0.15
Ceramic, stone and soil etc.	1.46
Domestic hazardous wastes	0.65
Sieve Remaining	3.76
Miscellaneous	1.80
Total	100.00

Table 4.3.10 3R and Intermediate Potential by Domestic Waste Composition

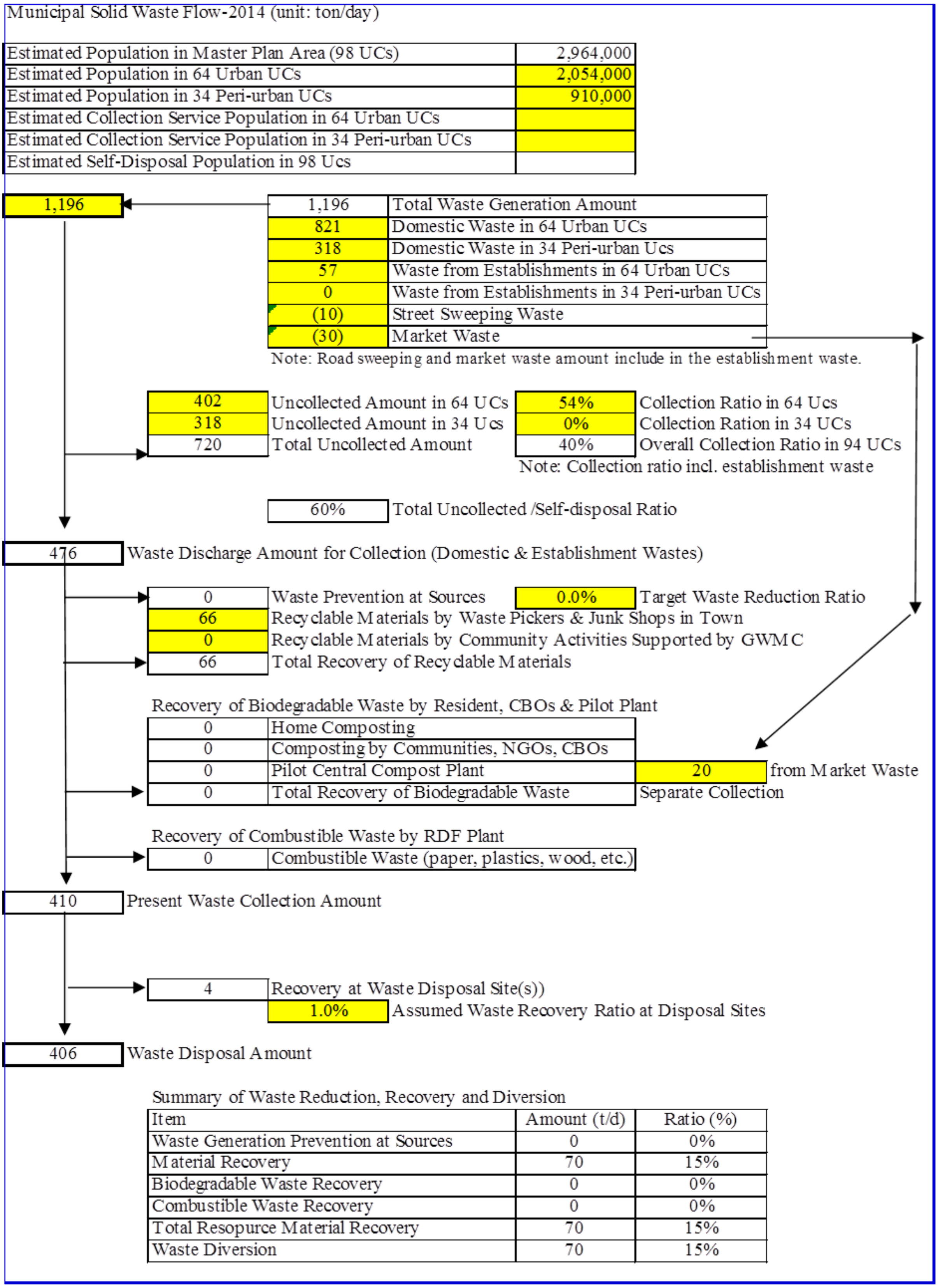
Material Recycling Potential		Composting Potential		RDF/Incineration Potential	
Component	Ratio (%)	Component	Ratio (%)	Component	Ratio (%)
Paper (recyclable)	2.63	Kitchen waste	59.37	Paper (recyclable)	2.63
Plastic (recyclable)	0.89	Grass and wood	1.64	Paper (non-recyclable)	13.46
Leather and rubber	0.79	**Total**	**61.01**	Textile	4.80
Metal (recyclable)	0.21			Grass and wood	1.64
Bottle and glass (recyclable)	1.12			Plastic (recyclable)	0.89
Subtotal (clean recyclables)	*5.64*			Plastic (non-recyclable)	7.26
Paper (Non-Recyclable)	13.46			Leather and rubber	0.79
Plastic (non-recyclable)	7.26			**Total**	**31.46**
Metal (non-recyclable)	0.01				
Bottle and glass (non-recyclable)	0.15				
Subtotal (dirty recyclables)	*20.88*				
Total Recyclable Wastes	**26.52**				
Proposed Value for Planning	**30%**		**60%**		**30%**

4.3.4 Waste Stream and Amount in Formulation of ISWM Master Plan for Gujranwala

Waste amount is estimated for each stage of waste management operation based on the waste generation, planned waste collection ratio, intermediate treatment and 3R promotion planning including recovery of recyclable materials, composting of organic waste, and final disposal. **Table 4.3.11** shows the summary of estimated waste amount in each stage of operation. As of 2014, the waste amount is estimated at 1,196 t/d for waste generation, 720 t/d for uncollected waste amount, 66 t/d for recovery amount of recyclable materials in town and at the disposal site, 410 t/d for waste collection amount and 406 t/d for final disposal after reduction of recovery of recyclable materials of 4 t/d at the disposal site. In 2015, the waste amount in each stage increases drastically as 3,346 t/d for waste generation, 0 t/d for uncollected waste amount, 602 t/d for recovery amount of recyclable materials in town, 510 t/d for intermediate treatment, 2,033 t/d for waste collection and 2,013 t/d for final disposal after reduction of recovery of recyclable materials of 20 t/d at the disposal site. The flow and waste amount in each stage for 2014, 2018, 2024 and 2030 are shown from **Figure 4.3.4** to **Figure 4.3.7**.

Table 4.3.11 Waste Amount for Major Elements in Waste Management Stream

Item	2014	2018	2024	2030
Total Waste Generation Amount (t/d)	1,196	1,595	2,304	3,346
Uncollected Waste Amount (t/d)	720	386	206	0
Waste Collection Ratio in 64 Urban UCs (%)	54	100	100	100
Waste Collection Ratio in 34 Peri-urban UCs (%)	0	0	64	100
Waste Discharge Amount for Collection (t/d)	476	1,209	2,098	3,346
Waste Generation Prevention Amount (t/d)	0	0	0	201
Recovery Amount of Resource Materials (t/d)	66	163	330	602
Intermediate Treatment Amount (Composting/RDF) (t/d)	0	0	252	510
Waste Collection Amount (t/d)	410	1,046	1,515	2,033
Recovery of Resource Materials at Disposal Site (t/d)	4	10	15	20
Waste Disposal Amount (t/d)	406	1,036	1,500	2,013



Municipal Solid Waste Flow-2014 (unit: ton/day)

Estimated Population in Master Plan Area (98 UCs)	2,964,000
Estimated Population in 64 Urban UCs	2,054,000
Estimated Population in 34 Peri-urban UCs	910,000
Estimated Collection Service Population in 64 Urban UCs	
Estimated Collection Service Population in 34 Peri-urban UCs	
Estimated Self-Disposal Population in 98 Ucs	

1,196

1,196	Total Waste Generation Amount
821	Domestic Waste in 64 Urban UCs
318	Domestic Waste in 34 Peri-urban Ucs
57	Waste from Establishments in 64 Urban UCs
0	Waste from Establishments in 34 Peri-urban UCs
(10)	Street Sweeping Waste
(30)	Market Waste

Note: Road sweeping and market waste amount include in the establishment waste.

402	Uncollected Amount in 64 UCs	54%	Collection Ratio in 64 Ucs
318	Uncollected Amount in 34 Ucs	0%	Collection Ration in 34 UCs
720	Total Uncollected Amount	40%	Overall Collection Ratio in 94 UCs

Note: Collection ratio incl. establishment waste

60% Total Uncollected /Self-disposal Ratio

476 Waste Discharge Amount for Collection (Domestic & Establishment Wastes)

0	Waste Prevention at Sources
66	Recyclable Materials by Waste Pickers & Junk Shops in Town
0	Recyclable Materials by Community Activities Supported by GWMC
66	Total Recovery of Recyclable Materials

0.0% Target Waste Reduction Ratio

Recovery of Biodegradable Waste by Resident, CBOs & Pilot Plant

0	Home Composting
0	Composting by Communities, NGOs, CBOs
0	Pilot Central Compost Plant
0	Total Recovery of Biodegradable Waste

20 from Market Waste Separate Collection

Recovery of Combustible Waste by RDF Plant

0	Combustible Waste (paper, plastics, wood, etc.)

410 Present Waste Collection Amount

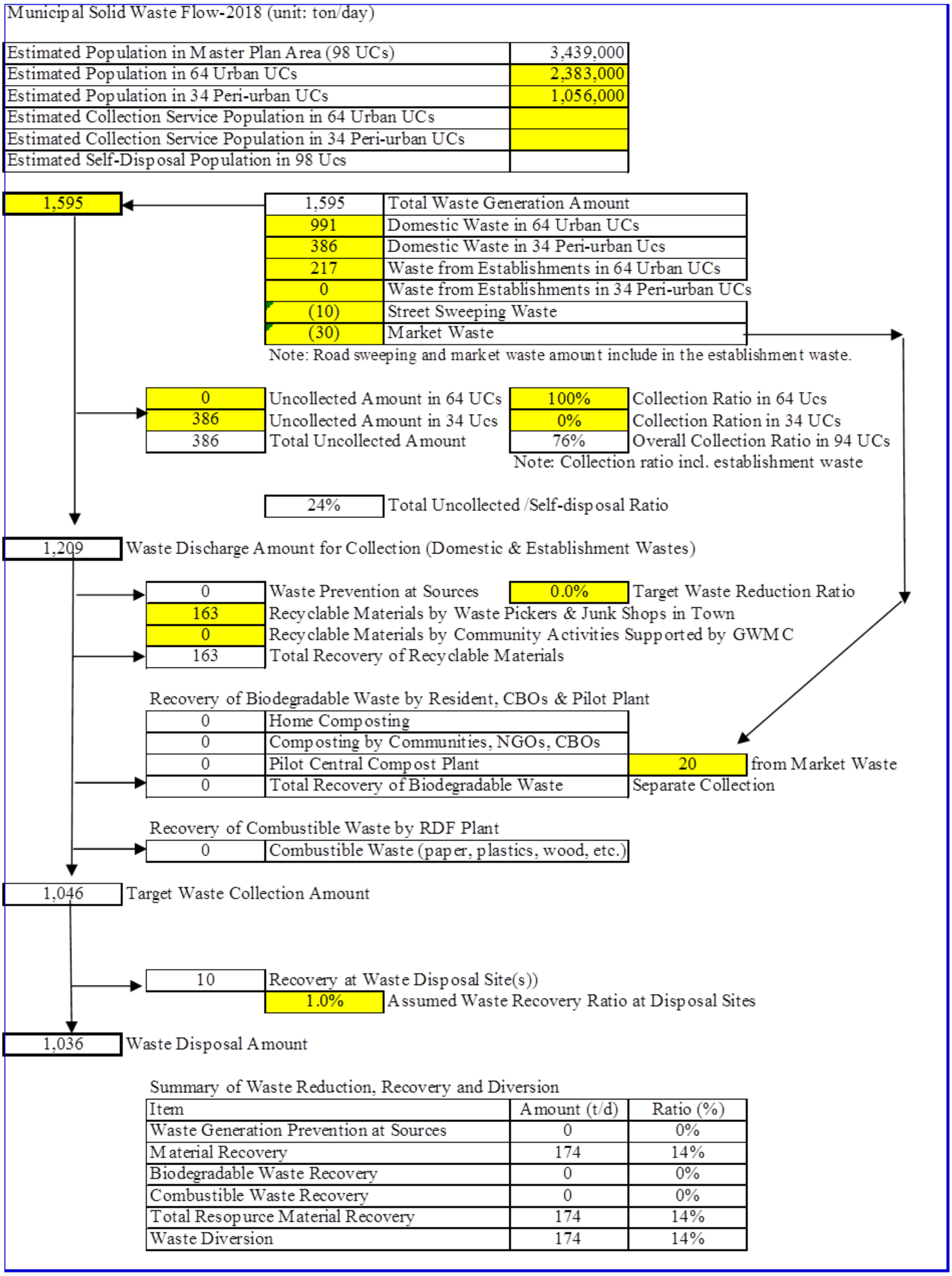
4	Recovery at Waste Disposal Site(s))
1.0%	Assumed Waste Recovery Ratio at Disposal Sites

406 Waste Disposal Amount

Summary of Waste Reduction, Recovery and Diversion

Item	Amount (t/d)	Ratio (%)
Waste Generation Prevention at Sources	0	0%
Material Recovery	70	15%
Biodegradable Waste Recovery	0	0%
Combustible Waste Recovery	0	0%
Total Resopurce Material Recovery	70	15%
Waste Diversion	70	15%

Figure 4.3.4 Waste Management Flow and Estimated Waste Amount in 2014



Municipal Solid Waste Flow-2018 (unit: ton/day)

Estimated Population in Master Plan Area (98 UCs)	3,439,000
Estimated Population in 64 Urban UCs	2,383,000
Estimated Population in 34 Peri-urban UCs	1,056,000
Estimated Collection Service Population in 64 Urban UCs	
Estimated Collection Service Population in 34 Peri-urban UCs	
Estimated Self-Disposal Population in 98 Ucs	

1,595

1,595	Total Waste Generation Amount
991	Domestic Waste in 64 Urban UCs
386	Domestic Waste in 34 Peri-urban Ucs
217	Waste from Establishments in 64 Urban UCs
0	Waste from Establishments in 34 Peri-urban UCs
(10)	Street Sweeping Waste
(30)	Market Waste

Note: Road sweeping and market waste amount include in the establishment waste.

0	Uncollected Amount in 64 UCs	100%	Collection Ratio in 64 Ucs
386	Uncollected Amount in 34 Ucs	0%	Collection Ration in 34 UCs
386	Total Uncollected Amount	76%	Overall Collection Ratio in 94 UCs

Note: Collection ratio incl. establishment waste

24% Total Uncollected /Self-disposal Ratio

1,209 Waste Discharge Amount for Collection (Domestic & Establishment Wastes)

0	Waste Prevention at Sources
163	Recyclable Materials by Waste Pickers & Junk Shops in Town
0	Recyclable Materials by Community Activities Supported by GWMC
163	Total Recovery of Recyclable Materials

0.0% Target Waste Reduction Ratio

Recovery of Biodegradable Waste by Resident, CBOs & Pilot Plant

0	Home Composting
0	Composting by Communities, NGOs, CBOs
0	Pilot Central Compost Plant
0	Total Recovery of Biodegradable Waste

20 from Market Waste
Separate Collection

Recovery of Combustible Waste by RDF Plant

0	Combustible Waste (paper, plastics, wood, etc.)

1,046 Target Waste Collection Amount

10 Recovery at Waste Disposal Site(s))

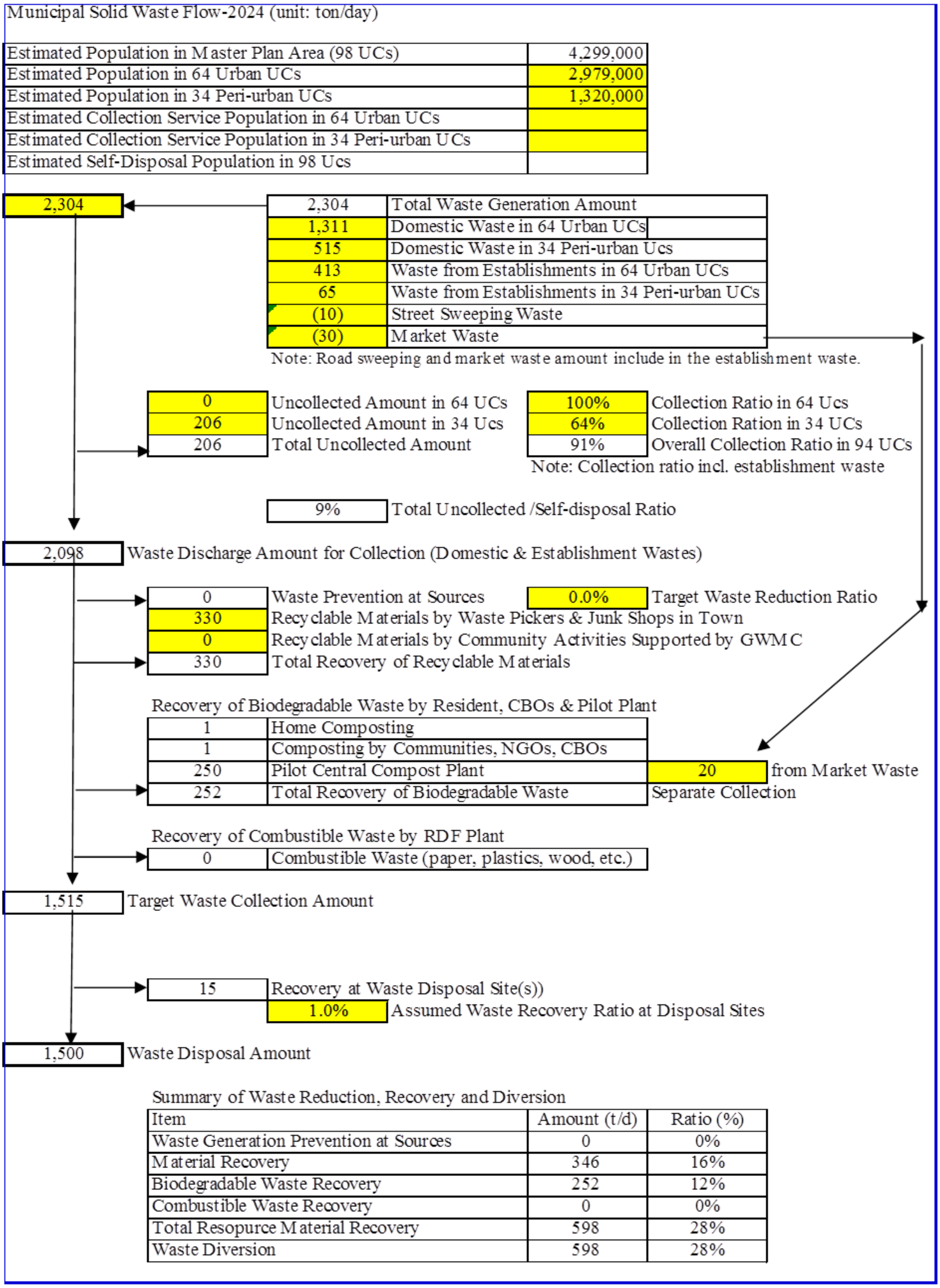
1.0% Assumed Waste Recovery Ratio at Disposal Sites

1,036 Waste Disposal Amount

Summary of Waste Reduction, Recovery and Diversion

Item	Amount (t/d)	Ratio (%)
Waste Generation Prevention at Sources	0	0%
Material Recovery	174	14%
Biodegradable Waste Recovery	0	0%
Combustible Waste Recovery	0	0%
Total Resopurce Material Recovery	174	14%
Waste Diversion	174	14%

Figure 4.3.5 Waste Management Flow and Estimated Waste Amount in 2018



Municipal Solid Waste Flow-2024 (unit: ton/day)

Estimated Population in Master Plan Area (98 UCs)	4,299,000
Estimated Population in 64 Urban UCs	2,979,000
Estimated Population in 34 Peri-urban UCs	1,320,000
Estimated Collection Service Population in 64 Urban UCs	
Estimated Collection Service Population in 34 Peri-urban UCs	
Estimated Self-Disposal Population in 98 Ucs	

2,304

2,304	Total Waste Generation Amount
1,311	Domestic Waste in 64 Urban UCs
515	Domestic Waste in 34 Peri-urban Ucs
413	Waste from Establishments in 64 Urban UCs
65	Waste from Establishments in 34 Peri-urban UCs
(10)	Street Sweeping Waste
(30)	Market Waste

Note: Road sweeping and market waste amount include in the establishment waste.

0	Uncollected Amount in 64 UCs
206	Uncollected Amount in 34 Ucs
206	Total Uncollected Amount

100%	Collection Ratio in 64 Ucs
64%	Collection Ration in 34 UCs
91%	Overall Collection Ratio in 94 UCs

Note: Collection ratio incl. establishment waste

9%	Total Uncollected /Self-disposal Ratio

2,098	Waste Discharge Amount for Collection (Domestic & Establishment Wastes)

0	Waste Prevention at Sources
330	Recyclable Materials by Waste Pickers & Junk Shops in Town
0	Recyclable Materials by Community Activities Supported by GWMC
330	Total Recovery of Recyclable Materials

0.0%	Target Waste Reduction Ratio

Recovery of Biodegradable Waste by Resident, CBOs & Pilot Plant

1	Home Composting
1	Composting by Communities, NGOs, CBOs
250	Pilot Central Compost Plant
252	Total Recovery of Biodegradable Waste

20	from Market Waste
	Separate Collection

Recovery of Combustible Waste by RDF Plant

0	Combustible Waste (paper, plastics, wood, etc.)

1,515	Target Waste Collection Amount

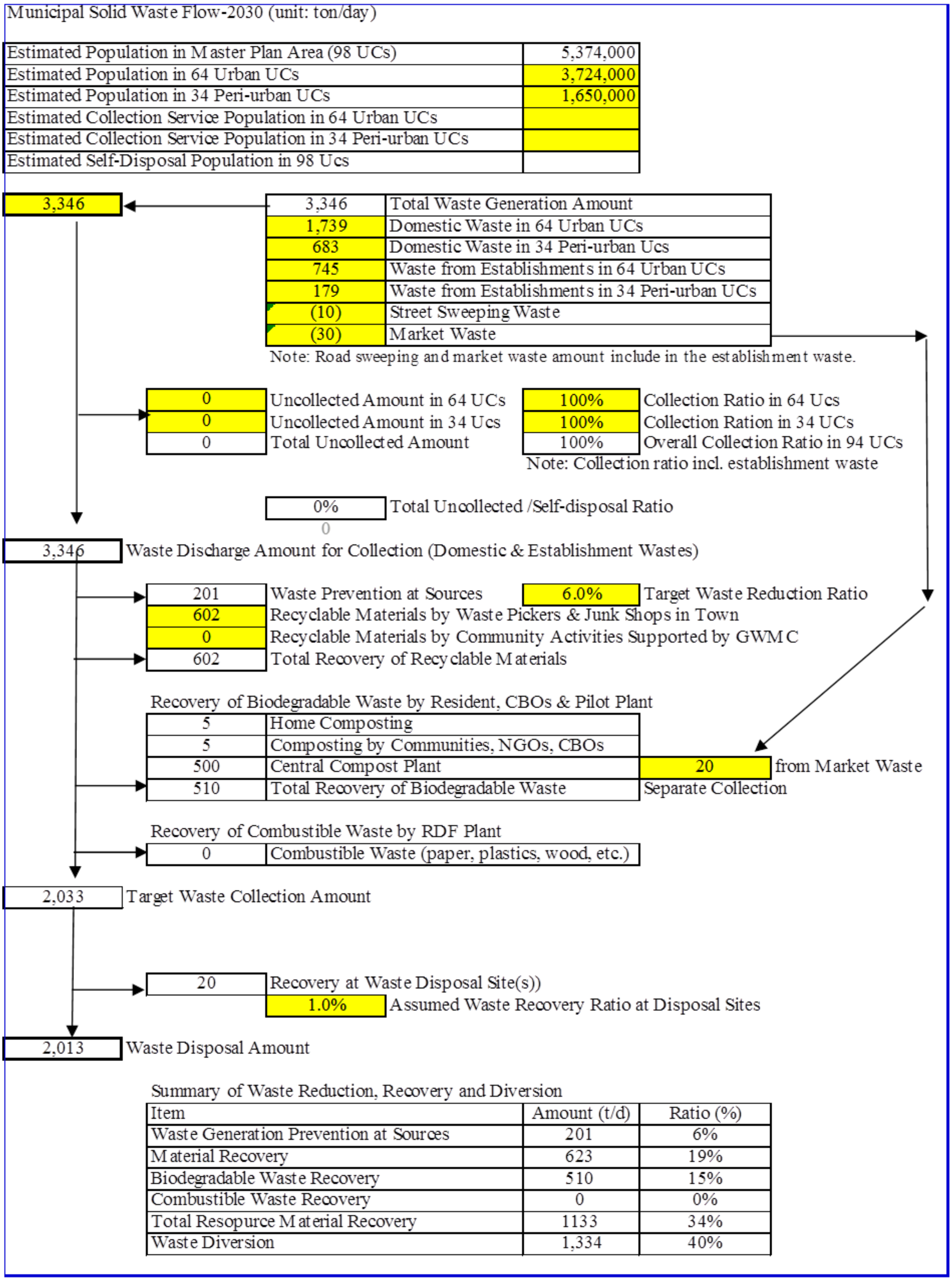
15	Recovery at Waste Disposal Site(s))
1.0%	Assumed Waste Recovery Ratio at Disposal Sites

1,500	Waste Disposal Amount

Summary of Waste Reduction, Recovery and Diversion

Item	Amount (t/d)	Ratio (%)
Waste Generation Prevention at Sources	0	0%
Material Recovery	346	16%
Biodegradable Waste Recovery	252	12%
Combustible Waste Recovery	0	0%
Total Resopurce Material Recovery	598	28%
Waste Diversion	598	28%

Figure 4.3.6 Waste Management Flow and Estimated Waste Amount in 2024



Municipal Solid Waste Flow-2030 (unit: ton/day)

Estimated Population in Master Plan Area (98 UCs)	5,374,000
Estimated Population in 64 Urban UCs	3,724,000
Estimated Population in 34 Peri-urban UCs	1,650,000
Estimated Collection Service Population in 64 Urban UCs	
Estimated Collection Service Population in 34 Peri-urban UCs	
Estimated Self-Disposal Population in 98 Ucs	

3,346	Total Waste Generation Amount
1,739	Domestic Waste in 64 Urban UCs
683	Domestic Waste in 34 Peri-urban Ucs
745	Waste from Establishments in 64 Urban UCs
179	Waste from Establishments in 34 Peri-urban UCs
(10)	Street Sweeping Waste
(30)	Market Waste

Note: Road sweeping and market waste amount include in the establishment waste.

0	Uncollected Amount in 64 UCs
0	Uncollected Amount in 34 Ucs
0	Total Uncollected Amount

100%	Collection Ratio in 64 Ucs
100%	Collection Ration in 34 UCs
100%	Overall Collection Ratio in 94 UCs

Note: Collection ratio incl. establishment waste

0% Total Uncollected /Self-disposal Ratio

0

3,346 Waste Discharge Amount for Collection (Domestic & Establishment Wastes)

201	Waste Prevention at Sources
602	Recyclable Materials by Waste Pickers & Junk Shops in Town
0	Recyclable Materials by Community Activities Supported by GWMC
602	Total Recovery of Recyclable Materials

6.0% Target Waste Reduction Ratio

Recovery of Biodegradable Waste by Resident, CBOs & Pilot Plant

5	Home Composting
5	Composting by Communities, NGOs, CBOs
500	Central Compost Plant
510	Total Recovery of Biodegradable Waste

20 from Market Waste
Separate Collection

Recovery of Combustible Waste by RDF Plant

0	Combustible Waste (paper, plastics, wood, etc.)

2,033 Target Waste Collection Amount

20 Recovery at Waste Disposal Site(s))

1.0% Assumed Waste Recovery Ratio at Disposal Sites

2,013 Waste Disposal Amount

Summary of Waste Reduction, Recovery and Diversion

Item	Amount (t/d)	Ratio (%)
Waste Generation Prevention at Sources	201	6%
Material Recovery	623	19%
Biodegradable Waste Recovery	510	15%
Combustible Waste Recovery	0	0%
Total Resopurce Material Recovery	1133	34%
Waste Diversion	1,334	40%

Figure 4.3.7 Waste Management Flow and Estimated Waste Amount in 2030

4.4 Development of the Master Plan Alternatives

4.4.1 Optimum Options for Each Component of the Master Plan

Based on the preconditions mentioned in the preceding sections, the ISWM Master Plan will be formulated. The ISWM Master Plan, as described in **Section 3.4**, is composed of seven programmes in technical, and institutional and financial arrangement. To develop the Master Plan alternatives, the optimum options for each component will be selected by focusing on four (4) components, i.e., (1) the waste collection and transportation plan; (2) the final disposal plans; (3) the intermediate treatment and 3R promotion plan; and (4) the environmental education and public awareness raising plan, as presented in the following:

(1) Waste Collection and Transportation Plan

The waste collection and transportation plan will be formulated depending primarily on the way of waste discharge from the generation sources. There is no doubt that the waste separation at source is the preferable option in the initial stage of the ISWM scheme. Although the detailed discussions in terms of comparative study for selection of the optimum alternatives are made in **Section 5.2**, the following three options are considered:

- Door-to-door collection by using mini-compactors (Narrow street); and Waste container (small type) by using compactor (Wide street) based on waste separation at source.
- Door-to-door collection by using mini-compactors (Narrow street); and Waste container (small type) by using compactor (Wide street), based on no waste separation at source.
- No other additional vehicles for waste collection and transportation (status quo).

(2) Final Disposal Plan

As presented in **Section 2.4**, the Pakistani side already selected Bhakhraywali as a new final disposal site for Gujranwala city after comparisons of some of candidate sites. A preliminary design for Bhakhraywali site is presented in **Section 5.3**, and the option of the final disposal plan will be the following two:

- Construction of a new final disposal site at Bhakhraywali
- No construction of any new final disposal sites (status quo)

(3) Intermediate Treatment and 3R Promotion Plan

Since the optimum alternatives in terms of intermediate treatment and 3R promotion are limited in view of the past experiences in Gujranwala and the surrounding cities, workability of technologies and economic feasibility, two options will be listed in the comparison of the master plan alternatives. The detailed study is carried out in **Section 5.4**.

- Composting and RDF
- No intermediate treatment and 3R promotion activities (status quo)

(4) Environmental Education and Public Awareness Raising Plan

Environmental education and public awareness raising activities are indispensable for implementation of the ISWM Master Plan because most residents in Gujranwala are indifferent to SWM as shown in the result of the Public Awareness Survey (see **Section 2.6**). Educating the people and raising their awareness towards improvement of the public health and SWM in the city is crucial to achieve the vison, mission and goal of ISWM in Gujranwala. Thus, the options to be considered are “with” and “without” these actions in this case while the plan of environmental education and public awareness raising activities is discussed in **Section 5.5**.

- Implementation of environmental education and public awareness raising activities
- No environmental education and public awareness raising activities (status quo)

4.4.2 Master Plan Alternatives by Combination of the Optimum Options for Each Component

The optimum options for each component to be selected are to be combined and the master plan alternatives are then developed accordingly. The following five (5) cases as shown in **Table 4.4.1** below will be evaluated in the next section.

Table 4.4.1 Master Plan Alternatives by Combination of the Optimum Options for Each Component

Master Plan (MP) Alternative	Waste Collection & Transportation		Final Disposal	Intermediate Treatment & 3R Promotion	Environmental Education & Public Awareness Raising
	Separation at Source	Collection & Transportation Method			
MP Option A	Done	Door-to-door + Mini-compactor (narrow street) Small container + Compactor (wide street)	Construction of a new final disposal site at Bhakhraywali	None (Status quo)	Environmental education & public awareness raising activities
MP Option B	Done	-ditto-	-ditto-	Composting & RDF	-ditto-
MP Option C	None	-ditto-	-ditto-	None (Status quo)	-ditto-
MP Option D	None	-ditto-	-ditto-	Composting & RDF	-ditto-
MP Option Z (Zero Option)	None	None (Status quo)	None (Status quo)	None (Status quo)	None (Status quo)

4.5 Evaluation of the Master Plan Alternatives

The master plan alternatives developed in the previous section are evaluated by the following aspects:

- Technical Aspects: The technical aspects are evaluated in terms of workability, stability and ease of operation and maintenance (O&M) of the applied technology, and so forth. The past experiences in Gujranwala and the surrounding cities should also be considered.
- Environmental and Social Impact Aspects: The environmental and social impact aspects are evaluated based on the result of the Environmental and Social Consideration Survey (E&S Survey). The E&S Survey was carried out on the conditions that the expected locations for transfer stations for waste collection and transportation, composting facilities and RDF plants are assumed.
- Economic and Financial Aspects: The rough scale of initial investment and O&M costs required for each option are relatively judged for comparison. The detailed economic and financial evaluation will be conducted only for the optimum master plan and presented in the next **Section 4.6**.

Institutional and Organisational Aspects: The vehicles additionally procured for the waste collection and transportation, for example, necessitate additional human resources and sometimes creation of new divisions or departments. Also, new or amended laws and regulations might be required for enforcement of the introduction of the new system.

Table 4.5.1 shows the result of evaluation of each alternative and concludes that the Master Plan Option B is the optimum master plan. The reasons this option is chosen are summarised as follows:

- Technically speaking, by applying the waste separation at source, it will be easier to collect and transport the waste, and promote intermediate treatment and 3R activities. In addition, the waste disposal amount will be reduced and it will result in longer life of the final disposal site;

- In terms of environmental and social consideration, the waste separation, and intermediate treatment and 3R activities will bring a good impact on residents' awareness and cooperation with proper SWM in the community level. The reduction of landfill gas emission will also be expected in accordance with the waste amount reduction;
- The initial investment required for provision of new collection vehicles and construction of a new landfill site is large; however, more economically efficient SWM services can be provided compared to "Zero Option (MP Option Z)";
- The life cycle cost of construction of the final disposal site might be the cheapest; that is, this option will be the most economically feasible because the cost of the construction is dominantly huge amount in the total project cost; and
- Although introduction of waste separation at source and Composting & RDF requires organisational strengthening and institutional arrangements additionally, these inputs are also crucial to the other option and this is therefore not a serious disadvantage.

Table 4.5.1 Evaluation of the Master Plan Alternatives

Master Plan (MP) Alternatives		**MP Option A**	**MP Option B**	**MP Option C**	**MP Option D**	**MP Option Z (Zero Option)**
Outline of the Option	Separation at Source	Done	Done	None	None	None
	Collection & Transportation Method	Door-to-door + Mini-compactor (narrow street) Small container + Compactor (wide street)	Door-to-door + Mini-compactor (narrow street) Small container + Compactor (wide street)	Door-to-door + Mini-compactor (narrow street) Small container + Compactor (wide street)	Door-to-door + Mini-compactor (narrow street) Small container + Compactor (wide street)	None (status quo)
	Final Disposal	Construction of a new final disposal site at Bhakhraywali	Construction of a new final disposal site at Bhakhraywali	Construction of a new final disposal site at Bhakhraywali	Construction of a new final disposal site at Bhakhraywali	None (status quo)
	Intermediate Treatment & 3R	None (status quo)	Composting & RDF	None (status quo)	Composting & RDF	None (status quo)
	Environmental Education & Public Awareness Raising	Environmental education & public awareness raising activities	Environmental education & public awareness raising activities	Environmental education & public awareness raising activities	Environmental education & public awareness raising activities	None (status quo)
Technical Aspects		• It is easier to collect and transport waste because the waste is already separated. • Staff of GWMC supervises and monitors the way of waste discharge, and it will bring deterrence of scattering waste around the container. • Reduction of waste disposal amount or waste diversion is not expected.	• It is easier to collect and transport waste and apply intermediate treatment and 3R promotion activities because the waste is already separated. • Staff of GWMC supervises and monitors the way of waste discharge, and it will bring deterrence of scattering waste around the container. • Reduction of waste disposal amount is expected by implementation of the intermediate treatment, and the lifetime of final disposal facilities will therefore be prolonged. • The stabilisation of landfill will be promoted through diversion of organic waste by composting.	• The same waste discharge method does not necessarily require introduction of any new waste collection and transportation scheme. This may not cause any improvement of scattered waste around the container. • Reduction of waste disposal amount or waste diversion is not expected.	• The same waste discharge method does not necessarily require introduction of any new waste collection and transportation scheme. This may not cause any improvement of scattered waste around the container. • No waste separation will make difficult to implement intermediate treatment and 3R. • Reduction of waste disposal amount is expected by implementation of the intermediate treatment, and the lifetime of final disposal facilities will therefore be prolonged. • The stabilisation of landfill will be promoted through diversion of organic waste by composting.	• The present waste collection and transportation services cannot cover the jurisdictional area of Gujranwala and the final disposal site at Gondlanwala will be filled up in less than two years. Although no technical difficulty can be seen, it will not bring any improvement of the current situation. • Reduction of waste disposal amount or waste diversion is not expected and huge land areas are filled with waste. • Open dumping landfill will cause environmental degradation in the surrounding area.
Environmental and Social Aspects		• Waste separation has good feature for natural and social environment and results in heightening public awareness especially related to 3R activities although it requires residents' cooperation. • No Composting & RDF will lose opportunity to utilisation of local resources (organic waste), waste reduction, and longer operation for the final disposal site. • The combination of waste separation with no composting & RDF means that the separated waste is not utilised and the separation process does not make sense. It may cause complains by the residents for nullifying their contribution.	• Waste separation has good feature for natural and social environment and results in heightening the public awareness especially related to 3R activities although it requires residents' cooperation. • Composting & RDF has good feature for environment, especially for utilisation of local resource, waste reduction, and longer operation of the Final Disposal Site. • The combination of waste separation with Compost & RDF is valuable since it has a process that the separated wastes are utilised for composting/RDF easily, and the total process effectively can work for utilisation of local resource, waste reduction and longer operation of the final disposal site. • The waste amount reduction by Compost & RDF will contribute to the reduction of greenhouse effects through reduction of generation amount of LFG (landfill gasses).	• No separation will make it difficult to implement 3R, and no waste reduction is expected. This situation reveals negative impact to environment and society, such as more frequent garbage collection and more generation of landfill gasses • No composting & RDF will lose opportunity to utilisation of local resource (organic waste), waste reduction, and longer operation for the final disposal site. • The combination of no waste separation without composting & RDF cannot expect utilisation of local resource, reduction of waste amount, and it will lose a chance for saving natural resources and led to environmental degradation.	• No separation will make it difficult to implement 3R, and no waste reduction is expected. This situation reveals negative impact to environment and society, such as more frequent garbage collection and more generation of landfill gasses. • Composting & RDF has good feature for environment, especially for utilisation of local resources, waste reduction, and longer operation of the final disposal site. • Composting/RDF without separation require time-energy consuming process in selecting materials for recycling. • The waste amount reduction by Compost & RDF will contribute to the reduction of greenhouse effects through reduction of generation amount of LFG.	• It will result in negative impacts on the society as described in scattered waste and illegal dumping. • Without the Final Disposal site, open dumping will continue and the situation reveal environmental and social problems, such as soil and water contamination, bad scenery, and odour makes local residents' life difficult. • The complaints of the residents will spread in Gujranwala because of the environmental and sanitation degradation caused by uncollected waste scattering in the daily life spaces. • Final disposal site become the source of LFG which will influence to the global warming.
Economic and Financial Aspects		• Although the initial investments on facilities and equipment for the final disposal and the collection and transport are large, more economically efficient SWM services can be provided.	• Although the initial investments on facilities and equipment for the final disposal and the collection and transport are large, more economically efficient SWM services can be provided.	• Although the initial investments on facilities and equipment for the final disposal and the collection and transport are large, more economically efficient SWM services can be provided.	• Although the initial investments on facilities and equipment for the final disposal and the collection and transport are large, more economically efficient SWM services can be provided.	• Due to the absence of new investments on facilities and equipment for the final disposal and collection and transport, the SWM services remain inefficient. • The cost for providing SWM services will

Master Plan (MP) Alternatives	**MP Option A**	**MP Option B**	**MP Option C**	**MP Option D**	**MP Option Z (Zero Option)**
	• The operation costs for the final disposal and the collection and transport are relatively low due to the separation at source. • The benefits accrued from the material recovery are less due to the absence of new investments on the intermediate treatment and 3R.	• The longer life of the final disposal site makes the life cycle cost of final disposal decrease. • The operation cost for the final disposal and the collection and transport are relatively low due to the separation at source. • The benefits accrued from the material recovery through 3R activities will be significantly increased.	• The operation cost for the final disposal and the collection and transport are relatively high due to the absence of separation at source. • The benefits accrued from the material recovery are less due to the absence of new investments on the intermediate treatment and 3R.	• The longer life of the final disposal site makes the life cycle cost of final disposal decrease. • The operation cost for the final disposal and the collection and transport are relatively high due to the absence of separation at source. • The benefits accrued from the material recovery through 3R activities will be significantly increased.	be relatively high due to the huge amount of illegal dumped wastes. • The operation cost for the final disposal and the collection and transport are relatively high due to the absence of separation at source • The benefits accrued from the material recovery are less due to the absence of new investments on the intermediate treatment and 3R. • Due to the absence of the public awareness raising activities, citizen's WTP will not be improved, thereby making it difficult to introduce the tariff system.
Institutional and Organisational Aspects	• It is necessary to establish a by-law including a provision on the separation at source and enforcement. • Enhancement of waste separation at source requires organisational strengthening including establishment of a new department and unit to deal with this new system of the society. • Introduction of vehicle collection necessitates capacity development on preparation of collection routes and vehicle management. • It is necessary to develop capacity on the management of a sanitary landfill site. • Implementation of public awareness raising and environmental education requires establishment of a new unit specifically in charge of its activities.	• It is necessary to establish a by-law including a provision on separation at source and enforcement. • Enhancement of waste separation at source requires organisational strengthening including establishment of a new department and unit to deal with this new system of the society. • Introduction of vehicle collection necessitates capacity development on preparation of collection routes and vehicle management. • It is necessary to develop capacity on the management of a sanitary landfill site. • Even if the composting and RDF is partially privatised, institutional arrangements will be necessitated to some extent to secure and develop the market of composting material and products of RDF. • Implementation of public awareness raising and environmental education requires establishment of a new unit specifically in charge of its activities.	• Introduction of vehicle collection necessitates capacity development on the preparation of collection routes and vehicle management. • It is necessary to develop capacity on the management of a sanitary landfill site. • Implementation of public awareness raising and environmental education requires establishment of a new unit to be specifically in charge of its activities.	• Introduction of vehicle collection necessitates capacity development on the preparation of collection routes and vehicle management. • It is necessary to develop capacity on the management of a sanitary landfill site. • Even if the composting and RDF is partially privatised, institutional arrangements will be necessitated to some extent to secure and develop the market of composting material and products of RDF. • Implementation of public awareness raising and environmental education requires establishment of a new unit specifically in charge of its activities.	• Without improvement of waste collection & transportation and final disposal, GWMC cannot fulfill its mandate and objectives stipulated in the laws and regulations.
Comprehensive Evaluation	• Introduction of the source separation brings technical advantages especially for waste collection and transportation method. Additionally, it may also result in positive impacts on heightening public awareness and residents' cooperation on the ground. • However, the absence of intermediate treatment and 3R promotion activities lacks one of integral ingredients of ISWM master plan as a whole.	• Combination of waste separation at source, and intermediate treatment and 3R activities, such as promotion of Composting & RDF, results in a wide variety of advantages of not only technical and environmental but also financial and economic aspects. • As an ISWM master plan, concept of intermediate treatment and 3R promotion is indispensable, and side effects are proactively expected like public awareness raising on environment and more assertive residents' cooperation for introduction of waste charges in future. • The life cycle cost of construction of the final disposal site might be the cheapest; that is, this option will be the most economically feasible because the cost of the construction is dominantly huge amount in the total project cost. • **<u>This option is the most recommendable alternative in this evaluation.</u>**	• The absence of consideration of intermediate treatment and 3R as well as source separation has no positive impacts on environment and society. • Without consideration of intermediate treatment and 3R, the ISWM master plan is incomplete.	• Although intermediate treatment and 3R activities are introduced, the absence of source separation does not give any advantage in terms of improvement of waste collection and transportation method, and public awareness enhancement. • In this sense, this option is inferior to Option B.	• No action makes no improvement although new investment is not required.

4.6 Evaluation of the Optimum Master Plan and Selection of Priority Projects

4.6.1 Technical Evaluation

Based on the detailed comparative study discussed in **Section 5.2**, the collection and transportation plan in Option B does not include large-scale civil works unlike the final disposal sector. The proposed collection and transportation system is to be a combination of use of mini-dumpers for narrow streets and compactors for wide streets depending on the road width. Since private waste collectors have not been operating in Gujranwala, these vehicles should be procured by GWMC through subsidy from the local government and operated under the management of GWMC at the beginning. Therefore, the system to be newly introduced in the city should be workable and sustainable under the local conditions, accordingly. In this respect, it is judged that the proposed waste collection and transportation system meets these requirements.

The only concern in terms of the new system of collection and haulage of waste is the commencement of waste separation at source. Although it seems to be difficult to disseminate this new idea widely at the grassroots level from the beginning, GWMC should take a strong leadership by supporting the local government and provincial government organise and manage an environmental education programme and public awareness heightening campaign. This is an integral part of the ISWM Master Plan and a key of success of implementation of the Master Plan.

Promotion of 3R is also a key issue for ISWM. Considering the local condition of Gujranwala, promotion of composting is the best option because composting does not require any special mechanisation and huge investment. Moreover, a private company in Lahore has produced composting material by using incoming waste to the final disposal site. Based on this experience and with appropriate institutional arrangements including government support, composting plants will be introduced depending on socio-economic circumstances such as income level, types of housing, and location and volume of waste. RDF that is also operated in Lahore by private involvement will be programmed after segregation of waste can provide the suitable waste for the plant in the late stage of the Master Plan.

To minimise negative impacts on the environment, the present official disposal site in Gondlanwala should be operated properly until end of the life and the former disposal site in Chianwali should be decommissioned in the right manner. Simultaneously, preparation for a new landfill site in Bhakhraywali should be started while another new site will be additionally required in the long run. The process of decision making and budget allocation is always delayed like EIA for example, and so the earliest preparation and actions will be necessary at any rate.

4.6.2 Environmental and Social Impact Evaluation

In this subsection, environmental and social consideration is carried out for Master Plan Option B. Firstly, each component of Option B, which are Separate Collection, Composting and RDF, is evaluated in environmental and social aspects. Secondly, evaluation of Option B in terms of environmental and social consideration is summarised.

(1) Features of Each Component in Master Plan Option B

(a) Separate Collection

Separate Collection of waste is essential issue for building Intermediate Treatment/3R system in integrated solid waste management (ISWM). In case waste is separated in each purpose of reduce, reuse and recycle, treatment in later process is easier and more effective. This action of making separation of waste itself does not have any negative impact to environment and society in Gujranwala.

Separated waste will be easy to control compared to mixed waste. This situation makes better working condition at the collection level and less accident will occur by categorised or separated waste because of easy handling. In addition to the social benefit, odour and vectors will be reduced since organic waste is separated from the other wastes in the container.

Practice of waste separation at household level will be a new duty of residents in Gujranwala. At the introduction stage of separate collection, this practice will be a burden to their daily life, and wrong separation, like waste separated but in wrong category, will happen frequently. However, the solution will be found by long-term environmental education and awareness programme.

Separate collection has significant meanings in case waste is utilised in secondary use by Intermediate Treatment and 3R process, such as Composting and RDF.

(b) Composting

Composting has good feature for natural and social environment. Since organic waste is biodegraded by composting procedure, the amount of waste will be reduced. Reduction of the amount of organic waste contributes to reduction of negative environmental impact and environmental load in the landfill site. Less amount of organic waste means less generation of odour, vectors and methane gas in the landfill site. These make the lifetime of landfill site longer.

Other feature of composting is utilisation of local resource. Currently, it is planned that 125 tons of compost will be produced by 250 tons of organic waste in the proposed compost facility. Using natural compost is environmental friendly and it may avoid soil contamination by agricultural activities compared to chemical fertilizer. However, using natural compost in agriculture is not popular in Gujranwala currently, awareness campaign and development of end-market is necessary to be developed.

Basically, compost facilities are environmentally safe and have no specific risk in working process, but odour, especially ammonia odour, would be a problem. This problem must be carefully considered in case a compost facility will be constructed in residential area. However, in the proposed Option B, the composting facility is constructed in the compound of the landfill site, and the site is in the distance from neighbouring community. Therefore, odour from the compost facility would not be a problem of residents' life in the situation of Option B.

For application of compositing in ISWM, the separate collection at waste generation point is preferably applied in advance. Organic waste that collected separately could apply for composting process directly. On the other hand, collecting organic waste in mixed waste is time-taking and requires additional working process and labour force. Mixed waste wait-to-be-separated have to be carefully controlled otherwise it will be a problem of odour and dirty environment.

(c) RDF

RDF has good feature for waste management. It has positive impact to waste management and contribute to utilisation of local resource because RDF process transforms useless material to solid fuel. In addition, introducing the new system like RDF may stimulate residents' interest to solid waste management. RDF also requires separate collection in advance because production of RDF utilises the waste that organic materials are separated.

There are some difficulties in the operation of RDF facilities. The famous negative impact of RDF is generation of dioxin in the production process. Since RDF is a relatively new technology, producing RDF is high-cost and quality of RDF is relatively low compared to the other solid fuel. End market where to sell RDF and who will buy RDF, must be carefully considered because RDF is not competitive in the market regarding the quality as solid fuel. Storage of RDF must be carefully controlled because it has possibility of fire accident. Once fire accident happens in the storage, fire extinction takes long time and dangerous since RDF is a type of fuel. It is strongly recommended that difficulties are discussed with the Lahore Compost, a compost company which is operating the RDF in Lahore, before the implementation of RDF starts in Gujranwala.

(2) Evaluation of Option B

Option B has a great combination of the processes involved in waste management, namely; Separate Collection, Composting and RDF. In this combination of the three processes, the following good features are expected, and some issues need to be considered for reducing negative impact in future.

(a) Expected Positive Impact

- The technical process mutually contributes to each other that separate collection contributes to the easiest application of waste to Composting/RDF, and Composting/RDF utilises separated waste to make useful materials such as natural compost and one type of fuel;
- This combination effectively contributes to reduce the amount of waste;
- It reduces negative environmental impact, such as odour, vectors and methane gas;
- It makes life longer for the final disposal site;
- Separate Collection and Composting are not environmentally harmful and have no serious negative impact;
- Composting/RDF contributes to utilisation of local materials;
- Using natural compost in agriculture will contribute to reduce environmental load compared to chemical fertilizer; and
- Separated waste is easy to control compared to mixed waste; and
- Separated organic waste reduces generation of odour and vectors.

(b) Issues for Consideration

- The effectiveness of the combination depends on the residents' cooperation regarding waste separation at household level. Awareness and environmental education become very important;
- Development of end-market of natural compost produced by the compost facility and RDF is necessary; and
- Generation of dioxin and other difficulties in the production of RDF is to be controlled before the implementation of RDF in Gujranwala.

4.6.3 Financial and Economic Evaluation

(1) Financial Evaluation

(a) Objective

The purpose of the financial evaluation is to ensure the long-term financial sustainability of the implementation of the master plan, which implies the following:

- Estimation of the project revenues and costs on the market price basis and their implications in terms of cash flow;
- Definition of the project financing structure as well as its financial viability; and
- Verification of the sufficiency of the projected cash flow to ensure the adequate operation of the SWM services.

For the purpose of preparation of the application for funding, the financial evaluation is necessary in order to provide the basis for the calculation of the funding gap of the selected option of the master plan. The verification of the project financial sustainability implies a cumulative positive cash flow for each year of the selected option.

(b) Presumptions

(i) Project Life

The period for the economic evaluation of the master plan is assumed to be 15 years from 2016 to 2030.

(ii) Prices

The prices employed for the financial evaluation are all market prices as of March 2015.

(iii) Cut-off Rate

The cut-off rate for the economic evaluation is 8.5 per cent, being equivalent to the reverse repo rate of the State Bank of Pakistan as of March 2015, which is also known as the policy rate or the discount rate of Pakistan.

(c) Identification of Financial Costs

(i) Investment Cost

The investment cost for the master plan on the financial price basis is estimated at Rs. 12,082 million for the period of 15 years from 2016 to 2030. The investment cost is composed of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed financial investment cost for the entire period of the master plan is as shown in **Table 4.6.1**.

Table 4.6.1 Financial Investment Cost for the Master Plan

Year	Investment Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Env. Education	Env. Monitoring	GWMC's HQ	
2016	776,492	408,382	0	1,250	0	1,774	1,187,897
2017	589,240	247,600	0	0	0	0	836,840
2018	51,265	1.093,648	0	0	0	0	1,144,913
2019	0	129,800	0	0	0	1,108	130,908
2020	0	144,020	430,000	0	0	100	574,120
2021	588,010	229,140	0	0	0	0	817,150
2022	501,470	226,140	0	1,250	0	883	729,743
2023	127,458	219,900	0	0	0	996	348,354
2024	300,000	240,520	0	0	0	112	540,632
2025	588,010	517,950	0	0	0	225	1,106,185
2026	501,470	363,020	0	0	0	112	864,602
2027	0	370,264	0	0	0	0	370,264
2028	588,010	680,280	4,000	1,250	0	112	1,273,653
2029	606,470	464,344	530,000	0	0	0	1,600,814
2030	57,333	498,184	0	0	0	112	555,630
Total	5,275,226	5,833,192	964,000	3,750	0	5,535	12,081,704

(ii) Operation and Maintenance Cost

The operation and maintenance cost for the master plan on the financial price basis is estimated at Rs. 8,087 million for the period of 15 years from 2016 to 2030. The operation and maintenance cost is composed of personnel costs, operating costs and maintenance costs of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed financial operation and maintenance cost for the entire period of the master plan is as shown in **Table 4.6.2**.

Table 4.6.2 Financial Operation and Maintenance Cost for the Master Plan

Year	Operation and Maintenance Cost (Rs. 1000)						
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Env. Education	Env. Monitoring	GWMC's HQ	Total
2016	18,669	185,191	0	748	2,090	8,170	214,868
2017	21,859	218,786	0	830	2,090	8,170	251,736
2018	31,603	335,414	0	945	1,290	8,170	377,421
2019	32,780	352,063	0	1,578	1,290	10,858	398,569
2020	31,680	371,094	0	2,396	1,290	11,348	417,808
2021	32,687	414,666	39,239	2,455	1,290	11.348	501,685
2022	33,770	399,540	42,415	3,897	1,290	13,056	493,968
2023	37,312	430,536	43,376	4,040	1,290	15,254	531,808
2024	43,898	463,018	44,799	5,006	1,290	15,744	573,755
2025	44,892	497,574	45,866	5,042	1,290	16,725	611,388
2026	45,878	533,055	45,866	5,972	1,290	17,215	649,275
2027	48,772	569,938	45,866	6,123	1,290	17,215	689,203
2028	49,949	611,009	45,866	6,279	1,290	17,704	732,097
2029	51,124	656,729	45,866	7,461	1,290	17,704	780,174
2030	58,801	705,943	70,886	8,476	1,290	18,195	863,591
Total	583,672	6,744,555	470,045	61,248	20,950	206,876	8,087,346

(iii) Replacement Cost

The replacement cost for the master plan on the financial price basis is estimated at Rs. 1,153 million for the period of 15 years from 2016 to 2030. The replacement cost is composed of the replacement of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed financial replacement cost for the entire period of the master plan is as shown in**Table 4.6.3**.

Table 4.6.3 Financial Replacement Cost for the Master Plan

Year	Replacement Cost (Rs. 1000)						
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Env. Education	Env. Monitoring	GWMC's HQ	Total
2016	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0
2020	0	980	0	0	0	0	980
2021	0	2660	0	100	0	74	2,834
2022	0	4,620	0	100	0	7	4,727
2023	16,500	24,500	0	100	0	62	41,162
2024	0	74,280	0	100	0	0	74280
2025	0	65,380	0	100	0	7	65,487
2026	0	135,160	0	1,450	0	74	136,684
2027	0	160,336	0	200	0	37	160,573
2028	0	158,256	0	200	0	118	158,574
2029	66,000	221,056	0	200	0	12	287,268
2030	0	220,416	0	200	0	0	220,616
Total	82,500	1,067,644	0	2,750	0	398	1,153,292

(iv) Total Project Cost

The total cost for the master plan on the financial price basis is estimated at Rs. 21,322 million for the period of 15 years from 2016 to 2030, summing up the investment cost, the operation and maintenance cost and the replacement cost of all project components. The contingencies for the project cost are separately added. The detailed total financial project cost for the entire period of the master plan is as shown in **Table 4.6.4**.

Table 4.6.4 Total Financial Project Cost for the Master Plan

Year	Total Cost (Rs. 1000)						
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Env. Education	Env. Monitoring	GWMC's HQ	Total
2016	795,161	593,572	0	1,998	2,090	9,944	1,402,765
2017	611,099	466,386	0	830	2,090	8,170	1,088,575
2018	82,867	1,429,062	0	945	1,290	8,170	1,522,334
2019	32,780	481,863	0	1,578	1,290	11,973	529,484
2020	31,680	516,094	430,000	2,396	1,290	11,448	992,908
2021	620,696	646,466	39,239	2,555	1,290	11,422	1,321,669
2022	535,240	630,300	42,415	5,247	1,290	13,946	1,228,438
2023	181,270	674,936	43,376	4,140	1,290	16,312	921,323
2024	343,898	777,818	44,799	5,106	1,290	15,856	1,188,767
2025	632,902	1,080,904	45,866	5,142	1,290	16,956	1,783,060
2026	547,348	1,031,235	45,866	7,422	1,290	17,401	1,650,561
2027	48,772	1,100,538	45,866	6,323	1,290	17,252	1,220,040
2028	637,959	1,449,545	49,866	7,729	1,290	17,935	2,164,324
2029	723,593	1,342,129	575,866	7,661	1,290	17,717	2,668,256
2030	116,134	1,424,543	70,886	8,676	1,290	18,308	1,639,836
Total	5,941,398	13,645,391	1,434,045	67,748	20,950	212,809	21,322,341

(d) Identification of Financial Benefits

The financial project benefits of the master plan are calculated based on the market prices as of March 2015. The benefit accrued from the methane gas reduction is excluded from the financial project benefits, since the benefit cannot actually be converted into real monetary values. Other unquantifiable benefits are also excluded from the financial project benefits.

The total benefit of the master plan on the financial price basis is estimated at Rs. 25,685 million for the period of 15 years from 2016 to 2030, summing up a wide range of the economic benefits, social benefits and environmental benefits. The detailed total benefits for the entire period of the master plan are as shown in **Table 4.6.5**.

Table 4.6.5 Project Benefits on Financial Price Basis for the Master Plan

Year	Economic Benefit			Social Benefit	Environmental Benefit	Total Benefit (Rs. 1000)
	Total Saved Cost by Final Disposal (Rs. 1000)	Total Saved Cost by Collection and Transport (Rs. 1000)	Recycling (Rs. 1000)	Willingness to Pay (Rs. 1000)	Methane Gas Reduction (Rs. 1000)	
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	329,629	592,873	0	0	0	922,502
2019	362,554	652,093	111,352	0	0	1,125,999
2020	398,083	715,995	122,264	0	0	1,236,343
2021	436,639	785,343	134,106	0	0	1,356,088
2022	478,390	860,436	146,929	0	0	1,485,756
2023	523,489	941,551	160,780	0	0	1,625,821
2024	572,143	1,029,062	175,724	0	0	1,776,929
2025	619,344	1,113,956	307,156	146,814	0	2,187,271
2026	667,929	1,201,343	331,252	152,378	0	2,352,903
2027	722,245	1,299,035	358,189	158,154	0	2,537,622
2028	782,091	1,406,675	387,869	229,034	0	2,805,668
2029	844,058	1,518,130	418,601	237,714	0	3,018,504
2030	912,776	1,641,727	452,681	246,724	0	3,253,908
Total	7,649,370	13,758,220	3,106,904	1,170,818	0	25,685,312

(e) Cases of Evaluation

The timing of the introduction of the tariff system and the involvement of the private sector through outsourcing are major variations to affect the financial viability of the master plan. The following 3 cases including the base case (Case A) together with 2 variations are the cases of the financial evaluation in the master plan.

- Case A: Base Case of Master Plan
- Case B: Based on the current level of users' willingness to pay, the tariff system will be introduced from 2019 at the early stage of the master plan.
- Case C: Outsourcing to the private sector (service contract of the collection and transport) will be introduced from 2028 based on the basic organisational and institutional setting up of the master plan.

(f) Results of Financial Evaluation

(i) FIRR and NPV

The results of the calculations of financial internal rate of return (FIRR) and net present value (NPV) for 3 cases for the financial evaluation are as per **Table 4.6.6**, and the major findings are as below. The detailed cost and benefit streams for the financial evaluation of the base case of the master plan are as shown in **Table 4.6.7**.

Table 4.6.6 Results of FIRR and NPV for Master Plan

Case	FIRR (Per cent)	NPV (Rs. 1000)
Case A	9.77	709,574
Case B	11.46	1,148,046
Case C	9.86	742,925

- For Case A, the base case of the master plan, in which the full-scale tariff system will be introduced from 2028 and the outsourcing to the private sector will not be carried out, the FIRR and the NPV are estimated at 9.77 per cent and Rs. 710 million, respectively.

- For Case B in which the full-scale tariff system will be introduced from 2019 at the early stage of the master plan from and the outsourcing to the private sector will not be carried out, the FIRR and the NPV are estimated at 11.46 per cent and Rs. 1,148 million, respectively.
- For Case C in which the full-scale tariff system will be introduced from 2028 and the outsourcing to the private sector will be carried out from 2028, the FIRR and the NPV are estimated at 9.86 per cent and Rs. 743 million, respectively.

Table 4.6.7 Cost and Benefit Streams for Financial Evaluation

Year	Total Financial Cost (Rs. 1000)	Total Financial Benefit (Rs. 1000)	Net Financial Benefit (Rs. 1000)	Net Accumulated Financial Benefit (Rs. 1000)
2016	1,462,074	0	-1,462,074	-1,462,074
2017	1,142,484	0	-1,142,484	-2,604,558
2018	1,527,121	922,502	-604,619	-3,209,177
2019	529,484	1,125,999	596,515	-2,612,662
2020	992,908	1,236,343	243,435	-2,369,227
2021	1,380,470	1,356,088	-24,382	-2.393,609
2022	1,277,455	1,485,756	208,301	-2,185,308
2023	927,057	1,625,821	698,764	-1,486,545
2024	1,188,767	1,776,929	588,162	-898,383
2025	1,841,861	2,187,271	345,410	-552,973
2026	1,699,578	2,352,903	653,325	100,352
2027	1,220,040	2,537,622	1,317,582	1,417,934
2028	2,223,125	2,805,668	582,543	2,000,477
2029	2,717,273	3,018,504	301,231	2,301,707
2030	1,645,570	3,253,908	1,608,338	3,910,046
Total	21,775,266	25,685,312	3,910,046	3,910,046

(ii) Sensitivity Analysis

Table 4.6.8 indicates the results of the financial evaluation together with the assumptions for risk factors of each option applied for the sensitivity analysis to measure the impacts caused by 10 per cent increase in costs and 10 per cent decrease in benefits.

Since the initial investment, especially the investment on the final disposal component, is large at the early stage of the master plan, the project is vulnerable to the both the increase of costs and the decrease of benefits in all cases. Especially, when the cost increase and the benefit decrease simultaneously hit the project, all the FIRRs for Case A, Case B and Case C will sharply fall down to the negative figures which are all below the cut-off rate.

Table 4.6.8 Results of Financial Evaluation and Sensitivity Analysis

Case	Case No.	Scenario	FIRR (Per cent)	NPV (Rs. 1000)
Base Case	A-1	No Risk Factor	9.77	709,504
	A-2	Cost 10 % increase	4.38	-746,986
	A-3	Benefit 10% decrease	3.79	-812,597
	A-4	Cost 10% increase and benefit 10% decrease	-2.55	-2,215,689
Introduction of Full-scale Tariff System from 2019	B-1	No Risk Factor	11.46	1,148,046
	B-2	Cost 10 % increase	6.03	-255,046
	B-3	Benefit 10% decrease	5.41	-369,851
	B-4	Cost 10% increase and benefit 10% decrease	-1.34	-1,772,943
Private Sector Involvement from 2028	C-1	No Risk Factor	9.86	742,925
	C-2	Cost 10 % increase	4.82	-651,485
	C-3	Benefit 10% decrease	4.25	-725,778
	C-4	Cost 10% increase and benefit 10% decrease	-1.75	-2,120,188

(g) Conclusion

For Case A-1, although the net financial benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net financial benefit would be positive. In 2021, the net financial benefit would be temporarily negative in this single year mainly due to the additional investment of the landfill site. The total net financial benefit is estimated at Rs. 3,910 million. While the FIRR for Case A-1 is calculated at 9.77 per cent which is slightly over the cut-off rate of 8.5 per cent, the NPV for Case A-1 is estimated at Rs. 710 million. The result proved that the implementation of the master plan is financially viable.

For Case B-1, although the net financial benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net financial benefit would be positive. In 2021, the net financial benefit would be temporarily negative in this single year mainly due to the additional investment of the landfill site. The total net financial benefit is estimated at Rs. 4,395 million. While the FIRR for Case B-1 is calculated at 11.46 per cent which is significantly over the cut-off rate of 8.5 per cent, the NPV for Case B-1 is estimated at Rs. 1,148 million. The result proved that the implementation of the master plan, if the tariff system would be introduced at the early stage of the master plan from 2019, the financial viability would be more favourable than the Case A-1.

For Case C-1, although the net financial benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net financial benefit would be positive. In 2021, the net financial benefit would be temporarily negative in this single year mainly due to the additional investment of the landfill site. The total net financial benefit is estimated at Rs. 4,123 million. While the FIRR for Case C-1 is calculated at 9.86 per cent which is slightly over the cut-off rate of 8.5 per cent, the NPV for Case C-1 is estimated at Rs. 743 million. The result proved that the implementation of the master plan, if the private sector involvement would be started from 2028, the financial viability would be slightly favourable than the Case A-1.

The sensitivity analysis proved that, in every case, the implementation of the master plan is financially vulnerable to the cost increase and the benefit decrease. Especially, the financial viability will be significantly reduced when the cost increase and the benefit decrease take place at the same time.

(2) Tariff Review

(a) Objective and Scenarios

The purpose of the tariff review is to provide the additional financial evaluation for verifying an optimum level of the tariff for SWM services, thereby achieving the long-term financial sustainability of the master plan.

There are mainly three (3) scenarios for the cost recovery of SWM projects in accordance with the scope of the cost coverage including the capital investment cost, operation and maintenance cost and replacement cost.

- Scenario 1: The operation and maintenance cost will be covered by the total revenue.
- Scenario 2: The operation and maintenance cost plus the depreciations for replacement of existing facilities will be covered by the total revenue.
- Scenario 3: The operating cost and maintenance cost plus the depreciations for replacement of existing facilities and part of new investment will be covered by the total revenue.

Scenario 1 is the most realistic scenario for the tariff review, taking into account the expected cost coverage based on the current willingness to pay for SWM services.

(b) Cases of Evaluation

The cases of the tariff review analysis are the following 4 cases to be assumed based on the variations of 2 variables: i) the collection efficiency of the tariff; and ii) the timing for the full-scale introduction of the tariff system, and their combinations as tabulated in with the following descriptions.

Table 4.6.9 Cases of Evaluation for Tariff Review Analysis

Case	Willingness to Pay (Rs. per month per household)			Collection Efficiency (Per cent)			Full-scale Tariff Introduction Timing	
	Low	Medium	High	Low	Medium	High	2025	2028
Case 1	25	50	100	50.0	60.0	70.0	X	
Case 2	25	50	100	60.0	70.0	80.0		X
Case 3	25	50	100	50.0	60.0	70.0	X	
Case 4	25	50	100	60.0	70.0	80.0		X

- Case 1: The collection efficiency of the tariff is relatively lower, and the timing for the full-scale introduction of the tariff system including low-income areas will be started in 2025 for the first year of the long-term period.
- Case 2: The collection efficiency of the tariff is relatively lower, and the timing for the full-scale introduction of the tariff system including low-income areas will be started in 2028 for the fourth year of the long-term period.
- Case 3: The collection efficiency of the tariff is relatively higher, and the timing for the full-scale introduction of the tariff system including low-income areas will be started in 2025 for the first year of the long-term period.
- Case 4: The collection efficiency of the tariff is relatively higher and the timing for the full-scale introduction of the tariff system including low-income areas will be started in 2028 for the fourth year of the long-term period.

(c) Results of Tariff Review

(i) Cost Recovery Rate

The results of the analysis on the cost recovery for the above 4 cases are tabulated in **Table 4.6.10** to **Table 4.6.13**, and the major findings are as follows:

- For Case 1, in which the collection efficiency of the tariff is relatively lower and the timing for the full-scale introduction of the tariff system in low-income areas is relatively earlier in 2025 in the first year of the long-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 34.6 per cent.
- For Case 2, in which the collection efficiency of the tariff is relatively lower and the timing for the full-scale introduction of the tariff system in low-income areas is relatively later in 2028 in the fourth year of the long-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 32.2 per cent.
- For Case 3, in which the collection efficiency of the tariff is relatively higher and the timing for the full-scale introduction of the tariff system in low-income areas is relatively earlier in 2025 in the first year of the long-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 40.6 per cent.
- For Case 4, in which the collection efficiency of the tariff is relatively higher and the timing for the full-scale introduction of the tariff system in low-income areas is relatively later in 2028 in the fourth year of the long-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 37.7 per cent.

Table 4.6.10 Cost Recovery Rate for Case 1

Year	Revenue from Proposed Tariff (Rs.1000)			Operation and Maintenance Cost (Rs.1000)	Net Revenue (Rs.1000)	Cost Recovery Rate (%)	Required Amount of Subsidies (Rs.1000)
	Low Income Area	Medium Income Area	High Income Area				
2016	0	0	0	214,868	-214,868	0.0	214,868
2017	0	0	0	251,736	-251,736	0.0	251,736
2018	0	0	0	377,421	-377,421	0.0	377,421
2019	0	0	0	398,569	-193,569	0.0	398,569
2020	0	0	0	417,808	-417,808	0.0	417,808
2021	0	0	0	483,685	-483,685	0.0	483,685
2022	0	0	0	475,568	-475,568	0.0	475,568
2023	0	0	0	512,808	-512,808	0.0	512,808
2024	0	0	0	554,155	-554,155	0.0	554,155
2025	58,035	110,383	36,431	591,388	-386,539	34.6	386,539
2026	60,234	114,566	37,812	629,275	-416,662	33.8	416,662
2027	62,517	118,909	39,245	669,203	-448,533	33.0	448,533
2028	64,887	123,415	40,732	712,097	-483,063	32.2	483,063
2029	67,346	128,093	42,276	760,174	-522,460	31.3	522,460
2030	69,898	132,947	43,878	833,591	-586,867	29.6	586,867
Total	382,917	728,313	611,742	7,882,346	-6,530,741	17.1	6,530,741

Table 4.6.11 Cost Recovery Rate for Case 2

Year	Revenue from Proposed Tariff (Rs.1000)			Operation and Maintenance Cost (Rs.1000)	Net Revenue (Rs.1000)	Cost Recovery Rate (%)	Required Amount of Subsidies (Rs.1000)
	Low Income Area	Medium Income Area	High Income Area				
2016	0	0	0	214,868	-214,868	0.0	214,868
2017	0	0	0	251,736	-251,736	0.0	251,736
2018	0	0	0	377,421	-377,421	0.0	377,421
2019	0	0	0	398,569	-193,569	0.0	398,569
2020	0	0	0	417,808	-417,808	0.0	417,808
2021	0	0	0	483,685	-483,685	0.0	483,685
2022	0	0	0	475,568	-475,568	0.0	475,568
2023	0	0	0	512,808	-512,808	0.0	512,808
2024	0	0	0	554,155	-554,155	0.0	554,155
2025	0	110,383	36,431	591,388	-444,574	24.8	444,574
2026	0	114,566	37,812	629,275	-476,897	24.2	476,897
2027	0	118,909	39,245	669,203	-511,050	23.6	511,050
2028	64,887	123,415	40,732	712,097	-483,063	32.2	483,063
2029	67,346	128,093	42,276	760,174	-522,460	31.3	522,460
2030	69,898	132,947	43,878	833,591	-586,867	29.6	586,867
Total	202,130	728,313	240,375	7,882,346	-6,711,527	14.9	6,711,527

Table 4.6.12 Cost Recovery Rate for Case 3

Year	Revenue from Proposed Tariff (Rs.1000)			Operation and Maintenance Cost (Rs.1000)	Net Revenue (Rs.1000)	Cost Recovery Rate (%)	Required Amount of Subsidies (Rs.1000)
	Low Income Area	Medium Income Area	High Income Area				
2016	0	0	0	214,868	-214,868	0.0	214,868
2017	0	0	0	251,736	-251,736	0.0	251,736
2018	0	0	0	377,421	-377,421	0.0	377,421
2019	0	0	0	398,569	-193,569	0.0	193,569
2020	0	0	0	417,808	-417,808	0.0	417,808
2021	0	0	0	483,685	-483,685	0.0	483,685
2022	0	0	0	475,568	-475,568	0.0	475,568
2023	0	0	0	512,808	-512,808	0.0	512,808
2024	0	0	0	554,155	-554,155	0.0	554,155
2025	69,642	128,780	41,636	591,388	-351,330	40.6	351,330
2026	72,281	133,661	43,214	629,275	-380,120	39.6	380,120
2027	75,021	138,727	44,851	669,203	-410,605	38.6	410,605
2028	77,864	143,984	46,551	712,097	-443,698	37.7	443,698
2029	80,815	149,441	48,316	760,174	-481,603	36.6	481,603
2030	83,878	155,105	50,147	833,591	-544,461	34.7	544,461
Total	459,500	849,699	274,714	7,882,346	-6,928,433	20.1	6,928,433

Table 4.6.13 Cost Recovery Rate for Case 4

Year	Revenue from Proposed Tariff (Rs.1000)			Operation and Maintenance Cost (Rs.1000)	Net Revenue (Rs.1000)	Cost Recovery Rate (%)	Required Amount of Subsidies (Rs.1000)
	Low Income Area	Medium Income Area	High Income Area				
2016	0	0	0	214,868	-214,868	0.0	214,868
2017	0	0	0	251,736	-251,736	0.0	251,736
2018	0	0	0	377,421	-377,421	0.0	377,421
2019	0	0	0	398,569	-193,569	0.0	193,569
2020	0	0	0	417,808	-417,808	0.0	417,808
2021	0	0	0	483,685	-483,685	0.0	483,685
2022	0	0	0	475,568	-475,568	0.0	475,568
2023	0	0	0	512,808	-512,808	0.0	512,808
2024	0	0	0	554,155	-554,155	0.0	554,155
2025	0	128,780	41,636	591,388	-420,972	28.8	420,972
2026	0	133,661	43,214	629,275	-452,401	28.1	452,401
2027	0	138,727	44,851	669,203	-485,625	27.4	485,625
2028	77,864	143,984	46,551	712,097	-443,698	37.7	443,698
2029	80,815	149,441	48,316	760,174	-481,603	36.6	481,603
2030	83,878	155,105	50,147	833,591	-544,461	34.7	544,461
Total	382,917	728,313	274,714	7,882,346	-6,515,377	17.3	6,515,377

(ii) Required Tariff Level for Full Cost Recovery

Since it is obvious the cost recovery rate is 34.6 per cent out of the total operation and maintenance cost in 2025 even after the introduction of the tariff system which is in line with the current willingness to pay, the remaining balance should be replenished by other stable financial sources and/or subsidies from the provincial government. In this section, the required tariff level for the full coverage of the total operation and maintenance cost by the tariff alone will be estimated for all 4 cases. **Table 4.6.14** tabulates the required tariff level for the full recovery of the operation and maintenance cost at the commencement of the introduction of the tariff system.

- For Case 1, in which the collection efficiency of the tariff is relatively lower and the timing for the full-scale introduction of the tariff system in low-income areas is relatively earlier in 2025 in the first year of the long-term period, the required monthly tariff level for the full recovery of the operation and maintenance cost is estimated at Rs. 72.2 per month per household in low-income areas. Rs. 144.3 per month per household in middle-income areas, Rs. 288.7 per month per household in high-income areas, respectively. The said tariff level in case of low-income areas is 2.89 times as much as the assumed level of the tariff of Rs. 25.0 based on the social study.
- For Case 2, in which the collection efficiency of the tariff is relatively lower and the timing for the full-scale introduction of the tariff system in low-income areas is relatively later in 2028 in the fourth year of the long-term period, the required monthly tariff level for the full recovery of the operation and maintenance cost is estimated at Rs. 77.7 per month per household in low-income areas. Rs. 155.5 per month per household in middle-income areas, Rs. 310.9 per month per household in high-income areas, respectively. The said tariff level in case of low-income areas is 3.11 times as much as the assumed level of the tariff of Rs. 25.0 based on the social study.
- For Case 3, in which the collection efficiency of the tariff is relatively higher and the timing for the full-scale introduction of the tariff system in low-income areas is relatively earlier in 2025 in the first year of the long-term period, the required monthly tariff level for the full recovery of the operation and maintenance cost is estimated at

Rs. 61.6 per month per household in low-income areas. Rs. 123.2 per month per household in middle-income areas, Rs. 246.4 per month per household in high-income areas, respectively. The said tariff level in case of low-income areas is 2.46 times as much as the assumed level of the tariff of Rs. 25.0 based on the social study.

- For Case 4, in which the collection efficiency of the tariff is relatively higher and the timing for the full-scale introduction of the tariff system in low-income areas is relatively later in 2028 in the fourth year of the long-term period, the required monthly tariff level for the full recovery of the operation and maintenance cost is estimated at Rs. 66.3 per month per household in low-income areas. Rs. 132.7 per month per household in middle-income areas, Rs. 265.3 per month per household in high-income areas, respectively. The said tariff level in case of low-income areas is 2.65 times as much as the assumed level of the tariff of Rs. 25.0 based on the social study.

Table 4.6.14 Required Tariff Level for Full Recovery of Operation and Maintenance Cost at Commencement of Full-scale Tariff System

Case	Area	Generated Revenue at Commencement of Tariff System (Rs.1000)	Required Revenue for Full Recovery of Operation and Maintenance Cost at Commencement of Tariff System (Rs.1000)	Required Tariff for Full Recovery of Operation and Maintenance Cost at Commencement of Full-scale Tariff System (Rs. per month per household)
Case 1	Low	58,035	167,544	72.2
	Middle	110,383	318,669	144.3
	High	36,431	105,175	288.7
	Total	204,849	591,388	Not Applicable (n.a.)
Case 2	Low	64,887	201,741	77.7
	Middle	123,415	383,714	155.5
	High	40,732	126,642	310.9
	Total	229,034	712,097	n.a.
Case 3	Low	69,642	171,565	61.6
	Middle	128,780	317,253	123.2
	High	41,636	102,570	246.4
	Total	240,058	591,388	n.a.
Case 4	Low	77,864	206,582	66.3
	Middle	143,984	382,009	132.7
	High	46,551	123,506	265.3
	Total	268,399	712,097	n.a.

(3) Economic Evaluation

(a) Objective

The purpose of the economic evaluation is to ensure that the project has a positive net contribution to the improvement in welfare and SWM services in Gujranwala, thereby being worth to be financed. Economic efficiency is a fundamental criterion for the public investment on the SWM sector, which means that benefits must outweigh costs of using scarce resources. The benefits in the cost-benefit analysis should be converted to monetary values. Total benefits are calculated based on three sub-groups: economic, social and environmental benefits.

(b) Presumptions

(i) Project Life

The period for the economic evaluation of the master plan is assumed to be 15 years from 2016 to 2030.

(ii) Prices

Taxes, Customs duties, government subsidies, etc., are not inherent cost items incurred in the project. These transfer items should be excluded from the project cost. The project cost is estimated by the prices as of March 2015. The inflationary cost elements incurred during the construction period should be excluded, since these are external factors for the project.

(iii) Cut-off Rate

The cut-off rate for the economic evaluation is 8.5 per cent, being equivalent to the reverse repo rate of the State Bank of Pakistan as of March 2015, which is also known as the policy rate or the discount rate of Pakistan.

(iv) Standard Conversion Factor

The local currency portion for facilities and equipment related to the project should be converted into economic prices by applying the standard conversion factor, because this portion is usually evaluated within Pakistan and the prices are distorted due to the inefficient markets. Consequently, they do not reflect international market prices. In this master plan, the standard conversion factor employed is 0.904.

(v) Opportunity Cost of Unskilled Labour

The skilled labour cost is considered to reflect the market price. However, the unskilled labour cost is not considered to reflect the market price because of the lack of liquidity of workers which is the surplus of workers caused by the rate of unemployment or potential unemployment in Pakistan. The unskilled labour cost is necessary to be revised by the opportunity cost. Hence, the opportunity cost of the unskilled labour is assumed to be 0.750 of the financial price as the conversion factor by taking into account the unemployment rate of Pakistan.

(vi) Physical Contingency

The physical contingency is calculated as 10 per cent of the relevant construction cost of the final disposal site including civil works, facilities and equipment.

(c) Identification of Economic Costs

The economic costs are estimated based on the financial costs required for extending the improved SWM services in the master plan. The economic costs consist of all resources required to put in place and maintain SWM services in the selected master plan as well as other costs that result from the implementation of the master plan. These costs include investment cost, operation and maintenance costs, and replacement costs.

(i) Investment Cost

The investment cost for the master plan on the economic price basis is estimated at Rs. 9,430 million for the period of 15 years from 2016 to 2030. The investment cost is composed of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarters of GWMC. The detailed investment cost for the entire period of the master plan is as shown in **Table 4.6.15**.

Table 4.6.15 Economic Investment Cost for the Master Plan

Year	Investment Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Env. Education	Env. Monitoring	GWMC's HQ	
2016	602,559	313,229	0	959	0	1,378	918,124
2017	460,568	189,909	0	0	0	0	650,477
2018	39,320	838,828	0	0	0	0	878,148
2019	0	99,557	0	0	0	864	100,421
2020	0	110,463	378,740	0	0	77	489,280
2021	451,004	175,750	0	0	0	0	626,754
2022	384,627	173,449	0	959	0	686	559,721
2023	113,139	168,663	0	0	0	775	282,577
2024	230,100	184,479	0	0	0	89	414,668
2025	451,004	397,268	0	0	0	178	848,450
2026	384,627	278,436	0	0	0	89	663,153
2027	0	283,992	0	0	0	0	283,992
2028	451,004	521,775	3,068	959	0	89	976,894
2029	488,462	356,152	466,857	0	0	0	13,11,471
2030	43,975	382,107	0	0	0	89	426,171
Total	4,100,387	4,474,059	848,665	2,876	0	4,314	9,430,302

(ii) Operation and Maintenance Cost

The operation and maintenance cost for the master plan on the economic price basis is estimated at Rs. 6,201 million for the period of 15 years from 2016 to 2030. The operation and maintenance cost is composed of personnel costs, operating costs and maintenance costs of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed operation and maintenance cost for the entire period of the master plan is as shown in **Table 4.6.16**.

Table 4.6.16 Economic Operation and Maintenance Cost for the Master Plan

Year	Operation and Maintenance Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Env. Education	Env. Monitoring	GWMC's HQ	
2016	15,316	140,832	0	623	1,603	6,441	164,815
2017	17,763	166,364	0	686	1,603	6,441	192,858
2018	25,737	255,015	0	774	989	6,441	288,956
2019	26,640	267,491	0	1,259	989	8,659	305,038
2020	25,796	281,987	0	1,887	989	9,055	319,714
2021	26,568	315,117	30,814	1,943	989	9,055	384,486
2022	27,399	303,614	33,434	3,132	989	10,481	379,050
2023	30,116	327,206	34,192	3,242	989	12,303	408,047
2024	35,559	351,938	35,335	3,983	989	12,698	440,502
2025	36,321	378,244	36,216	4,010	989	13,491	469,271
2026	37,077	405,258	36,216	4,724	989	13,887	498,151
2027	39,297	433,325	36,216	4,839	989	13,887	528,554
2028	40,200	464,575	36,216	5,008	989	14,283	561,271
2029	41,101	499,366	36,216	5,915	989	14,283	597,870
2030	47,576	536,816	55,747	6,693	989	14,680	662,502
Total	472,466	5,127,149	370,601	48,718	16,069	166,082	6,201,085

(iii) Replacement Cost

The replacement cost for the master plan on the economic price basis is estimated at Rs. 904 million for the period of 15 years from 2016 to 2030. The replacement cost is composed of the replacement of a wide range of facilities and equipment required for the improvement of the final disposal, the collection and transport system, the intermediate treatment and 3R, the environmental education, the environmental monitoring and the strengthening of the headquarter of GWMC. The detailed replacement cost plan for the entire period of the master plan is as shown in **Table 4.6.17**.

Table 4.6.17 Economic Replacement Cost for the Master Plan

Year	Replacement Cost (Rs. 1000)						Total
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Env. Education	Env. Monitoring	GWMC's HQ	
2016	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0
2019	0	0	0	0	0	5	5
2020	0	752	0	0	0	0	752
2021	0	2,040	0	77	0	74	2,191
2022	0	3,544	0	77	0	5	3,625
2023	16,500	18,792	0	77	0	62	35,430
2024	0	56,973	0	77	0	0	57,049
2025	0	50,146	0	77	0	5	50,228
2026	0	103,668	0	1,112	0	74	104,854
2027	0	122,978	0	153	0	37	123,168
2028	0	121,382	0	153	0	116	121,652
2029	66,000	169,550	0	153	0	12	235,716
2030	0	169,059	0	153	0	0	169,212
Total	82,500	818,883	0	2,109	0	392	903,884

(iv) Total Project Cost

The total cost for the master plan on the economic price basis is estimated at Rs. 16,535 million for the period of 15 years from 2016 to 2030, summing up the investment cost, the operation and maintenance cost, and the replacement cost of all project components. The contingencies for the project cost are also included. The detailed total economic project cost for the entire period of the master plan is as shown in **Table 4.6.18**.

Table 4.6.18 Total Economic Project Cost for the Master Plan

Year	Total Cost (Rs. 1000)						
	Final Disposal	Collection and Transport	Intermediate Treatment and 3R	Env. Education	Env. Monitoring	GWMC's HQ	Total
2016	617,876	454,061	0	1,582	1,603	7,818	1,082,940
2017	478,331	356,274	0	686	1,603	6,441	843,335
2018	65,057	1,093,843	0	774	989	6,441	1,167,104
2019	26,640	367,047	0	1,259	989	9,528	405,464
2020	25,796	393,202	378,740	1,887	989	9,131	809,746
2021	477,572	492,908	30,814	2,019	989	9,129	1,013,431
2022	412,026	480,607	33,434	4,168	989	11,172	942,397
2023	159,754	514,661	34,192	3,318	989	13,140	726,219
2024	265,659	593,389	35,335	4,059	989	12,788	912,219
2025	487,324	825,658	36,216	4,087	989	13,674	1,367,949
2026	421,704	787,362	36,216	5,836	989	14,050	1,266,158
2027	39,297	840,296	36,216	4,993	989	13,924	935,715
2028	491,203	1,107,732	39,284	6,120	989	14,488	1,659,817
2029	595,563	1,025,068	503,073	6,068	989	14,295	1,257,885
2030	91,551	1,087,983	55,747	6,847	989	14,769	1,257,885
Total	4,655,353	10,420,091	1,219,266	53,703	16,069	170,788	16,535,271

(d) Identification of Economic Benefits

(i) Economic Benefits

The economic benefits which will be converted to the monetary values would include the following three (3) categories of benefits.

- ***Saving in Disposal Costs of Wastes:*** Waste disposal costs can be significantly reduced by introducing more efficient disposal and segregating wastes in the master plan. The unit saved cost per ton to dispose wastes is estimated at Rs. 747.3 per ton of wastes on the financial price basis. The said unit cost is applied to the waste amount to be disposed of each project year.
- ***Saving in Collection and Transport Costs of Wastes:*** Waste collection and transport costs can be significantly reduced by introducing more efficient collection and transport in the master plan. The unit saved cost per ton to collect and transport wastes is estimated at Rs. 1,344.1 per ton of wastes on the financial price basis. The said unit cost is applied to the waste amount to be disposed of each project year.
- ***Saving through Resource Cost Recovery:*** Cost savings can be also achieved through various types of resource cost recovery which enables waste generators to recover monetary values by selling them in the markets. When reusing reclaimed materials on site, purchase costs of new materials avoided can become economic benefits to the project. The resource cost recovery includes a wide range of the material recovery, the biodegradable waste recovery and the combustible waste recovery. The average values employed for the economic evaluation of the material recovery, the biodegradable waste recovery, and the combustible waste recovery are estimated at Rs. 27.38 per kg, Rs. 5.0 per kg, and Rs. 52.5 per ton, respectively.

(ii) Social Benefits

The social acceptance of a SWM project is generally expressed in the form of users' ***Willingness to Pay (WTP)*** for the improvement of SWM services. This is the so-called demand side of the project benefit. In the cost-benefit analysis of the SWM sector, the WTP can be included in the financial and economic benefits only after the said WTP can be converted to real waste collection charges as monetary values under the tariff system.

Although ***Contingent Valuation Method (CVM)*** is one of the methodologies which enable to convert beneficiaries' WTP to monetary values of environmental benefits, there is uncertainty that the results of the CVM represent the accurate monetary values of a SWM project. Therefore, the WTP in the financial and economic evaluation of the master plan will not be employed as monetary values unless the official tariff system is introduced from 2028. The social study in this project revealed that the average WTP is approximately Rs. 25 per month per household in low-income areas, Rs. 50 per month per household in middle-income areas, and Rs. 100 per month per household in high-income areas.

(iii) Environmental Benefits

Although it is rather difficult to convert to monetary values, the benefits in the master plan would also include the environmental benefits derived from the reduction of ***GHG (Greenhouse Gas)*** emissions. The said environmental benefits can be converted to the theoretical monetary values by using the carbon price in the international market under ***CDM (Clean Development Mechanism)***.

Carbon credits under CDM provide an opportunity for an extra source of revenue for SWM projects in developing countries. The main idea is that developed countries will pay for projects in developing countries that contribute to the reduction of GHG emissions. Given that solid waste is a significant source of pollution such as emissions of methane gas by anaerobic degradation, carbon finance represents a good opportunity for SWM projects in developing countries. Actually, methane gas is the most critical GHG emission to air from landfills.

However, carbon credits are difficult to originate due to all the stringent requirements and long scrutiny processes that the project has to go through. Therefore, it would not be realistic to assume that the project is certain to receive an income from carbon credits. For this reason, this analysis will not present scenarios including revenues from carbon credits as financial values in the financial evaluation, while the theoretical economic values based on the current carbon price can be counted in the economic evaluation.

The environmental benefits of the reduced methane gas, one of major GHG emissions should be incorporated into the calculation of environmental benefits in the economic evaluation, which can be traced from the avoidance of methane gas through the construction of the well-controlled landfill site as well as the abolishment of the current badly-managed landfill site based on the following concepts.

A sanitary landfill with a combination of liners, leak detection and leachate collection systems would significantly decrease the amount of methane gas. On the other hand, the current uncontrolled open dumping of wastes releases much methane gas into the environment. Therefore, switching from an open dumping and an ill-managed landfill site to a well-controlled landfill site will significantly reduce the methane gas emission.

The benefits accrued from the reduction of methane gas emissions can be included in the economic analysis alone by applying theoretical monetary values of carbons. Carbon prices had hit the record-low price of €2.75 per ton in the international market in 2013, and the current price level stands at €6.75 per ton in March 2015. Since carbon prices recently tend to sharply fall and frequently fluctuates in the international market, the record-low carbon price in 2013 is applied for the economic evaluation to avoid the downward risk of carbon prices.

The unit economic value of methane gas reduction per ton is estimated at Rs. 6,354.8 based on the recent record-low unit carbon price of €2.75 per ton in the international market.

Table 4.6.19 indicates the estimation of methane generation amount in anaerobic landfill waste. The sanitary landfill site planned in the master plan will significantly reduce the methane generation amount of 38.1 kg-CH_4 per ton-waste by 50 per cent, which leads to the sizable environmental benefit.

Table 4.6.19 Estimation of Methane Generation Amount in Anaerobic Landfill Waste

Biodegradable Waste Category in Incoming Waste Composition Survey	Objective Biodegradable Waste for Calculation of CH_4	Emission Coefficient (kg-CH_4/kg-waste)	Mixed Ratio of Objective Biodegradable Waste (Dry-base) (%)	Methane Generation Amount (kg-CH_4/ton-waste)
Kitchen Waste	Food Waste	0.145	9.2	13.4
Paper (recyclable)	Waste Paper	0.136	0.4	0.6
Paper (other paper)	Waste Paper	0.136	3.1	4.2
Textile	Waste Fiber	0.150	3.2	4.8
Grass & Wood	Waste Wood	0.151	1.3	1.9
Sieve Remaining	Sludge from Night Soil Treatment Plant	0.133	5.4	7.2
Miscellaneous	Sludge from Night Soil Treatment Plant	0.133	4.6	6.1
Total		-	27.2	38.1

(iv) Unquantifiable Benefits

The economic evaluation on a SWM project generally identifies and quantifies relevant benefits by using appropriate measurement and valuation methods. Although it is relatively difficult to convert them into monetary values, the project benefits accrued from the master plan would also include the following unquantifiable social and environmental benefits.

It is widely recognised that the inclusion of these unquantifiable benefits contributes to the indicators of the economic evaluation which frequently underestimates potential positive impacts of a SWM project. Although there are a handful of unquantifiable benefits which might be regarded as rather difficult to be converted into monetary values, it is extremely important to identify and describe the following unquantifiable benefits accrued from the implementation of the master plan.

Direct Benefits Related to Health Improvement

The implementation of the selected master plan, especially the improvement of the poorly-managed landfill sites, might mitigate a wide spectrum of transmissions of infectious diseases around the landfill sites through water-borne diseases, polluted air-borne diseases and vector-borne diseases. Although these direct health impacts can be measured by such indicators as the reduction in incidence rates (number of cases reduced per year) and the reduction in mortality rates (number of deaths avoided per year), it is rather difficult to convert them into monetary values.

Indirect Benefits Related to Health Improvement

Indirect benefits related to the health improvement include medical and public health costs to be avoided due to the mitigated incidence rates of infectious diseases around the landfill sites. The cost saving for the vector control activities to prevent outbreaks of vector-borne diseases around the landfill site is another indirect benefits related health improvement.

Increase in Land Value

The mitigation of visual dis-amenities and odours by the existing ill-managed landfill site and illegal dump sites would increase the prices of lands around the current landfill site and illegal dump sites. The hedonic pricing method (HPM) seeks to find a relationship between the levels of environmental services and the prices of the real estates including land and housing assets. HPM has been used to value such things as noise around airports, amenity values of woodland and dis-amenity values of living near landfill sites. However, it is rather difficult to identify the increase in the specific land value.

(v) Total Benefits

The total benefit for the master plan on the economic price basis is estimated at Rs. 20,651 million for the period of 15 years from 2016 to 2030, summing up a wide range of the economic, social and environmental benefits. The detailed total economic benefits for the entire period of the master plan are as per **Table 4.6.20**.

Table 4.6.20 Project Benefits on Economic Price Basis for the Master Plan

Year	Economic Benefit			Social Benefit	Environmental Benefit	Total Benefit (Rs. 1000)
	Total Saved Cost by Final Disposal (Rs. 1000)	Total Saved Cost by Collection and Transport (Rs. 1000)	Recycling (Rs. 1000)	Willingness to Pay (Rs. 1000)	Methane Gas Reduction (Rs. 1000)	
2016	0	0	0	0	0	0
2017	0	0	0	0	0	0
2018	252,825	454,734	0	0	40,956	748,515
2019	278,079	500,155	85,047	0	45,047	908,688
2020	305,330	549,168	93,776	0	49,462	997,737
2021	334,902	602,358	102,859	0	54,253	1,094,372
2022	366,925	659,954	112,695	0	59,440	1,199,015
2023	401,516	722,170	123,318	0	65,044	1,312,049
2024	438,834	789,291	134,780	0	71,089	1,433,994
2025	475,037	854,404	235,589	112,606	76,954	1,754,591
2026	512,302	921,430	254,070	116,874	82,990	1,887,667
2027	553,962	996,360	274,731	121,304	89,739	2,036,095
2028	599,864	1,078,920	297,496	175,669	97,175	2,249,122
2029	647,392	1,164,406	321,067	182,327	104,874	2,420,067
2030	700,099	1,259,205	347,206	189,237	113,413	2,609,160
Total	5,867,067	10,552,255	2,382,995	898,017	950,436	20,651,070

(e) Cases of Evaluation

The timing of the introduction of the tariff system and the involvement of the private sector through outsourcing are major variations to affect the economic viability of the master plan. The following three (3) cases including the base case (Case A) together with two (2) variations are the cases of the economic evaluation in the master plan.

- Case A: Base Case of Master Plan
- Case B: Based on the current level of users' willingness to pay, the tariff system will be introduced from 2019 at the early stage of the master plan.
- Case C: Outsourcing to the private sector (service contract of the collection and transport) will be introduced from 2028 based on the basic organisational and institutional setting up of the master plan.

(f) Results of Economic Evaluation

(i) EIRR and NPV

The results of the calculations of economic internal rate of return (EIRR) and net present value (NPV) for 3 cases for the economic evaluation are as per **Table 4.6.21**, and the major findings are as below. The detailed cost and benefit streams for the economic evaluation of the base case of the master plan are as shown in **Table 4.6.22**.

Table 4.6.21 Results of EIRR and NPV for the Master Plan

Case	EIRR (Per cent)	NPV (Rs. 1000)
Case A	11.52	949,343
Case B	13.35	1,307,221
Case C	11.76	1,015,656

- For Case A, the base case of the master plan, in which the full-scale tariff system will be introduced from 2028 and the outsourcing to the private sector will not be carried out, the EIRR and the NPV are estimated at 11.52 per cent and Rs. 949 million, respectively.
- For Case B in which the full-scale tariff system will be introduced at the early stage of the master plan from 2019 and the outsourcing to the private sector will not be carried out, the EIRR and the NPV are estimated at 13.35 per cent and Rs. 1,307 million, respectively.
- For Case C in which the full-scale tariff system will be introduced from 2028 and the outsourcing to the private sector will be carried out from 2028, the EIRR and the NPV are estimated at 11.76 per cent and Rs. 1,016 million, respectively.

Table 4.6.22 Cost and Benefit Stream for Economic Evaluation

Year	Total Economic Cost (Rs. 1000)	Total Economic Benefit (Rs. 1000)	Net Economic Benefit (Rs. 1000)	Net Accumulated Economic Benefit (Rs. 1000)
2016	1,128,430	0	-1,128,430	-1,128,430
2017	884,683	0	-884,683	-2,013,113
2018	1,170,775	748,515	-422,260	-2,435,373
2019	405,464	908,689	503,224	-1,932,148
2020	809,746	997,737	187,991	-1,744,157
2021	1,058,531	1,094,372	35,841	-1,708,317
2022	979,993	1,199,015	219,022	-1,489,295
2023	730,452	1,312,048	581,596	-907,699
2024	912,219	1,433,993	521,774	-385,925
2025	1,413,049	1,754,590	341,541	-44,384
2026	1,303,754	1,887,667	583,913	539,529
2027	935,715	2,036,095	1,100,381	1,639,910
2028	1,704,918	2,249,122	544,205	2,184,114
2029	2,182,652	2,420,067	237,414	2,421,529
2030	1,262,283	2,609,160	1,346,877	3,768,406
Total	16,882,664	20,651,070	3,768,406	3,768,406

(ii) Sensitivity Analysis

Table 4.6.23 indicates the results of the economic evaluation together with the assumptions for risk factors of each option applied for the sensitivity analysis to measure the impacts caused by 10 per cent increase in costs and 10 per cent decrease in benefits.

Since the initial investment, especially the investment on the final disposal component, is large at the early stage of the master plan, the project is vulnerable to the both the increase of costs and the decrease of benefits in all cases. Especially, when the cost increase and the benefit decrease simultaneously hit the project, all the EIRRs for Case A, Case B and Case C will sharply fall to the figures close to zero which are all below the cut-off rate.

Table 4.6.23 Results of Economic Evaluation and Sensitivity Analysis

Case	Case No.	Scenario	EIRR (Per cent)	NPV (Rs. 1000)
Base Case	A-1	Base Case	11.52	949,343
	A-2	Cost 10 % increase	6.52	-137,694
	A-3	Benefit 10% decrease	5.95	-232,629
	A-4	Cost 10% increase and benefit 10% decrease	0.06	-1,319,667
Introduction of Full-scale Tariff System from 2019	B-1	Base Case	13.35	1,307,221
	B-2	Cost 10 % increase	8.11	220,183
	B-3	Benefit 10% decrease	7.52	-319,155
	B-4	Cost 10% increase and benefit 10% decrease	1.26	-407,651
Private Sector Involvement from 2028	C-1	Base Case	11.76	1,015,656
	C-2	Cost 10 % increase	6.88	-64,751
	C-3	Benefit 10% decrease	6.33	-166,316
	C-4	Cost 10% increase and benefit 10% decrease	0.69	-1,246,723

(g) Conclusion

For Case A-1, although the net economic benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net economic benefit would be positive. The total net economic benefit is estimated at Rs. 3,768 million. While the EIRR for Case A-1 is calculated at 11.52 per cent which is slightly over the cut-off rate of 8.5 per cent, the NPV for Case A-1 is estimated at Rs. 949 million. The result proved that the implementation of the master plan is economically feasible.

For Case B-1, although the net economic benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net economic benefit would be positive. The total net financial benefit is estimated at Rs. 4,097 million. While the FIRR for Case B-1 is calculated at 13.35 per cent which is significantly over the cut-off rate of 8.5 per cent, the NPV for Case B-1 is estimated at Rs. 1,307 million. The result proved that the implementation of the master plan, if the tariff system would be introduced at the early stage of the master plan from 2019, the economic feasibility would be more favourable than the Case A-1.

For Case C-1, although the net economic benefit would be negative during the period from 2016 to 2018, immediately after the full-scale operation of the new landfill site, the net economic benefit would be positive. The total net financial benefit is estimated at Rs. 3,931 million. While the FIRR for Case C-1 is calculated at 11.76 per cent which is slightly over the cut-off rate of 8.5 per cent, the NPV for Case C-1 is estimated at Rs. 1,016 million. The result proved that the implementation of the master plan, if the private sector involvement would be started from 2028, the economic feasibility would be slightly favourable than the Case A-1.

The sensitivity analysis proved that, in every case, the implementation of the master plan is economically vulnerable to the cost increase and the benefit decrease. Especially, the financial viability will be significantly reduced when the cost increase and the benefit decrease take place at the same time.

(4) Overall Conclusion for Financial and Economic Evaluation

(a) Project Feasibility

The results of the economic evaluation show that the implementation of the selected option of the master plan proved to be economically feasible, while those of the financial evaluation show that the master plan is financially viable. The sensitivity analysis reveals that the master plan is financially and economically vulnerable to the increase of costs and the decrease of benefits. The cost recovery levels for the full coverage of the operation and maintenance costs remain approximately one-third of those costs, implying the necessity of other alternative stable financial sources. However, taking into account a spectrum of various unquantifiable benefits which cannot be converted to monetary values, it is obvious that the selected option of the master plan is economically feasible and financially viable thereby the master plan is worth implementing.

(b) Recommendations

In order to implement the selected optimum option of the master plan, the following recommendations should be taken into account in terms of economic feasibility and financial viability.

- Although the selected option of the master plan proves to be economically feasible and financially viable, the capital investment should be funded by a sort of concessional loan whose interest rate is relatively lower than those of commercial banks, taking into account the relatively lower FIRRs.
- Since the project is rather vulnerable to such risks as the increase of costs as well as the decrease of benefits, the financial statements such as cash flow statements should be continuously monitored by GWMC. ***The continuous financial monitoring on revenues, expenditures and the cost recovery rate by GWMC*** is absolutely necessary to avoid any risks to enlarge the gap between the projected cash flow and the actual cash flow. GWMC’s headquarter should be institutionally strengthened so that the financial statements would be readily prepared in comparison with the original calculation tables of the FIRRs.
- ***The construction of the final disposal site should not be delayed*** to generate the project benefits at least from 2018 which is the last year of the short-term period, since the project is extremely vulnerable to the cost increase in the early stage of the master plan.
- It is revealed that the earlier the introduction of the tariff system is, the higher the EIRR and FIRR are, implying that ***the early introduction of the proposed tariff system is a key to the financial stability*** of the master plan.
- The cost recovery by the introduction of the optimum variable-rate user charge system is not sufficient to fully cover the operation and maintenance cost required for the implementation of the master plan. ***The introduction of the revenue generation through the provincial property tax as the stable financial sources should be urgently explored*** to cover the shortage of revenues. The negotiation with the provincial government on this revenue generation through the provincial property tax should be commenced as soon as possible.
- ***The users’ willingness to pay should be transformed into the actual payment of user charges under the official tariff table*** so that the stable revenue generation for SWM services can be secured. However, the user charge system in low-income areas whose willingness to pay is extremely low should be carefully introduced by the delayed timing of the implementation of the full-scale tariff system in all areas.
- The budget request to the provincial government for the capital investment cost as well as the request to CDGG for the recurrent cost should be applied in time for each financial year of GWMC, and those requests should be based on the cash flow statement of the

master plan.

- ***The financial key performance indicators (KPIs) should be monitored*** by the management information system (MIS) unit to keep the financial performance well controlled by the management of GWMC.
- The recurrent cost such as operating, personnel and maintenance costs should be minimised based on the cost minimisation plan by GWMC.
- Since ***the benefits accrued from the methane gas reduction cannot be converted into the actual cash flow*** due to the current situation of the CDM as well as the international market of carbon prices, the financial IRR is relatively low. However, in addition to the environmental monitoring, the traded price level of carbon credits in the international market should be continuously monitored for the identification of the environmental impacts by monetary values.

4.6.4 Institutional and Organisational Evaluation

(1) Evaluation of Option B

From the perspective of institutional and organisational aspect, Option B is most preferable. This is because it is most important for GWMC/CDGG to comply with laws and regulations that is the provision of waste collection and transportation services in City and Sadar areas. For this purpose, although it requires initial investment, it is essential to solve the problems of collection & transportation and final disposal. Introduction of separation at source and intermediate treatment is recommended as it decreases the running cost of collection & transport and final disposal.

The necessary arrangements in terms of institution and organisation include the following:

(a) Establishment of Gujranwala Solid Waste Management By-Law

Currently, there is no comprehensive by-law in Gujranwala and there are no rules and regulations on separation at source. Therefore, in order to implement Option B, the Gujranwala Solid Waste Management By-law should be established and include clauses on separation at source.

(b) Organisational Restructure of GWMC

Implementation of Option B requires the following organisational restructure.

- Strengthening of Operation Unit
- Establishment of Intermediate Treatment Unit under Operation Department
- Establishment of Communication Unit under Operation Department
- Strengthening of Procurement & Contracts (P&C) Department for PPP introduction of collection and transport
- Establishment of Monitoring & Evaluation Department under General Manager

(c) Capacity Development of GWMC Staff

Implementation of Option B requires hiring new staff as well as developing capacity of existing staff of the above mentioned departments and units. Hiring new capable staff requires more attractive working environment. Capacity development includes provision of regular training based on needs assessment and monitoring result of Monitoring & Evaluation Department.

(2) Issues to be Considered

- Implementation and enforcement of the by-law depends on understanding and awareness of residents.
- Organisational structure and capacity should be periodically monitored and evaluated.

4.6.5 Overall Evaluation

The target collection rate of 100% for covering 98 UCs in year 2030 is an ideal goal for all the residents of Gujranwala, so that the plans for pursuing this goal should be carried out with dedication and dispatch. To realise the Vision of ISWM for Gujranwala City, the proposed projects in the Master Plan should be carried out since implementation of these projects will bring large benefits to the residents of Gujranwala.

A significant feature of public awareness in Gujranwala is characterised that the residents are displaying indifference towards SWM issues. GWMC, therefore, should conduct firstly all technical improvements as well as support for start-up of environmental education and public awareness raising programmes. The 3R promotion activities should be initiated from introduction of waste separation at source that is a basis of the new collection and transportation scheme, and they are integral parts of the new ISWM Master Plan. Public awareness raising and the implementation of environmental education are thus indispensable for the promotion of 3R even if the visible effects on ISWM will take quite a long time to appear.

In order to establish effective and sustainable provision of SWM services, financial stability of GWMC is required. However, GWMC cannot collect waste charges or tariff from the residents due to uncooperative people and political issues. In addition, since private involvement has not been matured in the sector of SWM, GWMC should take lead to carry out the required actions in the early stage of the Master Plan, based on the subsidy of the local government and the provincial government.

A new final disposal site is necessary to secure the proposed ISWM system in any cases and needs a huge amount of money. Therefore, the Government of Pakistan, including the Government of the Punjab, should consider that some financial arrangements are indispensable for the implementation of the action plans. It should also be recognised that the implementation of a proper SWM requires to some extent a financial burden from the government, but the responsibility should be shared equally by the government or public sector, the private collectors or private sector, and the residents or people.

4.6.6 Selection of Priority Projects

The priority projects are defined as the action plans for the short-term period of the Master Plan. The details are described in the following **Chapter 5** and these projects are thus enumerated as follows:

(1) Waste Collection and Transportation Plan

1-1 Formulation of Waste Collection Plan

1-2 Study/Planning for the method of separate collection and implementation at the pilot study area(s)

1-3 Increasing of Waste Collection Ratio in 64UCs up to 100% in 2018

1-4 Procurement of Waste Collection Vehicles and Containers in 64UCs

1-5 Monitoring on Improvement of Waste Collection and Transportation in 64UCs

1-6 Conducting Street Cleaning in 64UCs

1-7 Collection of Bulky Waste

1-8 Cleaning up of Illegal Dumping sites in 64 UCs

1-9 Collection of Construction and Demolition Waste

1-10 Construction of Parking Area

(2) Final Disposal Plan

2-1 Procurement of Sanitary Landfill Site

2-2 Engineering Service for Sanitary Landfill Facilities (Stage 1)

2-3 Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywali

2-4 Procurement of Landfill Machine

2-5 Operation and Maintenance of Landfill Facilities

2-6 Improvement Work of the Existing Landfill in Gondlanwala

2-7 Safety Closure of the Landfill Site in Gondlanwala

2-8 Safety Closure of the Landfill Site in Chianwali

2-9 Monitoring of Final Disposal in Bhakhraywali

2-10 Post-closure Monitoring of Gondlanwala and Chianwali

(3) Intermediate Treatment and 3R Promotion Plan

3-1 Awareness IEC (Information, Education and Communication) campaign on resource recovery

3-2 Implementation of Simplified WACS

(4) Environmental Education and Public Awareness Raising Plan

4-1 Capacity Development of Communication Unit to Strenthen the Coordination among Relevant Bodies

4-2 Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students to Enhance Knowledge/Awareness on SWM and 3R Promotion

4-3 Development and Implementation of Educational Programmes Targeting General Public to Enhance Knowledge/Awareness on SWM and 3R Promotion

4-4 Development of Environmental Education Facility and its Utilisation Plan including the Content of Educational Programmes

(5) Economic and Financial Plan

5-1 Priority Project for Sustainable Cost Recovery

5-2 Priority Project for Accurate Total Costing

5-3 Priority Project for Proper Tariff Introduction

5-4 Priority Project for Financially Efficient Private Sector Involvement

(6) Environmental and Social Consideration

6-1 Environmental Monitoring for Collection and Transportation Work

6-2 Environmental Monitoring for Final Disposal Site in Bhakhraywali

6-3 Environmental Monitoring for Post-Closure Final Disposal Site in Gondlanwala and Chianwali

(7) Institutional Strengthening and Organisational Plan

7-1 Establishment of Gujranwala Solid Waste Management By-Law

7-2 Organisational Restructure of GWMC

7-3 Capacity Development of GWMC staff

CHAPTER 5. FORMULATION OF EACH COMPONENT OF THE MASTER PLAN

5.1 Introduction

This section presents the contents of each component of the master plan, which includes development of alternatives for each plan, evaluation of the alternatives and selection of priority projects. The result of the discussions and examinations in this section is reflected the formulation of the master plan described in previous **Chapter 4**.

5.2 Waste Collection and Transportation Plan

5.2.1 Development of Alternatives for Waste Collection and Transportation Plan

(1) Planning Concept for Development of Alternatives

For selecting the optimum waste collection and transportation plan, possible options will be developed depending upon what kind of waste is dealt with, what kind of vehicle and equipment are used, what method of waste transfer can be applied and so forth. The following concept is adopted to enumerate the possible alternatives:

(a) Introduction of Source Separation

Waste generated from households or commercial entities can be separated when it is discharged for collection, and this is one of important options in the master plan to determine which collection and transportation method is adopted appropriately at the site. Additionally, as waste recovery such as composting or RDF facility is applied in the city, separated waste like organic waste is necessary for the plant. The collected waste after source separation would have the potential to convert to the environmental friendly resource.

Currently, GWMC collects mixed waste and transfers to the landfill site. The condition of waste is deteriorating and has bad odour because a collection vehicle collects and transfers the container when it becomes full of waste. It is difficult to separate organic waste from the other waste. In addition, there is no custom such as source separation in residents at present. It means the most potential recyclable material is disposed as it is.

There is a concern that it might take time to disseminate and absorb such a new system to the residents. However, it is assumed that the issue can be solved by conducting public awareness campaign, monitoring the disposal method around the container or introducing a different type of the container on site.

Since one of the ultimate purposes in integrated solid waste management (ISWM) is recycling of the waste, source separation matches with the goal of the ISWM. Therefore, source separation activity for waste collection starts in 2016 in this master plan.

(b) Waste Collection Method by Street Condition

The road configuration in Gujranwala city is complicated and it is difficult to distinguish as categories. However, there is general tendency for street condition that can be seen almost all areas in the city, which is divided into income levels: high income group, middle income group and low income group. Street width in the middle income group and low income group in Gujranwala city is narrow, and there is no room for two way traffic. On the contrary, street width in the high income group in the city is wider than that of middle income and low income group area. Because the width of the street affects the waste collection and transportation method during the operation, the waste collection and transportation options in this study takes into account the following two street conditions: narrow and wide streets.

(i) Narrow Street

The street with a width of less than four (4) metres is defined as a narrow street from the viewpoint of workability of collection vehicles; in general, an arm-roll truck and a large compactor cannot approach the road in this case.

For instance, the width of an arm-roll truck is 2.5 metres and a street gutter on one side is 0.5 metre. Based on the situation of a narrow street, a sanitary worker has to conduct waste collection in the space of only 0.25 metre width of street, which will reduce the working efficiency significantly. Large vehicles are not usable in the narrow street.

(ii) Wide Street

The street with a width of more than four (4) metres is considered as a wide street. Any type of waste collection vehicle is able to access this street.

(c) Consideration of Waste Discharge Method

The waste discharge method is also considered since the method of discharging the waste is closely related to the method of collection and haulage. In consideration of the site condition, three (3) methods are discussed in this study: door-to-door, curbside (stationary) and waste container. The conditions in each case are described as follows:

(i) Door-to-Door

The residents pass the waste to a sanitary worker during the collection. This waste discharge method is applicable for a narrow street and it is currently applied in middle and low income group area in the city.

(ii) Curbside (Stationary)

The residents are obliged to put the waste to a designated discharge point and the sanitary worker collects the disposed waste on site. This waste discharge method is applicable for a wide street and it is currently applied in high income group area in the city.

(iii) Waste Container

The residents need to dump the waste into the container on a designated location. This waste discharge method is applicable for a wide street and GWMC mainly uses this method.

(2) Possible Options for Waste Collection and Transportation

Based on the above preconditions, possible options for waste collection and transportation can be evolved in accordance with the actual operation procedures; specifically, there are two (2) options in primary collection method on a narrow street and other two (2) options exist in secondary collection on a wide street.

Since the primary collection options only can be adopted in waste collection on a narrow street while the waste collection on a wide street does not require the primary collection, the following two (2) are exclusively considered:

- Primary collection method on a narrow street; and
- Secondary collection method on a wide street.

(a) Primary Collection Method on a Narrow Street

Two options, namely, (i) mini-dumper and (ii) mini-compactor are set as the primary collection methods on a narrow street in this case. GWMC utilises mini-dumpers for waste collection to the low income group area in the city although GWMC does not apply mini-compactors for waste collection.

The carrying capacity of both mini-dumper and mini-compactor is quite small at 500kg of waste per one trip for one mini-dumper and 2.0 tons of waste per one trip for one mini-compactor. Therefore, both cases necessitate a transfer station to make up for the small haulage amounts per one trip by increase of the number of trips. Collected waste by a mini-dumper is transported to the landfill site via the transfer station as one of the waste transportation system in the study.

The waste collection by using mini-dumpers has some of alternatives depending on combination with auxiliary equipment, i.e., (i) mini-dumper + arm-roll truck, (ii) mini-dumper + compaction unit + arm-roll truck, (iii) mini-dumper + large compactor and (iv) mini-dumper + compaction container + arm-roll truck.

Handcarts are checked off in this study. Since the handcart is a subsidiary tool for waste collection, the function of the handcart will be decreased if a mini-dumper or a mini-compactor starts operating the waste collection. In summary, the following five (5) alternatives are to be considered for the comparison:

(i) Mini-dumper + Arm-Roll Truck

Mini-dumpers dump collected waste into a 10 cubic metres (m^3) container in the transfer station. Once the container is filled with waste, a $10m^3$ arm-roll truck hauls the waste to the landfill site.

(ii) Mini-dumper + Compaction Unit + Arm-Roll Truck

Mini-dumpers dump collected waste into a $10m^3$ container in the transfer station. After the compaction unit in the transfer station compresses the waste, a $10m^3$ arm-roll truck hauls the waste to the landfill site.

(iii) Mini-dumper + Compaction Container + Arm-Roll Truck

Mini-dumpers dump collected waste into a container with the compaction unit in the transfer station. After the compaction unit in the transfer station has compressed the waste, a $10m^3$ arm-roll truck hauls the waste to the landfill site.

(iv) Mini-dumper + Large Compactor

Mini-dumpers dump collected waste into a large compactor of $13m^3$ capacity in the transfer station. After the compaction unit in the transfer station has compressed the waste, the compactor hauls the waste to the landfill site.

(v) Mini-compactor

Mini-compactors haul the collected waste from each generation source to the landfill site directly. No transfer station is required in this option.

(b) Secondary Collection Method on a Wide Street

On wide streets in the city, (i) arm-roll truck and (ii) compactor are to be applied as the secondary collection method in the study, as follows.

(i) Arm-Roll Truck

One or two containers ($10m^3$ or $5m^3$) are deployed on the street based on the present road and traffic conditions. This method has been broadly utilised in the city.

(ii) Compactor

One or two small containers ($0.8m^3$) are deployed on the street. This method is being applied in Lahore at present.

(3) Development by Combination of Waste Collection and Transportation Options

Based on the possible options enumerated in the above, the waste collection and transportation method is developed by combination of these options. **Figure 5.2.1** illustrates a flow chart of combination of collection method on each operation stage, and all cases for comparison of each waste collection and transportation alternative are shown in **Figure 5.2.2.**

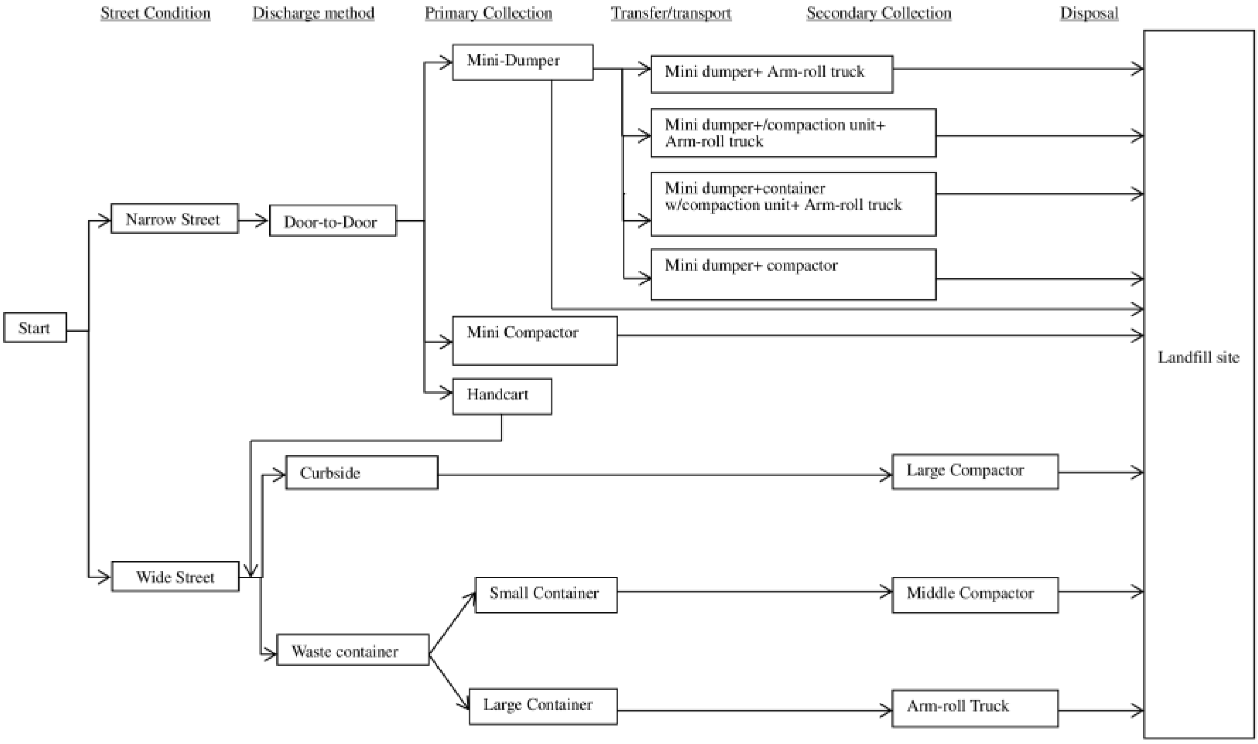


Figure 5.2.1 Flow Chart of Combination of Collection Method of Each Operation Stage

Case 1: Narrow street

	Type of street	waste discharge	primary collection	transfer/ Transportation	secondary collection
case 1-1	Narrow street	door-to-door	mini dumper	mini dumper+a-r truck	arm-roll truck
case 1-2	Narrow street	door-to-door	mini dumper	mini dumper+compaction unit+a-r truck	arm-roll truck
case 1-3	Narrow street	door-to-door	mini dumper	mini dumper+container w/compaction unit+a-r truck	compactor
case 1-4	Narrow street	door-to-door	mini dumper	mini dumper+compactor	compactor
case 1-5	Narrow street	door-to-door	mini compactor		

Case 2: Wide street

	Type of street	waste discharge	primary collection	transfer station	secondary collection
case 2-1	Wide street	curb side			Large Compactor
case 2-2	Wide street	Waste Container	small container		Middle Compactor
case 2-3	Wide street	Waste Container	Large container		arm-roll truck

Figure 5.2.2 All Cases for Comparison of Each Waste Collection and Transportation Alternative

(4) Comparison of Each Option for Waste Collection Method on a Narrow Street

(a) Cases for Comparison

Due to the road condition, this method is applied to middle and low income group area. Waste discharge method in each case is door to door collection. There is no enough space for stationary point or container point. For selecting waste collection system on a narrow street, five cases shown on **Table 5.2.1** are set. The waste collection and transportation method on a narrow street applies the optimal case in the table.

Table 5.2.1 Summary of Each Case on a Narrow Street

Item	Waste Discharge	Primary Collection	Transfer/ Transportation
Case 1-1	Door-to-door	Mini-dumper	Mini-dumper + Arm-roll truck
Case 1-2			Mini-dumper+compaction unit + Arm-roll truck
Case 1-3			Mini-dumper + containener w/ compaction unit + Arm-roll truck
Case 1-4			Mini-dumper + Large compactor
Case 1-5		Mini-compactor	-

Case1-1: A mini-dumper collects waste and dumps it into a container at the transfer station. Once the container is filled with waste, an arm-roll truck hauls it to the landfill site.

Case1-2: A mini-dumper collects waste and dumps it into a container at the transfer station. Once the container is filled with waste, an arm-roll truck hauls it to the landfill site. Necessary area of the transfer station is smaller than Case1-1.

Case1-3: A mini-dumper collects waste and dumps it into container attached to a compaction unit at the transfer station. A compaction unit with a container compresses the collected waste in the container. An arm-roll truck hauls the waste to the landfill site after compaction of the waste by compaction unit. Necessary area of the transfer station is smaller than Case1-1. The difference between Case 1-2 and Case 1-3 is the compaction method and type of compaction machinery.

Case1-4: A mini-dumper collects waste and takes it to the transfer station. A large compacter receives the waste from the mini-dumper and compresses it. A large compactor hauls the waste to the landfill site after compaction of the waste by compaction unit. Necessary area of the transfer station is the smallest in four cases (Case1-1 to 1-4).

Case1-5: A mini-compactor collects waste and hauls it to the landfill site directly. The transfer station is omitted in this case.

(b) Transfer Station

Mini-dumpers used to haul the waste and dump it at Sabrri Chowk transfer station, UC No.17 and Qadri Darbar, and UC No.52. However, the land got full of garbage and seemed to be like a temporary landfill site. Unloaded waste on the ground was scooped by wheel loader and dumped into a 5m^3 container. An arm-roll truck came to pick up the container when it was full of garbage. The unloaded garbage was chronically there because waste collection vehicles kept coming to dump the waste there. For this reason, GWMC got complaints from the residents near Qadri Darbar transfer stations and had to close the operation. Sabrri Chowk transfer station was also closed because GWMC found another place for the transfer station in Mugal Chowk, UC No.12 located in the north-eastern part of the city and near the Sialko, where a bypass road is located.

Currently, some waste is collected by mini-dumper and transported to the open plot in Mughal Chowk. Transported waste is loaded into a container on site by wheel loader and is hauled to the landfill site. GWMC rents the land and uses it as a temporary transfer station. However, the condition of the land is the same as the previous transfer stations. It might be a matter of time before closure due to complaints from the residents near the transfer station.

For comparing five cases, the location of the transfer station is set in this site. The site is close to a large road, Sialkot Bypass Road.

Figure 5.2.3 shows the tentative location of the transfer station. **Figure 5.2.4** shows a tentative layout plan for the transfer station.

Figure 5.2.3 Tentative Location of the Transfer Station (Not to Scale)

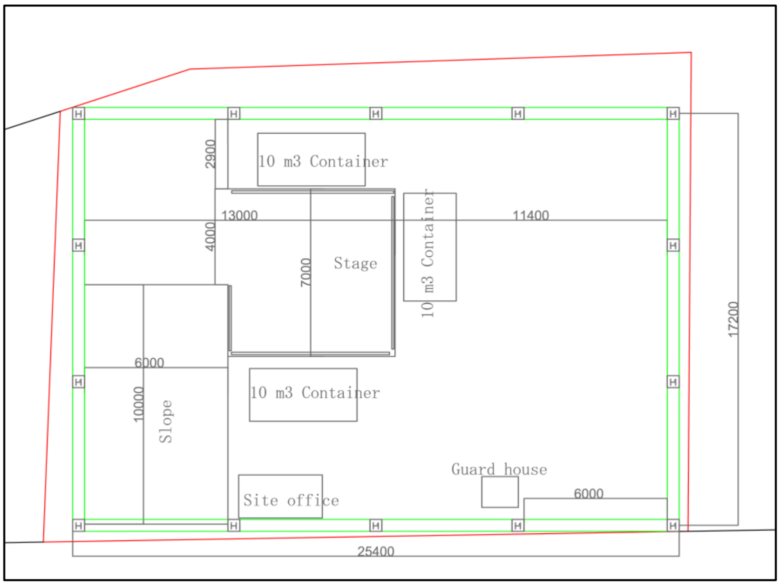


Figure 5.2.4 Tentative Layout Plan for Transfer Station

The condition of the transfer station is as follows:

- Area: 18m × 25m (450m^2)
- Number of containers: 3 pcs (10m^3)
- Structure: steel skeleton structure
- Office: 1 unit
- Guard house: 1 unit
- Gate: 1unit

(c) Comparison of Each Case on a Narrow Street

The selection criteria in this study consider the following conditions: (i) Environmental impact, (ii) Workload, and (iii) Cost comparison.

(i) Environmental Impact

If a transfer station is located in a residential area, the residents near the station might complain about the odour from the transfer station.

There is no environmental impact on direct hauling.

(ii) Workload

Collected waste has to be unloaded at the transfer station, again. It is not efficient to transfer collected waste at the transfer station.

It is efficient if collected waste is hauled to the landfill site directly.

(iii) Cost Comparison

For estimating the cost on each case, vehicle, compaction unit and container cost information is provided from the local supplier. The annual cost of each vehicle is set with consideration of depreciation periods (8 years). The annual maintenance cost for the vehicle is set as 5%. As one of operating cost, two workers (driver + sanitary worker) are deployed on compactors and one driver is deployed on arm-roll truck. Another operating cost such as fuel cost is estimated based on the result of time and motion survey and the information from LWMC. The annual container cost is calculated in the same manner: the depreciation year is set as 5 years and annual maintenance cost is 5%. **Table 5.2.2** shows the annual cost of each item. Looking at vehicle prices on the table, a mini-dumper is the most economical vehicle and a mini-compactor is the second most economical vehicle.

Table 5.2.2 Annual Cost of Each Item on a Narrow Street

Item	Vehicle Cost (Rs.)	Depreciation Period (Year)	Annual Vehicle & Container Cost (Rs.)	Maintenance Cost (Rs.)	Operation Cost (Rs.)	Labour Cost (Rs.)	Annual Cost (Rs.)
Mini-dumper	1,000,000	8	125,000	50,000	196,128	396,000	767,128
Compaction Unit	2,400,000	8	300,000	120,000	30,000	180,000	630,000
Container w/ Compaction unit	2,400,000	8	300,000	120,000	30,000	180,000	630,000
Mini-Compactor (4 m^3)	3,500,000	8	437,500	175,000	196,128	396,000	1,204,628
Arm-roll truck (10 m^3)	5,000,000	8	625,000	250,000	819,360	216,000	1,910,360
Large Compactor (13 m^3)	9,200,000	8	1,150,000	460,000	282,240	396,000	2,288,240
Transfer Station	15,936,183	30	531,206	24,146	24,146	198,000	777,698

Note: Vehicle, compaction unit and container cost are based on quotation from the supplier.

Necessary number of mini-dumpers per case is considered as follows:

Case 1-1: Container 10m^3/ (Mini-dumper 1m^3 × 5Trips) = 2 Mini-dumpers
Case 1-2: Container 10m^3/ (Mini-dumper 1m^3 × 5Trips) / Compaction unit (0.5m^3) = 4 Mini-dumpers
Case 1-3: Container 10m^3/ (Mini-dumper 1m^3 × 5Trips) / Compaction unit (0.5m^3) = 4 Mini-dumpers
Case 1-4: Large Compactor 13m^3/ (Mini-dumper 1m^3 × 5Trips) = 3 Mini-dumpers
Case 1-5: There is no mini-dumper in this case.

Waste hauling cost of each case is estimated. **Table 5.2.3** shows the cost comparison table on each case. Case 1-5 is the most economical plan in five cases. All wastes are transferred to the transfer station in the other four cases. Thus, operating operation and maintenance cost is higher.

Even if there is no transfer station in Case 1-4, Case 1-5 is the most economical among the five cases. The reason for this is that Case 1-4 needs to have 3 mini-dumpers for filling up the compactor.

Table 5.2.3 Cost Comparison Table on Each Case

Item	Mini-dumper/ Mini-compactor (Rs.)	Transfer Station (Rs.)	Compaction Unit (Rs.)	Arm-roll truck/Large Compactor (Rs.)	Total Cost (Rs.)
Case 1-1	1,534,256	753,354	-	1,910,360	4,197,970
Case 1-2	3,068,512	753,354	630,000	1,910,360	6,362,226
Case 1-3	3,068,512	753,354	630,000	1,910,360	6,362,226
Case 1-4	2,301,384	753,354	-	2,288,240	5,342,978
Case 1-5	1,204,628	-	-	-	1,204,628

Table 5.2.4 shows the result of the comparison in each case. Case 1-5 is the most optimal plan among the five cases. Collected wastes are hauled directly in Case 1-5, so that the case is evaluated “better” in all conditions.

Table 5.2.4 Result of the Comparison in Each Case

Item	Case 1-1	Case 1-2	Case 1-3	Case 1-4	Case 1-5
Environmental impact	Fair	Fair	Fair	Good	Better
Workload	Good	Fair	Fair	Fair	Better
Cost comparison	Fair	Fair	Fair	Good	Better
Evaluation Result	Good	Fair	Fair	Good	Better

(d) The Optimal Plan for Waste Collection on a Narrow Street

As the result of the comparison, Case 1-5 is applied in the waste collection and transportation on a narrow street.

(5) Comparison of Each Option for Waste Collection Method on a Wide Street

There is no restriction on a wide street due to the street condition. Therefore, curbside collection or container collection is applicable for the waste collection method. For selecting waste collection system on a wide street, three cases shown on **Figure 5.2.2** are evaluated and the optimal case is set as the waste collection and transportation method on a wide street. **Table 5.2.5** shows the summary of each case on a wide street. Based on the waste discharge method on a street, the utilised vehicle varies in each case.

Table 5.2.5 Summary of Each Case on a Wide Street

Item	Waste discharge	Secondary Collection
Case 2-1	Curbside	Large compactor
Case 2-2	Small Container	Middle compactor
Case 2-3	Large Container	Arm-roll truck

Case 2-1: Waste is disposed on a designated curbside are by residents and a compactor collects the waste and hauls it to the landfill site.
Case 2-2: A smaller container compared to an existing container is deployed on the street. A compactor collects waste from the container and transfers to the landfill site.
Case 2-3: A large sized container is deployed on the street. An arm-roll truck collects the container and hauls it to the landfill site. GWMC applies this method, now.

(a) Comparison of Each Case on a Wide Street

Set as selection criteria in this study are (i) Environmental impact, and (ii) Workload and Cost comparison.

(i) Environmental Impact

- If curbside collection is applied, uncollected waste is scattered on the station. In addition, live stocks with free-range on the street mess up uncollected waste on the station.
- Currently, illegal dumping on the open plots in the city is one of the serious issues in the city. It is assumed that there would be some people who throw the waste other than designated day. It becomes like an illegal dumping site.
- Small container: The lid is attached to the top of the container so that few residents attempt to throw the waste into the container. The environment around the container is cleaner than the other two cases.
- Larger container: Some residents throw the waste into the container. Therefore, waste that did not go into the container is scattered around the container and it gets dirty and unsanitary. The weather condition affects the condition of waste.

(ii) Workload

- Curbside collection: A sanitary worker collects all waste from the ground. It sometimes takes much time. If waste is not disposed in an appropriate way (e.g., the bag is torn and waste is scattered on the ground), the worker has to clean it up. The condition of the collection points is affected by weather condition. The disposed waste flows out during the monsoon season.
- Small container: A sanitary worker disposes the collected waste from the container into a compactor and it might take time for loading the waste. However, it is assumed that amount of scattered waste around the container is fewer so that the worker does not require much time for cleaning around the container.
- Large container: An arm-roll truck driver collects the container. A sanitary worker has to clean the waste scattered around the container. It is assumed that it takes much time compared with the work with a small container.

(iii) Cost Comparison

For estimating the cost on each case, vehicle, compaction unit and container cost information is provided from the local supplier. The annual cost of each vehicle is set with consideration on depreciation periods (8 years). The annual maintenance cost for the vehicle is set as 5%. As one of operating cost, two workers (driver + sanitary worker) are deployed on compactors and one driver is deployed on arm-roll truck. Another operating cost such as fuel cost is estimated based on the result of time and motion survey and the information from LWMC. The annual container cost is calculated on the same manner: the depreciation year is set at 5 years and annual maintenance cost is 5%. **Table 5.2.6** shows the annual cost of each item. Based on the table, a middle compactor is the most economical vehicle among the three.

Table 5.2.6 Annual Cost of Each Item on a Wide Street

Item	Vehicle/ Container Cost (Rs.)	Depreciation Period (Year)	Annual Vehicle and Container Cost (Rs.)	Maintenance Cost (Rs.)	Vehicle Operation Cost (Rs.)	Labour Cost (Rs.)	Annual Cost (Rs.)
Middle Compactor ($7\ m^3$)	4,500,000	8	562,500	225,000	282,240	396,000	1,465,740
Large Compactor ($13\ m^3$)	9,200,000	8	1,150,000	460,000	282,240	396,000	2,288,240
Arm-roll truck ($5\ m^3$)	3,500,000	8	437,500	175,000	819,360	216,000	1,647,860
Small Container ($0.8\ m^3$)	28,000	5	5,600	1,400	-	-	7,000
Large Container ($5\ m^3$)	200,000	5	40,000	10,000	-	-	50,000

Necessary number of containers per vehicle is considered on each vehicle.

Case 2-1: No container
Case 2-2: Compactor $7m^3$/ container $0.8m^3$ × 2 trips/day × 6 days × 4 weeks × 12 months = 2,520 pcs
Case 2-3: Large container $5m^3$ × 5 trips/day × 6 days × 4 weeks × 12 months = 7,200 pcs

Table 5.2.7 shows the annual cost for each case. Case 2-2 is the lowest cost in three cases because there is no container cost in this case. On the other hand, Case 2-3 is the most expensive. The number of containers collected by an arm-roll truck reflects the cost.

Table 5.2.7 Annual Cost for Each Case

Item	Vehicle Cost (Rs.)	Container Cost (Rs.)	Total Cost (Rs.)
Case 2-1	2,288,240	-	2,288,240
Case 2-2	1,465,740	17,640,000 (7,000 × 2,520)	19,105,740
Case 2-3	1,647,860	360,000,000 (50,000 × 7,200)	361,647,860

Table 5.2.8 shows the comparison table on each case. As the result of the comparison table, Case 2-2 is the most optimal plan in the master plan. Only looking at the cost comparison, Case 2-1 is the lowest. However, it is too early to apply curbside collection in this city based on the current waste disposal manner by residents. Disposal method needs to be controlled by GWMC.

Table 5.2.8 Comparison Table on Each Case

Item	Case 2-1	Case 2-2	Case 2-3
Environmental impact	Bad	Better	Fair
Workload	Fair	Better	Good
Cost Comparison	Better	Good	Fair
Evaluation Result	Fair	Better	Good

(b) Optimal Plan for Waste Collection and Transportation on a Wide Street

Case 2-2 is the most economical and environmental friendly collection method in three cases. Thus, the combination of a small container and a middle compactor is applied in this master plan.

(6) Planned Waste Collection Amount

Based on the planned waste collection population, area and amount, the number of planned waste collection and transportation vehicles is decided. The number of vehicles and containers has to meet the necessary waste collection amount in each year.

(a) Waste Collection Area and Its Areal Population

Currently, waste collection is conducted in 64 UCs. **Figure 5.2.5** shows the planned waste collection area. GWMC is divided into 8 zones in 64UCs and collects waste in each zone.

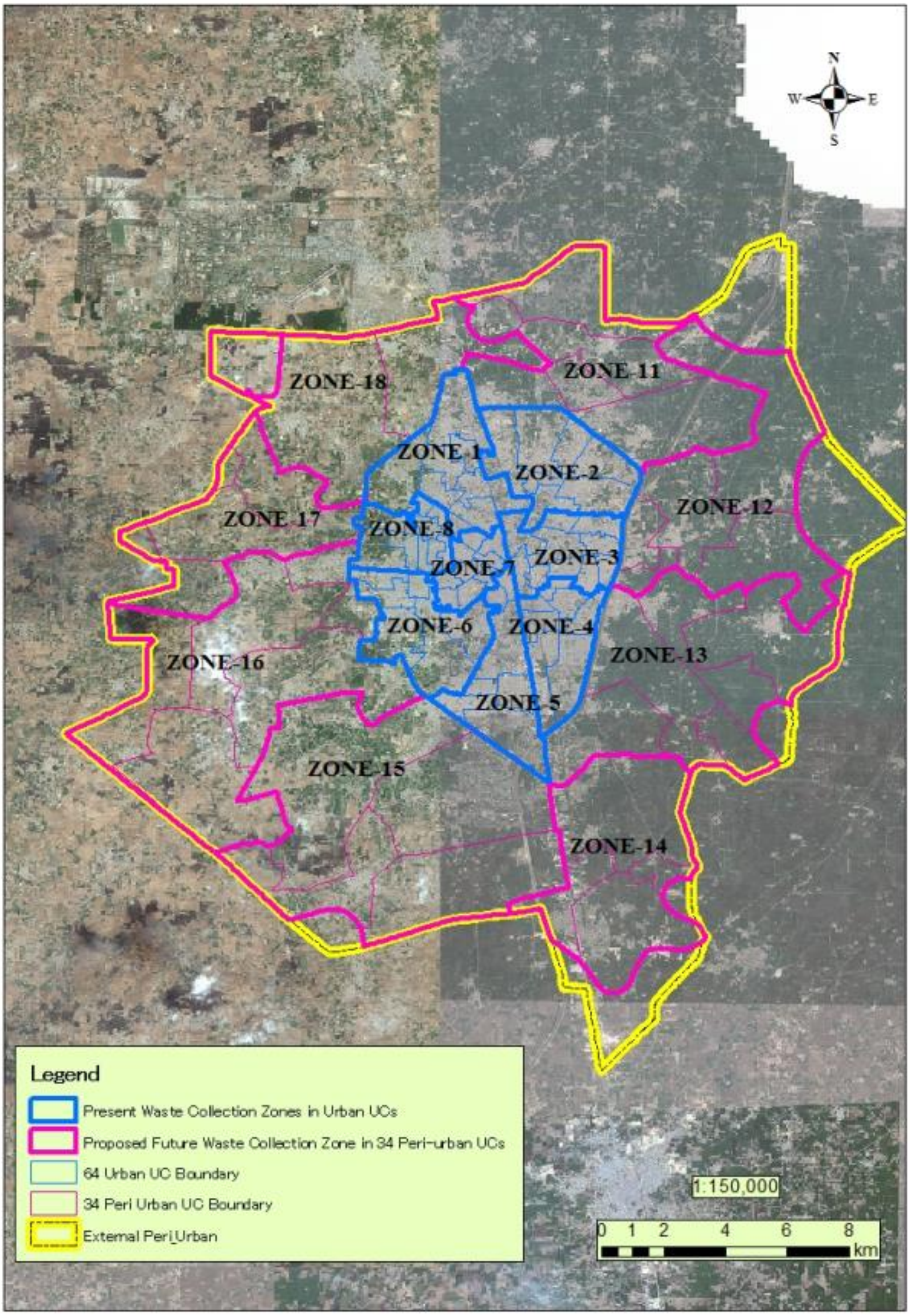


Figure 5.2.5 Planned Waste Collection Area

In this master plan, waste collection area is expanded and it covers 100% collection in 64 UCs in 2018. Waste collecting operation starts in 34 UCs in 2019 and covers 100% in 2030. 34 UCs are also divided into 8 zones. Zone 9 and Zone 10 are set as street sweeping areas. Collection zones are also expanded from 8 zones to 16 zones. **Table 5.2.9**, **Table 5.2.10** and **Table 5.2.11** show the collection area in each zone. The population in 98 UCs will be 5,373,752 in 2030.

Table 5.2.9 Collection Area and Population in Each Zone (Year 2014-2019)

Item	Area (km^2)	2014	2015	2016	2017	2018	2019
Zone-1	11.30	260,390	270,259	280,501	291,132	302,165	313,617
Zone-2	11.45	219,759	228,087	236,731	245,702	255,014	264,678
Zone-3	7.23	317,412	329,442	341,928	354,888	368,338	382,299
Zone-4	7.57	235,384	244,306	253,564	263,174	273,147	283,499
Zone-5	8.69	219,182	227,489	236,109	245,058	254,347	263,987
Zone-6	9.81	223,582	232,054	240,848	249,976	259,450	269,282
Zone-7	3.67	298,929	310,257	322,015	334,218	346,885	360,031
Zone-8	5.27	279,027	289,601	300,576	311,969	323,794	336,066
Sub Total	64.99	2,053,665	2,131,495	2,212,272	2,296,117	2,383,140	2,473,459
Zone-11	29.68	188,686	195,839	203,259	210,963	218,959	227,258
Zone-12	29.85	159,180	165,212	171,474	177,973	184,718	191,719
Zone-13	35.66	115,017	119,377	123,901	128,597	133,470	138,529
Zone-14	24.07	108,222	112,324	116,582	121,000	125,586	130,346
Zone-15	51.82	111,162	115,375	119,748	124,286	128,997	133,886
Zone-16	45.80	130,528	135,475	140,609	145,939	151,470	157,211
Zone-17	21.90	51,949	53,918	55,962	58,083	60,285	62,570
Zone-18	23.70	45,005	46,710	48,480	50,318	52,225	54,204
Sub Total	262.48	909,749	944,230	980,015	1,017,159	1,055,710	1,095,723
Grand Total	327.47	2,963,414	3,075,725	3,192,287	3,313,276	3,438,850	3,569,182

Table 5.2.10 Collection Area and Population on Each Zone (Year 2020-2024)

Item	Area (km^2)	2020	2021	2022	2023	2024
Zone-1	11.30	325,503	337,840	350,645	363,935	377,727
Zone-2	11.45	274,709	285,121	295,926	307,143	318,785
Zone-3	7.23	396,788	411,827	427,436	443,636	460,450
Zone-4	7.57	294,244	305,396	316,969	328,982	341,451
Zone-5	8.69	273,992	284,377	295,155	306,341	317,951
Zone-6	9.81	279,487	290,079	301,073	312,485	324,328
Zone-7	3.67	373,676	387,838	402,537	417,794	433,629
Zone-8	5.27	348,804	362,024	375,745	389,985	404,765
Sub Total	64.99	2,567,203	2,664,502	2,765,486	2,870,301	2,979,086
Zone-11	29.68	235,871	244,810	254,087	263,717	273,713
Zone-12	29.85	198,986	206,527	214,355	222,478	230,911
Zone-13	35.66	143,780	149,228	154,884	160,754	166,847
Zone-14	24.07	135,286	140,413	145,734	151,258	156,991
Zone-15	51.82	138,960	144,226	149,692	155,364	161,252
Zone-16	45.80	163,170	169,354	175,773	182,434	189,348
Zone-17	21.90	64,941	67,402	69,956	72,607	75,359
Zone-18	23.70	56,259	58,392	60,605	62,902	65,286
Sub Total	262.48	1,137,253	1,180,352	1,225,086	1,271,514	1,319,707
Grand Total	327.47	3,704,456	3,844,854	3,990,572	4,141,815	4,298,793

Table 5.2.11 Collection Area and Population on Each Zone (Year 2025-2030)

Item	Area (km^2)	2025	2026	2027	2028	2029	2030
Zone-1	11.30	392,042	406,900	422,321	438,328	454,939	472,180
Zone-2	11.45	330,867	343,408	356,423	369,930	383,950	398,502
Zone-3	7.23	477,900	496,012	514,812	534,322	554,574	575,591
Zone-4	7.57	354,391	367,822	381,762	396,231	411,249	426,835
Zone-5	8.69	330,000	342,506	355,487	368,960	382,944	397,458
Zone-6	9.81	336,620	349,378	362,621	376,365	390,629	405,434
Zone-7	3.67	450,063	467,120	484,823	503,197	522,268	542,061
Zone-8	5.27	420,105	436,025	452,551	469,701	487,502	505,978
Sub Total	64.99	3,091,988	3,209,171	3,330,800	3,457,034	3,588,055	3,724,039
Zone-11	29.68	284,087	294,854	306,029	317,627	329,665	342,159
Zone-12	29.85	239,661	248,745	258,172	267,957	278,112	288,652
Zone-13	35.66	173,171	179,733	186,545	193,615	200,953	208,569
Zone-14	24.07	162,941	169,115	175,525	182,177	189,081	196,247
Zone-15	51.82	167,363	173,706	180,290	187,122	194,214	201,574
Zone-16	45.80	196,524	203,973	211,704	219,728	228,055	236,699
Zone-17	21.90	78,214	81,178	84,255	87,448	90,763	94,202
Zone-18	23.70	67,760	70,328	72,993	75,759	78,631	81,611
Sub Total	262.48	1,369,721	1,421,632	1,475,513	1,531,433	1,589,474	1,649,713
Grand Total	327.47	4,461,709	4,630,803	4,806,313	4,988,467	5,177,529	5,373,752

(b) Waste Collection Ratio

GWMC conducts waste collection in 64 UCs, but waste collection area does not cover the whole city. For instance, there are some places where waste is collected once or twice a week or two weeks. They are called as partial collection areas. Based on the survey done by waste managers in GWMC, percentages of collection area, partial collection area and no collection area are known.

Table 5.2.12 and **Table 5.2.13** show waste collection ratio from 2014 to 2030. The waste collection ratio is 43% in 2014 as mentioned in **Chapter 4**. In this master plan, the waste collection ratio in 2018 is 100% and waste collection service in 34 UCs (Peri-urban area) starts in 2019 and covers 34 UCs in 2030.

Table 5.2.12 Waste Collection Ratio from 2014 to 2021

(Unit: %)

Year	2014	2015	2016	2017	2018	2019	2020	2021
64UCs	43	57	71	85	100	100	100	100
34UCs	0	0	0	0	0	10	20	30

Table 5.2.13 Waste Collection Ratio from 2022 to 2030

(Unit: %)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
64UCs	100	100	100	100	100	100	100	100	100
34UCs	40	50	60	67	73	80	87	93	100

(c) Waste Collection Population

Table 5.2.14 shows waste collection population in each year. Waste collection population in each year is multiplied by the waste collection ratio each year.

Table 5.2.14 Waste Collection Population in Each Year

Year	64 UC	34 UC	Total
2014	883,076	0	883,076
2015	1,214,952	0	1,214,952
2016	1,570,713	0	1,570,713
2017	1,951,699	0	1,951,699
2018	2,383,140	0	2,383,140
2019	2,473,459	109,572	2,583,031
2020	2,567,203	227,451	2,794,654
2021	2,664,502	354,106	3,018,608
2022	2,765,486	490,034	3,255,520
2023	2,870,301	635,757	3,506,058
2024	2,979,086	791,824	3,770,910
2025	20,654,876	917,713	21,572,589
2026	39,358,053	1,037,791	40,395,845
2027	76,332,967	1,180,411	77,513,378
2028	150,192,475	1,332,347	151,524,822
2029	297,817,747	1,478,211	299,295,957
2030	592,970,991	1,649,713	594,620,704

(d) Waste Amount per Capita

For estimating the total waste amount in the master plan, waste amount per capita is calculated from the result of WACS survey.

Table 5.2.15 and **Table 5.2.16** show waste amount per capita in each year. Waste generation per capita is related with the economic growth. 1% of increment in each year is estimated and added on waste amount per capita in the master plan. In 2030, waste amount per capita in 64 UCs is 0.467 kg and the one in 34 UCs is 0.414kg.

Table 5.2.15 Waste Amount per Capita on Each Year (Year 2014-2022)

(Unit: kilograms per capita)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
64UCs	0.400	0.404	0.408	0.412	0.416	0.420	0.424	0.428	0.432
34UCs	0.350	0.354	0.358	0.362	0.366	0.370	0.374	0.378	0.382

Table 5.2.16 Waste Amount per Capita on Each Year (Year 2023-2030)

(Unit: kilograms per capita)

Year	2023	2024	2025	2026	2027	2028	2029	2030
64UCs	0.436	0.440	0.444	0.448	0.452	0.457	0.462	0.467
34UCs	0.386	0.390	0.394	0.398	0.402	0.406	0.410	0.414

(e) Waste Generation Amount (Domestic Waste)

Waste generation amount is calculated by population in waste collection area and waste amount per capita. **Table 5.2.17** and **Table 5.2.18** show waste generation amount in each year. In 2014, waste generation amounts to 821 tons per day in 64 UCs and 318 tons per day in

34 UCs. In 2030, the waste generation amount becomes 1,739 tons per day in 64 UCs and 683 tons per day in 34 UCs.

Table 5.2.17 Waste Generation Amount on Each Year (Year 2014-2022)

(Unit: ton/day)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
64UCs	821	861	903	946	991	1,039	1,089	1,140	1,195
34UCs	318	334	351	368	386	406	425	446	468

Table 5.2.18 Waste Generation Amount on Each Year (Year 2023-2030)

(Unit: ton/day)

Year	2023	2024	2025	2026	2027	2028	2029	2030
64UCs	1,251	1,311	1,373	1,438	1,506	1,580	1,658	1,739
34UCs	491	515	540	566	593	622	652	683

(f) Commercial and Other Wastes

GWMC is also responsible for commercial waste and other wastes such as wastes form government offices, schools, commercial facilities, restaurants and street sweeping, etc. **Table 5.2.19** and **Table 5.2.20** show the commercial and other waste amount ratio. It is assumed that commercial and other economic activities will increase in the city in the future. For this reason, the commercial and other waste ratio on 64 UCs in 2030 is set as 30% and the one in a rural area (34 UCs) is 26% in 2030.

Table 5.2.19 Commercial and Other Waste Amount Ratio (Year 2014-2021)

(Unit: %)

Year	2014	2015	2016	2017	2018	2019	2020	2021
64UCs	0.14	0.15	0.16	0.17	0.18	0.19	0.2	0.21
34UCs	0.12	0.13	0.14	0.15	0.16	0.17	0.17	0.18

Table 5.2.20 Commercial and Other Waste Amount Ratio (Year 2022-2030)

(Unit: %)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
64UCs	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.3
34UCs	0.19	0.2	0.21	0.22	0.23	0.24	0.24	0.25	0.26

(g) Planned Waste Collection Amount

The waste collection amount is calculated by the waste generation amount, waste collection ration and commercial and other waste ratio. For estimating the number of vehicles and containers, calculated waste collection amount is divided by 6/7, which means 6 waste collection days in a week and waste collection amount for waste collection and transportation needs to consider the amount on Sunday.

Table 5.2.21 and **Table 5.2.22** shows planned waste collection amount. Total waste collection amount in 98 UCs is 3,904 ton/day in 2030.

Table 5.2.21 Planned Waste Collection Amount (Year 2014-2022)

(Unit: ton/day)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
64 UC	478	673	889	1,129	1,410	1,496	1,586	1,683	1,786
34 UC	0	0	0	0	0	55	117	185	260
Total	478	673	889	1,129	1,410	1,551	1,703	1,868	2,046

Table 5.2.22 Planned Waste Collection Amount (Year 2023-2030)

(Unit: ton/day)

Year	2023	2024	2025	2026	2027	2028	2029	2030
64 UC	1,895	2,011	2,135	2,265	2,405	2,560	2,724	2,898
34 UC	344	436	514	592	684	786	886	1,006
Total	2,239	2,447	2,649	2,857	3,089	3,346	3,610	3,904

The waste collection ratio is 43% in 2014 based on the calculation. In this master plan, waste collection ratio in 2018 is 100% and waste collection service in 34 UCs (Peri-urban area) starts in 2019 and covers 34UCs in 2030.

(h) Summary of Planned Waste Collection Population and Amount

Table 5.2.23, **Table 5.2.24**, **Table 5.2.25** and **Table 5.2.26** show the summary of planned waste collection population and amount. Total waste collection amount in 98 UCs is 3,904 tons/ day in 2030.

Table 5.2.23 Summary of Planned Waste Collection Population and Amount (Year 2014-2018)

Item		2014	2015	2016	2017	2018
64UCs	Population	2,053,665	2,131,495	2,131,495	2,212,272	2,296,117
	Waste amount per capita per day (kg/day)	0.4	0.404	0.408	0.412	0.416
	Waste Generation Amount (ton/day)	821	861	903	946	991
	Collection ratio (domestic) (%)	43	57	71	85	100
	Waste collection amount-Domestic (ton/day)	353	491	641	804	991
	Commercial ratio (%)	14	15	16	17	18
	Commercial waste	57	86	121	164	217
	Total waste collection amount	410	577	762	968	1,208
	Total necessary waste collection amount	478	673	889	1,129	1,410
34UCs	Population	909,749	944,230	944,230	980,015	1,017,159
	Waste amount per capita per day (kg/day)	0.35	0.354	0.358	0.362	0.366
	Waste Generation Amount (ton/day)	318.2	334.3	350.7	368.4	386.3
	Collection ratio (domestic) (%)	0	0	0	0	0
	Waste collection amount-Domestic (ton/day)	0	0	0	0	0
	Commercial ratio (%)	12	13	14	15	16
	Commercial waste	0	0	0	0	0
	Total waste collection amount	0	0	0	0	0
	Total necessary waste collection amount	0	0	0	0	0
98UCs	Total waste collection amount (ton/day)	410	577	762	968	1,208
	Total necessary waste collection amount (ton/day)	478	673	889	1,129	1,410

Table 5.2.24 Summary of Planned Waste Collection Population and Amount (Year 2019-2022)

Item		2019	2020	2021	2022
64UCs	Population	2,383,140	2,473,459	2,567,203	2,664,502
	Waste amount per capita per day (kg/day)	0.42	0.424	0.428	0.432
	Waste Generation Amount (ton/day)	1,039	1,089	1,140	1,195
	Collection ratio (domestic) (%)	100	100	100	100
	Waste collection amount-Domestic (ton/day)	1,039	1,089	1,140	1,195
	Commercial ratio (%)	19%	20%	21%	22%
	Commercial waste	243	271	302	336
	Total waste collection amount	1,282	1,360	1,442	1,531
34UCs	Total necessary waste collection amount	1,496	1,586	1,683	1,786
	Population	1,055,710	1,095,723	1,137,253	1,180,352
	Waste amount per capita per day (kg/day)	0.37	0.374	0.378	0.382
	Waste Generation Amount (ton/day)	405.5	425.3	446.1	468
	Collection ratio (domestic) (%)	10	20	30	40
	Waste collection amount-Domestic (ton/day)	41	85	134	187
	Commercial ratio (%)	17%	17%	18%	19%
	Commercial waste	7	15	25	36
	Total waste collection amount	47	100	158	223
	Total necessary waste collection amount	55	117	185	260
98UCs	Total waste collection amount (ton/day)	1,329	1,459	1,601	1,754
	Total necessary waste collection amount (ton/day)	1,551	1,703	1,868	2,046

Table 5.2.25 Summary of Planned Waste Collection Population and Amount (Year 2023-2026)

Item		2023	2024	2025	2026
64UCs	Population	2,765,486	2,870,301	2,979,086	3,091,988
	Waste amount per capita per day (kg/day)	0.436	0.44	0.444	0.448
	Waste Generation Amount (ton/day)	1,251	1,311	1,373	1,438
	Collection ratio (domestic) (%)	100	100	100	100
	Waste collection amount-Domestic (ton/day)	1,251	1,311	1,373	1,438
	Commercial ratio (%)	23%	24%	25%	26%
	Commercial waste	373	413	457	504
	Total waste collection amount	1,624	1,724	1,830	1,942
34UCs	Total necessary waste collection amount	1,895	2,011	2,135	2,265
	Population	1,225,086	1,271,514	1,319,707	1,369,721
	Waste amount per capita per day (kg/day)	0.386	0.39	0.394	0.398
	Waste Generation Amount (ton/day)	490.9	514.9	539.9	566
	Collection ratio (domestic) (%)	50	60	67	73
	Waste collection amount-Domestic (ton/day)	245	309	362	413
	Commercial ratio (%)	20%	21%	22%	23%
	Commercial waste	49	65	79	94
	Total waste collection amount	295	374	441	507
	Total necessary waste collection amount	344	436	514	592
98UCs	Total waste collection amount (ton/day)	1,919	2,098	2,271	2,449
	Total necessary waste collection amount (ton/day)	2,239	2,447	2,649	2,857

Table 5.2.26 Summary of Planned Waste Collection Population and Amount (Year 2027-2030)

Item		2027	2028	2029	2030
64UCs	Population	3,209,171	3,330,800	3,457,034	3,588,055
	Waste amount per capita per day (kg/day)	0.452	0.457	0.462	0.467
	Waste Generation Amount (ton/day)	1,506	1,580	1,658	1,739
	Collection ratio (domestic) (%)	100	100	100	100
	Waste collection amount-Domestic (ton/day)	1,506	1,580	1,658	1,739
	Commercial ratio (%)	27%	28%	29%	30%
	Commercial waste	556	614	677	745
	Total waste collection amount	2,062	2,194	2,335	2,484
34UCs	Total necessary waste collection amount	2,405	2,560	2,724	2,898
	Population	1,421,632	1,475,513	1,531,433	1,589,474
	Waste amount per capita per day (kg/day)	0.402	0.406	0.41	0.414
	Waste Generation Amount (ton/day)	592.9	621.7	651.6	683
	Collection ratio (domestic) (%)	80	87	93	100
	Waste collection amount-Domestic (ton/day)	474	541	606	683
	Commercial ratio (%)	24%	24%	25%	26%
	Commercial waste	112	132	154	179
	Total waste collection amount	586	673	760	862
	Total necessary waste collection amount	684	786	886	1,006
98UCs	Total waste collection amount (ton/day)	2,648	2,867	3,094	3,346
	Total necessary waste collection amount (ton/day)	3,089	3,345	3,610	3,904

(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation

(a) Proposed Waste Collection Vehicles

GWMC operates 5 cubic metre (5m^3) arm-roll truck, 10m^3 arm-roll truck, tractor trolley and mini-dumper for waste collection and transportation.

Table 5.2.27 shows the type of vehicles in use. Most vehicles are used for waste transfer except mini-dumpers. Only 5 mini-dumpers directly haul the waste to the landfill site.

Table 5.2.27 Type of Vehicles in Use

Type of Vehicles	Number of vehicles
Arm-roll truck (10 m^3)	4
Arm-roll truck (5 m^3)	22
Tractor trolley	43
Mini-dumper	5 (35)

Note: Total number of mini-dumper is 35. However, five mini-dumpers go to the landfill site directly after waste collection from each UC.

Most of the vehicles are procured in approximately the year 2000. Duration year of the vehicles is expired. However, GWMC repairs when a vehicle breaks down and continues to utilise them up to now.

Table 5.2.28 shows the vehicles applied to waste collection and transportation in the master plan. Three types of compactors conduct waste collection and transfer the waste in the city in the master plan.

Table 5.2.28 Vehicles Applied to Waste Collection and Transportation in the Master Plan

Type of Vehicles	Carrying Capacity (ton)
Compactor (13 m^3)	6.5
Compactor (7 m^3)	3.5
Compactor (4 m^3)	2.0

Based on the following conditions for compactor, the necessary number of collection vehicles is determined as follows:

- The 13m^3 compactor is applied to a large sized street.
- The 7m^3 compactor is applied to a middle sized street.
- The 4m^3 compactor is applied to a small sized street.
- Number of necessary vehicles is calculated from necessary waste collection amount in each year.
- Durable year for a vehicle is set as 8 years. After 8 years, 10% of the vehicles are interchanged. (All procured vehicles are interchanged in 18 years since the vehicles are procured.)
- Existing vehicles are planned to be utilised in 64 UCs until 2018. These vehicles are planned to be utilised in 34 UCs from 2019 to 2021. All existing vehicles are phased out in 2022.
- A few 5m^3 arm-roll trucks are kept for collecting waste from large waste amount disposers such as shopping centre, etc.
- Two mini-dumpers are deployed for the primary collection in each UC. Basically, the primary collection is conducted by the compactor. However, there are few small streets where the compactor cannot access. Mini-dumpers are applied to this type of street. Collected waste is transferred to a large sized compactor such as 13m^3 or 7m^3 compactor on the street.

(b) Number of Trips and Other Conditions

For estimating the necessary number of vehicles, the following conditions are set.

(i) Waste Loading Capacity on Each Vehicle

Table 5.2.29 shows waste loading capacity of each vehicle. For estimating the waste carrying amount on each vehicle, waste loading capacity is set. The bulk specific gravity is set as 0.5 m^3 per ton. According to the interview survey to a GWMC Waste Manager, the bulk specific gravity of the waste coming to the landfill site is 0.5 m^3 per ton. This ratio is applied in the master plan.

Table 5.2.29 Waste Loading Capacity of Each Vehicle

Item	Waste Loading Capacity (ton/vehicle)
Arm-roll truck (5 m^3)	2.5
Arm-roll truck (10 m^3)	5.0
Tractor Trolley	1.6
Compactor (13 m^3)	6.5
Compactor (7 m^3)	3.5
Compactor (4 m^3)	2.0

(ii) Number of Trips

The number of trips is estimated from the result of Time and Motion survey. **Table 5.2.30** shows the number of trips on each vehicle. The number of trips per vehicle is one of the factors to estimate the waste collection amount per vehicle.

Table 5.2.30 Number of Trips on Each Vehicle

Item	Number of trips
Arm-roll truck (5 m^3)	5
Arm-roll truck (10 m^3)	5
Tractor trolley	2
Compactor (13 m^3)	1
Compactor (7 m^3)	2
Compactor (4 m^3)	3
Mini-dumper	4

The conditions on the number of trips on each vehicle are the following:

- The number of trips of a 5m^3 arm-roll truck is set based on the Time and Motion Study.
- The number of trips of a 10m^3 arm-roll truck is referred to the 5m^3 arm-roll truck. The size of both trucks is almost the same.
- The number of trips of tractor trolley is set based on the Time and Motion Study.
- The number of trips of 13m^3 compactor is set based on the result of tractor trolley in the Time and Motion Study. A tractor trolley collects 1 ton of waste per hour. Even if the sanitary worker changes the collection method, it is assumed that time consumed for collection work is the same. The capacity of a 6.5 ton compactor is 13 m^3 so that it is estimated that 6 to 6.5 hours for waste collection is necessary per trip. A vehicle can make only one trip in a day.
- The number of trips for 7m^3 compactor is set based on the result for tractor trolley in the Time and Motion Study. A tractor trolley collects 1 ton of waste per hour. Even if the sanitary worker changes the collection method, it is assumed that time consumed for collection work is the same. The capacity of the compactor is 7 m^3 (3.5 ton) so that it is estimated that 3 -3.5 hours for waste collection is necessary per trip. A vehicle can make only 2 trips in a day.
- The number of trips of a 4m^3 compactor is set based on the result for tractor trolley in the Time and Motion Study. A tractor trolley collects 1 ton of waste per hour. Even if a sanitary worker changes the collection method, it is assumed that time consumed for collection work is the same. The capacity of the compactor is 4m^3 (2 ton) so that it is estimated that 2 to 2.5 hours for waste collection is necessary per trip. The vehicle can make only 3 trips in a day.
- The number of trips for mini-dumper is set based on the time and motion survey.

(c) Necessary Number of Waste Collection Vehicles

Table 5.2.31 and **Table 5.2.32** show the total number of vehicles in 64UCs. The total number of vehicles in 64 UCs becomes 449 in 2030. **Table 5.2.33**, **Table 5.2.34** and **Table 5.2.35** show the total waste collection amount by vehicle in 64UCs. **Figure 5.2.6** shows total number of vehicles in 64 UCs. Total waste collected amount in 64 UCs becomes 2,165 tons/day in 2030.

Table 5.2.36 and **Table 5.2.37** show the total number of vehicles in 34 UCs. The total number of vehicles in 34 UCs becomes 151 in 2030.

Table 5.2.38, **Table 5.2.39** and **Table 5.2.40** show the total waste collection amount by vehicle in 34 UCs. **Figure 5.2.7** shows the total number of vehicles in 34 UCs. The total waste collected amount in 64 UCs becomes 1,013 tons/day in 2030.

Table 5.2.31 Total Number of Vehicles Required in 64 UCs (Year 2016-2022)

64UCs			2016	2017	2018	2019	2020	2021	2022
Existing	Arm-roll truck	10.0 m^3	4	4	4	0	0	0	0
	Arm-roll truck	5.0 m^3	22	22	22	0	0	0	0
	Tractor trolley	3.2 m^3	43	43	43	0	0	0	0
	Mini-dumper	1.0 m^3	35	35	35	35	35	35	35
Master Plan	Arm-roll truck	10.0 m^3	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	0	0	0	5	5	5	5
	Compactor	13.0 m^3	13	28	68	78	93	93	108
	Compactor	7.0 m^3	38	58	98	98	98	98	112
	Compactor	4.0 m^3	0	0	40	40	40	40	40
	Mini-dumper	1.0 m^3	0	0	0	0	0	0	0
Total			155	190	310	256	271	271	300

Table 5.2.32 Total Number of Vehicles Required in 64 UCs (Year 2023-2030)

64UCs			2023	2024	2025	2026	2027	2028	2029	2030
Existing	Arm-roll truck	10.0 m^3	0	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	0	0	0	0	0	0	0	0
	Tractor trolley	3.2 m^3	0	0	0	0	0	0	0	0
	Mini-dumper	1.0 m^3	28	24	21	17	14	10	6	3
Master Plan	Arm-roll truck	10.0 m^3	0	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	5	5	5	6	6	6	6	6
	Compactor	13.0 m^3	117	128	140	148	160	171	189	206
	Compactor	7.0 m^3	120	126	135	145	153	164	172	181
	Compactor	4.0 m^3	40	40	40	40	40	40	40	40
	Mini-dumper	1.0 m^3	0	0	0	0	2	6	10	13
Total			310	323	341	356	375	397	423	449

Table 5.2.33 Total Waste Collection Amount by Vehicle in 64UCs (Year 2016-2020)

64UCs			Capacity (ton)	Number of trips	2016	2017	2018	2019	2020
Existing	Arm-roll truck	10.0 m^3	5	5	50	50	50	0	0
	Arm-roll truck	5.0 m^3	2.5	5	275	275	275	0	0
	Tractor trolley	3.2 m^3	1.6	3	206	206	206	0	0
	Mini-dumper	1.0 m^3	0.5	5	13	13	13	13	13
Master Plan	Arm-roll truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	0	0	0	63	63
	Compactor	13.0 m^3	6.5	1	85	182	442	507	605
	Compactor	7.0 m^3	3.5	2	266	406	686	686	686
	Compactor	4.0 m^3	2	3	0	0	240	240	240
	Mini-dumper	1.0 m^3	0.5	0	0	0	0	0	0
Total (ton)					895	1,132	1,912	1,509	1,607
Planned Waste Collection Amount (ton)					889	1,129	1,410	1,496	1,586

Table 5.2.34 Total Waste Collection Amount by Vehicle in 64UCs (Year 2021-2025)

64UCs			Capacity (ton)	Number of trips	2021	2022	2023	2024	2025
Existing	Arm-roll truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	0	0	0	0	0
	Tractor trolley	3.2 m^3	1.6	3	0	0	0	0	0
	Mini-dumper	1.0 m^3	0.5	5	12.5	10	10	7.5	7.5
Master Plan	Arm-roll truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	63	63	63	63	63
	Compactor	13.0 m^3	6.5	1	605	702	761	832	910
	Compactor	7.0 m^3	3.5	2	784	784	840	882	945
	Compactor	4.0 m^3	2	3	240	240	240	240	240
	Mini-dumper	1.0 m^3	0.5	0	0	0	0	0	0
Total (ton)					1,704	1,799	1,913	2,024	2,165
Planned Waste Collection Amount (ton)					1,683	1,786	1,895	2,011	2,135

Table 5.2.35 Total Waste Collection Amount by Vehicle in 64UCs (Year 2026-2030)

64UCs			Capacity (ton)	Number of trips	2026	2027	2028	2029	2030
Existing	Arm-roll truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	0	0	0	0	0
	Tractor trolley	3.2 m^3	1.6	3	0	0	0	0	0
	Mini-dumper	1.0 m^3	0.5	5	5	5	2.5	0	0
Master Plan	Arm-roll truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	75	75	75	75	75
	Compactor	13.0 m^3	6.5	1	962	1,040	1,112	1,229	1,339
	Compactor	7.0 m^3	3.5	2	1,015	1,071	1,148	1,204	1,267
	Compactor	4.0 m^3	2	3	240	240	240	240	240
	Mini-dumper	1.0 m^3	0.5	0	0	0	0	0	0
Total (ton)					2,297	2,431	2,577	2,748	2,921
Planned Waste Collection Amount (ton)					2,265	2,405	2,560	2,724	2,898

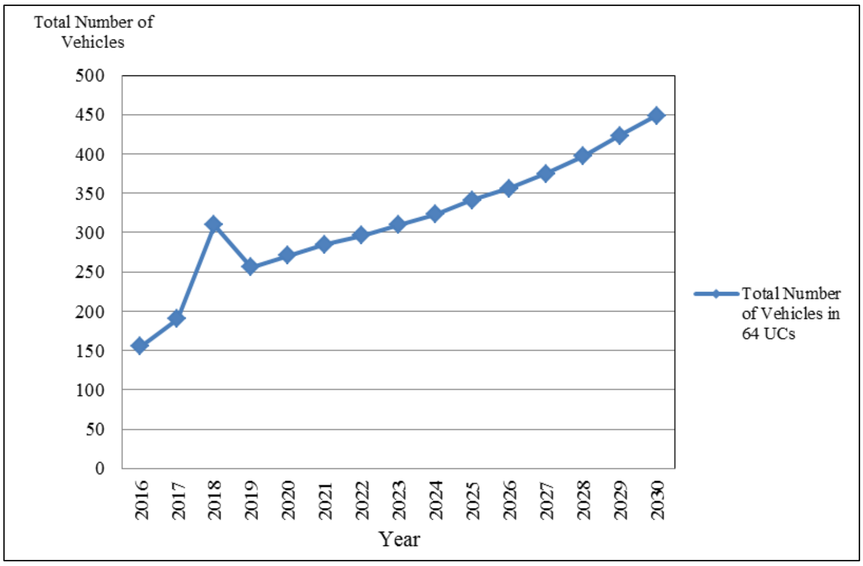


Figure 5.2.6 Total Number of Vehicles in 64UCs

Table 5.2.36 Total Number of Vehicles Required in 34 UCs (Year 2016-2022)

34UCs			2016	2017	2018	2019	2020	2021	2022
Existing	Arm-roll truck	10.0 m^3	0	0	0	4	4	4	0
	Arm-roll truck	5.0 m^3	0	0	0	22	22	22	0
	Tractor trolley	3.2 m^3	0	0	0	43	43	43	0
	Mini-dumper	1.0 m^3	0	0	0	0	0	0	0
Master Plan	Arm-roll truck	10.0 m^3	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	0	0	0	0	0	0	0
	Compactor	13.0 m^3	0	0	0	0	0	12	24
	Compactor	7.0 m^3	0	0	0	0	0	15	15
	Compactor	4.0 m^3	0	0	0	0	0	0	0
	Mini-dumper	1.0 m^3	0	0	0	0	0	0	0
Total			0	0	0	69	69	96	39

Table 5.2.37 Total Number of Vehicles Required in 34 UCs (Year 2023-2030)

34UCs			2023	2024	2025	2026	2027	2028	2029	2030
Existing	Arm-roll truck	10.0 m^3	0	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	0	0	0	0	0	0	0	0
	Tractor trolley	3.2 m^3	0	0	0	0	0	0	0	0
	Mini-dumper	1.0 m^3	0	0	0	0	0	0	0	0
Master Plan	Arm-roll truck	10.0 m^3	0	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	0	0	0	0	0	0	0	0
	Compactor	13.0 m^3	29	36	42	48	54	61	66	73
	Compactor	7.0 m^3	23	30	35	40	46	53	61	70
	Compactor	4.0 m^3	0	0	0	1	3	4	6	8
	Mini-dumper	1.0 m^3	0	0	0	0	0	0	0	0
Total			52	66	77	89	106	118	133	151

Table 5.2.38 Total Waste Collection Amount by Vehicle in 34UCs (Year 2016-2020)

34UCs			Capacity (ton)	Number of trips	2016	2017	2018	2019	2020
Existing	Arm-roll truck	10.0 m^3	5	5	0	0	0	4	4
	Arm-roll truck	5.0 m^3	2.5	5	0	0	0	22	22
	Tractor trolley	3.2 m^3	1.6	3	0	0	0	43	43
	Mini-dumper	1.0 m^3	0.5	5	0	0	0	0	0
Master Plan	Arm-roll truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	0	0	0	0	0
	Compactor	13.0 m^3	6.5	1	0	0	0	0	0
	Compactor	7.0 m^3	3.5	2	0	0	0	0	0
	Compactor	4.0 m^3	2	3	0	0	0	0	0
	Mini-dumper	1.0 m^3	0.5	5	0	0	0	0	0
Total (ton)					0	0	0	531	531
Planned Waste Collection Amount (ton)					0	0	0	55	117

Table 5.2.39 Total Waste Collection Amount by Vehicle in 34UCs (Year 2021-2025)

34UCs			Capacity (ton)	Number of trips	2021	2022	2023	2024	2025
Existing	Arm-roll truck	10.0 m^3	5	5	4	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	22	0	0	0	0
	Tractor trolley	3.2 m^3	1.6	3	43	0	0	0	0
	Mini-dumper	1.0 m^3	0.5	5	0	0	0	0	0
Master Plan	Arm-roll truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	0	0	0	0	0
	Compactor	13.0 m^3	6.5	1	12	24	29	36	42
	Compactor	7.0 m^3	3.5	2	15	15	23	30	35
	Compactor	4.0 m^3	2	3	0	0	0	0	0
	Mini-dumper	1.0 m^3	0.5	5	0	0	0	0	0
Total (ton)					714	261	350	444	518
Planned Waste Collection Amount (ton)					185	260	344	436	514

Table 5.2.40 Total Waste Collection Amount by Vehicle in 34UCs (Year 2026-2030)

34UCs			Capacity (ton)	Number of trips	2026	2027	2028	2029	2030
Existing	Arm-roll truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	0	0	0	0	0
	Tractor trolley	3.2 m^3	1.6	3	0	0	0	0	0
	Mini-dumper	1.0 m^3	0.5	5	0	0	0	0	0
Master Plan	Arm-roll truck	10.0 m^3	5	5	0	0	0	0	0
	Arm-roll truck	5.0 m^3	2.5	5	0	0	0	0	0
	Compactor	13.0 m^3	6.5	1	48	54	61	66	73
	Compactor	7.0 m^3	3.5	2	40	46	53	61	70
	Compactor	4.0 m^3	2	3	1	3	4	6	8
	Mini-dumper	1.0 m^3	0.5	5	0	0	0	0	0
Total (ton)					598	691	792	892	1,013
Planned Waste Collection Amount (ton)					592	684	786	886	1,006

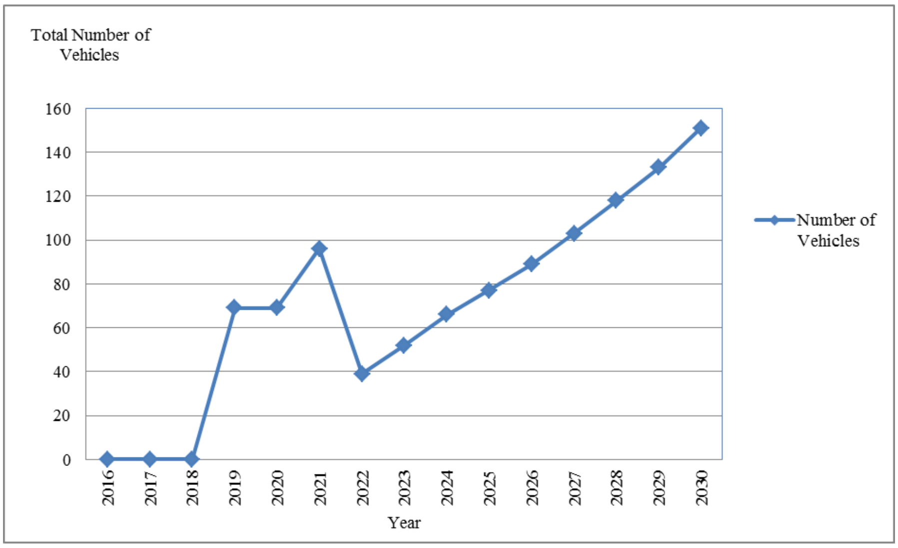


Figure 5.2.7 Total Number of Vehicles in 34UCs

(d) Necessary Number of Waste Containers

A container of 0.8 cubic metre (m^3) with lid is applied in the master plan. Currently, $5m^3$ containers and $10m^3$ containers are deployed by GWMC in waste collection area. Large sized containers can receive a large amount of waste, but the size of these containers is a disadvantage to waste collection. They require larger space on site so that it is sometimes difficult to find a place for the container or there is no space in certain areas.

Another issue on the containers is that they do not have a lid at the top. Therefore, foul odour is not prevented from the containers and it may cause complaints from the nearby residents. For solving this issue, a container with lid is applied in the master plan to prevent emission of foul odour.

The size of the container is much smaller than the large container so that there is no issue inconsidering the location of the container on the street. Durable year of the container is set as five years. After 5 years, 10% of the containers are replaced.

Some of the $5m^3$ containers are stationed at large discharge points such as commercial area or shopping malls in the city.

Table 5.2.41 shows the existing containers in the city and **Table 5.2.42** shows the applied container in the master plan. The concept of bulk specific gravity is the same as the waste collection and transportation vehicles.

Table 5.2.41 Existing Containers in the City

Item	Container Capacity
Container (5 m^3)	2.5 ton/container
Container (10 m^3)	5.0 ton/container

Table 5.2.42 Applied Container in the Master Plan

Item	Container Capacity
Container (0.8 m^3)	0.4 ton/container

The number of required containers is estimated from the waste collection amount necessary in each year. However, the existing containers and waste collection vehicles are deployed in 64 UCs from 2016 to 2018, and 34 UCs from 2019 to 2021. Necessary waste collection amount in a small container needs to consider the collection amount from existing containers and vehicles. Following is the calculation method for estimating the required number of containers.

(Necessary waste collection amount - Waste collection amount by existing containers and vehicles) / small container capacity = Required number of containers

Table 5.2.43 and **Table 5.2.44** show the total number of containers in 64 UCs. **Table 5.2.45**, **Table 5.2.46** and **Table 5.2.47** show the total waste collection amount by containers in 64 UCs. **Figure 5.2.8** shows the total number of containers in 64 UCs.

Table 5.2.48, Table 5.2.49 and **Table 5.2.50** show the total waste collection amount by containers in 34 UCs. **Figure 5.2.9** shows the total number of containers in 34 UCs.

The total collection capacity of containers on-site has to exceed the necessary waste collection amount in each year. In 2030, the total number of containers in 98 UCs is 9,927.

Table 5.2.43 Total Number of Containers Required in 64 UCs (Year 2016-2022)

64UCs		2016	2017	2018	2019	2020	2021	2022
Existing	10.0 m^3	6	6	6	0	0	0	0
	5.0 m^3	195	195	195	30	30	30	30
Master Plan	10.0 m^3	4	4	4	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0
	0.8 m^3	950	1,650	2,250	3,600	3,815	4,070	4,325
Total		1,155	1,855	2,455	3,630	3,845	4,100	4,355

Table 5.2.44 Total Number of Containers Required in 64 UCs (Year 2023-2030)

64UCs		2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	0	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	0	0	0	0	0	0	0	0
	5.0 m^3	30	30	30	30	30	30	30	30
	0.8 m^3	4,600	4,890	5,205	5,545	5,883	6,271	6,694	7,362
Total		4,630	4,920	5,235	5,575	5,913	6,301	6,724	7,392

Table 5.2.45 Total Waste Collection Amount by Containers in 64 UCs (Year 2014-2022)

64UCs		Capacity (ton)	2014	2015	2016	2017	2018	2019	2020	2021	2022
Existing	10.0 m^3	5.0	30	30	30	30	30	0	0	0	0
	5.0 m^3	2.5	488	488	488	488	488	75	75	75	75
Master Plan	10.0 m^3	5.0	0	20	20	20	20	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0	0	0
	0.8 m^3	0.4	0	140	380	660	900	1,440	1,526	1,628	1,730
Total (ton)			518	678	918	1,198	1,438	1,515	1,601	1,703	1,805
Planned Waste Collection Amount (ton)			478	673	889	1,129	1,410	1,496	1,586	1,683	1,786

Table 5.2.46 Total Waste Collection Amount by Containers in 64 UCs (Year 2023-2030)

64UCs		Capacity (ton)	2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	5.0	0	0	0	0	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	5.0	0	0	0	0	0	0	0	0
	5.0 m^3	2.5	75	75	75	75	75	75	75	75
	0.8 m^3	0.4	1,840	1,956	2,082	2,218	2,353	2,508	2,678	2,945
Total (ton)			1,915	2,031	2,157	2,293	2,428	2,583	2,753	3,020
Planned Waste Collection Amount (ton)			1,895	2,011	2,135	2,265	2,405	2,560	2,724	2,898

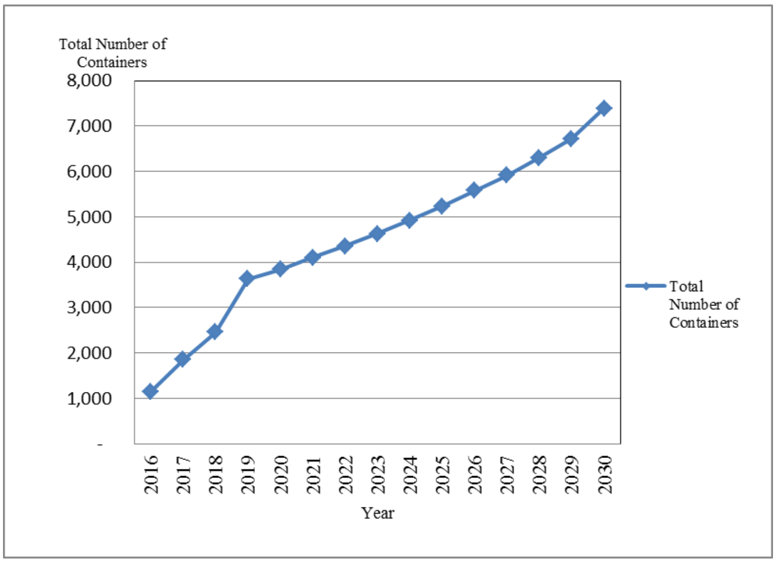


Figure 5.2.8 Total Number of Containers in 64UCs

Table 5.2.47 Total Number of Containers Required in 34 UCs (Year 2016-2022)

34UCs		2016	2017	2018	2019	2020	2021	2022
Existing	10.0 m^3	0	0	0	10	10	10	0
	5.0 m^3	0	0	0	90	80	70	0
Master Plan	10.0 m^3	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0
	0.8 m^3	0	0	0	0	0	0	750
Total		0	0	0	100	90	80	750

Table 5.2.48 Total Number of Containers Required in 34 UCs (Year 2023-2030)

34UCs		2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	0	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	0	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0	0
	0.8 m^3	900	1,150	1,350	1,550	1,775	2,035	2,270	2,565
Total		900	1,150	1,350	1,550	1,775	2,035	2,270	2,565

Table 5.2.49 Total Waste Collection Amount by Containers in 34 UCs (Year 2014-2022)

34UCs		Capacity (ton)	2014	2015	2016	2017	2018	2019	2020	2021	2022
Existing	10.0 m^3	5.0	0	0	0	0	0	50	50	50	0
	5.0 m^3	2.5	0	0	0	0	0	225	200	175	0
Master Plan	10.0 m^3	5.0	0	0	0	0	0	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0	0	0
	0.8 m^3	0.4	0	0	0	0	0	0	0	0	300
Total (ton)			0	0	0	0	0	275	250	225	300
Planned Waste Collection Amount (ton)			0	0	0	0	0	55	117	185	260

Table 5.2.50 Total Waste Collection Amount by Containers in 34 UCs (Year 2023-2030)

34UCs		Capacity (ton)	2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	5.0	0	0	0	0	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	5.0	0	0	0	0	0	0	0	0
	5.0 m^3	2.5	0	0	0	0	0	0	0	0
	0.8 m^3	0.4	360	460	540	620	710	814	908	1,026
Total (ton)			360	460	540	620	710	814	908	1,026
Planned Waste Collection Amount (ton)			344	436	514	592	684	786	886	1,006

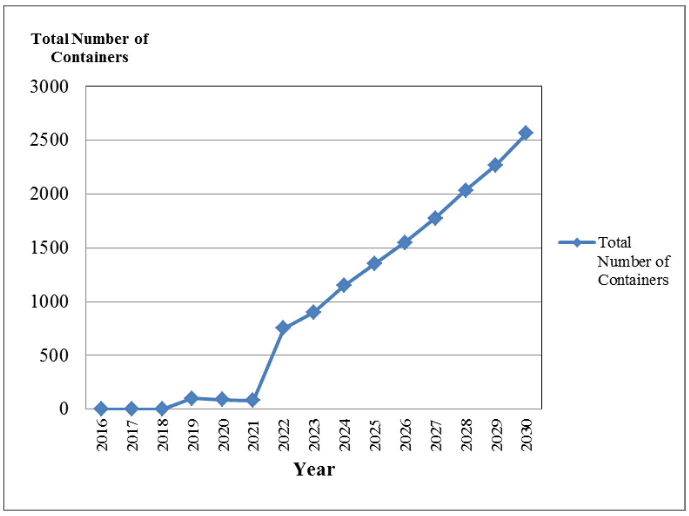


Figure 5.2.9 Total Number of Containers in 34UCs

(e) Necessary Number of Workers for Waste collection

Based on the necessity of collection vehicles, the total number of workers is estimated for the master plan. For estimating the number of workers, four types of workers are set: (i) Sanitary inspector, (ii) Sanitary supervisor, (iii) Driver, and (iv) Sanitary worker.

(i) Sanitary Inspector

Currently, sanitary inspectors are deployed and responsible for checking in several UCs. They get the report regarding waste collection work from the sanitary supervisors. GWMC has 8 zones in 64 UCs. Therefore, one sanitary worker is sufficient for one zone. In the master plan, one sanitary inspector is assigned to each zone. Therefore, the total number of sanitary inspectors for waste collection and transportation is 16 persons.

(ii) Sanitary Supervisor

Sanitary supervisors are responsible for checking the waste collection and illegal dumping sites in the assigned UC. If there is a problem with waste collection, they report it to their sanitary inspectors. In the master plan, one sanitary supervisor is deployed onfor each UC. The total number of sanitary supervisors is 98 persons.

(iii) Vehicle Driver

One driver is deployed on each vehicle.

(iv) Sanitary Worker

Sanitary workers are deployed in each UC. However, the waste collection method is changed in the master plan so that sanitary workers also work with driver during waste collection.

Table 5.2.51 and Table 5.2.52 show the necessary number of workers for waste collection. Figure 5.2.10 shows the total number of workers in each year. For achieving the waste collection and transportation, GWMC requires 319 workers in 2016 and 1,193 workers in 2030. The total number of workers in 2022 temporarily decreases compared with the total number of workers in 2021 because all existing vehicles are passed out in 2022 and total necessary number of vehicles is decreased.

Table 5.2.51 Necessary Number of Workers for Waste Collection (Year 2016-2022)

Item		2016	2017	2018	2019	2020	2021	2022
64UC	Driver	161	196	276	216	231	245	256
	Sanitary worker	86	121	241	251	266	280	291
	Sanitary Supervisor	64	64	64	64	64	64	64
	Sanitary Inspector	8	8	8	8	8	8	8
34UC	Driver	0	0	0	69	69	96	39
	Sanitary worker	0	0	0	0	0	15	15
	Sanitary Supervisor	0	0	0	34	34	34	34
	Sanitary Inspector	0	0	0	8	8	8	8
Total	Driver	161	196	276	285	300	341	295
	Sanitary worker	86	121	241	251	266	295	306
	Sanitary Supervisor	64	64	64	98	98	98	98
	Sanitary Inspector	8	8	8	16	16	16	16
	Grand total	319	389	589	650	680	750	715

Table 5.2.52 Necessary Number of Workers for Waste Collection (Year 2023-2030)

Item		2023	2024	2025	2026	2027	2028	2029	2030
64UC	Driver	270	283	301	316	335	357	383	409
	Sanitary worker	305	318	336	350	369	391	417	443
	Sanitary Supervisor	64	64	64	64	64	64	64	64
	Sanitary Inspector	8	8	8	8	8	8	8	8
34UC	Driver	52	66	77	89	103	118	133	151
	Sanitary worker	23	30	35	41	49	57	67	78
	Sanitary Supervisor	34	34	34	34	34	34	34	34
	Sanitary Inspector	8	8	8	8	8	8	8	8
Total	Driver	322	349	378	405	438	475	516	560
	Sanitary worker	328	348	371	391	418	448	484	521
	Sanitary Supervisor	98	98	98	98	98	98	98	98
	Sanitary Inspector	16	16	16	16	16	16	16	16
	Grand total	764	811	863	910	970	1,037	1,114	1,195

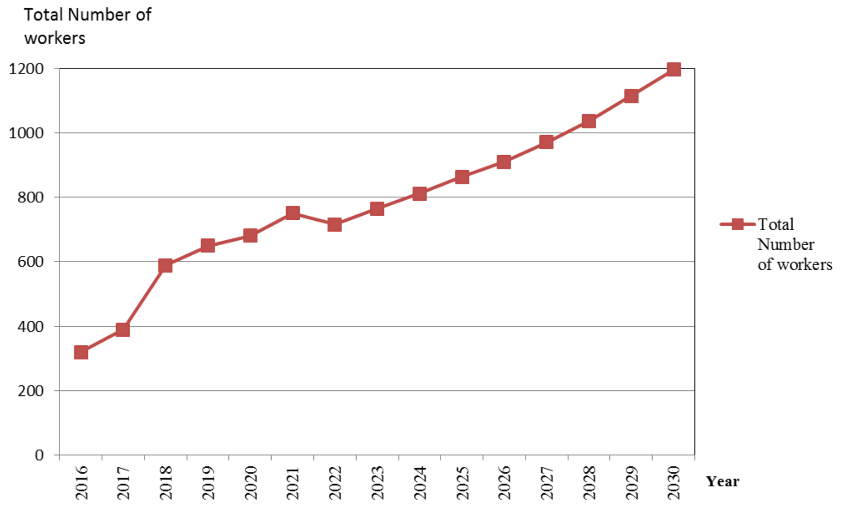


Figure 5.2.10 Total Number of Workers in Each Year

(f) Procurement Cost

Table 5.2.53 shows the procurement cost of waste collection and transportation. For estimating the implementation cost, procurement cost of each item is referred from the quotation of a local supplier and GWMC. Price of Compactors is higher than arm-trucks and mini-dumpers: Compactors are equipped with a compaction unit on the vehicle and the system of the unit is complicated compared with arm-roll trucks and mini-dumper.

Table 5.2.53 Procurement Cost for Waste Collection and Transportation

Item	Procurement Cost (Rs.)
Arm-roll truck (5 m^3)	5,000,000
Arm-roll truck (10 m^3)	3,500,000
Compactor (13 m^3)	9,200,000
Compactor (7 m^3)	4,500,000
Compactor (4 m^3)	3,500,000
Mini-dumper	1,000,000
Container (10 m^3)	36,0000
Container (5 m^3)	20,0000
Container (0.8 m^3)	28,000

Based on the information, operation and maintenance cost is calculated. The total amount of operation and maintenance cost is shown below in item **(h) Implementation Cost of Waste and Transportation.**

(g) Operation and Maintenance Cost

Operating cost is necessary for daily waste collection. Necessary items for daily operation are labour cost, diesel oil and gasoline, etc. Similar to operating cost, maintenance cost is needed for waste collection and transportation in the master plan. Waste collection vehicles operate 6 days in a week. GWMC needs to conduct regular checkup of vehicles and prepare for unexpected car breakdown during the operation.

(i) Fuel Consumption on Each Vehicle

Fuel consumption is also one of the important factors for operating waste collection and transportation work. Based on fuel consumption for each vehicle and number of trips,

Table 5.2.54 shows the fuel consumption and daily mileage per vehicle. The fuel consumption for each vehicle is referred from the result of Time and Motion Study and information from LWMC Operation Division acquired by a GWMC Waste Manger.

Table 5.2.54 Fuel Consumption and Daily Mileage on Each Vehicle

Item	Fuel consumption (km/Litre)	Daily Mileage (km)
Arm-roll truck (5 m^3)	4.10	144
Arm-roll truck (10 m^3)	4.10	144
Tractor trolley	3.40	50
Compactor (13 m^3)	2.75	50
Compactor (7 m^3)	3.75	50
Compactor (4 m^3)	5.40	49
Mini-dumper	5.40	49

The conditions for fuel consumption and daily mileage of each vehicle are the following:

- Fuel consumption and daily mileage of arm-roll truck ($5m^3$) is set based on the Time and Motion Study.
- Fuel consumption and daily mileage ofn arm-roll truck ($10m^3$) is referred to the arm-roll truck ($5m^3$). The size of both trucks is almost the same.
- Fuel consumption and daily mileage of tractor trolley is set based on the Time and Motion Study.
- Fuel consumption and daily mileage of compactor ($13m^3$) is set based on the result of tractor trolley in the Time and Motion survey and information from LWMC. A compactor in LWMC consumes 2.75 km per litre during operation. For the daily mileage, it is assumed that waste collection behaviour of a compactor is similar to a tractor trolley.
- Fuel consumption and daily mileage of compactor ($7m^3$) is set based on the result of tractor trolley in the Time and Motion survey and information from LWMC. A compactor in LWMC consumes 3.75 km per litre during operation. For the daily mileage, it is assumed that waste collection behaviour of a compactor is similar to a tractor trolley.
- Fuel consumption and daily mileage of compactor ($4m^3$) is set based on the result of mini-dumper in the Time and Motion Study. The size of the compactor is similar to mini-dumper so that it is assumed that fuel consumption and daily mileage of the compactor is the same.
- Fuel consumption and daily mileage are set based on the Time and Motion Study.

(ii) Maintenance Cost

It is difficult to estimate the maintenance cost for each vehicle because there are various types of vehicle applied in the master plan. In this master plan, 5% of vehicle cost is set as maintenance cost. However, the maintenance cost for the tractor trolley is set as the same as the arm-roll truck ($5m^3$). The reasons for this are as follows:

- Most of the tractor trolleys are old. The oldest one was made in the 1970's. It needs to have much maintenance cost.
- The frequency of breakdown of tractor trolley is an occasional matter during the waste collection operation. In fact, a tractor trolley monitored at the Time and Motion Study broke down and the alternative trolley also broke down during the Study.
- It means GWMC needs to take much care of trolleys and it may cost much.

As the maintenance cost of containers, the same manner applied to the vehicle is adopted to the container. The maintenance cost of the container is 5% of procurement cost of the container.

(iii) Fuel Cost

Table 5.2.55 shows the fuel cost. The price of each type of fuel is based on the current price checked by a GWMC Waste Manager. The price of diesel shows a unique tendency. Normally, the price of diesel oil is cheaper than the price of gasoline oil. However, prices in Pakistan are the opposite.

Table 5.2.55 Fuel Cost

Item	Price (Rs./ litre)
Diesel	81
Gasoline	75

(iv) Labour Cost

Table 5.2.56 shows monthly and annual wages of workers. The information is given by CDGG through a GWMC officer.

Table 5.2.56 Monthly and Annual Wages on Workers

Item	Monthly Wage (Rs.)	Annual Wage (Rs.)
Sanitary Inspector	31,000	372,000
Sanitary Supervisor	21,000	252,000
Driver	18,000	216,000
Sanitary Worker	15,000	180,000

Based on the information, Operation and maintenance cost is calculated. The total amount of Operation and maintenance cost is shown in the following item **(h) Implementation Cost for Waste and Transportation.**

(h) Implementation Cost for Waste Collection and Transportation

Table 5.2.27 and **Table 5.2.28** show the total cost of waste collection and transportation vehicles. Total cost of waste collection and transportation vehicles is Rs. 11,457,063,000 in the master plan. **Table 5.2.29** and **Table 5.2.60** show the total cost of waste collection container. Total cost of waste collection and transportation container is Rs. 514,493,000 in the master plan.

Table 5.2.57 Total Cost of Waste Collection and Transportation Vehicles (Year 2016-2023)

(Unit: thousand Rs.)

Vehicle	2016	2017	2018	2019	2020	2021	2022	2023
Procurement Cost	173,000	228,000	688,000	92,000	138,000	198,000	198,000	220,200
Maintenance Cost	28,655	40,055	74,455	67,555	74,455	86,500	98,720	108,610
Operating Cost	126,163	151,674	234,263	256,458	268,289	297,590	268,837	289,047
Total	327,818	419,729	996,718	416,013	480,744	582,090	565,557	617,857

Table 5.2.58 Total Cost of Waste Collection and Transportation Vehicles (Year 2024-2030)

(Unit: thousand Rs.)

Vehicle	2024	2025	2026	2027	2028	2029	2030	Total
Procurement cost	252,600	315,100	428,900	490,600	511,300	635,000	658,400	5,227,100
Maintenance Cost	119,615	130,895	140,860	152,590	165,095	179,625	195,065	1,662,750
Operating Cost	309,768	331,765	352,326	376,692	403,793	434,061	466,487	4,567,213
Total	681,983	777,760	922,086	1,019,882	1,080,188	1,248,686	1,319,952	11,457,063

Table 5.2.59 Total Cost of Waste Collection Containers (Year 2016-2023)

(Unit: thousand Rs.)

Container	2016	2017	2018	2019	2020	2021	2022	2023
Procurement cost	16,800	19,600	16,800	37,800	7,000	9,800	32,760	24,200
Maintenance Cost	1,402	2,382	3,222	5,040	5,341	5,698	7,105	8,000
Total	18,202	21,982	20,022	42,840	12,341	15,498	39,865	32,200

Table 5.2.60 Total Cost of Waste Collection Containers (Year 2024-2030)

(Unit: thousand Rs.)

Container	2024	2025	2026	2027	2028	2029	2030	Total
Procurement cost	25,200	25,200	26,880	30,800	35,600	38,400	51,000	397,840
Maintenance Cost	8,756	9,477	10,233	11,021	11,928	12,850	14,198	116,653
Total	33,956	34,677	37,113	41,821	47,528	51,250	65,198	514,493

(8) Street Cleaning

According the interview survey with a waste manager, GWMC conducts street sweeping manually. Sanitary workers conduct the street sweeping early in the morning for 6 days to avoid the heavy traffic in the city in the daytime. GWMC also conduct mechanical road sweeping on major streets such as G.T. Road. There is no official record for working area except Zone 9 and Zone 10 so that the total length of the mechanical and manual sweeping is not grasped by GWMC.

Street sweeping is also included in this master plan.

(a) Street Sweeping Length

GWMC set Zone 9 and Zone 10 as street sweeping. Street sweeping on middle sized roads is conducted by sanitary workers. However, GWMC does not grasp the accurate data such as total length and waste amount of the road in the city. Targeted streets in Zone 9 and Zone 10 are as follows. **Table 5.2.61** shows a summary of major road lengths.

Zone 9: G.T. Road, Gondhlawala Road, Nowshera Road, Hafizabad Road and Sheikhupura Road

Zone 10: G.T. Road, Pasrur Road, Silkot Road, DC Road and Civil Hospital Road

Table 5.2.61 Summary Major Road Lengths

Zone	Name of Road	Length (km)
9	Gondlanwala Road	4.4
	Nowshera Road	3.2
	Hafizabad Road	4.4
	Sheikhupura Road	4.2
	G.T. Road	6.9
Sub-Total		23.1
10	G.T. Road	5.5
	Pasrur Road	3.0
	Sialkot Road	4.7
	DC+Hospital Road	3.3
Sub-Total		16.5
Grand Total		39.6

GWMC conducts street cleaning for 23.1km of major city streets in Zone 9 and 16.5km in Zone 10. In this master plan, other roads such as Sialkok Bypass Road are also targeted for street cleaning.

The necessary length for street sweeping has been estimated by measurement from the map in Google Earth. Based on the result of the measurement, targeted length is set in the master plan.

Figure 5.2.11 shows the targeted major roads for street cleaning. **Table 5.2.62** shows the total length of the streets in Zone 9 and **Table 5.2.63** shows the total length of the streets in Zone 10.

Figure 5.2.11 Targeted Major Road for Street Cleaning (Not to Scale)

Table 5.2.62 Total Length of the Street in the City (Zone 9)

Road name	Length (km)	Number of Lanes	Necessary Cleaning Length (km)
Gondlanwala Road	4.4	3	26.4
Nowshera Road	3.2	3	19.2
Hafizabad Road	4.4	3	26.4
Sheikhupura Road	4.2	3	25.2
G.T. Road	6.9	3	41.4
Nomania Road	0.6	2	2.4
Kharadian+daingawala Bazar	0.6	2	2.4
Urdu Bazar	0.4	2	1.6
Daal Bazar	0.3	2	1.2
Circular Road	1.8	2	7.2
Nomania+College+Garjakh Road	4.3	2	17.2
Clock Tower Road	0.4	2	1.6
Rail Bazar	3.0	2	12.0
Qazafi Road	1.2	2	4.8
Parao+Mubarikshah Road	1.6	2	6.4
Mian Sansi Road	1.4	2	5.6
Kach Khiali Road	2.2	2	8.8
Nowshera Sansi Road	3.3	2	13.2
Jinnah Road	7.3	2	29.2
Bypass road-West side	15.5	2	93.0
Total	51.5	-	345.2

Note: All roads are two-way traffic

Table 5.2.63 Total Length of the Street in the City (Zone 10)

Road name	Length (km)	Number of lanes	Necessary Cleaning Length (km)
G.T. Road	5.5	3	33.0
Pasrur Road	3.0	3	18.0
Sialkot Road	4.7	3	28.2
DC+Hospital Road	3.3	3	19.8
Kacha Fatomand	3.1	2	12.4
Main Road	2.9	2	11.6
Kashmir Road	3.5	2	14.0
Jalaludeen Road	1.7	2	6.8
Aminabad Road+Faisal Road	3.0	2	12.0
Circuar Road+Ghordor Road	4.3	2	17.2
Faerozwala Road	2.8	2	11.2
Sir Syad Ali Road Satellite Town	1.3	2	5.2
Fateh ali Road	0.9	2	3.6
Hamilton Road	0.5	2	2.0
Gill Road+Sui-Gas Road	3.8	2	15.2
Kachari Road	0.7	2	2.8
Jinnah Road	4.3	2	17.2
Approach Road	0.9	2	3.6
Bypass-East Side	14.3	2	85.8
Total	50.2	-	319.6

Note: All roads are two-way traffic.

Total length of other roads in the city has been estimated from Google Earth. (**Figure 5.2.12**) The congested area in the centre of the city is selected for calculating the street length.

Sample area: 200m × 500m

Number of street in the area: 200m × 10 pcs (two-way street, 1 lane on each way)

Total street length in sample area: 4,000m (200m×10×2)

Total necessary street cleaning length inner city: $64km^2/0.1km^2$×4,000m = 2,560km

Figure 5.2.12 Sample Area for Estimation of Total Length of the Roads (Not to Scale)

(b) Necessary Number of Vehicles for Street Cleaning

Traffic on major roads such as G.T. Road and Bypass road is heavy but it is necessary to clean them portion by portion once a week. Traffic on roads in the city area is also heavy but not as heavy as the major roads and hence sufficient to conduct street cleaning portion by portion once in every two weeks. The street sweeper is applied for major roads and road washing machine is applied for other roads. **Table 5.2.64** shows the number of street cleaning equipment. Two mechanical sweepers and four road washers are deployed in the master plan.

Table 5.2.64 Number of Street Cleaning Equipment

Item	Number of Vehicles	Cleaning Length per Vehicle (km/month)	Cleaning Length per Vehicle (km/month)	Total Length of Road (km)	Frequency of Cleaning per Location
Street sweeper	2	1,296	2,496	665	Once a week
Road washer	4	1,296	4,992	2,560	Once in two weeks

Table 5.2.65 and **Figure 5.2.13** show the number of vehicles for street cleaning in each year. It is assumed that major roads and other roads will be extended and improved in the future. For meeting the future situation, 6 street sweepers and 6 road washers are deployed in 2030.

Table 5.2.65 Number of Vehicles for Street Cleaning (Year 2016-2030)

Item	2016-2020	2021-2025	2026-2030
Street sweeper	2	4	6
Road washer	4	4	6

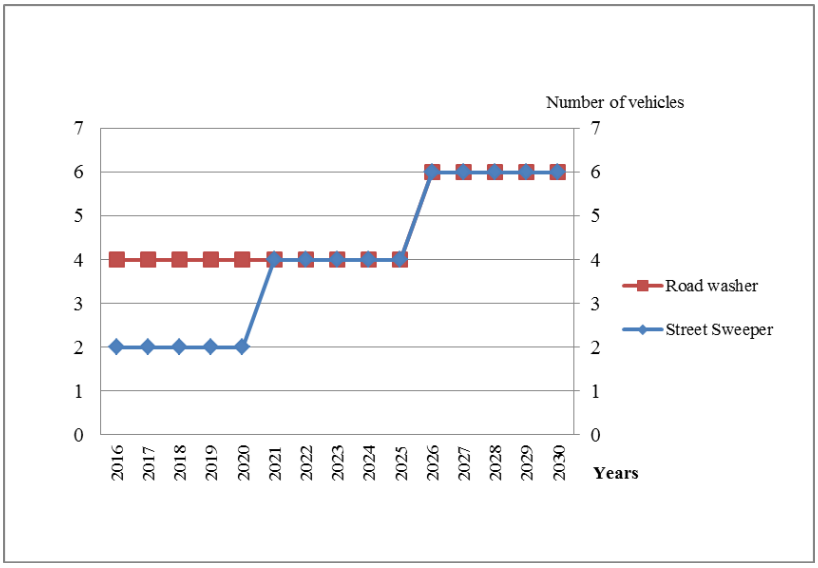


Figure 5.2.13 Number of Vehicles for Street Cleaning (Year 2016-2030)

(c) Procurement and Operation and Maintenance Costs

(i) Procurement Cost

Based on the necessary vehicles, workers and street sweeping cost is estimated. For estimating the procurement cost and maintenance cost, procurement cost on each item is referred from the quotation of a local supplier and GWMC. **Table 5.2.66** shows the procurement cost per unit of vehicle.

Table 5.2.66 Procurement Cost per Unit of Vehicle

Vehicle	Procurement Cost (Rs.)
Street sweeper	12,000,000
Road washer	9,200,000

(ii) Operating Cost

The conditions for labour cost and fuel cost are the same as the prices mentioned in **(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Fuel consumption amount for street cleaning vehicles varies depending on the traffic condition so that it is not appropriate to set the fuel consumption per vehicle but based on the consumption of arm-roll truck. The chassis of both cleaning vehicles are the same as the arm-roll truck and daily mileage is both around 48 km. The average speed of each type of vehicle for cleaning a street is 6 km/hr and working hour is 8 hours.

(iii) Maintenance Cost

The condition for maintenance cost is the same as the price mentioned in **(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Five per cent (5%) of vehicle cost is set as maintenance cost.

(d) Implementation Cost

Table 5.2.67 shows the total cost of street sweeping.

Table 5.2.67 Total Cost of Street Sweeping (Year 2016-2023)

(Unit: thousand Rs.)

Item	2016	2017	2018	2019	2020	2021	2022	2023
Procurement Cost	60,800	0	0	0	0	24,000	0	0
Maintenance Cost	2,780	2,780	2,780	2,780	2,780	3,160	3,160	3,160
Operating Cost	3,748	3,748	3,748	3,748	3,748	5,237	5,237	5,237
Total	67,328	6,528	6,528	6,528	6,528	32,397	8,397	8,397

Table 5.2.68 Total Cost of Street Sweeping (Year 2024-2030)

(Unit: thousand Rs.)

Item	2024	2025	2026	2027	2028	2029	2030	Total
Procurement cost	21,200	0	42,400	9,200	0	12,000	9,200	178,800
Maintenance Cost	3,160	3,160	4,740	4,740	4,740	4,740	4,740	53,400
Operating Cost	5,237	5,237	7,855	7,855	7,855	7,855	7,855	84,198
Total	29,597	8,397	54,995	21,795	12,595	24,595	21,795	316,398

(9) Bulky Waste

There are 37 public parks in Gujranwala and the total area is approximately 580,000 square metres (m^2). The largest park in the city is Gulshan-e-Iqbal Park (106,000 m^2) abutted on G.T. Road. There are also trees along the street. Green waste is generated from the park and the street.

Bulky wastes generated from tree trimming, old furniture, etc., need to be considered for waste collection. They are not occasionally generated from the source so that necessary vehicles and workers for these wastes are deployed separately from the regular collection in the master plan.

(a) Necessary Vehicles and Workers for Bulky Waste

Two 5-ton trucks and one wheel loader are deployed for the collection of bulky wastes. One driver and one sanitary worker are deployed per 5-ton truck and one driver is depoyed on the wheel loader. **Table 5.2.69** and **Figure 5.2.14** give a summary of the vehicles and workers for bulky waste. The workers are deployed as one team and work in 6 days (Monday to Saturday). Basically, the team collects green waste such as tree trimmings. However, if a sanitary supervisor or sanitary inspector orders them to collect bulky waste from households, they collect them from the source.

Table 5.2.69 Summary of Vehicles and Workers for Bulky Waste

Item	Number of Vehicles and Workers
5 ton truck	2
Wheel Loader	1
Sanitary worker	1

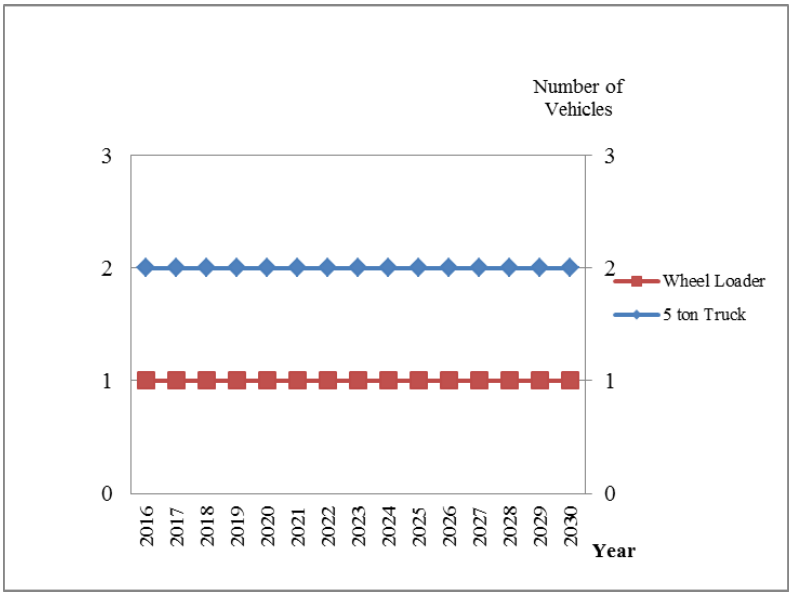


Figure 5.2.14 Number of Bulky Waste Collection Vehicles (Year 2016-2030)

(b) Operation and Maintenance Cost

(i) Procurement Cost

Based on the necessary vehicles and workers for collecting bulky waste, waste collection cost is estimated. **Table 5.2.70** shows the procurement cost of each item. For estimating the procurement cost and maintenance cost, procurement cost on each item is referred from the quotation of a local supplier and GWMC.

Table 5.2.70 Procurement Cost of Each Item

Item	Procurement Cost (Rs.)
5 Ton Truck	3,800,000
Wheel Loader	12,000,000

(ii) Operating Cost

The condition for labour cost and fuel cost is the same as the price mentioned in **(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Fuel consumption, daily mileage and umber of trips for a 5 ton truck are set based on the arm-roll truck. The fuel consumption for operating the wheel loader is set at 0.3 litres per ton.

(iii) Maintenance Cost

The condition for maintenance cost is the same as the price mentioned in **(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Five per cent (5%) of vehchicle cost is set as maintenance cost.

(c) Implementation Cost for Bulky Waste

Table 5.2.71 and **Table 5.2.72** show the project cost for bulky waste. The total cost for collecting bulky waste is Rs. 97,343 thousand in total.

Table 5.2.71 Implementation Cost for Bulky Waste (Year 2016-2023)

Unit: thousand Rs.

Item	2016	2017	2018	2019	2020	2021	2022	2023
Procurement cost	19,600	0	0	0	0	0	0	0
Maintenance Cost	980	980	980	980	980	980	980	980
Operation Cost	3,150	3,150	3,150	3,150	3,150	3,150	3,150	3,150
Total	23,730	4,130	4,130	4,130	4,130	4,130	4,130	4,130

Table 5.2.72 Implementation Cost for Bulky Waste (Year 2024-2030)

Unit: thousand Rs.

Item	2024	2025	2026	2027	2028	2029	2030	Total
Procurement cost	15,800	0	0	0	0	0	0	35,400
Maintenance Cost	980	980	980	980	980	980	980	14,700
Operation Cost	3,150	3,150	3,150	3,150	3,150	3,150	3,150	47,243
Total	19,930	4,130	4,130	4,130	4,130	4,130	4,130	97,343

(10) Illegal Dumping Site

There are over 700 illegal dumping sites in Gujranwala City. Some these illegal dumping sites are large and some are small consisting of some heaps of garbage scattered over an open plot. The illegal dumping site cause not only the issue of appearance but also the issue of sanitary conditions such as bad odour and disease. Thus, urgent countermeasure is one of the important activities of solid waste management. The clearing of illegal dumping site is one of the most urgent issues to be tackled by GWMC.

GWMC tried to outsource and conduct bidding for cleaning of the illegal dumping sites in the city on May 2014, but the price offered by the Contractor was above the budget and hence ended in failure. For solving the situation, GWMC has been conducting One-Time Cleaning operation (hereafter referred to as “OTC”) since September 2014. Two tractor trolleys and one wheel loader are deployed on weekdays separately from the regular waste collection, and eight to ten arm-roll trucks and one wheel loader every Sunday.

(a) Amount of Waste of Illegal Dumping Sites in the City

Waste managers in GWMC conducted a survey on the location and amount of wastes in the illegal dumping sites in the city on August 2014. According to the survey, there are 728 illegal dumping sites and the total amount of waste is 31,385 tons.

It seems that the amount of waste in the sites has decreased. However, illegal dumping occurs at the same location after two or three weeks. One site has been totally cleaned by OTC. **Table 5.2.73** give a summary of the illegal dumping sites and OTC. There are still 24,264 tons of waste at the sites. The target collection amount of illegal dumping sites is 24,264 tons.

Table 5.2.73 Summary of Illegal Dumping Sites and OTC

Zone	Number of Illegal Dumping Sites	Waste Amount (ton)
1	85	6,949
2	203	2,030
3	35	9,346
4	68	2,754
5	190	4,660
6	112	4,749
7	15	349
8	30	998
(1) Sub-Total	738	31,835
(2) OTC		7,570
Waste amount ((1)-(2))		24,264

(b) Time Duration for Cleaning the Sites

In this master plan, the period of cleaning the illegal dumping sites is set as three years. The work is planned to start in 2016 and finished in 2018. At the end of 2018, the waste collection in 64 UCs should be 100% in the master plan in accordance with the waste collection plan.

(c) The Optimal Plan for Cleaning Illegal Dumping Sites

There are two possibilities to solve this issue: (i) GWMC conducts the cleaning of illegal dumping sites and (ii) GWMC hires a contractor for cleaning of illegal dumping sites. Based on comparing the cost comparison, the optimal plan for cleaning illegal dumping site is selected in the master plan.

(i) Cleaning of Illegal Dumping Sites by GWMC

In this case, GWMC procures adequate vehicles and workers for cleaning the sites in the city. Two 5-ton trucks, one wheel loader and two workers are needed for the work. **Table 5.2.74** shows the necessary vehicles and workers for the cleaning. The assigned vehicles and workers conduct only the cleaning work and are excluded from the regular waste collection work.

Table 5.2.74 Necessary Vehicles and Workers for the Cleaning

Item	Number of Vehicles and Workers
5 Ton Truck	2
Wheel Loader	1
Driver	3
Sanitary worker	2

The conditions for cleaning the illegal dumping sites are the following:

- The number of trips for a 5-ton truck is 5 based on the number of trips of arm roll truck in the result of time and motion survey because both types truck are similar machinery.
- The loading capacity is set as 2.5 tons per 5 m^3. Therefore, 2.5 tons × 5 trips/day × 2 vehicles = 50 ton/day =1,200 tons/month (6 working days, 4 weeks).
- Minimum waste collection amount is 674 tons/ month (24,264 tons /36 months).
- If a 5 ton truck is deployed for the work, the waste collection amount per month is 600 tons/ month (2.5 ton × 5 trips/day × 1 vehicles =25 ton/day= 600 tons/month (6 working days, 4 weeks).
- For loading waste to 5 ton trucks, one wheel loader is deployed.

(ii) Cleaning of Illegal Dumping Sites by a Hired Contractor

In this case, GWMC hires a contractor for cleaning the sites in the city. The contractor is obliged to hire the necessary number of vehicles for cleaning up illegal dumping sites in the city.

(d) Operating Cost

(i) Cleaning of Illegal Dumping Sites by GWMC

- Procurement Cost

  Based on the necessary vehicles and workers, cleaning cost for illegal dumping sites in the city is estimated. For estimating the procurement cost and maintenance cost, procurement cost of each item is referred from the quotation of a local supplier and GWMC. The price is the same as the price of Item **(10) Bulky Waste**.
- Operating Cost

  The condition for labour cost and fuel cost is the same as the price mentioned in **(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Fuel consumption, daily mileage and number of trips of 5-ton truck are set based on the arm-roll truck. The fuel consumption for operating the wheel loader is set at 0.3 litres per ton.
- Maintenance Cost

  The condition for maintenance cost is the same as the price mentioned in **(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Five per cent (5%) of vehicle cost is set as maintenance cost.

Table 5.2.75 shows the total cost of cleaning conducted by GWMC. It is estimated to clean-up all illegal dumping sites in 26 months at the cost of Rs. 25,626,627. The average cost for the cleaning is Rs. 1,024 per ton.

Table 5.2.75 Total Cost of Cleaning Conducted by GWMC

Responsible Agency	Working Duration (months)	Implementation Cost (Rs.)
GWMC	26	25,626,627

(ii) Cleaning of Illegal Dumping Sites by a Hired Contractor

In this case, GWMC hires a contractor for cleaning the sites in the city. GWMC conducted the tender for cleaning the illegal dumping site in May 2014. However, the tender price from the contractor exceeded the ceiling price so that there was no eligible tenderer for the work. **Table 5.2.76** shows the unit cost submitted by the contractor. The size and amount of waste on site vary in each site. Thus, the unit price for cleaning the site is adopted based on the average unit price offered by the contractor.

Table 5.2.76 Unit Cost Submitted by the Contractor

Item	Unit Cost per Ton (Rs.)
Lot 1	1,590
Lot 2	1,550
Lot 3	1,680
Lot 4	1,500
Average	1,565

The contractor submitted the unit price for the work: Rs. 1,565 per ton in average. In this master plan, the total cost for the work is estimated from the unit price.

Total amount 24,264 tons × Rs. 1,565/ton = Rs. 37,973,160

The total cost of cleaning all illegal dumping sites is Rs. 37,973,160.

(e) Cost Comparison and Conclusion

Table 5.2.77 shows the comparison of cost for the cleaning work. The cost of outsourcing of cleaning the sites is much cheaper than the work GWMC conducts by itself. The master plan adopts outsourcing the work of cleaning of illegal dumping sites to a private company.

Table 5.2.77 Comparison of Cost for the Cleaning Work

(Unit: thousand Rs.)

Item	Total Cost in three 3 years
The work conducted by GWMC	25,627
Outsourcing the work	37,973

(f) Implementation Cost

Table 5.2.78 shows the annual project cost of cleaning the illegal dumping sites in the city. The total cost for the cleaning work is Rs. 25,627,000.

Table 5.2.78 Project Cost for Cleaning the Illegal Dumping Sites in the City (Year 2016-2018)

(Unit: thousand Rs.)

Item	2016	2017	2018	Total
Clean-up the illegal dumping sites	22,382	2,782	463	25,627

(11) Construction and Demolition Waste

The collection and disposal of construction and demolition waste (C&D waste) is a part of GWMC's obligation according to the survey conducted by the JICA Project Team. C&D waste collection is also a part of the Master plan.

According to the LWMC report, the daily generation amount of the waste is 141 tons. However, it is difficult to assume the actual generated amount of C&D waste since the waste is collected with another type of wastes and abandoned C&D waste is scattered all over the city. Another reason for the difficulty of assumption is that C&D waste is not discharged in a particular place or particular amount. C&D waste generation is related to the process of land development by public and private sectors so that it is also unpredictable for GWMC to foresee the future development plan.

In this master plan, C&D waste is collected separately.

(a) Fee for Collection of C&D Waste and Outsourcing the Waste Collection

GWMC needs to set the schedule for charges on C&D waste. GWMC considers that collection of C&D waste is outsourced to a private company.

Currently, C&D waste collection fee is not taken from building contractors or land developers, and GWMC collects the waste for free. Most of C&D waste generated from construction sites is taken to the borrow pits in the city. However, others are dumped on the roadsides or open plots illegally and GWMC manages to take the waste to the landfill site for free.

C&D waste is generated from commercial activity. Most of them are rocks, sand, concrete and reinforced bar and the character of the waste is totally different from domestic waste or other commercial waste. A special vehicle for the waste collection and transportation is necessary for conducting the work. For acquiring the cost of operating and maintaining the vehicles, setting the schedules for charges is necessary.

GWMC needs to take time for collecting domestic and commercial waste for now and it is difficult for GWMC to handle C&D waste collection. In addition, 1) Collection area in 64 UCs is 100% covered in 2018, 2) Collection amount is increased up to 2030, 3) Waste collection in 34 UCs in Peri-urban area starts in 2019, and 4) Collection area in 34 UCs is 100 % covered in 2030. GWMC has to focus on the current waste collection work. Outsourcing the collection of C&D waste to a private company is to disburden the work load on GWMC.

(b) Operating and Maintenance Cost

(i) Number of Vehicles and Workers

C&D waste consists of rocks, sand and concrete, etc., so that the compactor is not suitable for C&D waste collection. C&D waste is generated from construction sites. The waste becomes a large heap and loading C&D waste is an arduous job for sanitary workers. It is necessary to deploy a wheel loader for loading the waste. **Table 5.2.79** shows the necessary vehicles for C&D waste. For reducing the idle time on trucks, three 5-ton trucks and one wheel loader for the collection work are deployed. In addition, most of the construction sites do not have enough space for C&D waste.

Table 5.2.79 Vehicles Necessary for the Collection of C&D Waste

Item	Number of Vehicles
5 Ton Truck	3
Wheel Loader	1

(ii) Procurement Cost

Based on the necessary number of vehicles and workers, cleaning cost for illegal dumping sites in the city is estimated. For estimating the procurement cost and maintenance cost, procurement cost of each item is referred from the quotation provided by a local supplier and GWMC. The price is the same as that of (10) Bulky waste.

GWMC is considering outsourcing of the C&D waste collection work to a private company so that depreciation is considered in estimating the procurement cost.

(iii) Operating Cost

The condition for labour cost and fuel cost is the same as the price mentioned in **(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Fuel consumption, daily mileage and the number of trips of a 5-ton truck are set based on the arm-roll truck. The fuel consumption of operating the wheel loader is set at 0.3 litres per ton.

(iv) Maintenance Cost

The condition for the maintenance cost is the same as the price mentioned in **(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation.** Five per cent (5%) of vehicle cost is set as maintenance cost.

(c) Implementation Cost

Table 5.2.80 shows the annual cost of C&D waste collection. Based on the implementation cost, GWMC needs to set the schedules for charges of C&D waste.

Table 5.2.80 Annual Cost of C&D Waste Collection

Item	Annual Cost (Rs.)
Collection cost for C&D waste	7,690,126

(12) Parking Area

The number of collection vehicles has been increasing and the collection rate has improved. An additional parking area for procured vehicles is necessary in the future.

GWMC has its own their parking area/garage in the centre of the city. The garage can accommodate approximately 100 vehicles. There is no expansion plan or additional parking plan in GWMC. The current garage has a limited area so that construction of additional car parking areas is necessary for the collection operation.

In this master plan, the number of parking areas is planned to be gradually increased based on the total number of collection vehicles from 2016 to 2030. Annual number of vehicles in the master plan is shown in **Table 5.2.81, Table 5.2.82** and **Table 5.2.83**. The total number of vehicles includes waste collection and transportation vehicles, vehicles for bulky waste and vehicles for street sweeping.

Table 5.2.81 Annual Number of Vehicles in the Master Plan (Year 2014-2019)

Year	2014	2015	2016	2017	2018	2019
Number of Waste Collection Vehicles	104	127	161	196	316	331

Table 5.2.82 Annual Number of Vehicles in the Master Plan (Year 2020-2025)

Year	2020	2021	2022	2023	2024	2025
Number of Waste Collection Vehicles	346	389	343	370	397	426

Table 5.2.83 Annual Number of Vehicles in the Master Plan (Year 2026-2030)

Year	2026	2027	2028	2029	2030
Number. of Waste Collection Vehicles	457	490	527	568	612

In 2030, the total number of vehicles becomes 612 vehicles. However, the existing Garage could accommodate only approximately 100 vehicles. Hence, the designated number of vehicles in one parking area is set as 100 vehicles. This number has the same capacity as the existing parking area. Necessary number of parking areas is calculated as follows:

Total number of vehicles 612 / 100 vehicles per parking area = 6 parking areas.

Therefore, 612/6 = 102 vehicles per parking area.

Based on the calculation, the capacity of parking area is designed for the parking capacity of 102 vehicles. The function of the parking area is only to park vehicles. The repair work is performed in the existing garage. The specifications of the new parking area are as follows:

- Size of the area: 600m^2
- Parking area: The area accommodates 102 vehicles
- Roofing: Steel skeleton structure
- Pavement: Asphalt-paved
- Security system: 1 unit of guardhouse, fencing around the parking area

For security reasons, one guardhouse is built and steel fence is installed around the facility. The place where vehicles are parked is covered with a steel skeleton building for protection against rain.

The existing garage has no pavement and no roofing in parking area. The cost for improvement of the garage is included in the master plan.

- Necessary pavement area on existing garage: 3,735m^2
- Necessary roofing area on existing garage: 1,344m^2

Based on the total number of vehicles in each year, total number of necessary parking area is estimated. **Table 5.2.84** and **Table 5.2.85** show the total number of parking area in each year.**Figure 5.2.15** shows the total number of waste collection vehicles and parking areas. Four parking areas are needed in short term and middle term. In 2030, six parking areas are needed.

Table 5.2.84 Annual Number of the Parking Area (Year 2016-2023)

Year	2016	2017	2018	2019	2020	2021	2022	2023
Number of Parking Area	2	2	4	4	4	4	4	4

Table 5.2.85 Annual Number of the Parking Area (Year 2024-2030)

Year	2024	2025	2026	2027	2028	2029	2030
Number of Parking Area	4	5	5	5	6	6	6

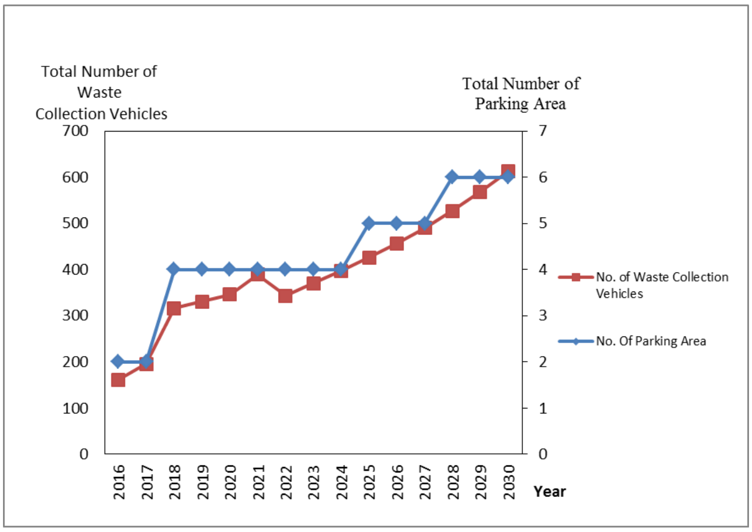


Figure 5.2.15 Total Number of Waste Collection Vehicles and Parking Areas (Year 2016-2030)

(a) Procurement, Operation and Maintenance Cost

(i) Procurement Cost

Based on the necessary items, the procurement cost for the parking area is estimated. For estimating the procurement cost and maintenance cost, the unit price of each item is referred from the quotation provided by a local contractor and GWMC. **Table 5.2.86** shows the unit price of each item. GWMC may need to rent the necessary land for the parking area.

Table 5.2.86 Unit Price of Each Item

Item	Unit Cost (Rs.)
Land Rental	50/m^2
Fencing	7,000/m
Asphalt Pavement	1,150/m^2
Guardhouse	16,140/m^2
Skeleton Structure Building	15,900/m^2
Gate	200,000/set

(ii) Operating Cost

The operating cost varies depending on the operation status in the parking area. Thus, it is illogical to estimate the operating cost for the parking area. In this master plan, 10% of land rental is set as the operating cost.

(iii) Labour Cost

Table 5.2.87 shows the monthly and annual wages of security guard. The information was provided by CDGG through a GWMC officer.

Table 5.2.87 Monthly and Annual Wages of Security Guard

Item	Monthly Wage (Rs.)	Annual Wage (Rs.)
Sanitary Inspector	16,500	198,000

(iv) Maintenance Cost

Due to weather condition or status of use in the parking area, the maintenance cost varies. Thus, it is illogical to estimate maintenance cost for the parking area. In this master plan, 5% of procurement cost is set as the maintenance cost.

(b) Implementation Cost for the Parking Area

Table 5.2.88 shows the implementation cost of the parking area.

Table 5.2.88 Implementation Cost of the Parking Area (Year 2016-2023)

(Unit: thousand Rs.)

Item	2016	2017	2018	2019	2020	2021	2022	2023
Procurement cost	118,582	0	388,848	0	0	0	0	0
Maintenance Cost	6,726	2,430	2,430	2,430	2,430	2,430	2,430	2,430
Operating Cost	1,116	1,116	2,232	2,232	2,232	2,232	2,232	2,232
Total	126,422	3,546	393,510	4,662	4,662	4,662	4,662	4,662

Table 5.2.89 Implementation Cost of the Parking Area (Year 2024-2030)

(Unit: thousand Rs.)

Item	2024	2025	2026	2027	2028	2029	2030	Total
Procurement cost	0	243,030	0	0	291,636	0	0	1,090,702
Maintenance Cost	2,430	2,430	2,430	2,430	2,430	2,430	2,430	45,610
Operating Cost	2,232	2,790	2,790	2,790	3,348	3,348	3,348	37,386
Total	4,662	248,251	5,220	5,220	297,415	5,778	5,778	1,173,699

(13) Project Cost

Table 5.2.90 and **Table 5.2.91** show the project cost of waste collection and transportation. The total cost of waste collection and transportation is Rs. 13,645,387,000 in the master plan.

Table 5.2.90 Project Cost of Waste Collection and Transportation (Year 2016-2023)

(Unit: thousand Rs.)

Year	2016	2017	2018	2019	2020	2021	2022	2023
Procurement cost	408,382	247,600	1,093,648	129,800	145,000	231,800	230,760	244,400
Maintenance Cost	41,333	49,417	83,999	78,785	85,986	98,768	112,395	123,180
Operating Cost	143,858	169,369	251,415	273,277	285,108	315,898	287,145	307,355
Total	593,573	466,386	1,429,062	481,862	516,094	646,466	630,300	674,935

Table 5.2.91 Project Cost of Waste Collection and Transportation (Year 2024-2030)

(Unit: thousand Rs.)

Year	2024	2025	2026	2027	2028	2029	2030	Total
Procurement cost	314,800	583,330	498,180	530,600	838,536	685,400	718,600	6,900,836
Maintenance Cost	134,941	146,942	159,243	171,762	185,174	200,625	217,413	1,889,963
Operating Cost	328,076	350,631	373,811	398,176	425,835	456,104	488,530	4,854,588
Total	777,817	1,080,903	1,031,234	1,100,538	1,449,545	1,342,129	1,424,543	13,645,387

5.2.2 Evaluation of the Alternatives

(1) Planning Concept

Door-to-door collection and container collection are applied to the waste collection and transportation plan in the master plan. The city is divided into 16 waste collection zones and necessary vehicles and containers for waste collection are procured to achieve the waste collection ratio and amount set for each year.

(2) Options for Waste Collection and Transportation

Source separation is adopted in the master plan. For evaluating source separation in the master plan, two alternatives are set: No Separation at Source and Zero Option.

(a) Separation at Source

Separation at source is conducted by each household. The activity starts in 2016. Two types of waste containers are applied to the plan. One is for disposing organic waste such as kitchen waste and market waste; the other is for disposing other waste except organic waste. These two containers are distinguished by painting them in two different colors for the residents to easily identify the appropriate container. Although it is an arduous work for the residents to separate waste for the first time and it takes time for them to understand the separation of wastes in the right way, the city would become cleaner and this option is compatible to the 3R plan in the master plan. **Table 5.2.92** shows the result of environmental and social survey on separation at source. The result of the survey shows that the separation at source gives positive impact. Separation at source is good from the environmental and social aspects.

Table 5.2.92 Result of Environmental and Social Survey on Source Separation

Item	Environmental Impact
Soil	Minor Positive Impact
Waste	Moderate Positive Impact
Ecosystems	Minor Positive Impact
Employment & Livelihood	Moderate Positive Impact
Utilisation of Land & Local Resources	Moderate Positive Impact
Infectious Diseases	Moderate Positive Impact

(b) No Separation at Source

No separation at source means that separation is not conducted by each household. Mixed waste is directly disposed into the container. Since the waste disposal method is not changed although it is easy for the residents to understand the disposal method, this option is not compatible with the 3R plan in the master plan. **Table 5.2.93** shows the result of environmental and social survey on the no source separation method. It is difficult to separate organic waste after the collection of waste. The result of the survey shows that no separation at source presents a negative impact. The city becomes cleaner but mixed waste is collected and transferred to the landfill site. This option is not suitable for the 3R plan.

Table 5.2.93 Result of Environmental and Social Survey on No Separation at Source

Item	Environmental Impact
Soil	Minor Negative Impact
Waste	Moderate Negative Impact
Ecosystems	Minor Negative Impact
Involuntary Settlement	Moderate Negative Impact
Employment & Livelihood	Moderate Positive Impact
Utilisation of Land & Local Resources	Major Negative Impact
Infectious Diseases	Moderate Negative Impact

(c) Zero Option

This option is the case where GWMC does not conduct any of the plans suggested in this master plan. There is no separation at source conducted by the residents. Waste collection area in the city is limited and uncollected waste is scattered on the open plots. The sanitation condition in the city deteriorates by waste. Currently, there is no separation at source conducted by the residents so that the result of environmental and social impact is negative in this case. The sanitation condition in the city therefore gets worse.

(d) Advantage and Disadvantage on Each Case

Table 5.2.94 shows advantages and disadvantages of each alternative measure. Both separation at source and no source separation systems make the city cleaner. Source separation is better if 3R activity is considered in the master plan but “no separation” is not compatible with the 3R plan. It takes time and cost for separation from mixed waste to organic waste.

Table 5.2.94 Advantages and Disadvantages of Each Alternative

Item	Advantages	Disadvantages	Evaluation
Separation at Source	- The city becomes cleaner. - The system has positive impacts on environmental and social condition. - The system is compatible with the 3R system.	- It takes time for residents to accustom themselves with waste separation - Some residents may dispose waste in a wrong container.	Better
No Source Separation	- Residents do not need to change their disposal method. - The city becomes cleaner. - All types of waste are disposed in one container.	- The environmental condition does not change. - The system has a negative impact on environmental and social condition. - The system does not correspond to the 3R system.	Fair
Zero Option	- Residents do not need to change their disposing method.	- The environmental condition does not change or gets worse. - The system has a negative impact on environmental and social condition	Bad

It is assumed that source separation conducted by the residents is at first difficult. However, they will become accustomed to the separation with the coordination of GWMC.

(e) Conclusion

Source separation is adopted in the master plan. The reasons for this are as follows:

- The city becomes cleaner;
- Source separation can omit the waste separation process at the landfill site, if collected waste is utilised for waste recovery such as composting, RDF, etc.;
- Source separation is compatible with 3R plan;
- Source separation gives positive impact on environment; and
- Other separation systems may be easily applied after the adoption of source separation by the residents.

5.2.3 Identification of Priority Projects for Waste Collection and Transportation Plan

(1) Short-Term Plan (2016-2018)

(a) Formulation of Waste Collection Plan

GWMC has to be responsible for the task of preparation for gaining approval of the integrated waste collection implementation plan from relevant authorities. The plan should at least include waste collection plan, monitoring of waste collection ratio, procurement plan of waste collection vehicles and waste containers including type and quantity, and budgetary arrangement.

(b) Study/Planning for the Method of Separate Collection and Implementation at the Pilot Study Area(s)

Implementation of separate collection in the Short-Term Period is intended as the activities in the transitional period toward a full-fledged separate collection prior to the start of operation of the compost plant scheduled in 2021. Separate collection will be practiced basically for i) biodegradable waste, ii) recyclable materials (paper, plastics, glass and metals), and iii) other residual waste. The study and/or planning will be carried out by the following key factors for the trial implementation at the pilot study area(s) although the details will be discussed and proposed in the course of formulation of the action plan.

- Determination of type of recyclable materials for segregation at source;
- Consideration of method of discharging/recovering the objective resource materials;
- Selection of the type, size and number of receptacles/containers for temporary storage depending on the recovery sites and discharge amount (for example, biodegradable waste put in a $5m^3$ container for fresh market, 20-50 littre container for large waste generators of biodegradable waste, and a $0.8m^3$ container for general domestic waste generators.);
- Determination of the method and frequency of recovery and transportation, and delivery sites of each resource materials;
- Selection of pilot study area(s) and orientation/education of participating waste generators;
- Procurement and/or dispatch of vehicles, receptacles/containers, and staffing for separate collection operation; and
- Evaluation of the pilot study and feed-back for improvement.

(c) Increasing of Waste Collection Ratio in 64 UCs up to 100% in 2018

GWMC has the responsibility to expand the waste collection area in the 64 UCs. GWMC has to prepare the necessary waste collection vehicles and waste containers deployment plan in the 8 zones.

(d) Procurement of Waste Collection Vehicles and Containers for 64 UCs

GWMC has to prepare the documents necessary for the annual budgetary arrangement for procurement of waste collection vehicles and waste containers to be submitted to the

Provincial Government. After acquiring the budget, GWMC shall procure the necessary number of waste collection vehicles and containers.

(e) Monitoring of Improvement of Waste Collection and Transportation in 64 UCs

GWMC is required to carry out regular monitoring of waste collection amount and waste collection rate. GWMC also needs to monitor waste collection vehicles and waste containers. In addition, GWMC needs to monitor the implementation status of source separation during the waste collection.

(f) Conducting Street Cleaning in 64 UCs

GWMC is obliged to conduct street cleaning in the 64 UCs. For this purpose, GWMC has to procure the necessary street cleaning vehicles.

(g) Collection of Bulky Waste

GWMC is obliged to collect bulky waste. For this purpose, GWMC has to procure the necessary waste collection vehicles for bulky waste.

(h) Cleaning up of Illegal Dumping sites in 64 UCs

GWMC needs to employ a private contractor for cleaning up over 700 places of illegal dumping sites in the 64 UCs. GWMC should monitor the condition after finishing the cleanup of the sites. The duration of cleaning the illegal dumping sites is set at three (3) years.

(i) Collection of Construction and Demolition Waste

GWMC is obliged to collect construction waste generated from construction sites. The collection work is separate from the ordinary collection of waste. Necessary collection vehicles and equipment shall be deployed for the work. The wastes are generated from sources such as the construction industry. Thus, GWMC has to set the appropriate fee schedule for construction and demolition waste.

(j) Construction of Parking Area

GWMC is obliged to construct necessary parking areas. Collection vehicles increase gradually for the waste collection activity. Necessary facilities shall be allocated by GWMC.

(2) Mid-Term Plan (2019-2024)

(a) Increase of Waste Collection Rate in 34 UCs from 0% to 50% in 2024

GWMC has to expand the waste collection area from the 64 UCs to the 34 UCs in the peri-urban area. GWMC has to prepare necessary waste collection vehicles and the waste containers deployment plan for 9 zones of the peri-urban area.

(b) Sustaining the Waste Collection Rate in 64 UCs with 100% in 2024

GWMC needs to sustain 100% of waste collection rate in the 64 UCs. GWMC has to monitor the deployment of waste collection vehicles and containers in the service area. If the deployment of waste vehicles and/or waste containers is not adequate, GWMC has to employ measures to rectify the situation.

(c) Procurement of Waste Collection Vehicles and Containers in 98 UCs

GWMC has to procure the necessary waste collection vehicles and containers with the approval of the Punjabi Government from 2019 to 2023.

(d) Monitoring of Improvement of Waste Collection and Transportation in 98 UCs

GWMC continuously requires carrying out regular monitoring of waste collection amount and waste collection rate. GWMC also needs to monitor the waste collection vehicles and waste containers in 2023. GWMC needs to take measures to improve of collecting waste if the actual waste collection rate does not achieve the target waste collection rate and waste amount. In addition, GWMC needs to monitor the implementation status of source separation during the waste collection.

(e) Conducting the Street Cleaning in 64 UCs

GWMC is obliged to conduct street cleaning in the 64 UCs. GWMC has to procure the necessary street cleaning vehicles.

(f) Collection of Bulky Waste

GWMC is continuously obliged to conduct collection of bulky waste. GWMC has to prepare the necessary waste collection vehicles for bulky waste.

(g) Collection of Construction and Demolition Waste

GWMC is obliged to collect construction waste generated from construction sites. The collection work is separate with ordinary collection of waste. Necessary collection vehicles and equipment shall be deployed for the work. GWMC has to revise the fee schedule for construction and demolition waste if the economic situation in the city is changed.

(h) Construction of Parking Area

GWMC is obliged to construct necessary parking areas. Collection vehicles increase gradually for waste collection activity. Necessary facility shall be allocated by GWMC.

(3) Long-Term Plan (2025-2030)

(a) Increase of Waste Collection Rate in 34 UCs to 100% in 2030

GWMC has to expand the waste collection area in 34 UCs, which are in peri-urban areas. GWMC has to prepare the necessary waste collection vehicles and the waste containers deployment plan for 9 zones in the peri-urban areas.

(b) Sustaining Waste Collection Rate in 64 UCs from the Present to 100% in 2030

GWMC needs to sustain 100% of waste collection rate in 64 UCs. GWMC has to monitor whether waste vehicles and containers are deployed adequately in the service area. If the deployment of waste vehicles and/or waste containers is inadequate, GWMC has to employ measures to rectify the situation.

(c) Procurement of Waste Collection Vehicles and Containers in 98 UCs

GWMC shall continuously procure necessary waste collection vehicles and containers with the approval of the Punjabi Government from 2021 to 2030.

(d) Monitoring of Improvement of Waste Collection and Transportation in 98 UCs

GWMC continuously requires carrying out regular monitoring on waste collection amount and waste collection rate. GWMC also needs to monitor waste collection vehicles and waste containers in 2030. GWMC needs to take measures to improve the collection of waste if the actual waste collection rate does not achieve the target waste collection rate and waste amount. In addition, GWMC needs to monitor the implementation status of source separation during waste collection.

(e) Conducting the Street Cleaning in 64 UCs

GWMC is obliged to conduct street cleaning in 64 UCs. GWMC has to procure the necessary street cleaning vehicles.

(f) Collection of Bulky Waste

GWMC is obliged to collect bulky waste. GWMC has to procure necessary waste collection vehicles for bulky waste.

(g) Outsourcing of Waste Collection and Transportation Services to a Private Company in 2025

GWMC needs to consider outsourcing the waste collection and transportation service to a private company. Due to the expansion of the waste collection service area, served population would become the number of population in half of Lahore City in the year of 2025. LWMC practices outsourcing of waste collection and transportation service to a Turkish private company and achieve satisfactory outcome of the services. GWMC should consider this option for the waste collection and transportation service.

(h) Collection of Construction and Demolition Waste

GWMC is obliged to collect construction waste generated from construction sites. The collection work is separate from the ordinary waste collection activities. Necessary collection vehicles and equipment are deployed for the work. GWMC has to revise the fee schedule for construction and demolition waste if the economic situation in the city is changed.

(i) Construction of Parking Areas

GWMC is obliged to construct necessary parking areas. Collection vehicles increase gradually for the waste collection activity. Necessary facilities shall be allocated by GWMC.

5.2.4 Implementation Schedule

Table 5.2.95 shows the implementation plan for the master plan. GWMC needs to monitor the waste collection and transportation work from 2016 to 2030.

Table 5.2.95 Implementation Schedule of the Collection and Transportation Plan

Plan, Program & Projects		Short-term			Mid-term						Long-term					
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
(1) Short-Term Plan (2016-2018)																
WCP-S-1	Formulation of Waste Collection Plan	■														
WCP-S-2	Increasing of waste collection ratio in 64UCs up to 100% in 2018	■	■	■												
WCP-S-3	Procurement of waste collection vehicles and containers in 64UCs	■	■	■												
WCP-S-4	Monitoring on Improvement of Waste Collection and Transportation in 64UCs	■	■	■												
WCP-S-5	Conducting Street cleaning in 64UCs	■	■	■												
WCP-S-6	Collection of bulky waste	■	■	■												
WCP-S-7	Cleaning up of illegal dumping sites in 64 UCs	■	■	■												
WCP-S-8	Collection of Construction and Demolition Waste	■	■	■												
WCP-S-9	Construction of Parking area	■	■	■												
(2) Mid-Term Plan (2019-2024)																
WCP-M-1	Increasing of Waste Collection ratio in 34 UCs from 0% to up to 50% in 2024				■	■	■	■	■	■						
WCP-M-2	Sustaining Waste Collection ratio in 64UCs with 100% in 2024				■	■	■	■	■	■						
WCP-M-3	Procurement of waste collection vehicles and containers in 98UCs				■	■	■	■	■	■						
WCP-M-4	Monitoring on Improvement of waste collection and transportation in 98UCs				■	■	■	■	■	■						
WCP-M-5	Conducting the Street cleaning in 64UCs				■	■	■	■	■	■						
WCP-M-6	Collection of Bulky waste				■	■	■	■	■	■						
WCP-M-7	Collection of Construction and Demolition Waste				■	■	■	■	■	■						
WCP-M-8	Construction of parking area				■	■	■	■	■	■						
(3) Long-Term Plan (2025-2030)																
WCP-L-1	Increasing of Waste Collection ratio in 34 UCs to 100% in 2030										■	■	■	■	■	■
WCP-L-2	Sustaining Waste Collection ratio in 64UCs from the current with 100% in 2030										■	■	■	■	■	■
WCP-L-3	Procurement of waste collection vehicles and containers in 98UCs										■	■	■	■	■	■
WCP-L-4	Monitoring on Improvement of waste collection and transportation in 98UCs										■	■	■	■	■	■
WCP-L-5	Conducting the Street cleaning in 64UCs										■	■	■	■	■	■
WCP-L-6	Collection of Bulky waste										■	■	■	■	■	■
WCP-L-7	Outsourcing the Waste Collection and Transportation Service to a private company in 2025										■	■	■	■	■	■
WCP-L-8	Collection of Construction and Demolition Waste										■	■	■	■	■	■
WCP-L-9	Construction of Parking areas										■	■	■	■	■	■

5.2.5 Project Cost

Table 5.2.96 shows the project cost for the Master Plan. The total cost of waste collection and transportation is Rs. 13,645,387,000.

Table 5.2.96 Project Cost of the Collection and Transportation Plan

Unit: thousand Rs.

Plan, Program & Projects		Short-term			Mid-term						Long-term						Total
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2029	
(1) Short-Term Plan (2016-2018)																	2,489,021
WCP-S-1	Formulation of Waste Collection Plan																
WCP-S-2	Increasing of waste collection ratio in 64UCs up to 100% in 2018																
WCP-S-3	Procurement of waste collection vehicles and containers in 64UCs	346,020	441,711	1,016,740													1,804,471
WCP-S-4	Monitoring on Improvement of Waste Collection and Transportation in 64UCs																
WCP-S-5	Conducting Street cleaning in 64UCs	67,328	6,527	6,527													80,382
WCP-S-6	Collection of bulky waste	23,730	4,130	4,130													31,990
WCP-S-7	Cleaning up of illegal dumping sites in 64 UCs	22,382	2,782	464													25,628
WCP-S-8	Collection of Construction and Demolition Waste	7,690	7,690	7,690													23,070
WCP-S-9	Construction of Parking area	126,423	3,546	393,511													523,480
(2) Mid-Term Plan (2019-2024)																	3,727,474
WCP-M-1	Increasing of Waste Collection ratio in 34 UCs from 0% to up to 50% in 2024																
WCP-M-2	Sustaining Waste Collection ratio in 64UCs with 100% in 2024																
WCP-M-3	Procurement of waste collection vehicles and containers in 98UCs				458,853	493,085	597,588	605,422	650,057	715,939							3,520,944
WCP-M-4	Monitoring on Improvement of waste collection and transportation in 98UCs																
WCP-M-5	Conducting the Street cleaning in 64UCs				6,527	6,527	32,396	8,396	8,396	29,596							91,838
WCP-M-6	Collection of Bulky waste				4,130	4,130	4,130	4,130	4,130	19,930							40,580
WCP-M-7	Collection of Construction and Demolition Waste				7,690	7,690	7,690	7,690	7,690	7,690							46,140
WCP-M-8	Construction of parking area				4,662	4,662	4,662	4,662	4,662	4,662							27,972
(3) Long-Term Plan (2025-2030)																	7,428,892
WCP-L-1	Increasing of Waste Collection ratio in 34 UCs to 100% in 2030																
WCP-L-2	Sustaining Waste Collection ratio in 64UCs from the current with 100% in 2030																
WCP-L-3	Procurement of waste collection vehicles and containers in 98UCs										812,436	959,199	1,061,703	1,127,716	1,299,936	1,385,150	6,646,140
WCP-L-4	Monitoring on Improvement of waste collection and transportation in 98UCs																
WCP-L-5	Conducting the Street cleaning in 64UCs										8,397	54,995	21,795	12,595	24,595	21,795	144,172
WCP-L-6	Collection of Bulky waste										4,130	4,130	4,130	4,130	4,130	4,130	24,780
WCP-L-7	Outsourcing the Waste Collection and Transportation Service to a private company in 2025																
WCP-L-8	Collection of Construction and Demolition Waste										7,690	7,690	7,690	7,690	7,690	7,690	46,140
WCP-L-9	Construction of Parking areas										248,250	5,220	5,220	297,414	5,778	5,778	567,660
Total		593,573	466,386	1,429,062	481,862	516,094	646,466	630,300	674,935	777,817	1,080,903	1,031,234	1,100,538	1,449,545	1,342,129	1,424,543	13,645,387

5.3 Final Disposal Plan

5.3.1 Urgent Improvement of the Current Landfill Operation in Gondlanwala

In the site visits, the JICA Project Team observed that the landfill operation started in March 2014 at the landfill site in Gondlanwala has a potential risk of environmental degradation. It is needless to say that the improvement plan of the provisional landfill in Gondlanwala is due to be included as one of the major projects to compose the final disposal plan for tackling the immediate measures against the current situation of environmental impacts.

In view of this situation, prior to the formulation of the master plan, the JICA Project Team decided to prepare a brief proposal, "*Proposal on Urgent/Preliminary Improvement of Gondlanwala Dump Site,*" for the improvement work of landfill in Gujranwala and submitted it to GWMC on the 7th of April 2014. The proposal contains several key measures to be taken by the GWMC for reducing the environmental impacts immediately. The following items describe the contents of the proposal, and the subsequent recommendations taking into consideration the situation thereafter.

(1) Proposal Submitted for Urgent Improvement of Gondlanwala Landfill Site

The proposal presents the measures for improving the existing open dumpsite at Gondlanwala to mitigate possible groundwater pollution and scattered dust and offensive odour taking place in the vicinity. The improvement work of the Gondlanwala Dump Site will be prepared as a part of the action plan in the Master Plan. However, since the action plan will be formulated in the end of the Project period according to the Project Schedule, it is predictable that such negative impacts at Gondlanwala will become worse in the latter stage. In order to avoid worse condition of the dump site, this paper urges immediate actions to tackle with the implementation of improvement work as urgently and preliminarily required. The urgent/preliminary improvement work of the open dump site consists of the following measures.

(a) Improvement of Existing Ramp or Approach Road and Construction of Unloading Area

The ramp leading to the bottom of the dump site is partly collapsed (see **Photo 5.3.1**) due to rainwater and the collapse of side slope will become a cause of incoming vehicles falling from the ramp. This collapse will become worse when the rainy season starts. The following measures will be effective to prevent the slope from collapsing:

- Bring clayey earth from the other corner of the dumpsite or purchase it from a nearby borrow pit;
- Fill the collapsed slope area shown in **Photo 5.3.1** and **Figure 5.3.1** with clayey earth and perform watering to bind the sand or remove voids in the filled earth to accelerate its stability;
- Tamper the slope well by machine or by hand; and
- Seed the slope area by fast-growing type of weeds to prevent erosion of the surface soil.

(b) Filling Water Area in the Dumpsite by Clayey Earth

The bottom of dumping area is filled with water and it may cause groundwater contamination in the course of waste dumping in the water area. It is assumed that the existing water table will rise by 1.5m or so, and dumped waste soaked in water will generate methane gas under the anaerobic condition. To avoid dumping waste in the water area, the following measures will be effective:

- Bring clayey earth from the other corner of the dumpsite or purchase it from a nearby borrow pit and put it onto the bottom of the dumping area; and
- Fill the earth at least 2.0 m above the existing water table and compact well to minimise infiltration of contaminated water or leachate into the underground.

(c) Temporary Leachate Control System

Leachate in the dumping area shall be collected by leachate mains to be installed on the bottom of the dumping area and conveyed to a leachate pond to be constructed in the corner of dumpsite at the place shown in **Photo 5.3.2** and **Figure 5.3.1**. Leachate in the pond shall be circulated in the dumpsite by a temporary pump and hose for reducing leachate amount by evaporation. Major work items are described as follows:

- Place the leachate mains of 200 mm dia. or larger diametre PVC (Polyvinyl-Choride) or HDPE (High Density Polyethylene) perforated pipes on the bottom of the dumpsite with a minimum slope of 5/1,000. The end of the leachate mains shall be connected to the leachate pond;
- Cover the leachate mains with gravel, as shown in the attached **Figure 5.3.1**;
- Construct an earthen pond lined with concrete or HDPE with the storage volume of minimum 100m^3; and
- Install a temporary pump unit and hose in the pond for circulation of leachate within the dumpsite area and operate a submerged pump at the inlet leachate pipes. The pump unit shall be operated for 1-2 hours after the daily landfill operation is finished to lower the water level in the leachate pond and withdraw the leachate effectively.

(d) Waste Dumping on the Bottom of Dumpsite

Waste dumping from the top of the dike has the risk of vehicles falling to the dumpsite. Waste dumping or unloading of waste shall be carried out from the bottom of the dumpsite. To unload the waste on the bottom of the dumpsite, the following works, at least, shall be required:

- Construct a temporary approach road leading to the landfill area. The minimum width shall be 3 m roadway with one (1) metre shoulders;
- Construct a platform or working area for unloading and turning of the vehicles with the minimum dimension of 15m by 15m wide; and
- Designate the working area for landfill work within the low earthen dike cell constructed with 1 to 2 m high and for the volume of approximately one (1) month landfill work.

(e) Regular Earth Covering onto the Dumped Waste

Regular earth covering is effective for minimising breeding of vectors, especially flies and also reducing the offensive odour. Unloaded waste in the working cell shall be spread horizontally and compacted well. Regular earth covering by soil excavated from the north-east side of the dumping area would be available.

(f) Control of Waste Pickers

Waste pickers pick out recyclable materials from the dumpsite. They sometimes disturb the unloading and landfill work. They are by themselves at risk working in the waste dumping area. Banning of recovery work is preferable but if not possible, they may be allowed after the waste dumping hours for the day.

(2) Additional Proposal for Urgent Improvement of Gondlanwala Landfill Site

(a) Measures to Lower the Ponding Water Level at the Bottom of Landfill Area

Stagnant leachate water at the bottom of the landfill area has raised the water level in September due to heavy rainfall during the monsoon season. Rise of water level in the landfill area causes the leachate flow into the groundwater aquifer in the peripheral zone and bring about the risk of groundwater contamination. If the groundwater level in the peripheral area is higher than that of the landfill site, the groundwater in the surrounding wells receive fresh groundwater recharge from the outer zone. Therefore, as the measures to lower the water level (groundwater table) in the landfill area, installation of a system and its operation to direct the groundwater flow from the peripheral zone to the side of the landfill site is considered to be effective. The system shall be comprised of a pump well, leachate drainage piping, and the leachate circulation and evaporation system. The water level in the pump well must be targeted to maintain approximately 1m lower than the bottom elevation of the landfill site by the water level in the pump well. With too much pumping below the water level in the pump well, the groundwater level will drop too low in the peripheral zone and will cause dry-up of, especially, the hand pump wells.

(b) Pest Control, Odour Control and Dust Control

Currently, in the landfill site, the adjacent house, operators of weighbridge, collection vehicle drivers, etc., are suffering from the outbreak of flies, offensive odour and dust. The situation is unsanitary and the risk of health hazard occurs. These environmental conditions must be improved immediately based on the following recommendations:

- Eradicate the flies by spraying environment-friendly pesticide;
- Conducting regular soil cover, at the same time, to eliminate the breeding sites of flies and to prevent generation of offensive odour;
- Periodic spraying onto the unloading waste by deodorant agent made from useful bacteria like lactic acid, enzymes, etc., to decompose offensive odour substance; and
- Periodic spraying of water to the approach road of vehicles and the weighbridge site to prevent the dust from winding up.

As of March 2015, some of the operational measures of the proposed urgent project for earth cover, pest control, etc. have been carried out by GWMC for controlling the waste dumping operation. However, it has not yet implemented the urgent improvement work which requires a relatively large amount of money due to shortage of funds of GWMC. The proposal still remains the same for implementing immediately the improvement work through funding with a special budget, if available. In the meantime, more effective measures will be proposed as a part of the project under the short-term development plan of final disposal.

Photo 5.3.1 Collapse of Gondlanwala Landfill Site

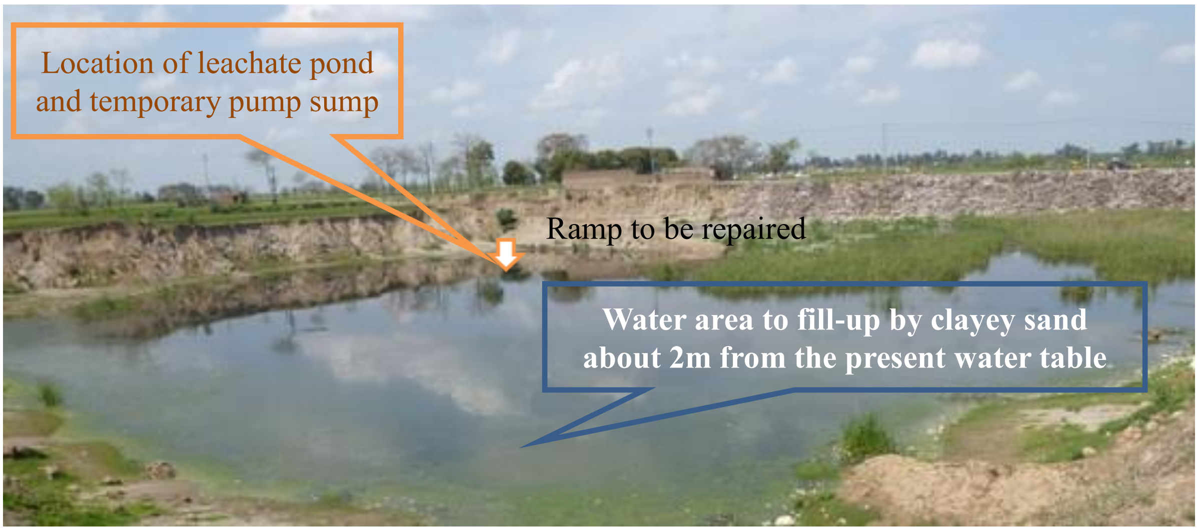


Photo 5.3.2 Leachate Condition of Gondlanwala Landfill Site

Figure 5.3.1 Urgent Improvement Plan for Gondlanwala Landfill Site

5.3.2 Development of Alternatives for Final Disposal Plan

(1) Waste Disposal Amount

Waste disposal amount is computed in accordance with the integrated municipal solid waste management flow. More concretely, the waste disposal amount is calculated from the waste generation amount presented in **Chapter 4** by reducing the following waste amounts:

- Un-collected waste amount;
- Waste generation prevention amount;
- Resource recovery amount by waste pickers in town and recycling industries;
- Organic waste recovery by home, community and central composting; and
- Combustible waste recovery by RDF plant.

The estimation of waste disposal amount is carried out in three (3) cases, i.e., 1) waste disposal amount with 3R activities and intermediate treatment; 2) waste disposal amount without 3R and intermediate treatment; and 3) waste disposal amount without any new project (Zero option). The result of computation is summarised in **Table 5.3.1**. From the table, the daily waste disposal amount of 406 t/d in 2014 increases drastically up to 2,013 t/d or 2,724 t/d in 2030 by the cases of with/without the activities of 3R and intermediate treatment. Meanwhile, the annual waste disposal amount of 148,000 t/year in 2014 increases to 735,000 t/year or 994,000 t/year for the cases of with/without 3R and intermediate treatment.

Table 5.3.1 Estimated Waste Disposal Amount by Cases

Daily Waste Disposal Amount (t/d)																	
Case	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R	406	500	658	833	1,035	1,133	991	1,105	1,227	1,359	1,500	1,612	1,724	1,848	1,981	2,115	2,013
Without 3R	406	500	658	833	1,035	1,133	1,241	1,356	1,478	1,610	1,752	1,888	2,027	2,182	2,353	2,528	2,724
Without Projects	406	406	406	406	406	406	406	406	406	406	406	406	406	406	406	406	406
Annual Waste Disposal Amount (1,000 t/year)																	
UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R	148	183	241	304	378	414	363	403	448	496	549	589	629	674	725	772	735
Without 3R	148	183	241	304	378	414	454	495	540	588	641	689	740	797	861	923	994
Without Projects	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148

Source: JICA Project Team

(2) Annual Landfill Volume

The landfill volume is estimated through conversion of waste amount in ton to volume in cubic metre (m^3) by the bulk density of filled waste layer obtained from the bulk density survey conducted at Chianwali and Gondlanwala disposal site. As mentioned earlier, the bulk density of 0.9 ton/m^3 was used for estimating the residual lifetime of the Gondlanwala disposal site. The bulk density of 1.0 ton/m^3 is used for the design of proposed Bhakhraywali landfill facilities considering the longer lifetime compared with that of the Gondlanwala site. Then, the cover soil volume of 20% to the waste volume is added to estimate the total landfill volume.

The result of landfill volume computation is tabulated in **Table 5.3.2** for the annual waste disposal volume together with the cover soil volume. The annual landfill volume is also divided into the two disposal sites: at Gondlanwala (2014-2017) and at Bhakhraywali (2018-2030). In addition, the landfill volume of Gondlanwala disposal site in 2014 has adjusted with the volume for 10 months since the landfill operation started in March 2014. In Gondlanwala disposal site, the annual waste disposal volume including waste disposal volume and cover soil volume increases from 148,000 m^3/year in 2014 to 365,000 m^3/year in 2017. In Bhakhraywali disposal site, the landfill volume of 453,000 m^3/year in 2014 increases up to 882,000 m^3/year or 1,193,000 m^3/year in 2030 for with/without the 3R and intermediate treatment cases.

Table 5.3.2 Estimated Annual Landfill Volume by Cases

Annual Waste Disposal Volume (1,000 m^3/year)																	
Case	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R . (Gondlanwala)	123	183	241	304													
With 3R (Bhakhraywali)					378	414	363	403	448	496	549	589	629	674	725	772	735
Without 3R . (Bhakhraywali)					378	414	454	495	540	588	641	689	740	797	861	923	994
Without New Projects	123	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148	148
Annual Cover Soil Volume (1,000 m^3/year)																	
UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R . (Gondlanwala)	25	37	48	61													
With 3R (Bhakhraywali)					76	83	73	81	90	99	110	118	126	135	145	154	147
Without 3R . (Bhakhraywali)					76	83	91	99	108	118	128	138	148	159	172	185	199
Without New Projects	25	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
Annual Landfill Volume (1,000 m^3/year)																	
With 3R . (Gondlanwala)	148	219	289	365													
With 3R (Bhakhraywali)					453	496	435	484	538	595	659	706	755	809	870	926	882
Without 3R . (Bhakhraywali)					453	496	545	594	648	705	770	827	888	956	1,033	1,107	1,193
Without New Projects	148	178	178	178	178	178	178	178	178	178	178	178	178	178	178	178	178

Source: JICA Project Team

Note: The landfill volume of Gondlanwala in 2014 has adjusted with the volume for 10 months since the landfill operation started in March 2014.

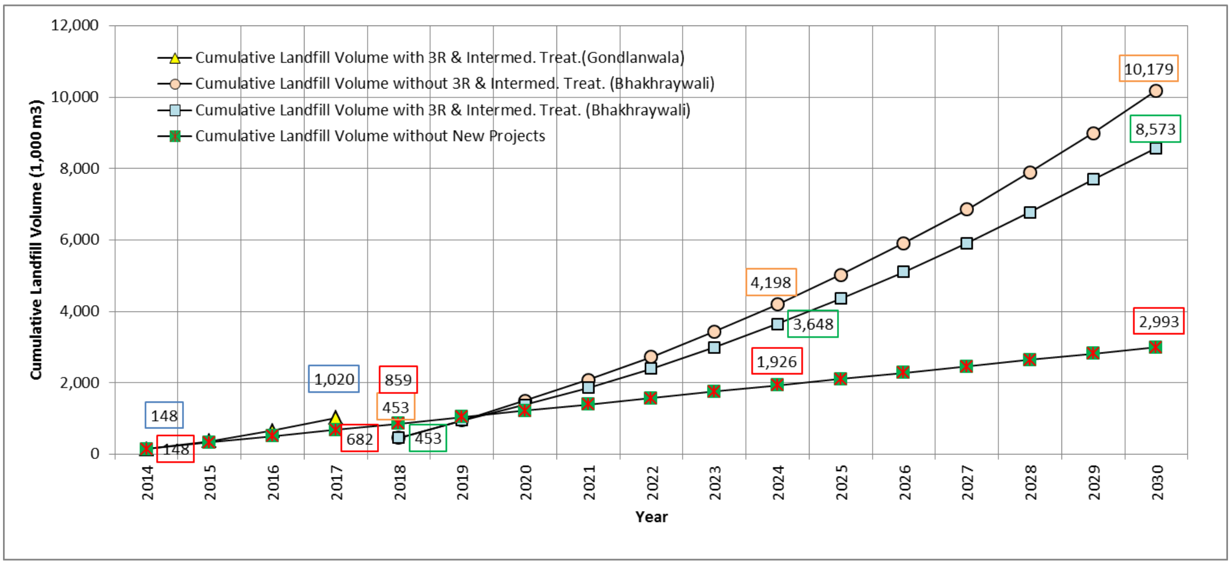
(3) Cumulative Landfill Volume

The cumulated annual landfill volume for each year is as shown in **Table 5.3.3** and the annual trend graph is shown in **Figure 5.3.2**. The cumulative landfill volume at Gondlanwala disposal site will become 1.0 million cubic metres in the end of 2017. The cumulative landfill volume for with/without 3R and intermediate treatment during the period from 2018 to 2030 will become 8.6 million cubic metres and 10.2 million cubic metres respectively. In case of "Zero Option" or no implementation of new projects, the cumulative landfill volume will become about 3 million cubic metres.

Table 5.3.3 Estimated Cumulative Landfill Volume by Cases

Cumulative Landfill Volume (m^3)																	
Case Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
With 3R . (Gondlanwala)	148	367	656	1,020													
With 3R (Bhakhraywali)					453	948	1,381	1,863	2,399	2,992	3,648	4,351	5,103	5,909	6,775	7,697	8,573
Without 3R . (Bhakhraywali)					453	948	1,491	2,083	2,728	3,431	4,198	5,022	5,907	6,860	7,889	8,992	10,179
Without New Projects	148	326	504	682	859	1,037	1,215	1,393	1,571	1,748	1,926	2,104	2,282	2,460	2,637	2,815	2,993

Source: JICA Project Team



Source: JICA Project Team

Figure 5.3.2 Increasing Trend of Cumulative Landfill Volume by Cases (1,000 m^3)

(4) Landfill Development Plan

(a) Available Landfill Volume and Lifetime of Disposal Site

The available landfill volume for Gondlanwala and Bhakhraywali disposal site are computed at 510,000 m^3 and 1,600,000 m^3 respectively. Judging from the available landfill volume of each site, the lifetime of Gondlanwala disposal site will end in 2016 based on the cumulative landfill volume indicated in **Table 5.3.3** or in **Figure 5.3.2** above. On the other hand, the lifetime of Bhakhraywali which started landfill in 2018 will end in 2021 for the cases of with/without 3R and intermediate treatment. Development alternatives of landfill sites are proposed in the following subsections based on the estimated lifetime of each disposal site described above.

(b) Alternative Landfill Development for Gondlanwala Site

The alternative landfill development of Gondlanwala is prepared to accommodate waste disposal up to the end of 2017 when the Bhakhraywali landfill site will become operational in 2018. The following four options in **Table 5.3.4** are proposed for the Gondlanwala site taking into account the circumstance of the neighbouring area.

Table 5.3.4 Landfill Development Options for Gondlanwala

Options	Existing Site	New Site	Waste Transfer
Option-1	Landfill waste up to the ground level with 510,000 m^3. Piling up about 8 m high from the ground level to accommodate another 510,000 m^3. Total 1,020,000 m^3 to dispose waste until the end of 2017.	None	None
Option-2	Landfill waste up to the ground level with 510,000 m^3. Piling up about 3 m high from the ground level to accommodate about 180,000 m^3. Total 690,000 m^3 to dispose waste until the middle of 2016.	Procure about 8 ha of land and use 80% of the area for landfill. Landfill 3m deep from the ground level and pile up 3m waste layer above the ground to receive waste from the middle of 2016 to the end of 2017.	None
Option-3	Same as Option-1	None	Transfer waste to the Bhakhraywali disposal site after completion of the landfill facilities.
Option-4	Landfill waste up to the ground level by the volume of 510,000 m^3.	None	Use the open space of Bhakhraywali landfill site for temporary storage for 1-2 years then transfer waste to the Bhakhraywali landfill site after completion of the landfill facilities.

Source: JICA Project Team

The options were evaluated from environmental, technical and economic aspects and concluded that Option-4 is the most realistic and preferable followed by Option-3. Option-4 implicates the operational uncertain factors depending on the development schedule and work plan of the Bhakhraywali landfill facilities. If the timing of the development work cannot accept the temporary waste storage, then Option-3 will be practiced.

(c) Alternative Landfill Development for Bhakhraywali Site

The alternative landfill development of Bhakhraywali is prepared to accommodate waste disposed from 2018 to 2030 until the end of the Master Plan period. The two options in **Table 5.3.5** are proposed for the Bhakhraywali site taking into account the circumstance of the neighbouring area.

Table 5.3.5 Landfill Development Options for Bhakhraywali

Options	Existing Site	New Site
Option-1	Stage-1 Development: Landfill waste up to the ground level with the volume of 1,600,000 m^3. Piling up about 10 m high from the ground level to accommodate another 2,200,000 m^3. Disposed waste until the middle of 2024 is 3,800,000 m^3 in total.	Procurement of 50 ha of land and use 80% or 40 ha for the landfill area. Landfill 3 m deep down from the ground level and pile up 11 m from the ground level. Stage-2 Development: Development of 20 ha landfill area to secure new volume of about 2,800,000 m^{3}or the cumulative volume of 6,600,000 m^3 to accommodate landfill from 2024 to the middle of 2028. Stage-3 Development: Development of 20 ha landfill area to secure 2,800,000 m^{3}or the cumulative volume of 9,400,000 m^3 to accommodate landfill from 2027 to 2030 and after.
Option-2	Stage-1 Development: Landfill waste up to the ground level with the volume of 1,600,000 m^3. Piling up about 8 m high from the ground level to accommodate another 1,600,000 m^3. o Disposed waste until the beginning of 2024 is 3,200,000 m^3 in total.	Procurement of 75 ha of land and use 80% or 60 ha for the landfill area. Landfill 3 m deep down from the ground level and pile up 8 m from the ground level. Stage-2 Development: Development of 30 ha landfill area to secure new volume of about 3,300,000 m^3 or the cumulative volume of 6,500,000 m^3 to accommodate landfill from 2024 to the middle of 2028. Stage-3 Development: Development of 30 ha landfill area to secure 3,300,000 m^3 or the cumulative volume of 9,800,000 m^3 to accommodate landfill from 2028 to 2030 and after.

Source: JICA Project Team

The respective options are feasible from the environmental, technical and economic aspects. However, Option-1 is superior to Option-2 from the viewpoint of possibility of land procurement and environmental issues. The rapid increase of incoming waste to the disposal site caused difficulties for the waste disposal plan. The best option of the disposal plan would be the implementation of more active 3R and intermediate plan to divert waste from the waste disposal through the financial support of the Punjab Government.

(5) Development of Design Alternatives for Final Disposal

The final disposal plan include improvement plan of the existing disposal site in Gondlanwala and safety closure of Chianwali disposal site in addition to the construction of landfill facilities in Bhakhraywali. The plan for Gondlanwala and Chianwali shall be formulated to the satisfactory level to mitigate current and future possible negative impacts in consideration of economic efficiency. Accordingly, the alternative study for the sites in Gondlanwala and Chianwali is not conducted in this subsection and the following discussions are the matters related with development of the landfill facilities in Bhakhraywali.

The waste management hierarchy begins with waste discharge. Final disposal is the last preferable option for storing eternally and safely the waste of no value. Landfill type is classified by the kind of waste to be disposed. The landfill types for municipal solid waste generally practiced in the developing countries can be divided into the following:

- Open dump site;
- Controlled open dump site; and
- Engineered landfill.

The definition of the landfill types listed above is different by countries and clear technical standards are not established.

There are several legal frameworks in the world stipulating landfill types and technical standards. According to the Directive 1999/31/EC on the landfill of waste, landfill types are divided into the three classes given below.

- Landfill for hazardous waste;
- Landfill for non-hazardous waste; and
- Landfill for inert waste.

The type of landfill for non-hazardous waste is intended for municipal solid waste. The said division of landfill type is also prescribed in the Waste Management Law in Japan, namely; the landfill types are:

- Stabilisation type;
- Management type; and
- Closed type.

The management type is applied for municipal solid waste in Japan and constructed by most of the local governments for final disposal facilities.

In Pakistan, the landfill types are categorised under the Punjab Municipal Solid Waste Management Guidelines. The types are divided by the tonnage of waste amount received as follows:

- Class A: Daily municipal solid waste of more than 1,000 tons
- Class B: Daily municipal solid waste of more than 500 tons and less than 1,000 tons
- Class C: Daily municipal solid waste of more than 100 tons and less than 500 tons
- Class D: daily municipal solid waste of less than 100 tons. (Stabilisation type)

The Guidelines also stipulates the requirements for landfill liner system, leachate management system, final cover system, etc., which shall be applied for municipal waste landfill. Requirements stated in the Guidelines are comparatively strict and the requirements are equivalent to the landfill type called for sanitary landfills practiced at many local governments in Japan.

5.3.3 Evaluation of Design Alternatives

Evaluation of final disposal alternatives generally begins with the construction of site alternatives. For this project, the landfill site selection survey conducted for 19 sites as delineated in **Section 2.4** has selected Bhakhraywali as the construction site of landfill facilities. The selected construction site is superior to other sites in terms of geographical, technical and environmental point of view and considered appropriate for the proposed construction site. Accordingly, the evaluation of the construction site alternative is not discussed anymore under this subsection.

The type of landfill for municipal solid waste has almost no option and the sanitary landfill becomes the most preferable options as mentioned in **Subsection 5.3.1**. However, there are some levels or grade of sanitary landfill system for consideration in the course of design of landfill facilities as discussed in the following subsections.

(1) Level of Sanitary Landfill Facilities

The level of Sanitary landfill can be defined or classified by the function of the facilities constructed and operation and maintenance procedures. Four levels of sanitary landfill are proposed, as follows:

- Level 1: Incoming waste recording and unloading control
- Level 2: Level 1 plus regular cover soil
- Level 3: Level 2 plus effluent control of leachate
- Level 4: Level 3 plus leachate treatment system

Level 1: Incoming waste recording and unloading control

The minimum requirements of the Level 1 landfill are the impermeable liner system for landfill waste containment, recording of incoming waste by weighbridge and control of waste unloading to the designated landfill area for the day.

Level 2: Level 1 plus regular cover soil

The minimum requirements of Level 2 are regular and daily filling with cover soil as the most preferable operation, in addition to the facilities and operation meeting the requirements of Level 1 landfill.

Level 3: Level 2 plus effluent control of leachate

The minimum requirements of Level 3 are the effluent control system of leachate including installation of leachate collection system and leachate pond, in addition to the facilities and operation meeting with the requirements of Level 2 landfill.

Level 4: Level 3 plus leachate treatment system

The minimum requirements of Level 4 are the leachate treatment system in addition to the facilities and operation meeting the requirements of Level 3 landfill.

The selection of sanitary landfill level among those defined above is made basically depending on the probable environmental impact of the landfill site to the natural and socil conditions in the surrounding area. The area surrounding the proposed site in Bhakhraywali is agricultural area and the nearest residential area is located at approximately 1 km away from the proposed site. Based on the conditions mentioned above, the function of landfill facilities and operation for Level 3 landfill will be proposed to satisfy the requirements for a new sanitary landfill from the environmental and economic viewpoints.

(2) Design Option for Semi-Aerobic Sanitary Landfill

Article 26 of The Punjab Waste Management Act of 2013 prescribes in the “Standards for Landfill” that the technical design of landfill shall meet the standards required by the authorised office and some of the technical requirements are specified. The design of Bhakhraywali sanitary landfill complies basically with the requirements specified under Article 26.

Furthermore, the Bhakhraywali sanitary landfill facilities shall have the function to facilitate semi-aerobic type landfill. The semi-aerobic type landfill can promote decomposition of organic waste for prompting early stabilisation and reducing generation amount of methane. In order to have the function of semi-aerobic landfill, the installation of leachate collection system, leachate pond, leachate pumpwell, and landfill gas vents is required. In particular, the size of the leachate collection conduit or pipes shall be large enough to entrain air into the conduit or the pipes in addition to the special design at the outlet section of the leachate collection system to the leachate pond designed to open to the air intermittently.

5.3.4 Identification of Priority Projects for Final Disposal Plan

(1) Priority Projects for Final Disposal Plan

The priority projects for final disposal are formulated to tackle the measures against the problems and issues defined in **Subsection 2.4.11.** The problems and issues pointed out three areas for taking measures for the final disposal plan. The first priority is given to the development of Bhakhraywali sanitary land facilities. The second priority is given to the improvement work of Gondlanwala existing disposal site and lastly to the safety closure of Chianwali disposal site. The plan is formulated in 3 phases, short-term from 2016 to 2018, mid-term from 2019 to 2024, and long-term from 2025 to 2030 as shown in the contents of the projects summarised in the following subsections. The project locations of the three sites are shown in the **Figure 5.3.3** to **Figure 5.3.6.**

Figure 5.3.3 Location of Bhakhraywali Sanitary Landfill Development Project

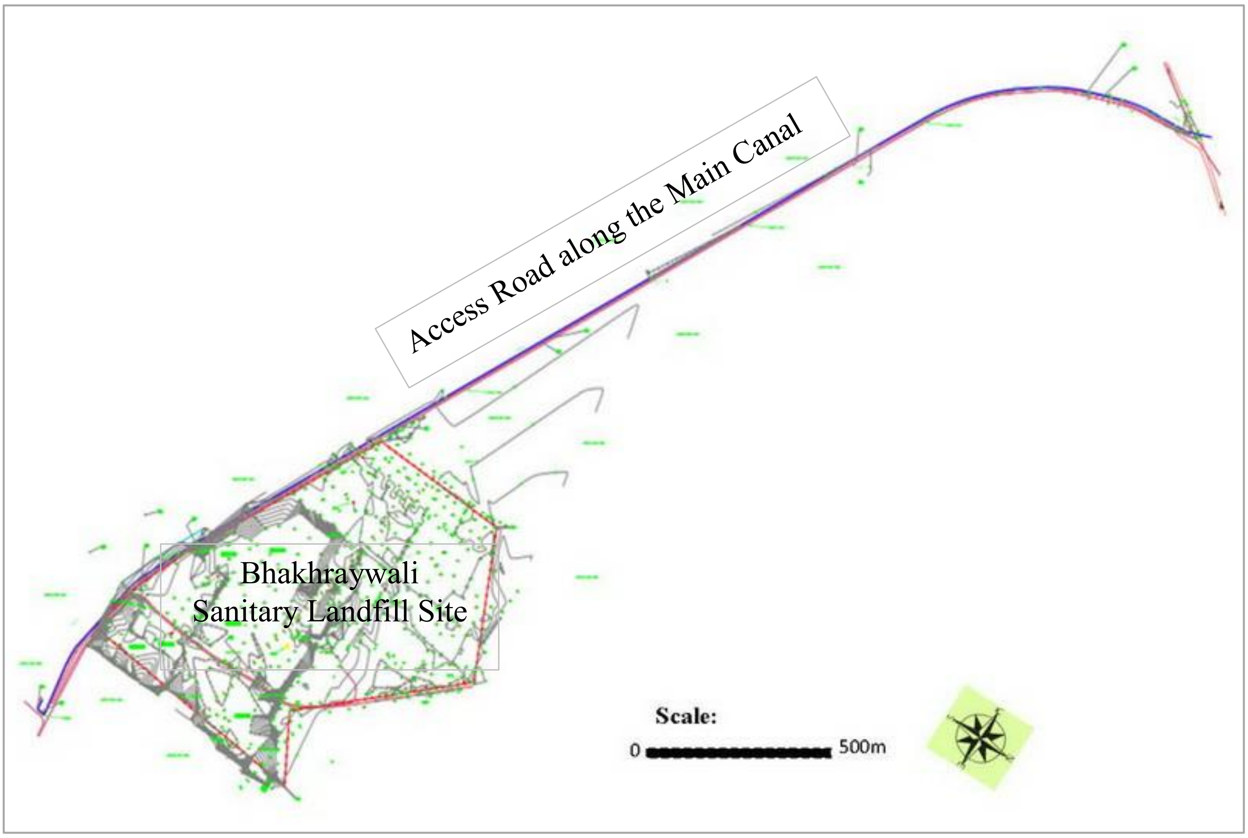


Figure 5.3.4 Access Road of Bhakhraywali Sanitary Landfill Facility

Figure 5.3.5 Location of Gondlanwala Disposal Site Improvement Project

Figure 5.3.6 Location of Chianwali Safe Closure Project

(2) Short-Term Plan (2016-2018)

(a) Procurement of Sanitary Landfill Site

Approximately 25 ha of land in Bhakhraywali have already been taken through the official procedures for procurement. However, the contract has not yet been signed with the land owners due to delay of funding for the procurement. GWMC shall include the procurement cost into the budget for the fiscal year 2015/2016 which will be submitted to the Punjab Government for approval. All the land procurement process must be completed by the end of 2015 to proceed to the engineering design of sanitary landfill facilities.

(b) Engineering Service for Sanitary Landfill Facilities (Stage 1)

The engineering service fee also shall be included in the budget for 2015/2016 fiscal year. GWMC shall prepare the tender and contract documents in advance for hiring an engineering service company and proceed to the contract signing upon completion of the land procurement contract signing. Engineering design and tender documents must be completed in 6 months to proceeds with the tender call by the middle of 2016. The engineering service includes the following services:

- Engineering design of sanitary landfill facilities;
- Construction cost estimates by the form of priced bill of quantities;
- Preparation of tender documents for construction work contract;
- Supporting of tender evaluation; and
- Construction supervisory services.

(c) Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywali

The sanitary landfill facility shall be constructed within the 25 ha site area. The actual area of landfill containment shall be 20 ha, approximately. The construction work takes the period of 15 to 18 months. All the construction work must be completed by the end of 2017 or the latest, in early 2018. The major components of the construction work include tha following:

- Improvement of access/exit road along the main canal;
- Earthworks for the construction of slopes of containment, intermediate dike, approach road, maintenance road, soil liner, etc.;
- Installation of geomenbrane impermeable liner;
- Leachate collection system, leachate pond and leachate circulation system;
- Installation of landfill gas vent system;
- Building works including site office & storage, weighbridge house, guard house, etc.
- Installation of weighbridge system;
- Power supply and lighting work; and
- Appurtenant facilities including perimetre fence, gates, relocation of water channel, landscaping, etc.

(d) Procurement of Landfill Machine

Additional machine for landfill operation at Gondlanwala disposal site is procured in 2016 and the landfill machines to be dispatched to the Bhakhraywali landfill site will be supplemented in 2017. The number of landfill machines will increase responding to the incoming waste amount for disposal. Required number of all the types of landfill machine and the procurement schedule is tabulated in **Table 5.3.6**. As shown in the table, the landfill machine to be procured during the Short-Term period is the following combination:

- One (1) unit of wheel loader in 2016;

- One (1) unit of excavator in 2016; and
- Two (2) units of bulldozer (chain dozer).

Table 5.3.6 Procurement Schedule of Landfill Machine

Basic Information	Year				
	2014	2016	2018	2024	2030
Incoming Waste Amount (t/d)	406	658	1,035	1,500	2,013
Required No. of Machine	3	5	7	11	17
Required No. of Procurement	0	2	2	4	6
Required No. of Replacement				3	4
Procurement Schedule	Year				
	2014	2016	2017	2023	2029
Existing machine (Bucket Tractor)	3				
Bulldozer (Chain Dozer)			2	2	3
Wheel Loader		1		1	2
Excavator		1		1	1
Replacement (Bucket Tractor)				3	
Replacement (Bulldozer)					2
Replacement (Wheel Loader)					1
Replacement (Excavator)					1

Source: JICA Project Team

(e) Operation and Maintenance of Landfill Facilities

Operation and maintenance work at Bhakhraywali disposal facilities shall be started in the beginning of 2018.

Even though the facilities have functions for the sanitary landfill, the satisfactory landfill will not be realised if the operation and maintenance works will not meet the requirements. An operation and maintenance plan shall be prepared based on the requirements of the technical guidelines and/or the operation and maintenance manuals for sanitary landfill. In order to carryout operation and maintenance properly to maintain the functionality of the sanitary landfill, the following are the major items to be specified for the operation and maintenance plan which shall be prepared in advance to the start of landfill operation at the Bhakhraywali landfill site.

- Policy and Strategies for the Better Management of Sanitary Landfill
- Incoming Waste Management
- Landfill Operation Management
- Landfill Facility Management

The operation and maintenance staff required for the sanitary landfill will consist of the following posts and the number of staff shown in **Table 5.3.7.** The landfill operation and maintenance carried out by 17 staff at present will require 36 persons in 2030.

Table 5.3.7 Operation and Maintenance Staff for Sanitary Landfill Management

Operation and Maintenance Staff	Present	2018	2024	2030
Senior Operation Manager	1	1	1	1
Landfill Site Manager	1	1	1	1
Assistant Landfill Site Manager	1	1	1	1
Data Entry Operators	3	3	3	3
Mechanical & Electrical Supervisor	1	1	1	1
Field Supervisor	1	4	4	4
Landfill Machine Operator	3	7	11	17
Security Guard	2	4	4	4
Sanitary Worker	4	4	4	4
Total	17	26	30	36

Source: JICA Project Team

(f) Improvement Work of the Existing Landfill in Gondlanwala

Improvement work shall be implemented immediately after funding by the Punjab Government or the latest in the beginning of 2016.

Improvement work is aiming at providing the required minimum functionality to the existing disposal site for upgrading the landfill operation. The improvement work consists of the following major works:

- Backfilling the bottom of the landfill area by clayey sand;
- Rehabilitation of ramp and construction of intermediate dike, approach road and unloading area in the bottom of the landfill area;
- Installation of leachate collection mains, leachate pond and leachate circulation system;
- Installation of landfill gas vent system; and
- Improvement of existing access road.

(g) Safety Closure of the Landfill Site in Gondlanwala

Safe closure work of Gondlanwala is scheduled to be carried out in 2018 after the completion of the Bhakhraywali disposal facilities.

The disposal site where landfill activities have been completed shall be closed properly for the safe storage of filled waste and prevention of pollution by leachate or methane gas resulting from the decomposition and degradation of the waste. The safe closure plan is composed of the physical closure of facilities of the landfill site focussing on the post-closure use of the land, and the post-closure monitoring and management activities to be proposed later in this subsection. The major facilities of Gondlanwala disposal site will be constructed under the improvement work in 2016. The items for safe closure work will be the following:

- Construction of maintenance road;
- Construction of perimetre fence and gates;
- Installation of landfill gas vent system; and
- Final earth cover.

(h) Safety Closure of the Landfill Site in Chianwali

Safe closure of Chianwali disposal site is scheduled to be carried out in 2018. The concept of safe closure of the landfill site in Chianwali is the same with that of the Gondlanwala disposal site. Since the landfill operation in Chianwali has been continuing without any appropriate landfill facilities, the major facilities required for safe closure of the site shall comprise of the following works:

- Grading, levelling and transferring waste layer;
- Construction of maintenance road;
- Improvement of existing fence and installation of entrance gate;
- Installation of leachate collection pipes;
- Construction of leachate pond, leachate circulation pump well and circulation pipes;
- Construction of monitoring wells; and
- Final earth cover.

(i) Monitoring of Final Disposal in Bhakhraywali

Monitoring of landfill of Bhakhraywali disposal site is carried out in parallel with the operation and maintenance work scheduled to start in 2018.

The monitoring work consists of the activities of regular observation of the parametres related with stability of filled-waste layer and the environmental influence. The environmental monitoring plan for the regular test of environmental quality parametres will be proposed separately under the Environmental and Social Consideration, accordingly, the monitoring work describes herein do not include those activities related with monitoring of the environmental quality parametres. The monitoring work of final disposal in Bhakhraywali shall be carried based on the following parametres to observe mainly the status of stability of the landfill layer:

- Rate of subsidence of landfill layer;
- Raw leachate water quality;
- Concentration of oxygen and methane gas; and
- Temperature of landfill layer.

(j) Post-Closure Monitoring of Gondlanwala and Chianwali

The post-closure monitoring activities for Gondlanwala and Chianwali shall start right after the completion of the safe closure work at the respective sites at the end of 2018.

The post-closure monitoring for the respective sites shall be carried out in compliance with the activities for the facility management stated in **Item (e), Operation and Maintenance of Landfill Facilities** and for the monitoring work stated in **Item (i), Monitoring of Final Disposal in Bhakhraywali.**

(3) Mid-Term Plan (2019-2024)

(a) Operation and Maintenance of Landfill Facilities

The operation and maintenance of the sanitary landfill facilities shall be in accordance with the requirements stated in **Item (e), Operation and Maintenance of Landfill Facilities**, in the Short-Term Period.

(b) Monitoring of Final Disposal in Bhakhraywali

Monitoring of the final disposal activities shall be in accordance with the requirements stated in **Item (i), Monitoring of Final Disposal in Bhakhraywali**, Short-term Period.

(c) Post-closure Monitoring of Gondlanwala and Chianwali

Monitor and maintain the closed sites in accordance with the requirements stated in **Item (j), Post-closure Monitoring of Gondlanwala and Chianwali**.

(d) Engineering Service for Sanitary Landfill Facilities (Stage 2)

Engineering service shall be carried out in or before 2021. The site shall be divided into three sections for the phased development of Stage 2 to Stage 3 sanitary landfill facilities. Then the engineering service shall be carried out for the area of Stage 2 sanitary landfill facilities. The engineering company shall carry out the services in accordance with the requirements stated in **Item (b) Engineering Service for Sanitary Landfill Facilities (Stage 1)**, Short-Term Period.

(e) Construction of Sanitary Landfill Facilities (Stage 2)

GWMC shall call the tender for the construction of Stage 2 Sanitary landfill facilities in 2021 and complete the facilities by the end of 2022. The construction work shall be carried out in accordance with the requirements stated in **Item (c), Construction of Sanitary Landfill Facilities (Stage 1)**.

(f) Procurement of Additional Landfill Machine

Procurement of additional landfill machine is required to dispose of the increased incoming waste amount. In addition, the superannuated landfill machines shall be replaced as well. The types of landfill machines and the number of units for procurement are listed as follows:

- Two (2) units of Bulldozer (Chain Dozer);
- One (1) unit of Wheel Dozer;
- One (1) unit of Excavator; and
- Three (3) units of Bucket Tractor for replacement.

(g) Site Selection of Sanitary Landfill Site (Stage 2 and Stage 3)

Prior to the commencement of the activities of **item (d) Engineering Service for Sanitary Landfill Facilities (Stage 2)**, GWMC shall procure the land of 50-75 ha for development of Stage 2 to Stage 3 sanitary landfill facilities in the adjacent area or the area nearby the Stage 1 site. The site selection must be started in or before 2020 and completed in the middle of 2020.

(h) Procurement of Sanitary Landfill Site (Stage 2 and Stage 3)

Procurement of site for development of sanitary landfill facilities for Stage 2 and Stage 3 shall be completed by the middle of 2021 to enable the start of engineering services on time.

(4) Long-Term Plan (2025-2030)

(a) Operation and Maintenance of Landfill Facilities

Operation and maintenance of the sanitary landfill facilities shall be in accordance with the requirements stated in **Item (e), Operation and Maintenance of Landfill Facilities**, Short-Term Period.

(b) Monitoring of Final Disposal in Bhakhraywali

Monitoring of the final disposal activities shall be in accordance with the requirements stated in **Item (i), Monitoring of Final Disposal in Bhakhraywali**, Short-Term Period.

(c) Post-Closure Monitoring of Gondlanwala and Chianwali

Monitoring and maintenance of the closed sites shall be in accordance with the requirements stated in **Item (j), Post-Closure Monitoring of Gondlanwala and Chianwali**.

(d) Engineering Service for Sanitary Landfill Facilities (Stage 3)

Engineering service shall be carried out in or before 2025 for Stage 3 sanitary landfill facilities. The engineering company shall carry out the services in accordance with the requirements stated in **Item (b), Engineering Service for Sanitary Landfill Facilities (Stage 1)**, Short-Term Period.

(e) Construction of Sanitary Landfill Facilities (Stage 3)

GWMC shall call the tender for construction of Stage 3 Sanitary landfill facilities by the middle of 2025 and complete the facilities by the end of 2026. The construction work shall be carried out in accordance with the requirements stated in **Item (c), Construction of Sanitary Landfill Facilities (Stage 1).**

(f) Replacement and Procurement of Landfill Machinery

Procurement of additional landfill equipment is required for disposal of the increased incoming waste amount. In addition, the superannuated landfill equipment shall be replaced as well. The types of landfill equipment and the number of units for procurement are listed as follows:

- Two (2) units of Bulldozer (Chain Dozer);
- One (1) unit of Wheel Dozer;
- One (1) unit of Excavator; and
- Three (3) units of Bucket Tractor for replacement.

(5) Implementation Schedule of Final Disposal Plan

The implementing schedule is divided into three phases. There are many activities concentrated in Short-Term period from 2016 to 2018 including the construction of Bhakhraywali sanitary landfill facilities, improvement work and safe closure of Gondlanwala disposal site and safe closure of Chianwali disposal site. The operation and maintenance of Bhakhraywali sanitary landfill will also start in this period, as shown in **Table 5.3.8.**

The major activities in the Mid-Term period from 2019 to 2014 are the operation and maintenance of the sanitary landfill facilities in Bhakhraywali and post-closure monitoring for Gondlanwala and Chianwali sites. Furthermore, the activities for procurement of new landfill and the development of Stage 2 landfill facilities are carried out.

During the Mid-Term period from 2025-2030, the major activities are the operation and maintenance of the sanitary landfill facilities in Bhakhraywali and post-closure monitoring for Gondlanwala and Chianwali sites. The activities for development of Stage 3 landfill facilities are also scheduled in this period.

(6) Investment, Operation & Maintenance Cost of Final Disposal Plan

Investment cost, and operation and maintenance cost for the period from 2016 to 2030 are shown in **Table 5.3.9.** The estimated total cost of the final disposal plan for 15 years is estimated at Rs. 4,852 million.

Table 5.3.8 Operation and Maintenance Staff for Sanitary Landfill Management

Plan, Program & Projects		Short-term						Mid-term												Long-term											
		2016		2017		2018		2019		2020		2021		2022		2023		2024		2025		2026		2027		2028		2029		2030	
(1) Short-Term Plan (2016-2018)																															
FDP-S-1	Procurement of sanitary landfill site	▨																													
FDP-S-2	Engineering service for sanitary landfill facilities (Stage 1)	▨																													
FDP-S-3	Construction of sanitary landfill facilities (Stage 1) in Bhakhraywali		▨	▨	▨																										
FDP-S-4	Procurement of landfill machine	▨		▨																											
FDP-S-5	Operation and maintenance of landfill facilities					▥	▥																								
FDP-S-6	Improvement work of the existing landfill in Gondlanwala	▨	▨																												
FDP-S-7	Safety closure of the landfill site in Gondlanwala					▨	▨																								
FDP-S-8	Safety closure of the landfill site in Chianwali					▨	▨																								
FDP-S-9	Monitoring of final disposal in Bhakhraywali					▥	▥																								
FDP-S-10	Post-closure monitoring of Gondlanwala and Chianwali					▥	▥																								
(2) Mid-Term Plan (2019-2024)																															
FDP-M-1	Operation and maintenance of landfill facilities							▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥												
FDP-M-2	Monitoring of final disposal in Bhakhraywali							▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥												
FDP-M-3	Post-closure monitoring of Gondlanwala and Chianwali							▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥												
FDP-M-4	Engineering service for sanitary landfill facilities (Stage 2)											▨																			
FDP-M-5	Construction of sanitary landfill facilities (Stage 2)												▨	▨	▨																
FDP-M-6	Procurement of additional landfill machine															▨															
FDP-M-7	Site selection of sanitary landfill site (Stage 2 - Stage 3)								▨																						
FDP-M-8	Procurement of sanitary landfill site (Stage 2 - Stage 3)									▨	▨																				
(3) Long-Term Plan (2025-2030)																															
FDP-L-1	Operation and maintenance of landfill facilities																			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥
FDP-L-2	Monitoring of final disposal in Bhakhraywali																			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥
FDP-L-3	Post-closure monitoring of Gondlanwala and Chianwali																			▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥	▥
FDP-L-4	Engineering service for sanitary landfill facilities (Stage 3)																			▨											
FDP-L-5	Construction of sanitary landfill facilities (Stage 3)																				▨	▨	▨								
FDP-L-6	Replacement and procurement of landfill machine																											▨			

Table 5.3.9 Investment Cost, Operation and Maintenance Cost of Final Disposal Plan

(Unit: 1,000 Rs)

Plan, Program & Projects		Short-term			Mid-term						Long-term						Total
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
(1) Short-Term Plan (2016-2018)																	1,489,127
FDP-S-1	Procurement of sanitary landfill site	150,000															150,000
FDP-S-2	Engineering service for sanitary landfill facilities (Stage 1)	49,522	49,522														99,044
FDP-S-3	Construction of sanitary landfill facilities (Stage 1) in Bhakhraywali	489,568	500,868														990,436
FDP-S-4	Procurement of landfill machine	31,500	38,850														70,350
FDP-S-5	Operation and maintenance of landfill facilities	18,669	21,859	31,603													72,131
FDP-S-6	Improvement work of the existing landfill in Gondlanwala	55,902															55,902
FDP-S-7	Safety closure of the landfill site in Gondlanwala			18,347													18,347
FDP-S-8	Safety closure of the landfill site in Chianwali			32,918													32,918
FDP-S-9	Monitoring of final disposal in Bhakhraywali																-
FDP-S-10	Post-closure monitoring of Gondlanwala and Chianwali																-
(2) Mid-Term Plan (2019-2024)																	1,745,564
FDP-M-1	Operation and maintenance of landfill facilities				32,780	31,680	32,687	33,770	94,645	43,898							269,460
FDP-M-2	Monitoring of final disposal in Bhakhraywali																-
FDP-M-3	Post-closure monitoring of Gondlanwala and Chianwali																-
FDP-M-4	Engineering service for sanitary landfill facilities (Stage 2)						49,522	49,522									99,044
FDP-M-5	Construction of sanitary landfill facilities (Stage 2)						489,568	500,868									990,436
FDP-M-6	Procurement of additional landfill machine								86,625								86,625
FDP-M-7	Site selection of sanitary landfill site (Stage 2 - Stage 4)																-
FDP-M-8	Procurement of sanitary landfill site (Stage 2 - Stage 4)					300,000											300,000
(3) Long-Term Plan (2025-2030)																	1,617,228
FDP-L-1	Operation and maintenance of landfill facilities										44,892	45,878	48,772	49,949	51,124	116,134	356,748
FDP-L-2	Monitoring of final disposal in Bhakhraywali																-
FDP-L-3	Post-closure monitoring of Gondlanwala and Chianwali																-
FDP-L-4	Engineering service for sanitary landfill facilities (Stage 3)										49,522	49,522					99,044
FDP-L-5	Construction of sanitary landfill facilities (Stage 3)										489,568	500,868					990,436
FDP-L-6	Replacement and procurement of landfill machine														171,000		171,000
Total		795,161	611,099	82,867	32,780	331,680	571,776	584,160	181,270	43,898	583,981	596,268	48,772	49,949	222,124	116,134	4,851,919

5.4 Intermediate Treatment and 3R Promotion Plan

As stated earlier in **Chapters 2 and 3**, the intermediate and treatment and 3R (Reduce, Reuse, Recycle) of current condition were studied and evaluated in **Section 2.5** including existing 3R activities in the city and peri-urban area, and current problem identification. Then, the planning directions of the master plan were described in terms of objectives, planning policies and strategies in **Subsection 3.4.1, Item (3)**. Furthermore, goals of the master plan for the intermediate treatment and 3R were formulated in **Section 3.5**. Based on the results of the study on the Project, the Intermediate Treatment and 3R Promotion Plan will be formulated in consideration of the applicable technology in Gujranwala, the Punjab Province and with the involvement of stakeholders through the utilisation of existing functions to the maximum extent including improvement.

5.4.1 Development of Alternatives for Intermediate Treatment and 3R Plan

(1) Intermediate Treatment Plan

(a) Outline of Proposed Intermediate Treatment Plan

Considering the overall financial constraint against the solid waste management by GWMC, the ISWM Master Plan is to be formulated with the required minimum system to be developed, especially, for waste collection services and waste disposal. However, as stated by the Managing Director of GWMC, the development of intermediate treatment shall be a privatisation option at this stage. The intermediate treatment facilities are indispensable for the establishment of an integrated solid waste management system for Gujranwala City. Therefore, studies should be carried out for several intermediate treatment options towards future development in consideration of the result of waste composition analysis, as described in the following subsections. The flowchart of selection of the intermediate treatment and 3R activities is shown in **Figure 5.4.1.**

(b) Proposed Technical Options of Intermediate Treatment

In view of the technical options commonly discussed nowadays among the people concerned, the six (6) technical options including Option 1, No Treatment; Option 2, Composting; Option 3, MRF (Material Recovery Facility); Option 4, Incineration; Option 5, RDF; and Option 6, Bio-gas were selected and considered for evaluating the most appropriate intermediate treatment facilities for Gujranwala, Punjab. These technical options were evaluated according to factors such as waste characteristics, progress and process of "waste to compost, to energy" projects in Gujranwala City, practices in other countries, cost factor, etc. Some technical information on the potential options will be introduced in details in the Draft Final Report of the Project for the Integrated Solid Waste Management Master Plan in coming September this year. The following items present the development of the plan and the evaluation for selecting the best option of intermediate treatment facility.

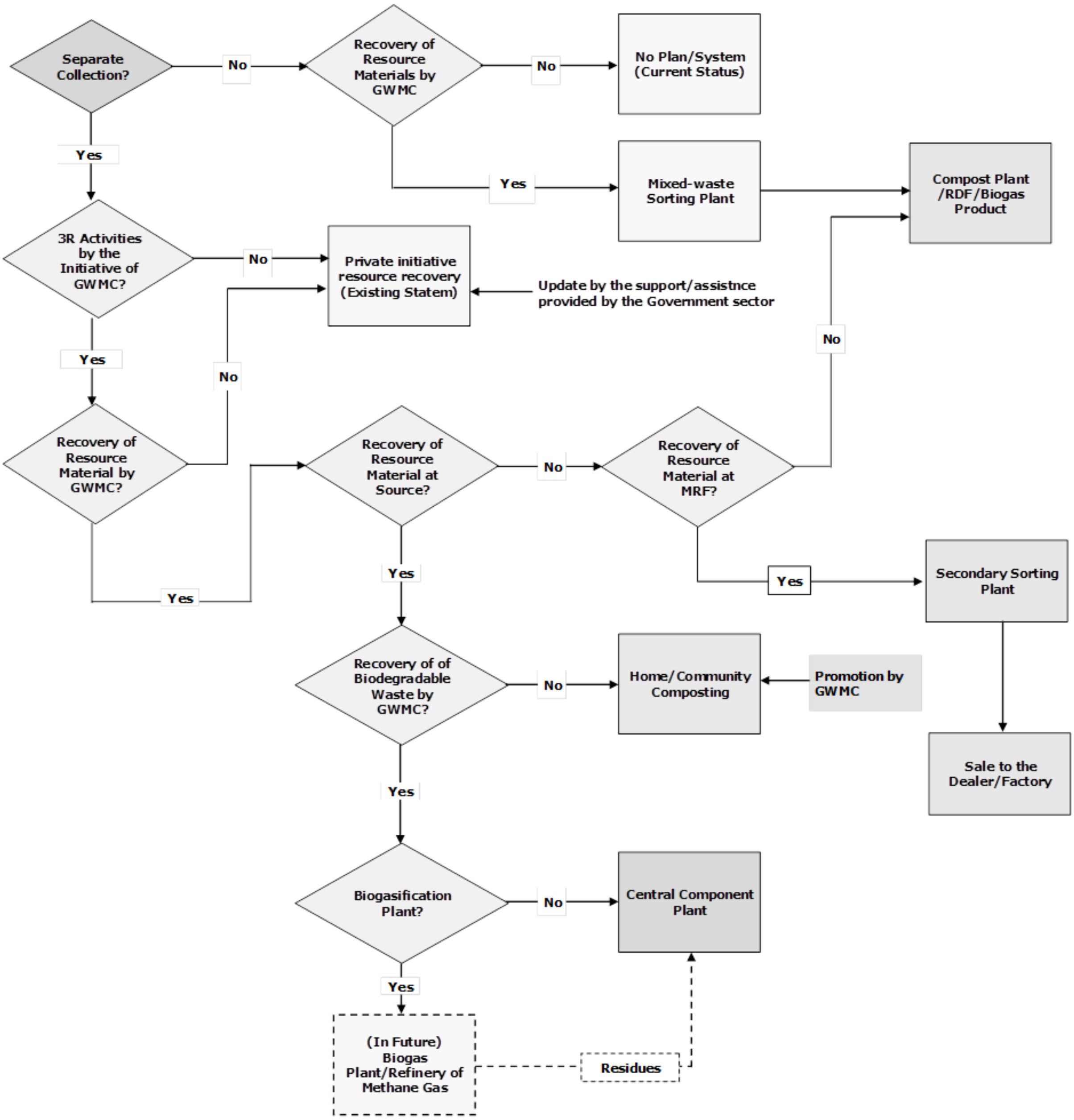


Figure 5.4.1 Flowchart of Selection of Intermediate Treatment and 3R Activity

(c) Qualitative Evaluation of Intermediate Treatment Options

Table 5.4.1 summarises the qualitative evaluation of the six (6) potential options for intermediate treatment which could be considered for the intermediate treatment facilities of Gujranwala City. As a whole, 1) waste characteristics;, 2) higher water content due to high ratio of food waste commingled gives an advantage to composting in municipal waste; 3) actual performance results; and 4) GWMC's policy on intermediate treatment, are the key to choose the best alternative. Waste incineration in Gujranwala City is disadvantageous. Considering the impacts to environment, Option 2, composting, and Option 5, RDF, are the more environment-friendly treatment systems. As stated earlier, the development of intermediate treatment is obliged to take consideration of the privatisation. The costs for investment, operation and maintenance in Option 3, Option 4 and Option 6 seem not affordable to private companies for the intermediate treatment and 3R activities.

Table 5.4.1 Qualitative Evaluation of Intermediate Treatment Options

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
Objective Waste	Mixed waste	Biodegradable waste	Sorted waste for recycling	Combustible	Combustible (plastic, paper)	Biodegradable
Cost of Facility	No cost due to no facility	Cheaper	Cheaper	Very expensive	Cheaper	Moderate
Environmental Aspect	Need removal of illegal waste disposals and pollutants in 64 UCs and 34 UCs	Odour in mis-operation	Odour in mis-operation	Need removal of pollutants from combustion gas emission	Need removal of pollutants from combustion gas emission	Odour in mis-operation
Applicability	-	Small towns to large cities	Small communities to middle cities	Small towns to large cities	Small towns to large cities	Villages /small towns in rural areas
Actual Practical Experiences in Punjab	-	There is Lahore Compost Company.	There is no MRF in Gujranwala.	There is no incineration plant for municipal waste treatment.	There are cement plants using RDF as fuel in D.G. Khan Cement Company, and Lafarge/Fauji Cement companies.	To date, NRSP* installed 197 biogas plants for cooking, reduce household expenses, etc. in the country.**
Recommendations for application to Gujranwala solid waste intermediate treatment facilities	-	Highly applicable	Less attractive than composting & RDF.	More attractive composting & RDF than incineration.	Highly applicable	Not now. In particular, recommended in future in rural areas.
Policy of GWMC	GWMC recommends Option 2, Composting, and Option 5, RDF, as the most practical/reliable intermediate treatment facilities through privatisation in Gujranwala.					
Evaluation Results	-	**Selected**	-	-	**Selected**	-

Source: JICA Project Team, GWMC

Note:* NRSP stands for National Rural Support Programme (NGO).

** NRSP, Monitoring, Evaluation & Research Section, "Renewable Energy: Evaluation of Biogas Initiative in Punjab" August 2011.

(d) Lahore Compost Company and D.G. Khan Cement Company

As shown in **Table 5.4.1**, both composting and RDF production have been selected as more appropriate intermediate treatment facilities in Gujranwala. There are companies for composting and RDF production, namely; the Lahore Compost Company and D.G. Khan Cement in Lahore, Punjab. The JICA Project Team visited the plants and equipment of the Lahore Compost Company and D.G. Khan Cement together with members of GWMC in 2014 and 2015. Major features of the plants are summarised in **Table 5.4.2** and some photos of the on-going Lahore Compost Plant are shown in **Photo 5.4.1** and **Photo 5.4.2.**

Table 5.4.2 Major Features of the Lahore Compost Company and D.G. Khan Cement

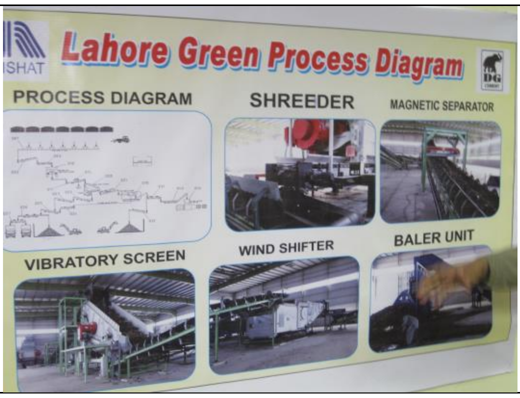
Project Name	Project Overview	Descriptions
Lahore Compost Plant	Contracting parties	City District Government Lahore and Lahore Compost (pvt.) Ltd.
	Description of service	Establishment of compost plant
	Operation capacity	1,000 tons/day
	Total plant area	25 acres
	Cost of raw material	Raw material, i.e., municipal solid waste is given free of cost to Lahore Compost and it shares 10% of its profit to LWMC,
	Description of staff involved	Project manager, supervisor, mechanics, engineers, biochemist, marketing representative, labourers, etc.
	Description of equipment	Imported plant from Belgium of Rs. 300 million containing all equipment sorting conveyors, trammel screen, shredder, turner, bagging unit
	Start of operation	March 2006
	Contract period	25 years
	Compost preparation time	60~90 days
	Production amount	200-250 tons/day of compost and approximately 250 tons/day of RDF
	Present status	In operation
D.G. Khan Cement RDF Plant	Contracting parties	Lahore Waste Management Company and D.G. Khan Cement Company (Pvt.) Ltd.
	Description of service	Establishment of Refuse Derived Fuel (RDF) plant
	Operation capacity	700-800 tons/day
	Cost of raw material	Raw material,i.e., municipal solid waste is given @ Rs. 52/ton to D.G. Khan cement company
	Total plant area	45 acres
	Description of staff involved	Project manager, plant engineer, supervisor, labourer, mechanics, etc.
	Description of equipment	Imported equipment plant from Germany containing shredder, magnetic separator, vibratory screen, wind shifter and baler unit.
	Start of operation	2013
	Total Cost	Rs. 1.5 billion. (total construction cost including equipment) Operation and maintenance cost: Rs. 200,000-300,000/month, production cost: Rs. 100/ton, transportation to Kallar Kahar: Rs. 900/ton, operation cost: Rs. 1,000-1,200/ton
	Production amount	280-320 tons/day of RDF
	Operation status	Under operation

Source: Interview results with Lahore Compost Company (Pvt) Ltd. and D.G. Khan Cement ((Pvt) Ltd.
Note: Actual operation of the Lahore Compost Plant started in March 2006.

	
Existing Mehmood Mooti landfill (Lahore) and Compound of Lahore Compost Plant	Store house and bagging unit next to the compost & RDF plant
	
Primary sorting process and magnetic separator for compost & RDF	Trammel screen for composting
	
Sorting process for RDF	Compost windrows (centre) and organic materials from parks (right)
	
RDF materials	Organic compost product

Photo 5.4.1 Composting Process under Operation of Lahore Compost Plant

RDF Product Plant



Presentation on RDF material process

Input waste into the RDF plant

Magnetic separator

Main equipment
(vibratory screen, wind shifter, baler unit)

Vibratory Screen

Wind Shifter

RDF material before baler unit

Photo 5.4.2 RDF Material Product under Operation of D.G. Khan Cement

(2) 3R Promotion Plan

(a) Outline of Development of 3R Promotion Plan

The programmes under the 3R promotion plan were formulated basically with soft component programmes defining the roles, responsibilities and activities of each party including GWMC, waste generators and CDGG. The implementation of programmes should be carried out through the primary initiative and effort of GWMC while the intermediate treatment facility is to be owned and managed the private sector and not GWMC. There are many programmes commonly practiced in the world for 3R activities which can be categorised with waste generation source control, waste discharge control, waste recovery and reuse, and recycling of materials. These programmes are also applicable for the 3R activities in Gujranwala City. The programmes and activities will be performed mostly with the raising of awareness of waste generators and stakeholders through public campaigns, formal and school education, pilot projects and capacity development of the GWMC staff concerned. In fact, it is revealed that the recovery of recyclable materials is highly activated by the development of material recovery facilities. Each programme under the 3R promotion plan is as elaborated below.

(b) Proposed Technical Options of 3R Promotion

Basically, the 3R scheme is composed of many kinds of soft component programmes for waste reduction, recovery, re-use and recycling to promote 3R activities among the parties concerned. The plan should be implemented comprehensively with all the possibly effective programmes which are divided into the four categories summarised below. The 3R programmes in the four categories are inter-related, and should be implemented to achieve the goals of 3R.

- Waste Generation Source Control for Waste Reduction
- Waste Discharge Control for Recovery and Waste Diversion
- Recovery of Recyclables at Sources and Reuse
- Recycling of Recyclable Materials

(i) Waste Generation Source Control for Waste Reduction

The programmes under the waste generation source control target the activities to minimise the generation of waste through the production of durable goods and the avoidance of over-packaging in distribution and sale, and by motivating and changing the awareness of waste generators toward a lifestyle of resource and environmental conservation. These activities should be implemented in five sub-programmes: production control, distribution and sale control, consumer control, waste charge control, and commercial and institutional waste control.

(ii) Waste Discharge Control for Recovery and Waste Diversion

Waste discharge control aims at reducing the amount of waste discharged by individual waste generation sources through self-disposal at the backyard, converting organic waste into compost, repair and reuse of broken instruments and appliances, and exchange or sale of reusable goods within the community. These activities should be carried out at the waste generation sources.

(iii) Recovery of Recyclables at Sources and Reuse

Activities under this programme intend to enhance the recovery of recyclable materials through segregation at waste generation sources, recovery of recyclable materials before the waste is discharged to the waste collection service, securing the routes for recovery and trading of recyclable materials, etc. These activities require extensive participation of the stakeholders and the communities.

(iv) Recycling of Recyclable Materials

Recycling industries or the recyclers or private shops/dealers should take the primary role in the activities of this programme by performing regular and constant recovery of recyclable materials and utilising the recovered materials for the production of goods. Gujranwala City has very activate formal and informal commercial and industrial societies for recycling of recyclable materials.

Figure 5.4.2 shows the conceptual flow of the four programmes and sub-programmes for easier understanding of the 3R activities.

The increase of efficiency in recovering recyclable materials and securing a storage area, a distribution centre, networking, etc., are also indispensable for the sustainability of 3R activities. The following subsections explain these key elements and the proposed target level associated with the 3R Promotion Plan for Gujranwala City.

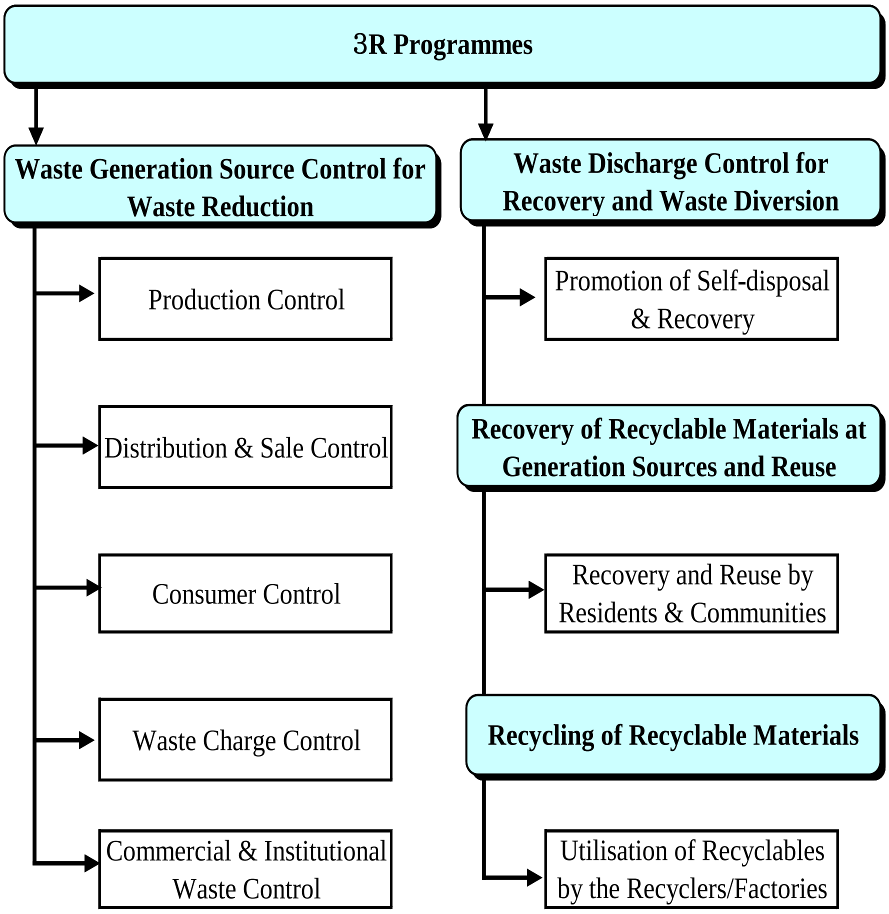


Figure 5.4.2 Conceptual Flow of Implementation of 3R Programmes

(c) Technical Options of Resource Recovery

In the process of recovery of recyclable materials from municipal waste in Gujranwala, the following two technical options are considered depending on the waste segregation condition summarised in **Table 5.4.3**. Those technical options are described in the following paragraphs.

Table 5.4.3 Technical Option for Recovery of Recycle Waste

Technical Option	Segregation Condition	Remarks
Option 1	Mixed waste and Recovery by sanitary workers and waste pickers in the course of collection services and final disposal.	Without the Project
Option 2	First and secondary segregation at generation sources, and final sorting at the Proposed Central Compost Plant before processing of compost and RDF product	With the Project

Note: While Option 1 does not change the current condition, Option 2 may be able to improve the current condition of SWM in the city economically and environmentally.

Option 1

This option is set in the highest hierarchy of resource recovery since the most challenging segregation activities at generation sources require the involvement or active participation of waste generators in the solid waste management system of the GWMC. Source separation is practiced partly in Gujranwala and street hawkers working in town collect the recyclable materials directly from the waste generators. Segregation at source shall be set up for a base as GWMC implements resource recovery from waste. Option 1 stands on the fact that waste as mixed is only waste but wastes as segregated become resources and are expectable for the recovery of more amounts of recyclable materials.

Option 2

Recyclable materials are picked out from mixed waste as in Option 1. However, the key player for recovery at the primary/secondary waste collections is the sanitary worker/waste pickers at the transfer stations/collection enclosures, which are commonly practiced today in the course of waste collection service. Recovered recyclable wastes collected are then brought to the dealers handling waste. Final waste collection is to be carried out at sorting process at the Central Compost Plant. Due to the picking-out action for recyclable materials in the course of loading waste to the vehicles and sorting process at the Plant, the efficiency of waste collection as a whole becomes improved.

(d) Initiatives of GWMC for 3R Activities

In order to implement the 3R activities effectively and efficiently, GWMC shall take the primary role to set up the implementing policies, purposes, strategies, and the phased target levels in addition to the coordination role for the parties concerned, such as stakeholders, NGOs, and so on. It will be required to formulate the implementation plans and programmes of 3R including public campaign, school and formal education, the encouragement of residents, support/assistance, and the coordination to form a linkage among the residents, NGOs, other community groups, waste pickers and private shops and dealers in the city. A special task force shall be composed of experts in the field of solid waste management and social services and the office staff to support the expert staff.

(e) Enhancement of 3R Activities

More recyclable materials will be recovered as segregation is carried out at residential houses and workplaces of the establishments. For the purpose of recycling, the recovery of recyclable materials shall be enforced and enhanced as social activities. The segregation and recovery of recyclables at the waste generation sources will need the active participation of waste generators so that the following activities shall be included in the implementation of 3R including the enhancement of resource recovery:

- Demonstration of 3R at pilot areas in communities which shall involve the waste generators, waste pickers, private shops and so on;
- Demonstration of 3R at pilot workplaces with the participation of all staff of

establishments;

- Raising awareness through education and public campaign to encourage the participation of waste generators in the 3R activities;
- Support of GWMC on the recovery activities by providing transportation for recyclable materials to the private shops or to the recycling factories; and
- Promotion of recovery of food waste and biodegradable waste for home composting and community level composting.

(f) Flow of Recyclables in Gujranwala

Based on the Waste Picker Survey (2015) described in **Subsection 2.5.1** of this report and the municipal waste flow analysis for the Project, a flow of recyclables in Gujranwala is assumed as shown in **Figure 5.4.3.**

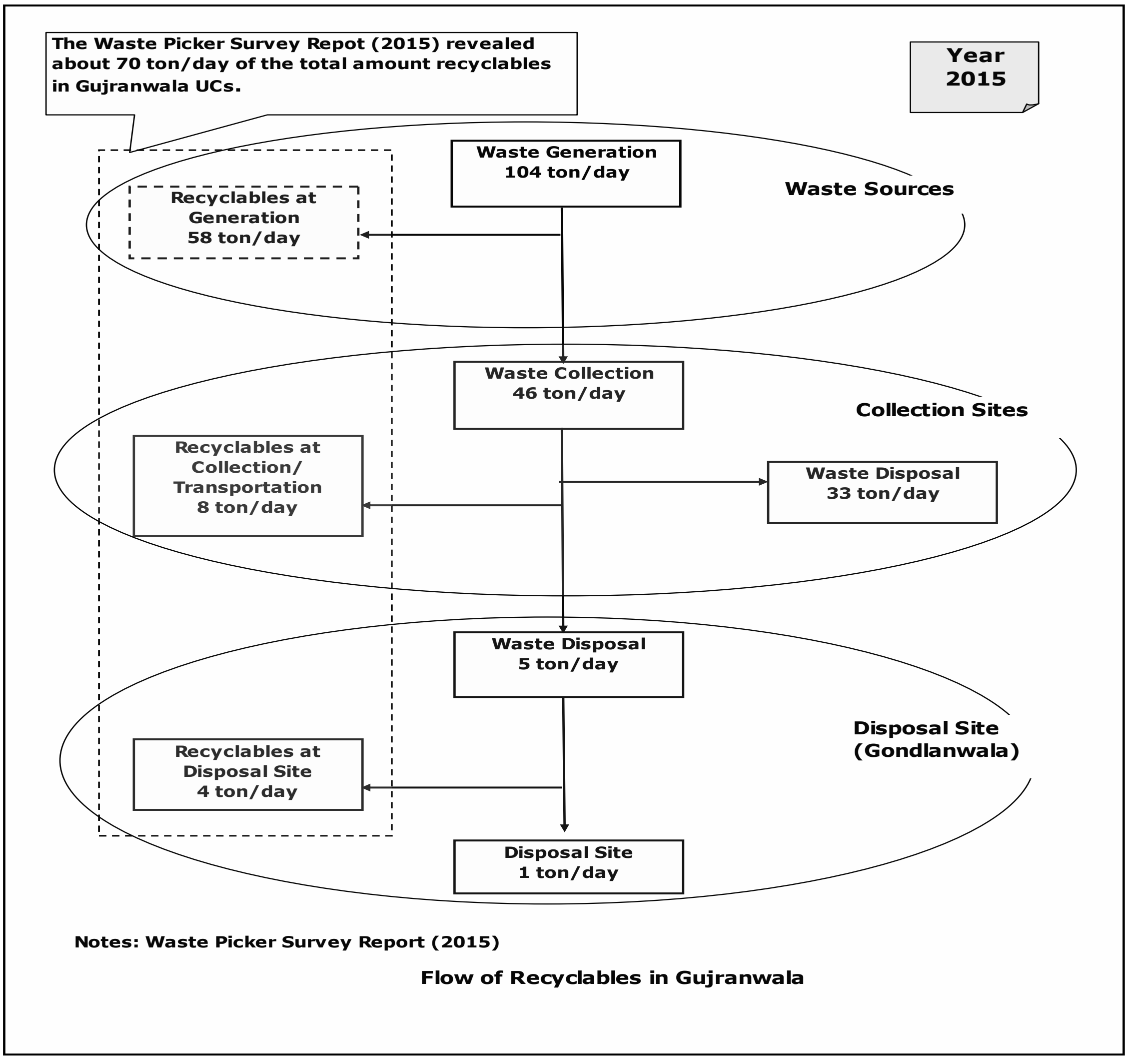


Figure 5.4.3 Flow of Recyclables in Gujranwala

The total amount of recyclables collected by waste pickers are estimated at about 70 ton/day based on the Waste Picker Survey Report in 2015 in Gujranwala. From the total recyclable amounts of approximately 70 ton/day and the results of WACS (2014/2015), approximately 58 ton/day of recyclables are assumed to be segregated at generation source; households and commercial establishments.

(g) Overall Target Level of 3R

The target levels of each 3R activity were determined based on the characteristics of municipal waste in Gujranwala City and the practices in many other countries. The proposed target levels shown in the table are cited in **Section 4.3** of this report.

Table 5.4.4 Proposed Target Level of 3R Activities

3R Activities	2014	2018	2024	2030
Waste Reduction	0%	0%	0%	6%
Material Recovery	15%	14%	16%	19%
Biodegradable Waste Recovery	0%	0%	12%	15%
Waste Diversion for Final Disposal	15%	14%	28%	40%

5.4.2 Evaluation of the Alternatives

Two (2) technical alternatives are selected for the intermediate treatment facilities in Gujranwala, namely; Alternative-1: Central Compost and RDF Plant, and Alternative 2: No intermediate treatment facility. The two alternatives are as compared below.

Table 5.4.5 Technical Alternatives for Intermediate Treatment Facility and 3R

Technical Alternatives	Description	Remarks
Alternative-1: Central Compost and RDF Plant	The proposed Central Compost and RDF Plant was selected as an appropriate facility for Intermediate Treatment and 3R plan.	Composting process is to be demonstrated regularly as 3R activities for stakeholders.
Alternative 2: No intermediate treatment facility	If there is no intermediate treatment facility including 3R activities, cumulative disposal amount without the intermediate treatment and 3R plan may become about 9.36 million tons per year in 2030, which is bigger than the 8 million ton/year for with-the plan.	

Therefore, Alternative-1: Central Compost and RDF Plant with 3R plan, is required for the ISWM in Gujranwala as presented below.

(1) Community Compost and RDF Plant

According to the proposed waste flow plan of the ISWM in Gujranwala City, the waste recovery amount with high organic for the proposed Central Compost Plant is designed to receive 250 ton/day of wastes for final sorting process including market biodegradable wastes, starting from year 2020. The value of 250 ton/day of wastes will be able to be derived from the actual organic waste recovery amount used in the Lahore Compost (Pvt.) Ltd. whose operation services started in 2006 and is under operation producing compost and RDF. The proposed Central Compost Plant in Gujranwala is composed of various types of equipment such as sorting conveyor, magnetic separator, trammel screen, trammel screen, and sieving screen at the plant, bagging unit near storehouse, turner at windrow, etc. Similarly, the same value of 250 ton/day will also be used for a proposed RDF plant after enlargement of the proposed Gujranwala Central Compost Plant in 2030.

Based on the 250 ton/day accepted in the proposed plant and 50% recovery rate and 80% working ratio, the Central Compost Plant will target a final compost product, which is equivalent to 125 tons per day. The cost-benefit conventional windrow-type composting process shall be applied for the Central Compost Plant to be sited adjacent or nearby the proposed final landfill site in Bhakhraywali. Considering cost, availability of construction site and the scale of a plant to analyse the effectiveness of large-scale composting in future, the central composting system shall be carried out with an enlargement work of one (1) plant. The initial plant with 125 tons per day compost product is scheduled to be constructed and operations will start in 2019, although yearly production for the initial several years may be increased step by step. This plant shall be operated for ten (10) years to study the appropriate running period of the design from the technical and economic points of view. After the ten (10) years evaluation period, another enlargement plan of the proposed central plant shall be planned and reconstructed at one plant in year 2029 for further RDF (reduced derived fuels) production for the development of proposed large-scaled Central Compost Plant for 500 ton per day in Gujranwala City. The investment cost and operation and maintenance cost shall be borne by privatisation.

It is also very important for GWMC and a company of the proposed Gujranwala Central Compost Plant that compost produced in the plant shall be verified and appealed to the people concerned through public IEC campaign to be safe and reliable for farming with verification test by public authorisation before the plant starts its operation in 2020.

(a) Proposed Central Composting and RDF Plant in 64 UCs

Simulation results of the proposed Central Compost Plant including RDF product in Gujranwala are presented in **Table 5.4.6**.

Table 5.4.6 Simulation Results of Proposed Central Compost Plant and RDF Plant in Gujranwala

Proposed Intermediate Treatment Plant	Input Waste Amount (ton/day)	Production Amount (ton/day)	IRR Evaluation	Remarks
Central Compost Plant	250	125	17.8	OK.
	20*	10	9.5	-
RDF Plant	250	100	N.G.	Subsidy may be required.
	500	200	N.G.	

Note: N.G. means there is no computation result.
A 20* ton/day of input waste amount was proposed to simulate IRR evaluation as a small scale initial production of composting but it was not feasible.

The proposed central composting and RDF plant is to be built near the proposed landfill site in Bhakhraywali and adjoining vacant land areas, according to MD GWMC. The required land area is to be about 5 hectares including land spaces for office, parking, workshop, store house, bagging unit, composting/RDF plant, windrows field, etc.

Major features of the proposed Gujranwala Central Compost Plant are shown in **Table 5.4.7.**

Table 5.4.7 Major Features of Proposed Gujranwala Compost Plant

Project Name	Project Overview	Descriptions
Proposed Gujranwala Compost Plant (Tentative only)	Contracting parties	City District Government Gujranwala, GWMC, and a private compost company (pvt.) Ltd.
	Location	In and around the proposed landfill site in Bhakhraywali
	Total plant area	5 hectares
	Description of service	Establishment of compost plant including RDF from 2030
	Operation capacity	250 tons/day
	Description of staff involved	Project manager, supervisor, mechanics, engineers, biochemist, marketing representative, labour, etc.
	Description of equipment	Imported plant containing all equipment sorting conveyors, trammel screen, shredder, turner, bagging unit, etc.
	Start of operation	2020
	Compost preparation time	60~90 days
	Production amount	125 tons/day of compost (and approximately 250 tons/day of RDF from 2030)

(b) Community Composting in 34 UCs

Community composting in 34 UCs is to be carried out through self-disposal system in collaboration with the community level in Sadar Tehsil in Gujranwala. According to the proposed waste flow in 34 UCs, organic waste recovery amounts are to be produced for small-scaled composting starting from less than 1 ton/day in 2023 to 1 ton/day in 2024 of the Mid-Term, and from 2 ton/day in 2025 to 5 ton/day in 2030 of the Long-Term. GWMC will be assigned to advise Sadal Tehsil Municipal Administrations (TMA) to manage the activity of not only composting but also segregation of recyclable materials at sources and primary waste collection in designated areas, and a community-based composting through IEC (Information, Education and Communication) campaign.

5.4.3 Identification of Priority Projects for Intermediate Treatment and 3R Plan

As mentioned in the previous subsections, the priority projects for the Intermediate Treatment and 3R activities are formulated as shown in the following **Table 5.4.8**.

Table 5.4.8 Programmes of Priority Projects for Intermediate Treatment and 3R Promotion Plan

Priority Project	Short-Term (3 years)			Mid-Term (6 years)						Long-Term (6 years)					
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1. Proposed Gujranwala Central Compost Plant				Plant Construction	Plant Operation										
Periods										10-Year Operation					
Cost (Rs. million)				430	39	42	43	45	46	46	46	46	46	46	46
Plant owner					Gujranwala Central Compost Company (Tentative)										
Enlargement Gujranwala Central Compost Plant for RDF													Detailed Design	Plant Enlargement Work	Plant Operation
Period															10-Year operation
Cost (Rs. million)													4	500	25
Total (Rs. million)				430	39	42	43	45	46	46	46	46	50	546	71
Plant owner					Gujranwala Central Compost Company for RDF Production (Tentative)										
2. 3R Campaign Activity	Awareness IEC campaign on resource recovery/ simplified WACS implementation														
	□ □	□ □	□ □												
	IEC campaign for the resource recovery at source /Registration of waste pickers and recycling industrie														
				□	□	□	□	□	□						
	IEC Campaign for the resource recovery at source /Registration of waste pickers and recycling industries														
										□	□	□	□	□	□

Source: JICA Project Team

The programme under the 3R (Reduce, Reuse, Recycle) shall be implemented in collaboration with the GWMC and a Gujranwala central compost company. The project cost is estimated to be Rs. 1,450 million up to year 2030. The proposed cost of each phase is summarised as follows:

Project Cost of Short-Term Period (2016-2018)	: Rs. 0 million
Project Cost of Mid-Term Period (2019-2024)	: Rs. 645 million
Project Cost of Long-Term Period (2025-2030)	: Rs. 805 million
Total	: Rs.1,450 million

The overall project cost of the Intermediate Treatment and 3R (Reduce, Reuse, Recycle) Promotion Plan including 10% of physical contingency to the construction cost will be approximately Rs. 1,540 million.

5.5 Environmental Education and Public Awareness Raising Plan

Result of the awareness survey may alter/modify the direction in environmental education plan. However, (1) framework to backup government's efforts and mechanism or strategy to coordinate among relevant bodies; (2) awareness raising activities targeting general public, school children especially primary students, and business establishment through regular programmes/campaign; and (3) in collaboration with community groups, feminist groups, and religious places (mosques) can be focused in the Plan.

Topics shall include, but not limited to, environmental awareness, waste collection/transportation/ disposal, source separation, 3R (Reduce, Reuse, Recycle), composting, and others.

5.5.1 Development of Alternatives for Environmental Education and Awareness Raising Plan

When considering environmental education and awareness raising plan, selecting the target population is one of the very important elements, not to mention what to teach/sensitize the population. Population can be targeted through a group or organisation that the population belongs to, ranging from each household to religious group, to school or business entities, etc. How to reach the population is also a key element in developing the environmental education and awareness raising plan.

In these viewpoints, there are mainly four components to develop the plan. Those are formal education, informal education, mass media, and periodical events. Each component has its own characteristics which are discussed below.

(1) Formal Education

Formal education is defined as the education given in a classroom to the student on a structured system provided by trained teachers under the supervision of the Board of Education of Punjab Province. In the context of environmental education in SWM, a) primary schools and b) higher education can be highlighted. Private and public schools exist in Gujranwala, and public schools, inevitably, have less focuses on environment than private schools.

(a) Primary School

Except for a small number of unfortunate children, almost all small children in Gujranwala go to either public or private primary schools. Currently, there is no formal programme dedicated to environmental education under the education board.

Solid waste can be dealt as part of an integrated environmental education when adopted in formal curriculum as it is an excellent educational material to: a) notice or show interest on the environment and its associated problem, b) acquire knowledge, c) aware of the solutions, and d) motivated to solve them.

The programme that covers the above contents requires not only very careful coordination with the authority concerned and other relevant bodies but also detailed study on the content sand how to integrate it with other subjects in the schools.

(b) Higher Education

Some colleges and universities already offer environmental education from environmental science to environmental laws. Those courses are helping to grow environmental specialists in the area; however, the impacts are very limited and do not necessarily stay within Gujranwala. Collaboration with scholars specialising in solid waste management can be sought.

(2) Informal Education

Informal education is a type of education outside of the official school curriculum. It can be offered in a school setting, of course, but also in other parts of society, i.e., it can also be called social education where all parts of a social unit from each household to neighbourhood/community group, religious group, etc.

(a) Schools

Primary schools in Gujranwala have some school activities outside of the official curriculum. GWMC can, in close coordination with schools and relevant bodies, offer an education programme delivered to each school. In the delivery programme, GWMC staff can visit schools and teach pupils about SWM.

In Gujranwala, many schools have recreational or orientation field trips visiting some local landmarks like historical monuments or museums. During this field trip, school students can visit one of the waste management facility or waste management activities on the ground.

Waste management educational facility can be established either within city, waste collection points or landfill site where visitors can learn about SWM through various displays, observation, or hands-on experience. This educational facility can be a building/house, but most likely can start with a single room or two, provided there is enough space to hold a class of students (approximately 30 students or so). On the walls inside the room, various explanations about waste management in the city can be displayed with samples. In the centre of the room, the students can sit and listen to the GWMC staff or practice how to separate recyclables using actual samples, for instance. Depending upon the size of a class, some creative activities can be also carried out in this space, like making artworks from recyclables, and let students think how to improve their environment though proper waste management.

Topic of the informal education at schools can include proper management of waste, separation of waste, 3R, compost, hygiene, and others.

(b) Social Group

Households play an important role in informal education since it is a basic unit of social structure. In general, a child learns various values and behaviours from his/her parents/siblings and other members of his family. Raising awareness of a household member can influence the entire household members and yield long-term impacts.

Other social groups, including neighbourhood/community groups, religious (mosque), labour union or other organisation, can also play important roles since they have their own influence in society. By closely coordinating with those groups, GWMC can help in their environmental activities and also work as entry point to spread the environmental message to the residents.

(c) Agency/ Business Establishments

Environmental education can be targeted for the manager/owner and staff. It can be also carried out at each agency, business establishment or association for its prospective staffs. Industries that general customers/consumers visit like shopping malls and banks can raise environmental awareness of their customers/consumers.

Likewise, GWMC should raise awareness of its own staff, i.e., office staff/sanitary workers, through appropriate environmental awareness trainings.

(3) Mass Media

There are mainly two ways to implement environmental education using mass media. One is to have an environmental programme focusing on SWM broadcasted by TV station or radio station. Another is to use them as a medium to spread environmental message or publicity to the public.

(a) Structured Programme

An educational programme focusing on the environment can be created or small portion of another programme can be delicate for the environmental topic in an existing programme. Either way, programme needs to be systematically developed and continuously broadcasted for optimal effect. Similar to formal education in schools, the process needs careful consideration.

Area and population covered are very large and impact is quick. Depending upon the time of day, target population can be fairly selective. However, as in any educational activity, the efforts must be conscious to raise and keep the awareness among recipient population.

(b) Advert

Another form of environmental education for using mass media is the advert type of PR activities. Using electronic media like TV, radio, SNS, and SMS, various types of environmental information can be disseminated. Billboards or advertisement space in buildings, public transportation like bus or tuku-tuku can also effectively disseminate environmental message to general public at large.

The message can be spread quickly and widely. Pictorials can be utilised for visually sending out the message at ease.

Advert does not have to be continuous and can be used in the specific period, like just before the day of awareness raising champagne.

(4) Periodical Environmental Event (such as Earth Day)

Environmental education also can be carried out at the time of periodical event. Earth Day which is held annually is a good example. Alternatively, GWMC can also establish and host some periodic events like SWM day/week, or utilise awareness raising activities in another event.

(a) Periodical Environmental Events

In this case, target population is not necessarily limited to school students or certain group, but also general public can raise their awareness on environment. Participants of the Earth day event are, naturally, environmentally conscious and thus it is easier to spread the message across.

During the event, GWMC can set up a booth to disseminate various information regarding solid waste management, recycling, 3R, composting, and others. Also it can provide hands on experience opportunity for the participants; for example, participants can separate wastes by types.

GWMC can also host a certain event, like SWM week whereby various stakeholders gather and raise awareness of the public.

(b) Public Gatherings not related to Environment

Educational opportunities are laid in other non-environmentally related events. For instance, religious event or festivals like Eid-ul-fitr day or Eid ul-Azha day would attract unspecified number of residents to gather in which environmental education can be carried out through the use of printed materials like brochure/flyer distribution or let public experience actual environmental conscious activities like separation of waste.

5.5.2 Evaluation of Alternatives for Environmental Education Plan

(1) Formal Education

(a) Primary

SWM education should be a part of a larger integrated environmental education programme that requires in-depth consideration and coordination with relevant bodies including authority. Important impact can be expected but requires understanding of the society for not only about solid waste but also for other elements of environment.

(b) Higher Education

Environmental programmes have already existed in selected colleges/universities. Students have learnt the subject in-depth, but the number of residents who enrolled in the programme is, inevitably, very limited.

(2) Informal Education

(a) Schools

If the awareness of small children is successfully raised in primary schools, the impact can spread to his/her households and be fruitful on the long-term since those children would lead the society in the future and thus influence the entire community.

It is also easier for GWMC to introduce environmental education on SWM to small children than going through formal education since GWMC can entirely host the programme.

(b) Social Groups

Various community groups exist in Gujranwala from town level to union council level. They are, in general, rooted on the local community and thus hold important impacts on their community members. There are a numerous number of such groups and interest in environmental issues also varies. Those social groups may be good entry point to community.

(c) Agency/Business Establishments

Governmental agency should play a leading role in proper solid waste management in Gujranwala. Consensus must be reached within all governmental bodies.

Business establishment can also influence the SWM activities in the city, but types, volume, and frequency of waste differs greatly depending upon the business type.

(3) Environmental Education using Mass Media

(a) Structured Programme

Creating a structured programme for environmental education in mass media can expect immediate and huge impacts to population across the city. Nonetheless, the cost is extremely high and the impact may well be eroded away as quickly as it reaches the population. There is a need to come up continuously with such huge cost in order to sustain a realistic and proper environmental education.

(b) Advert

Advert type of mass media can be very useful in spreading message quickly and widely. It should be used for publicity purpose only and not for continuous awareness raising media.

(4) Periodical Environmental Event (such as Earth Day)

(a) Periodical Environmental Events & Public Gatherings not related to Environment

Periodical environmental events can reach a wide range of population at one time. By consciously holding the same event or campaign, the message would be imbedded to the residents. **Table 5.5.1** gives a summary of the alternatives.

Table 5.5.1 Comparison of Alternatives of Environmental Education and Public Awareness Raising Activities

Options		Target	Recipient Number	Impact	Remarks
1) Formal	a) Primary	Small kids	Limited, but covers all students	Long-term	Influence in household as well
	b) Higher education	Young adults	Limited	Long-term	Specialists
2) Informal	a) School	Small kids	Limited, but covers good portion of students	Long-term	Influence in household as well
	b) Social	All member of society	Large	Long-term	Requires understanding from all parties
	c) Agency / business	Staff/ employees	Limited to specific body	Short-long term	
3) Mass media	a) Structured	General public	Large	Quick	Expensive
	b) Advert	General public	Large	Quick	Affordable if limited duration
4) Periodical event	a) Periodical	General public	Large	Short-long term	Participants are environmentally conscious
	b) Public gatherings	General public	large	Short – long term	Can reach non-environmentally conscious people

(5) Conclusion

Each option has its own unique characteristics. A summary of each option is as follows:

- Formal education is a solid way but requires extensive consideration and coordination with all parties involved.
- Informal education, on the other hand, can be carried out relatively easily since GWMC can control the content and activities on its own.
- Mass media have huge impact but requires large amount of fund to be effective in long term; therefore, it should be limited to advert type of utilisation.
- Periodical event, like Earth Day, can be an excellent opportunity to reach general population.

5.5.3 Identification of Priority Project for Environmental Education and Awareness Raising Plan

In identifying the priority project for environmental education and awareness raising, a) target, b) impact, and how easily the activities can be carried out by GWMC were considered. Ideally an activity can reach all population in the city with long lasting impact at minimum cost. This is important because this activity is a type of component that cannot expect immediate effect or sudden change in people’s behaviour.

Therefore, there are mainly two projects to proceed; specifically, one is informal education in schools targeting primary students, and the other is periodical events targeting general population. Following is the approximate schedule for each activity.

(1) Informal Education in Schools

There are approximately 161,000 students in 273 public and 437 private schools in Gujranwala. Among them, class 4 students are approximately 21,000. (Class 4 is picked since it consists of about 10 years old children who are old enough to understand the importance of environmental education and to think how to digest the knowledge and information received and put them into practice.)

In order to cover all class 4 students in the city by the end of 2030, the following targets were set.

Table 5.5.2 Target of Students Covered by Informal Education in Schools by Terms

	Short-Term (~ 2018)	Mid-Term (~2024)	Long-Term (~2030)
Target	Approx. 15%	Approx. 60%	100%
Number of Students	3,000	12,000	21,300

(a) Components of Informal Education Programmes

In informal education in schools, there are two approaches GWMC can take to reach the students. One of them is to deliver the programme to the schools, and the other one is to receive students at appropriate facility to teach and let them experience in practice.

In the short term (2016–2018), informal education should be focused on delivery of lectures in each school. In the delivery programme, a team of GWMC communication unit can visit each school and hold a session targeting class 4 students of that school. Topic would include a) general information about solid waste, b) current status of SWM in the city, c) what can be done and their effects, and d) other related topics.

In the environmental facility side which can be implemented in mid-term plan, GWMC can establish a facility to accept visitors from schools. The facility can be first set up within the city where schools can easily access but later on can be set up in landfill site where student can observe the actual condition of SWM.

In order to realise the above, the following components are necessary:

- Establishment of communication unit
- Establishment of SWM environmental education facility
- Development of materials for trainers (teachers) and for students
- Develop and implement Pilot Project for environmental education at schools

(i) Establishment of Communication Unit

Volume of work is expected to be carried out by the communication team; therefore, a number of new staff should be newly recruited in addition to the current manager and assistant manager of communication. Main responsibility of the communication unit include, a) coordination among relative bodies, b) preparation of training materials for trainers/ trainees, c) lecture to the students, and d) management of environment facility.

A team of five (5) members with two (2) drivers can start the programme in the short-term period, and gradually increasing these members as target students grow. **Table 5.5.3** shows a summary of number of students and communication team members in the school programme.

Table 5.5.3 Relationship between Number of Visiting Schools and Communication Members (Year 2016-2030)

Term/Year	Short-Term			Mid-Term						Long-Term					
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Schools	50	70	100	100	200	200	300	300	400	400	500	500	600	600	710
Number of Students	1,500	2,100	3,000	3,000	6,000	6,000	9,000	9,000	12,000	12,000	15,000	15,000	18,000	18,000	21,300
Staff (No.)	7	7	7	7	7	8	21	21	21	21	22	22	28	28	28

(ii) Establishment of Environmental Facility

In Gujranwala, schools commonly organise field trips for either recreational or orientations purpose and visit historical monuments or museums. During this field trip, students can visit the environmental education facility to learn about solid waste management, through displays, materials, observation, or hands-on experience. Examples of these contents would include: a) a display showing waste flows in Gujranwala, b) actual waste and recyclable materials and how they are treated, and c) experience in separating recyclables through games.

The communication team needs to come up with those display or materials interesting enough for students.

Number of schools (students) that visit and GWMC staff who manage the facility can be shared with: i) the above, meaning some schools targeted for the delivery programme can actually visit the environmental facility and one of the five (5) communication team members can manage this facility.

The facility does not have to limit its usage to school students but also open to the general public. This would help PR the GWMC's work to the public.

(iii) Development of Materials for Lecturer (GWMC Staff)

In order to facilitate the above components, GWMC has to develop the following:

- A detailed action plan to implement the activities;
- Materials to be used in the programme; and
- Guidelines (or lecture syllabus) to be used in a) coordinating with other entities and b) lecturing in school and environment facility.

Materials should be carefully developed to not only disseminate information about SWM in Gujranwala but also to help the recipient think about how waste is related to his life. For instance, the manner to separate recyclables from the waste stream in a household is good information itself, but can be much more meaningful if the method on which recycling could help conserve the environment or what would be the impact if thrown away into the environment were known.

The materials need to be developed by GWMC in the first period or within the short-term period (2016-2018), but needs to be regularly updated.

(iv) Pilot Project for Schools

In order to use the informal education in schools and use the material/plan developed in (i) to (iii) above, GWMC should start targeting certain areas and implement the programme as a pilot project.

The programme should target a certain town in the action plan and then gradually widen the target area. In this way, it will be easier to manage the programme and impacts may be more visible than targeting the entire city from the beginning.

In order to realise these activities, communication team needs to come up with proper materials, syllabus or training material for GWMC's trainers, coordination mechanisms, as well as means of transportation.

(b) Cost of Implementation of the Informal Education Programme

Approximate costs for environmental programme in schools are summarised in **Table 5.5.4** for short-term, and **Table 5.5.5** for mid- and long-term.

In the short-term plan, 50 schools will be targeted in the first year, and 70 schools and 100 schools in the second and third year, respectively. Some printed materials are expected to be produced and distributed (used) in the lecture. Staff in the table includes the technical staff who would go out and give lectures and 2 drivers. The two (2) drivers are necessary since there is a need to secure transportation for GWMC staff to take all the materials to the schools. Two new vehicles in the first year are needed and expected to be used in the following 10 years.

Table 5.5.4 Approximate Costs for the Short-Term Plan (Year 2016-2018)

Term/Year	Short-Term		
	2016	2017	2018
Number of Schools	50	70	100
Number of Students	1,500	2,100	3,000
Printing of Materials (Total)	18,000	25,200	36,000
Miscellaneous	150,000	210,000	300,000
Room	0	0	0
Staff	211,000	211,000	211,000
Vehicle	1,250,000	0	0
Vehicle Maintenance	40,000	40,000	40,000
Total Expenditure	1,669,000	486,200	587,000

Approximate costs for the mid- and long-term plans are shown in **Table 5.5.5**. Printed materials and number of staff increase as the target school increases. In addition to the short-term cost is the cost for the environmental facility from the 5th year (2021) and the new and repaired vehicles in 2022, 2026 and 2028.

Table 5.5.5 Approximate Cost for Mid and Long-Term Plans (Year 2020-2030)

Term/Year	Mid-Term					Long-Term					
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Schools	200	200	300	300	400	400	500	500	600	600	710
Number of Students	6,000	6,000	9,000	9,000	12,000	12,000	15,000	15,000	18,000	18,000	21,300
Printing of Materials (Total)	708,000	708,000	1,116,000	1,116,000	1,488,000	1,344,000	1,680,000	1,680,000	2,016,000	2,016,000	2,385,600
Miscellaneous	85,200	85,200	127,800	127,800	127,800	57,800	57,800	65,401	73,002	80,603	88,204
Room	0	100,000	100,000	100,000	100,000	100,000	200,000	200,000	200,000	200,000	200,000
Staff	211,000	256,000	449,000	449,000	449,000	449,000	449,000	449,000	642,000	642,000	642,000
Vehicle	0	0	625,000	0	0	0	1,250,000	0	625,000	0	0
Vehicle Maintenance	40,000	40,000	60,000	60,000	60,000	60,000	60,000	60,000	80,000	80,000	80,000
Total Expenditure	1,669,000	486,200	587,000	1,055,000	1,859,000	2,004,000	3,700,000	3,075,000	3,897,000	3,753,000	5,889,000

(2) Periodical Events (such as Earth Day)

There has been some awareness raising for activities in the environmental field in Gujranwala. In such events, many different activities could help sensitise the public by, for example, distributing flyers/brochures, gathering at a park, and so on.

In addition, GWMC can carry out SWM day (or week) at certain times of the day, just like the awareness raising activity carried out in May 2014. This type of activity can target a large number of the general public and by periodically and repeatedly sending out the same message again and again until they become well aware of the consequencies of unattended waste.

(a) Components of the Event

In periodical events, both in environmental events such as Earth day and non-environmental day such as Eid-ul-Fitr day or SWM day, GWMC can approach the general public in various ways. Components of this plan could be the following:

- Development of coordination plan for relevant bodies.
- Development of materials.
- Development of activity plan for periodic event.

(i) Development of Coordination Plan for Relevant Bodies

Earth day events involve many people; therefore, close coordination is necessary to successfully disseminate GWMC's message to the public. This would include not only the organizer of the event per se, but also the various media since this event is one of the key to let the public know the involvement of GWMC.

(ii) Development of Materials

The Communication Unit has to develop materials to be used during the periodical event. Topics should be similar to those of informal education in schools, aside from the information on how GWMC is working on solid waste management in the city.

(iii) Development of Activity Plan for Periodic Event

Activity plans include the planning stage up to actual content, evaluation, and review. The planning stage includes procedure and to whom the communication unit has to coordinate, while actual contents may include what and how to distribute the printed materials and how to attract the general public to participate in the GWMC work. The topic may be a) the current SWM condition in the city, b) GWMC's progress in SWM, and c) how to separate or practical advice for waste management.

(b) Cost of Implementation of the Event

Approximate cost for short term periodical events is shown in **Table 5.5.6**. This cost includes the printing of materials for distribution to the participants. Venue/advert is the cost for the specific venues if needed and advert cost for the event. This advert is assumed to be held for some electronic media like radio, SNS (Social Networking Service), and SMS (Short Message Service), as well as posters and advertisement space in public transportation. Any additional cost, such as cost involved in setting up a tent, if needed, should be covered by "miscellaneous" cost.

Table 5.5.6 Approximate Cost for Short-Term Periodical Events (2016–2018)

	Short-Term		
	2016	2017	2018
Printing of Materials (Rs.)	71,630	85,955	100,281
Venue/Advert (Rs.)	15,200	15,200	15,200
Miscellaneous (Rs.)	200,000	200,000	200,000
Total Expenditure (Rs.)	286,830	301,155	315,481

Approximate cost for the mid- and long-term plan is shown in **Table 5.5.7**. Number of expected participants and target households were derived from the current estimated number of households in Gujranwala, which is 255,819. In this calculation, 10% of households are expected to be a part of this effort by the end of the long-term plan (the year 2030).

Table 5.5.7 Approximate Cost for Periodical Events in the Mid and Long-Term Plan (2019–2030)

Term/Year	Mid-Term						Long-Term					
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of expected participants	3,000	6,000	6,000	9,000	9,000	12,000	12,000	15,000	15,000	18,000	18,000	21,300
Target number of households	2,047	2,302	2,558	5,116	7,675	10,233	12,791	15,349	17,907	2,047	23,024	25,582
Number of Campaigns	3	3	3	3	3	3	4	4	4	4	4	4
Printing of Materials (Rs. Total)	114,607	128,933	143,259	286,518	429,777	573,036	716,295	859,554	1,002,813	114,607	1,289,332	1,432,591
Venue/Advert (Rs.)	22,800	22,800	22,800	22,800	22,800	22,800	30,400	30,400	30,400	30,400	30,400	30,400
Miscellaneous (Rs.)	300,000	300,000	300,000	300,000	300,000	300,000	400,000	400,000	400,000	400,000	400,000	400,000
Staff (Rs.)	0	0	0	147,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000	147,000
Total Expenditure (Rs.)	437,407	451,733	466,059	756,318	899,577	1,042,836	1,293,695	1,436,954	1,580,213	692,007	1,866,732	2,009,991

5.6 Economic and Financial Plan

5.6.1 Development of Alternatives for Economic and Financial Plan

(1) Alternative Options for Cost Recovery

(a) Basic Principles for Cost Recovery

The optimum cost recovery can be attained by promoting GWMC’s rational uses of financial resources, thereby efficiently providing better SWM services. In order to achieve this objective, the following basic principles for the cost recovery should be satisfied.

- The tariffs for SWM services should cover at least the operating cost, desirably the depreciation for replacement cost of existing facilities and part of the debt service obligations for the future investment cost. The tariff should be accurately calculated by making use of the latest financial data and information available.
- For the optimum cost recovery, the tariff level should send clear signals to waste generators as well as GWMC, thereby efficiently providing SWM services. Users will adjust their waste generation amount to the tariff level. At the same time, the cost recovery level should be periodically readjusted to reflect the real cost of SWM services.
- The demand side such as users’ affordability and willingness to pay for SWM services should be properly taken into account, when the cost recovery level is projected based on the proper tariff system.

(b) Alternative Options for Cost Recovery

The major components to estimate costs for SWM services by which the cost recovery will be studied are as shown below.

- Operating costs, often called operating and maintenance expenditures, are costs of regular operation of services and performing routine maintenance of the related assets. The overhead and administrative expenses are also included.
- Replacement costs are often expressed as the depreciations of the capital replacement of existing facilities.
- Capital investment costs include costs of land, building facilities and procurement of equipment required for SWM services.

Based on the scope of costs mentioned above, the alternative options for the cost recovery include 3-step scenarios as below.

- **1st step:** The operation and maintenance cost will be covered by the total revenue.

- 2^{nd} **Step:** The operation and maintenance cost plus the depreciations for replacement of existing facilities will be covered by the total revenue.
- 3^{rd} **Step:** The operation and maintenance cost plus the depreciations for replacement of existing facilities and part of new investment will be covered by the total revenue.

(2) Alternative Options for Costing Methods

In order to provide the cost recovery analysis based on the accurately estimated costs for SWM services, the following costing methods are regarded as the alternative options.

(a) Average Cost Approach

The average cost is simply calculated from the sum of the required operation and maintenance cost, replacement cost and investment cost for the entire period of the master plan. The average cost reflects the total planned investment cost and the replacement cost in addition to the total planned operation and maintenance cost of each project year in the entire period of the master plan.

(b) Marginal Cost Approach

The marginal cost is the increase in total cost as a result of providing one more unit of SWM services. Since certain overhead costs are fixed, the marginal cost is almost always less than the total per-unit cost of providing SWM services averaged over the same services provided. The marginal cost achieves two goals: the efficient use of financial resources when operating at less than the full capacity and providing the signal to invest on the additional capacity of facilities.

In SWM services, the marginal cost pricing is problematic because of the relatively high start-up investment cost in comparison with the relatively low operation and maintenance cost. Significant fluctuations of the tariff would occur based on purely marginal cost calculations. Therefore, the marginal cost can be applied only to the phase in which the investment cost is borne as the project cost.

(3) Alternative Options for Tariff Charging System

(a) Basic Principles for Tariff Charging System

A tariff charging system for SWM services has several objectives: cost recovery, financial sustainability, efficient allocation of scarce resources and income distribution. It is unlikely that all these objectives can be met, so even the most carefully designed tariff will require trade-offs.

The principle underlying the imposition of direct user charges for SWM services is that the cost of the services should be recovered from users. A well-designed tariff structure is a major part of ensuring an efficient SWM services. Advantages and disadvantages of each tariff charging option should be streamlined for the selection of the optimum option.

It is absolutely necessary for GWMC to keep the financial sustainability for continuously providing SWM services. The tariff charging system must reflect the costs reasonably associated with rendering the services, including capital, operating, maintenance, administration and replacement costs. In the long run, GWMC is required to consider introducing the tariff charging system for SWM services to meet the cost of services.

The tariff charging system may be also used as an incentive to reduce waste generation and encourage recycling, so that those who pollute more pay more. Increased public awareness of solid waste issues and public involvement in the decision-making process may provide the opportunity to adjust user charges to reflect real costs required for SWM services.

Alternative tariff charging mechanisms for providing SWM services affect the efficiency, equity and sustainability. The following principles should be adopted in shaping the design of the user charging system for SWM services:

- ***Efficient allocation of resources**:* The efficient allocation of available financial resources between users should be fostered.
- ***Efficient supply of services**:* Incentives should be created to provide services at the lowest cost.
- ***Cost recovery**:* Tariffs must reflect the costs associated with providing SWM services, including operating and maintenance, capital, replacement and financing costs.
- ***Financial viability**:* Tariffs should allow for the financial sustainability of the service, taking any other subsidies into account.
- ***Horizontal equity**:* Users of services should be treated equitably and should pay the same amount for the same level of services.
- ***Vertical equity and poverty alleviation**:* Poor consumers should pay proportionally less for services. Poor households must pay tariffs that only cover operating and maintenance costs, or have special lifeline tariffs or be subsidised in such a way as to allow access to basic services.
- ***Administrative and technical feasibility**:* Any tariff should be administratively and technically feasible to implement. The implementation process should be less costly than the benefits of implementation itself.
- ***Polluter pays**:* Those responsible for waste generation and externalities from waste generation or disposal should pay for the social costs of this waste.
- ***Avoiding illegal dumping**:* The tariff should not provide incentives for tariff avoidance through illegal dumping.
- ***Proportionality**:* The amount the user pays should be in proportion to the use of the services.
- ***Transparency**:* Tariffs should be understandable and any subsidy which exist must be visible and understood by all those affected.

(b) Alternative Options for Tariff Charging System

There are a wide range of below tariff charging options together with advantages and disadvantages of each option.

<u>Option 1: Financing through Provincial Property Tax</u>

While the direct cost recovery for SWM services can be used depending on the quantity of SWM services, the indirect cost recovery for SWM may rely on the government revenues, especially, various forms of taxation including a special tax for SWM services and surcharges on other taxes. The property tax is one of the most promising candidates of this option, since this option tends to secure the vertical equity.

Advantages

- The revenue collection cost is relatively low.
- The charges through the provincial tax tend to be correlated with income and in turn with amounts of waste generated. Therefore, there might be some relationship between the costs imposed on consumers and the amount of wastes generated.
- The option provides for the vertical equity, since poorer households will tend to pay less for SWM services.
- Low value properties can be zero-rated thus providing free basic SWM services to those households.

Disadvantages

- It may not be horizontally equitable, since households with different service levels pay the same amount for different SWM services.
- The option provides no incentive to reduce wastes.
- It may be technically difficult to set aside the solid waste proportion of the property tax revenue.
- The number of the property taxpayers is limited.
- Tough negotiations with the provincial government will be required.
- The option does not provide any incentive for GWMC to provide SWM services more efficiently.

Option 2: SWM Services Funded by User Charges

Option 2-a: User Charges Based on Proxy for Amounts of Wastes Generated

In this option, a proxy variable such as stand size is used as the basis to distinguish the solid waste tariff.

Advantages

- The use of stand size is appropriate if collection costs increase with decreasing residential density and, therefore, this option promotes the proportionality principle.
- Stand size is likely to be correlated to a sizable degree with the volume of wastes generated and the income level of waste generators.
- Other proxies, such as tariffs differentiated by location, may be appropriate, if different areas have different waste generation rates on average and different costs.
- The option provides no incentive for illegal dumping because residents are charged anyway.
- The option is vertically equitable, since poorer households will tend to pay less for SWM services.

Disadvantages

- The option does not encourage waste reduction or recycling.
- There is only a limited relationship between stand size and waste volumes, and, therefore, it is not always horizontally equitable.
- It is technically complicated to establish and administer proxy variables.

Option 2-b: User Charges Based on Service Level

In this option, tariffs are based on the level of services provided to customers. Ideally, consumers would be able to choose the level of services according to demand and affordability.

Advantages

- The option has a greater degree of horizontal equity than a flat rate as customers pay for the services received.
- The option allows service level targeting of poor households. Poor households may be able to choose a lower service level for a lower charge or for no charge in the case of free basic SWM services.
- The option provides efficiency incentives for GWMC.

Disadvantages

- The option is only loosely proportional to the cost of provision as there are other cost drivers aside from service level.
- The option is not vertically equitable, since poor households pay the same as wealthy households if a single service level is provided.

- Service level is not always related to amount of waste generated and therefore does not meet the polluter pays principle.
- The option may encourage illegal dumping if service level choice is available.

Option 2-c: Charges Based on Actual Amounts Generated (Pay as You Throw)

The option requires a detailed recording of the amounts of wastes collected from a site and establishes a charge per amount of wastes generated. More crude versions of this approach are based on customers' purchasing special bags with a surcharge which goes to service providers, which are the only bags collected. The more wastes generated, the more bags have to be bought by a household.

Advantages

- There is direct relationship between waste generation and cost to the customer.
- The option provides incentives for waste reduction.
- The option is horizontally equitable.
- The option can allow for a free basic service such as the collection up to a certain mass or volume of waste can be provided at no charge.

Disadvantages

- The option has large technical costs and constraints.
- The option has social and management constraints.
- The option is not vertically equitable since all households pay an equal amount per volume of wastes.
- Use of plastic bags is not allowed in Pakistan for environmental reasons.
- The users' willingness to buy bags is low.

Option 3: Combined Options

Option 3-a: Flat-Rate and Variable-Rate User Charge

The use of a flat-rate user charge on all households and variable user charge by income level provides a workable option. If free basic SWM services are provided, the flat rate could be waived for poor households or households in low-income areas.

The flat-rate cost recovery is easily implemented, administered, altered, and explained to customers and provides predictable cash flows. It is appropriate for SWM services with a single customer class. The main disadvantage of a flat-rate cost recovery is the lack of concern or accountability for wastes.

On the other hand, a variable user charge by income group can impose the tariff in accordance with customers' willingness to pay. Although the combination of a flat rate user charge and a variable user charge is vertically equitable with the cross-subsidies among customers, it is rather difficult to identify a border of the income-block between low-income households and high-income households.

Option 3-b: Combination of Property Tax and Flat-Rate User Charges

This option splits the financing of SWM services between the stable revenue from a property tax account for SWM services and the additional flat-rate user charge for the minimum SWM services. The advantage of this option is that it aims at raising stable finance sources for providing SWM services, and, at the same time, it can easily accommodate equity considerations with low value properties having low rates or being exempted.

This combined option is being applied by many municipalities on an ad-hoc basis, when part of the revenues from a property tax is used to subsidise any deficit accruing on the SWM account. The ad-hoc approach, where any deficit is automatically funded out of the property tax account, provides no efficiency incentives and cannot be regarded as an acceptable and official tariff structure.

Option 3-c: Combination of Property Tax and Variable-Rate User Charges:

Option also splits the financing of SWM services between the stable revenue from a property tax account for SWM services and the additional variable-rate user charge for the minimum SWM services. Although the advantage of this option is basically the same as Option 3-b, the additional variable user charge is vertically equitable even if the property tax is imposed on high-income households due to the extra affordability to pay of high-income households.

Option 3-d: Combined Billing with WASA or GEPCO:

One of the less common cost-recovery methods is to combine billing of SWM services with that of another utility such as water and sewerage services or power supply services. This can be either a direct fee or a surcharge on the primary utility bills. The problem is that households receiving SWM services may consume little water or electricity or none at all. In effect, large customers of water supply/sewerage or electricity pay their own share plus part of the low-income users' share for SWM services.

This option may produce adequate revenue but is difficult to justify the basis of equity, because many low-income households will receive virtually free SWM services. In addition, the WASA or GEPCO will be reluctant to accept the joint billing proposal due to the anticipated increase in their bills which might induce their customers' strong objections.

(c) Alternative Options for Tariff Revision Mechanism

In addition to the tariff setting mechanism, the alternative options for the tariff revision mechanism should be also assumed. There are mainly three (3) options for regulating the overall tariff level: rate of return regulation, yardstick regulation and price cap regulation.

(i) Rate of Return Regulation

Rate of return regulation adjusts overall tariff levels to the operator's total accounting costs and cost of capital. The regulator reviews a service provider's overall tariff level in response to a claim that the expected rate of return is less than its cost of capital.

Since the current costs of capital of all GWMCs are substantially borne by the external financial sources, the rate of return regulation could be substantially *"total costing regulation"* without the cost of capital. Although the traditional rate-of-return regulation has been criticised on the grounds that it deteriorates incentives for cost efficiency, the monitoring on the management efficiency improvement through the performance monitoring indicators will be alternative measures to strengthen incentives for cost efficiency.

(ii) Yardstick Regulation

Yardstick regulation is a regulation method that a SWM service operator's (GWMC's in this case) performance is compared to other operators' performance such as SWM service operators in other cities of Punjab Province (LWMC, etc.) and other public utility operators like the water/sewerage sector and the power sector.

Penalties or awards are assessed based on a SWM service operator's relative performance. The most efficient operators would be rewarded with extra profits and the least efficient operators would be penalised in terms of the tariff level. Since operators are actually in different markets, it is important to keep those operators in similar situations so that the comparison is valid.

(iii) Price Cap Regulation

Price cap regulation allows a service provider to change its tariff level according to an index that is typically comprised of an inflation rate, I-factor, and a "productivity offset," which is commonly called the X-factor. Price cap regulation can be an alternative tariff revision method to traditional rate-of-return regulation. It has been widely used as a regulatory rule for limiting abuse of market power by a dominant supplier of public utility services after a service provider's obtaining sufficient operating profits.

Eventually, the price cap regulation would give a service operator more incentives to achieve and improve productive efficiency. Unlike the rate-of-return regulation, the price cap regulation does not require frequent arbitrary measures of a rate of return on capital.

(4) Alternative Options of Financial Arrangement for Private Sector Involvement

(a) Basic Principles for Private Sector Involvement

During the long-term period from 2025 to 2030, the private sector involvement will be started for the collection and transport services. The financial arrangement of each private sector involvement option is evaluated in terms of the economic efficiency and profitability under the following principles.

- The major economic reason for involving the private sector in SWM services is the enhancement of the efficiency of operations through competition. Private sector involvement through a competitive bidding can improve the efficiency of SWM services. By using the private sector's cost-saving expertise, outsourcing to the private sector will significantly reduce the financial burden on a public service provider.
- The involvement of the private sector can also enlarge the access to capital or financial resources for procurement of collection vehicles as well as human capital for expertise and skills. The degree of the accessibility to those financial and human capitals by the public sector is one of the important motivations for the private sector involvement.

(b) Alternative Options for Private Sector Involvement in terms of Financial Arrangement

- ***Licensing:*** Licensing or private subscription allows qualified private service providers licensed by an authority to compete for the delivery of SWM solid services in a specific zone. Under this arrangement, waste generators make contracts with individual private service providers.
- ***Service Contract:*** Service contract is a finite-term contract to a private service provider to render SWM services, and an authority pays the private service provider for charges in response to the services to be delivered. Part of SWM services such as collection and transportation of wastes and management of a sanitary landfill site can be contracted out to a private operator for a certain period.
- ***Management Contract:*** Management contract is a contract entrusting specific solid SWM services under private management for a certain period of time, for which a management fee is paid to the management contractor.
- ***Lease Contract:*** Lease contract grants a private operator full control over delivering specific SWM services in exchange for use of the fixed assets whose ownership and responsibilities belong to the authority.
- ***Concession:*** Concession is a long-term contractual arrangement in which a private operator is awarded an official license to provide specific SWM services over a longer period of time in exchange for a negotiated fee.

5.6.2 Evaluation of the Alternatives

(1) Alternative Options for Cost Recovery

By applying both of the revenue increase efforts and cost reduction efforts, the alternative options for the cost recovery through the following steps are selected:

- To apply the revenue increase efforts, thereby shifting the revenue line upward.
- To apply the cost reduction efforts, thereby shifting the operating cost line downward.

- To shift the break-even point leftward, thereby shortening the overall cost recovery years.
- To identify the optimum cost recovery level under the new break-even point.

Figure 5.6.1 illustrates the image of 3 phases of the cost recovery. Based on the above assumptions, out of 3 alternative options for the cost recovery, the first step which covers part of the operation and maintenance cost is the realistic and optimum option for the cost recovery for the evaluation in the master plan.

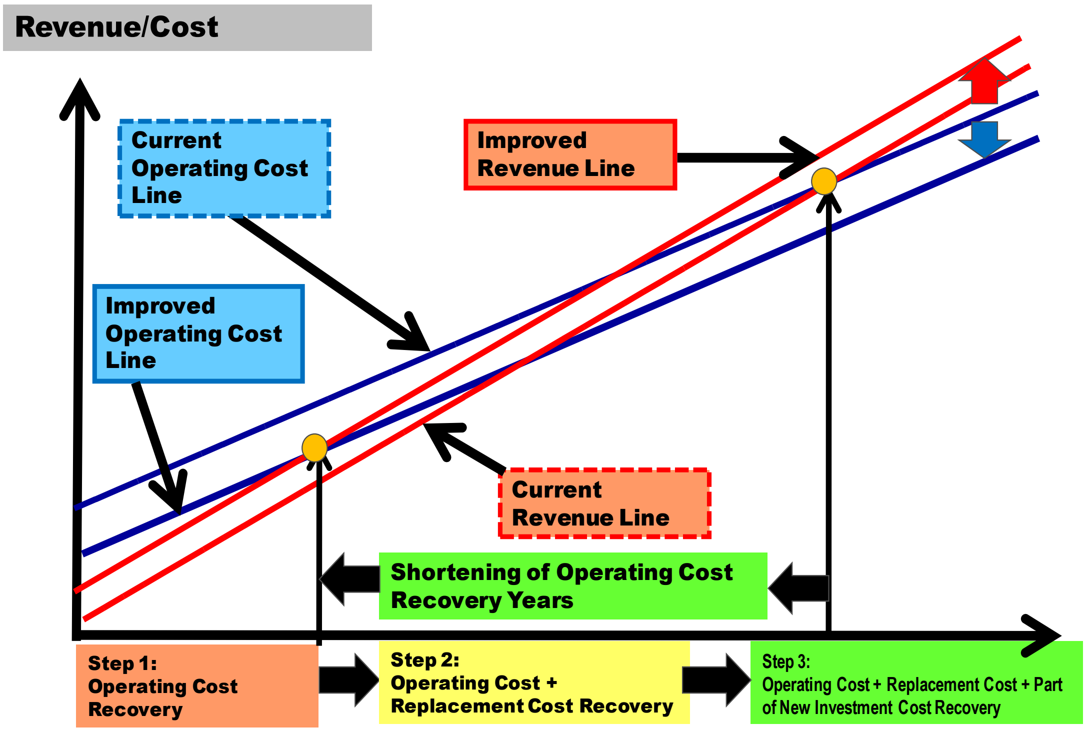


Figure 5.6.1 Image of Three Phases of Cost Recovery

(2) Alternative Options for Costing Methods

The costing method to be employed for the cost recovery is different in response to each phase of the cost recovery.

The costing method required for the phase where the cost recovery is only achieved to cover the operation and maintenance cost is the average cost method. On the other hand, the marginal cost includes the depreciation of assets. The cost of long-term investments in capital assets must be included in the cost-recovery applications.

Since the master plan is regarded as the first step/phase which only seeks for covering part of the operation and maintenance cost, the average costing method is employed for the appropriate option as the costing method. A key difference between the average cost and the marginal cost is that the former is concerned with the revenues needed to ensure the financial viability while the latter is concerned with relaying the appropriate price signals to consumers. The tariff level must be high enough to cover the average cost over the entire period of the master plan. **Table 5.6.1** shows alternative options for costing methods.

Table 5.6.1 Alternative Options for Costing Methods

Phase of Cost Recovery	1st Step	2nd Step	3rd Step
Cost Recovery	Operation and Maintenance Cost	Operation and Maintenance Cost + Capital Charge on Replacement Cost	Operation and Maintenance Cost + Capital Charge on Replacement Cost + Part of New Investment Cost
Average Costing Pricing Method	Yes	No	No
Marginal Cost Pricing Method	No	Yes	Yes

(3) Alternative Options for Tariff Charging System

(a) Tariff Charging System

Table 5.6.2 shows the results of evaluating alternative tariff charging options together with advantages and disadvantages of each option.

Table 5.6.2 Alternative Options for Tariff Charging System

Alternative Tariff Charging System		Advantage	Disadvantage
User Charge	Flat Rate	・ It is easy to administer the tariff system. ・ SWM charges will be minimaml due to the wider basis for the revenue generation.	・ There is lack of concern or accountability for wastes. ・ The cost of the door-to-door collection of SWM charges is relatively high. ・ Users' willingness to pay is low in low-income areas.
	Variable Rate	・ The vertical equity of the tariff system is secured.	・ The cost of the door-to-door collection of SWM charges is relatively high. ・ It is difficulty to identify the areas by income group.
Charging through Selling Plastic Bag System (Pay-as-you-Throw System)		・ There is direct relationship between waste generation and costs to customers. ・ The proportionality of the tariff charging system is secured. ・ There are incentives for waste reduction.	・ Users' willingness to buy plastic bags is relatively low ・ Use of plastic bags is not allowed in Pakistan.
Charging through Tax System	Charging through Provincial Property Tax	・ The revenue collection cost is relatively low. ・ The tariff can be charged only on the relatively high-income users, thereby achieving the vertical equity.	・ Negotiation with the Provincial Government is necessary. ・ The number of property tax payers is limited.
Combined Approach	Flat Rate + Variable User Charge	・ There is the vertical equity of the tariff system. ・ The revenue base is relatively large.	・ It is technically rather difficult to administer the tariff system. ・ The threshold between high-income customers and low-income customers is difficult to define.
	Property Tax + Flat-Rate Use Charge	・ The property tax is the stable income in addition to the flat-rate user charge. ・ The revenue basis is relatively large.	・ Negotiation with the provincial government is necessary. ・ The vertical equity of the tariff system is not enough.
	Property Tax + Variable-Rate User Charge	・ The property tax is the stable income in addition to the variable-rate user charge. ・ The revenue basis is relatively large.	・ It is technically rather difficult to administer the tariff system. ・ Negotiation with the provincial government is necessary. ・ The vertical equity of the tariff

Alternative Tariff Charging System		Advantage	Disadvantage
			system is secured.
Joint Billing with Other Public Utilities	Joint Billing with WASA (Water and Sanitation Bill)	・It is relatively easy to manage the charging system. ・The revenue collection cost is relatively low.	・Negotiation with WASA is necessary. ・The number of users connected to WASA water supply network is limited.
	Joint Billing with GEPCO (Electricity Bill)	・It is relatively easy to manage the tariff system. ・The revenue collection cost is relatively low.	・Negotiation with GEPCO is necessary. ・The number of users who are connected to the GEPCO grid network is limited. ・There is little horizontal equity.

Out of the above-listed alternative options, the combination of the provincial property tax as the baseline stable revenue and the variable user charge system as the additional revenue from high-income households is recommended as the optimum alternative option due to the following reasons.

- The variable-rate user charge can secure the vertical equity, since the majority of the households in Gujranwala are low-income households, and the flat-rate user charge does not secure the vertical equity.
- The affordability to pay for the high-income areas are more than their willingness to pay, and, therefore, the revenues through the property tax can be generated from high-income households.
- The revenue collection cost is relatively low for the provincial property tax, and the baseline income can be stable.
- The negotiation with the provincial government is much easier, compared with the negotiation with WASA and GEPCO, since they are more profit-oriented, and, therefore, they are much reluctant to add the SWM bill to their own bills.

In addition to the optimum option for the tariff charging system, the following arrangements for the introduction of the system are also recommended.

- Three-year preparation period (2022-2024) in the latter half of the mid-term period of the master plan should be assumed to secure the period for raising users’ willingness to pay.
- Three-year trial period (2025-2027) in the former half of the long-term period of the master plan should be assumed to smoothly introduce the tariff charging system. During this trial period, the tariff will be exempted for low-income households.
- The full-scale introduction of the recommended tariff charging system in all areas will be started from 2028.

(b) Tariff Revision Mechanism

In addition to the tariff charging system, the best option for the tariff revision mechanism should be also selected.

Since the current capital investment costs of GWMC are substantially borne by the external financial sources, the rate of return regulation could be “total costing regulation” without the cost of capital. Although the traditional rate-of-return regulation has been criticised on the grounds that it deteriorates incentives for cost efficiency, the monitoring on the management efficiency through the performance monitoring indicators will be alternative measures to strengthen incentives for cost efficiency.

Yardstick regulation depends on a wide range of data to provide indicative information on relative performance of similar SWM service operators and other public utilities service providers such as the power sector. In practice, information requirements in other service providers might be obstacles to the implementation of yardstick competition. Yardstick competition is the most effective when those service providers face similar conditions. Therefore, the yardstick regulation is not suitable for the tariff revision mechanism, since other service providers are operating in different management conditions.

On the other hand, the price cap regulation could be employed for the period only after achieving the cost recovery of operation and maintenance cost as well as the depreciation of the replacement cost.

In conclusion, “the rate of return” regulation is the recommended option for the tariff revision mechanism.

(4) Alternative Options for Private Sector Involvement

The optimum option for the private sector involvement is selected in the economic aspects such as form of management, tariff collection, contract term, status of monopoly, and ownership of assets. The step-wise service contract in the field of collection and transport is the best option for the private sector involvement due to the following reasons. **Table 5.6.3** shows the results of evaluating options for the private sector involvement.

- There are many low-income areas with extremely low customers’ willingness to pay, and, therefore, “licensing” and “concession”, in which the tariff collection by the private sector is required, will be excluded.
- Since GWMC is required to put the management of SWM services under control, “management contract” will be excluded.
- On the other hand, “lease contract” will be excluded due to the fact that GWMC cannot effectively utilise the current sanitation workers for the economy of scale.
- Unlike the concession, under the service contract, GWMC can finally decide the level of the tariff.

Table 5.6.3 Alternative Options for Private Sector Involvement in terms of Economic Aspects

Outsourcing Options	Management	Tariff Collection	Contract Term	Monopoly	Ownership of Assets
Licensing	Public	Private	Limited	No	Public
Service Contract	Public	Public	Limited	No	Private
Management Contract	Private	Public	Limited	No	Private
Lease Contract	Public	Public	Limited	No	Public
Concession	Private	Private	Limited	Yes	Private

5.6.3 Identification of Priority Projects for Economic and Financial Plan

(1) Short-Term Action Plan

(a) Priority Project for Sustainable Cost Recovery

During the short-term period from 2016 to 2018, the tariff system will not be introduced, and, therefore, the cost recovery for GWMC’s operation of SWM services will not be actually started. However, there are a handful of preparation activities for the future cost recovery even in the short-term period. There is a wide spectrum of activities in the field of the preparatory activities for the cost recovery as below. The proper cost recovery system in SWM services will be established in the long-term period. For the time being, the gap between the revenues and the expenditures due to the absence of the cost recovery system will be replenished by the CDGG’s financial assistance on the recurrent costs as well as the provincial government’s subsidies for the capital investment:

- To establish the long-term cost recovery strategies for the operation and maintenance costs to provide SWM services;

- To establish the financial monitoring system through a wide range of the financial key performance indicators (KPI) related to the cost recovery;
- To establish the standard procedure for monitoring the cost recovery;
- To prepare the manual for the management of the cost recovery;
- To train GWMC's staff in charge of managing the cost recovery;
- To prepare a 3-year recurrent cost rolling plan to request CDGG for the budgetary arrangement; and
- To prepare a 3-year capital investment cost rolling plan to request the provincial government for the budgetary arrangement

The typical standard procedures for monitoring the cost recovery are as follows:

Step 1: Setting up of Assumptions
Step 2: Estimating of Revenues
Step 3: Estimating of Expenditures

Step 3-a: Operating and Maintenance Expenditures (Opex)

Opex is broken down into 2 components: fixed costs which are not significantly related to the volume of disposed wastes, and variable costs related to the volume of disposed wastes or the number of customers. Estimating the future Opex would be based on the parametres indicated in the master plan.

Step 3-b: Capital Maintenance Charge (Depreciation for Replacement Cost)

The capital maintenance charge, which is depreciations for the replacement cost of existing facilities, is also important. One controversial issue concerning capital maintenance charge is whether assets funded by third parties should be included in the capital maintenance charge. Since the third-party-funded assets such as CDGG and the provincial government also generate the revenues over the master plan period, those capital maintenance charges should be also included.

Step 3-c: Capital Expenditures (Capex)

The capital expenditures required for the new investment which are actually covered by the budget of the provincial government in accordance with the master plan will be included.

Step 4: Calculation of Financial Gap between Revenues and Expenditures
Step 5: Calculation of Required Subsidies to be covered by CDGG and Provincial Government

An appropriate monitoring system though a wide range of the financial KPIs is a key to the cost recovery in the long-term period. Therefore, the monitoring system through those financial KPIs should be established at the early stage of the short-term period of the master plan. The financial KPIs are subject to quantitatively measure the delivery of SWM services in a financially efficient manner.

The staff in charge of the financial KPIs of the newly created MIS unit inside GWMC will be responsible of periodically monitoring the data and information on the selected financial KPIs. The following institutional set-up should be arranged for monitoring the financial KPIs.

- Timing for collection, aggregation and feedback of the collected data
- Frequency for collection, aggregation and feedback of the collected data
- Methodologies for collection, aggregation and feedback of the collected data

GWMC should develop a number of the following financial KPIs to assess its performance with respect to the situation of the cost recovery and other benchmarks. These monitoring indicators will serve as effective tools to assess the financial status of GWMC.

- Unit Operational Cost: Total annual operating expenses divided by total amount of disposed wastes

- Salary Costs as a Proportion of Operating Costs: Total annual salary costs (including salaries, wages, pensions, other allowances, etc.) expressed as a percentage of total annual operating costs
- Collection period: Year-end accounts receivable divided by total annual operating revenues expressed in month's equivalent collected charges
- Collection Efficiency: Number of customers who actually paid the bills divided by the total number of customers
- Contract Rate: Number of customers who actually contracted divided by the total number of customers
- Cost Recovery Rate to Total Cost: Total annual expenses divided by total annual operating revenues
- Cost Recovery Rate to Operation and Maintenance Cost: Total annual operating expenses divided by total annual operating revenues

(b) Priority Project for Accurate Total Costing

Although, during the short-term period from 2016 to 2018, the tariff will not be charged, it is absolutely necessary to accurately grasp the total cost based on the selected methodologies for future monitoring the cost recovery after the full-scale introduction of the tariff system from 2028. There is a wide range of actions to be taken for grasping the total cost as well as the cost structure of providing SWM services as follows:

- To establish the cost centre inside the financial department of GWMC;
- To monitor and streamline the latest operating costs for SWM services;
- To monitor and streamline the latest maintenance costs for SWM services;
- To carry out the break-even point analysis as well as the breakdown of the operation and maintenance costs by fixed costs and variable costs;
- To estimate the average cost and the marginal cost per unit amount of the disposed wastes;
- To prepare and start the cost minimisation plan for SWM services;
- To prepare the operation manual for the standard procedures for the cost centre; and
- To train the staff of the cost center for estimating various costs for SWM services.

The cost centre will be established inside the financial department of GWMC, and the centre provides the management of GWMC with a convenient mechanism to determine the proper tariff level to recover the total operation and maintenance costs required for the providing SWM services.

Another important action to be taken is to minimise the cost of providing SWM services by the financially efficient manner under the cost minimisation plan of GWMC. The organisational assessment was carried out in the master plan, and the most efficient organsational structure was proposed. The purpose of organisation assessment is to realign organisation's resources in a way that GWMC will be able to achieve the best performance and SWM services thus minimising the operating costs.

The cost minimisation plan, being jointly prepared by the financial department and the human resources development department of GWMC, will include a series of actions to significantly reduce operating costs and bring improvements in the service delivery efficiency such as the operation of the sanitary landfill, the operation of the collection and transport, billing and collection, and fuel and repairs of collection vehicles, the overhead cost of the headquarters, etc.

In addition, the preventive maintenance programme will help identify possible inefficiency in the operation of the sanitary landfill as well as the collection and transport of wastes with minimum expenses thus saving major repairs and maintenance costs. The efficient collection route should be continuously reviewed in each service zone which will bring more efficiency in the operations thus reducing costs.

(c) Priority Project for Proper Tariff Introduction

During the short-term period from 2016 to 2018, the tariff system will not be introduced, and, therefore, the cost recovery for SWM services through the introduction of the tariff system will not be actually started. However, there is a wide spectrum of the following activities in the field of the preparatory activities for the introduction of the tariff system as below. The partial establishment of the cost recovery through the full-scale introduction of the optimum tariff system will be commenced from 2028 during the long-term period. For the time being, the absence of cost recovery will be replenished by the CDGG's financial support for the recurrent costs and the provincial government's subsidies for the investment and replacement on facilities and equipment required for SWM services, as flollows:

- To forecast the cost recovery rate and the optimum tariff level as well as the required amount to be covered by the provincial property tax;
- To compare the estimated SWM tariff level with those of SWM service providers in other cities;
- To roughly establish the tariff table in low-income, middle-income and high-income areas;
- To establish the standard procedure for the tariff setting;
- To prepare the 3-year recurrent cost rolling plan to request CDGG for the budgetary arrangement;
- To prepare the 3-year investment capital investment cost rolling plan to request the provincial government for the budgetary arrangement;
- To carry out the survey on customers' willingness to pay by income group;
- To carry out the survey on customers' affordability to pay by income group;
- To train the staff in charge of establishing and operating the financial monitoring system; and
- To start the negotiation with the provincial government for exploring the required legal actions for the introduction of the additional surcharge of the provincial property tax.

It is essential to set the SWM tariff at the level for which users can actually afford to pay. In this connection, the concept of ATP (Affordability to Pay) is frequently used. ATP is defined as the amount which beneficiaries can pay for certain public utility services, being calculated with reference to household income and composition of household expenditures in the service areas. There are various methodologies employed for estimating ATP. A typical methodology is to determine ATP as a certain share of a household's disposable income based on a household economy survey. The survey on the household economy for estimating ATP should be periodically carried out during the early stage of the short-term period.

WTP (Willingness to Pay) is another consideration factor of the demand side, which is the amount expressed by respondents on the monetary value on users' degree of payment willingness for SWM services. WTP can be measured through a questionnaire survey such as CVM (Contingent Valuation Method).

Based on the survey results of the updated level of ATP and WTP, the optimum level of the tariff as well as the required revenue to be covered by the provincial property tax will be estimated.

(d) Priority Project for Financially Efficient Private Sector Involvement

During the short-term period from 2016 to 2018, the private sector involvement will not be started. However, there is a wide range of preparation activities for the future commencement of the efficient private sector involvement for the collection and transport as below. The outline of the service contract to be outsourced including such as area, scope and criteria to select the private service providers will be clarified:

- To study the tender procedure for the service contract;
- To study the area and scope of the service contract; and
- To review the unit cost of outsourcing.

(e) Other Relevant Projects

During the short-term period from 2016 to 2018, the following actions should be taken for the implementation of the master plan:

- To review the experiences of the LWMC’s service contract and the private sector involvement in other cities in Punjab; and
- To study the situational analysis on the availability and capacities of private service providers in the field of SWM services

(2) Mid-term Action Plan

(a) Priority Project for Sustainable Cost Recovery

During the mid-term period from 2019 to 2024, in response to the preparatory activities for the cost recovery conducted during the short-term period, the following activities to accelerate the cost recovery in SWM services will be carried out:

- To update the long-term cost recovery strategies for the operation and maintenance costs to provide SWM services;
- To operate the financial monitoring system through a wide range of the financial KPIs related to the cost recovery;
- To update the standard procedure for monitoring the cost recovery;
- To update the manual for the management of the cost recovery;
- To continue on-the-job training of GWMC’s staff in charge of managing the cost recovery;
- To review the previous 3-year recurrent cost rolling plan and prepare the new 6-year recurrent cost rolling plan to request CDGG for the budgetary arrangement; and
- To review the previous 3-year capital investment rolling plan and prepare the new 6-year capital investment rolling plan to request the provincial government for the budgetary arrangement

The mid-term financial monitoring system will significantly contribute to the feedback mechanisms for rectifying the financial performance of GWMC. GWMC is requested to monitor whether or not SWM services are actually and properly being delivered by the efficient manner.

(b) Priority Project for Accurate Total Costing

During the mid-term period from 2019 to 2024, the tariff will not be charged yet, and, therefore, the cost recovery for the operation of SWM services will not be actually started. However, there are various activities for the cost centre to support the cost recovery by estimating the total operation and maintenance cost as below. The actual establishment of the cost recovery system in SWM services will be started from the long-term period. Even during the mid-term period, the absence of the cost recovery will be replenished by the subsidies or the revenues from the provincial property tax. The activities of the cost centre will be a basis for the explanation to the provincial government and users for raising funds from the provincial property tax and the tariff system:

- To make the cost center function well to accurately estimate the total cost for SWM services;
- To update the latest operating costs for SWM services;
- To update the latest maintenance costs for SWM services;
- To update the break-even point analysis as well as the breakdown of the operating costs by fixed costs and variable costs;
- To update the average cost and the marginal cost per unit amount of the disposed wastes;
- To fully implement the cost minimisation plan of GWMC;
- To fully make use of the operation manual for the standard procedures for the cost centre; and
- To continue the training the staff of the cost center for estimating various costs for SWM services

(c) Priority Project for Proper Tariff Introduction

During the mid-term period from 2019 to 2024, the tariff will not be charged yet, and, therefore, the cost recovery for the operation of SWM services will not be actually started. However, there is a wide spectrum of activities in the field of the preparatory activities for the full-scale introduction of the tariff system from 2025 as below:

- To prepare the official tariff table for requesting the approval by the price regulatory organisation under the provincial government;
- To prepare for the partial and test introduction of the tariff system under the selected option from 2025 only in middle-income and high-income areas;
- To prepare for the full-scale introduction of the tariff system under the selected option from 2028 in all areas;
- To explore the possibility of outsourcing the tariff collection through the introduction of the cross subsidy system;
- To continuously update the survey on ATP and WTP;
- To prepare for the establishment of monitoring the users' grievance on the tariff collection practices;
- To prepare for the smooth transfer of the property tax surcharge to GWMC; and
- To start training the staff in charge of collection of user charges

During the mid-term period, more in-depth tariff level should be carefully studied based on the updated level of ATP and WTP. The degree of WTP depends upon two major factors. The most important factor is the financial status of waste generators in Gujranwala. While in an area where the financial status is relatively high, there is a tendency for paying for SWM services. The second issue is the level of service provided. The better the SWM service, the more willing households are to pay. The tariff system must be introduced with the following considerations:

- The bases for imposing charges are easy to explain and the structure and level of tariffs, equitable and easy to understand;
- The collection methods of user charges are based on long-standing or accepted practices; and
- Prior to implementation of the tariff system, GWMC is requested to fully explain the intention and reasons for imposing or revising the tariff system.

To set up a regulatory organisation on imposing and revising the tariff is another critical action to be taken during the mid-term period. Since there is currently no official tariff system for SWM services in Punjab, the tariff setting and revision for SWM services is not being regulated by an independent organisation of the provincial government. On the other hand, the tariff setting and revision plans are subject to be approved by the independent price regulatory organisations for the water/sewerage and electricity sectors under the provincial and federal government, respectively.

The cross-subsidy system which provides financial assistance to poor households through transferring user charges from well-off households to poor households should be introduced by setting the tariff based on the proposed income-wise variable-rate user charges with the following principles:

- The subsidy should be limited to the poor to guarantee access to SWM services;
- The level of the subsidised tariff should be decided on the basis of the affordability-to-pay survey on poor households; and
- The subsidy system, including eligibility criteria, should be separately set up in close cooperation with the provincial government.

(d) Priority Project for Financially Efficient Private Sector Involvement

During the mid-term period from 2019 to 2024, there will be a wide range of preparatory activities of the outsourcing by GWMC in the form of the service contract with the selected private service provider, which will be actually carried out from 2028 with the following actions:

- To prepare for the procedures required for the tender practices for the service contract;
- To prepare for the monitoring of the financial performance of the selected private service provider by the KPIs which are separated from those of GWMC;
- To prepare for the establishment of the auditing services for the selected private service provider; and
- To plan the scope of the outsourced service zone.

The monitoring system which contributes to the feedback mechanisms for improving the performance of the selected service provider will be arranged during the mid-term period.

The following financial KPIs for the selected service provider should be established apart from the KPIs for GWMC:

- Degree of meeting contractual level of quality of SWM services;
- Degree of meeting contractual frequency of SWM services;
- Waste collection rate;
- Charge collection rate;
- Degree of cooperation for 3R activities;
- Contents of financial and activity reports;
- Number of grievances; and
- Degree of meeting other contractual requirements.

(e) Other Actions for Priority Projects

During the mid-term period from 2019 to 2024, the following actions should be taken for the implementation of the master plan:

- To continuously review the experiences of the LWMC’s service contract and the private sector involvement in other cities in Punjab; and
- To continuously study the situational analysis on the availability and capacities of private

service providers in the field of SWM services

(3) Long-Term Action Plan

(a) Priority Project for Sustainable Cost Recovery

During the long-term period from 2025 to 2030, the full-scale tariff system will be introduced in 2028, and, therefore, the cost recovery for the operation of SWM services will be partially attained. Accordingly, the cost recovery for the operation and maintenance costs in SWM services will be to the certain extent enhanced during the long-term period. The following actions should be taken for the sustainable cost recovery during the long-term period. In spite of the partial cost recovery, CDGG's financial support for the recurrent cost as well as the provincial government's subsidies for the investment cost will be still required:

- To update the long-term cost recovery strategies for the operation and maintenance costs to provide the SWM service;
- To continuously operate the financial monitoring system through a wide range of the financial KPIs related to the cost recovery;
- To update the standard procedure for monitoring the cost recovery;
- To update the manual for the management of the cost recovery;
- To continue on-the-job training of GWMC's staff in charge of managing the cost recovery;
- To review the previous 6-year recurrent cost rolling plan and prepare the new 6-year recurrent cost rolling plan to request CDGG for the budgetary arrangement ; and
- To review the previous 6-year capital investment rolling plan and prepare the new 6-year investment cost rolling plan to request the provincial government for the budgetary arrangement

Based on the tariff actually collected, the actual cost recovery level should be accordingly updated. The gap between the actual operation and maintenance cost and the tariff actually collected should be replenished the revenue from the subsidies or the provincial property tax revenues from the provincial government.

(b) Priority Project for Accurate Total Costing

During the long-term period from 2025 to 2030, in response to the actual introduction of the tariff system, the cost centre of GWMC is requested to implement its full-scale operations with the following activities:

- To make the cost centre function well to accurately and continuously update the total cost for SWM services;
- To update the latest operating costs for SWM services;
- To update the latest maintenance costs for SWM services;
- To update the break-even point analysis as well as the breakdown of the operating costs by fixed costs and variable costs;
- To update the average cost and the marginal cost per unit amount of the disposed wastes;
- To continuously implement the cost minimisation plan of GWMC;
- To fully make use of the operation manual for the standard procedures for the cost centre; and
- To continue the training of staff of the cost centre for estimating various costs for SWM services.

It is extremely important for the cost centre to identify the costs in the long-term period in which the tariff will be actually imposed, thereby updating the planned cost recovery rate under the official tariff charging system. At the same time, the cost minimisation plan by GWMC is critical for transparency and accountability of the tariff system, since the tariff will be actually charged on users during the long-term period.

(c) Priority Project for Proper Tariff Introduction

During the long-term period from 2025 to 2030, the proposed tariff system will be actually introduced to partially cover the operation and maintenance cost for SWM services. The said partial cost recovery will be started from 2025 with the following activities related to the introduction of the proper tariff system:

- The partial and test introduction of the tariff system under the selected option from 2025 only in middle-income and high-income areas;
- The full-scale introduction of the tariff system under the selected option from 2028 in all areas;
- To explore the possibility of outsourcing the tariff collection services;
- To continuously update the survey on ATP and WTP;
- To monitor the users' grievance on the tariff collection practices;
- To smoothly transfer the property tax surcharge to GWMC; and
- To continuously train the staff in charge of collection of user charges.

The trial introduction of the tariff system from 2025 will be carried out only in middle-income and high-income areas, while the full-scale introduction of the tariff system will be implemented from 2028, the latter half of the long-term period. The collection efficiency as well as the actually collected amount of user charges will be continuously monitored for verifying the optimum tariff level for the full cost recovery of the operation and maintenance cost during the long-term period. The tariff level should be also adjusted to the total cost including the outsourcing costs for the collection and transport services to the selected private service provider.

(d) Priority Project for Financially Efficient Private Sector Involvement

During the long-term period from 2025 to 2030, the outsourcing by GWMC in the form of the service contract with the selected private service provider will be actually carried out from 2028 with the following actions:

- To manage the tender procedure for the service contract;
- To monitor the financial performance of the selected private service provider by the financial KPIs which are separated from those of GWMC;
- To provide the auditing services for the selected private service provider; and
- To properly manage the outsourced service zone.

The pre-contract requirements for a zone-wise service contract for waste collection and transport services are the management of the complicated tendering procedures for the private sector involvement. Especially, it is crucial to secure the following 7-step processes of preparing for the service contract:

- Step 1: Preparation for expression of interests and pre-qualification of bidders
- Step 2: Preparation of tender documents
- Step 3: Preparation of the bid
- Step 4: Clarifications and feedbacks to tender documents
- Step 5: Bid bond
- Step 6: Submission of bids
- Step 7: Selection of the private service provider

Effective performance monitoring requires that the GWMC monitors whether or not the service is actually and properly being delivered by the selected service provider in the financially sound manner. The staff of the MIS unit inside GWMC should monitor the performance of the private service provider on the regular basis.

After the long-term period, the private sector involvement through the partial outsourcing of the collection and transport services will be comprehensively reviewed to achieve the long-term sustainability of the private sector involvement in future. This review requires the continuous performance monitoring of the selected service provider for the future expansion of the outsourced zones.

(e) Other Actions for Priority Project

During the long-term period from 2025 to 2030, the following actions should be taken for the implementation of the master plan:

- To continuously review the experiences of the LWMC's service contract and the private sector involvement in other cities in Punjab; and
- To continuously study the situational analysis on the availability and capacities of private service providers in the field of SWM services.

5.7 Environmental and Social Considerations

5.7.1 Necessity of Environmental Monitoring

The environmental management is essential to specify the monitoring work for finding problems and improvement points that would be predictable in the field of the disposal sites, namely Bhakhlaywali, Gondlanwala and Chianwali, collection and transport, and composting. Contents of monitoring listed and implementation schedule is presented at the end of this section.

Regarding the new landfill site at Bhakhlaywali, GWMC, the responsible agency of the landfill management, will prepare quarterly environmental compliance and a project performance report in order to foresee the environmental and social impacts of the new landfill site. Major issues of the internal reports are health, safety, and environmental performance of the landfill site. The reports must be filed as a part of project archives and environmental database as an EIA Report.

In EIA, specific environmental monitoring items are recommended to be measured by professional environmental consultancy. Proposed items are air quality, water quality, noise level, smelly gas (landfill gases), treated wastewater effluent, leachate, vegetation/plantation, and safety and traffic. Most of these items should be monitored quarterly except for vegetation and plantation, and safety and traffic that are measured annually as shown in **Table 5.7.1**. This proposed plan seems to be an operation phase of the proposed landfill site.

However, detail of Environmental Monitoring Plan is not shown in the EIA report, one of proposed Environmental Monitoring in the landfill site is described in the following **Subsection 5.7.2**.

Table 5.7.1 Proposed Environmental Monitoring Plan in EIA Report for Bhakhlaywali

Environmental Component	Parametres	Standard	Frequency
Ambient Air Quality	SPM, PM_{10}, SO_2, NO_2, CO, CO_2, Vapors	NEQS	Quarterly
Groundwater Quality	pH, Temperature, TDS, Conductivity, Fluoride, Nitrate, DO, Hardness, Turbidity, Color, Chloride, Arsenic, etc.	NEQS	Quarterly
Noise Level	dB(A)	NEQS	Quarterly
Smelly Gases (Landfill Gasses)	SO_2, H_2S, CH_4	NEQS	Quarterly
Treated Wastewater Effluent	BOD, COD, TOC, TSS, DO, Chloride, Sulphate, Turbidity, Conductivity, Oil and Grease, Color, TIN, Heavy metals	NEQS	Quarterly
Leachate	BOD, COD, TOC, TSS, DO, Chloride, Sulphate, Turbidity, Conductivity, Oil and Grease, Color, TIN, Heavy metals	NEQS	Quarterly
Vegetation and Plantation	Visual inspection of plant species survival rate and status of maintenance	N/A	Annual Report
Safety and Traffic	1) Inspection of Signage 2) Faulty, overloaded and speeding of vehicles	N/A	Annual Report

NEQS: National Environmental Quality Standard, Pakistan
Source: EIA Report

5.7.2 Environmental Monitoring for Final Disposal Site

(1) Monitoring of Leachate and Surface Water

Water quality of leachate and surface water is one of the most important factors in environmental monitoring for the final disposal site and shall be monitored and analysed periodically in order to determine the conditions of the landfill and the potential impact to the environment. The water quality data of leachate can also be used to determine the state of stabilisation of the landfill.

(a) Monitoring Points of Leachate and Receiving Water Body

Monitoring point(s) of leachate shall be the outlet point(s) of leachate from the landfill site and outlet point(s) of leachate treatment facilities and/or recirculation facilities. In addition, several monitoring points shall be determined at the water receiving body to check the influence of discharge of leachate. The recommended leachate monitoring points are indicated but not limited to the following sites:

Raw Leachate Quality

- Outflow/Outlet points from the landfill site or influent water of the leachate treatment/recirculation facilities
- Leachate of instantaneous and total flows must be recorded according to Punjab Solid Waste Management Guidelines (2011).

Treated/Recirculation Leachate Quality

- Outlet points of leachate treatment/recirculation facilities or effluent water

Leachate Influence to the Water receiving Body

- Upstream and downstream side of outfall of leachate to the water receiving body

(b) Sampling/Monitoring Conditions

Leachate quality shall be monitored periodically at the regular sampling points. In addition, the leachate quality under the maximum/minimum flows shall be monitored. Sampling day of leachate for periodical/regular monitoring may be determined on a day after consecutive fine/cloudy days or more than 24 hours after stop of falling rain to minimise the influence of rain.

The conditions of monitoring/sampling shall be recorded to include at least the following conditions:

- Name of person in charge
- Name of sampling points
- Date and time
- Weather conditions
- Water temperature and ambient temperature
- Flow rate as required
- Photos of sampling work

Table 5.7.2 shows the required parametres that are described in the EIA report and recommended parametres as well. The water quality parametres shall be analysed by the accredited laboratory.

Table 5.7.2 Parametres for Leachate Monitoring

	Parametres Specified in EIA Report*	Recommended Parametres
General Items	COD, BOD_5, Total Suspended Solids, Electric Conductivity, Oil/Grease, Sulohate, Turbidity, Color, TIN	Water Temperature, pH, Settleable Solids, Total Dissolved Solids, Surfactants (MBAS), Phenolic Substances as Phenols, Total Coliform Count
Heavy Metals	Name of parametres are not specified	Arsenic, Cadmium, Chromium (hexavalent), Cyanide, Lead, Mercury (Tot.), PCB, Formaldehyde

Source: EIA report

(c) Frequency of Monitoring

The minimum frequency of monitoring of leachate is four (4) times in a year or quarterly basis.

(2) Monitoring of Groundwater Quality

Poor lining system and inappropriate leachate control will cause a potential contamination source of groundwater quality. A sign of groundwater contamination appears to the change of water quality parametres. Accordingly, the groundwater quality shall be monitored periodically for the representative water quality parametres and analysed series of recorded data to grasp a significant change of groundwater quality.

(a) Monitoring Points of Groundwater

Monitoring of groundwater should consist of the following items according to the Punjab Solid Waste Management Guidelines (2011):

- At least one groundwater monitoring well should be installed hydraulically above the gradient of the landfill and at least three monitoring wells should be installed hydraulically below the gradient direction;
- The monitoring well system should include a sufficient number of multi-level well nests for measurement of vertical gradients;
- Locations of the monitoring wells should be sufficiently close to the active disposal area to allow early detection of contamination and implementation of remedial measures; and
- The monitoring wells are to be retained throughout the lifespan of the facility.

(b) Sampling/Monitoring Conditions

Groundwater quality shall be monitored periodically under the maximum/minimum groundwater table. Special sampling tools shall be used to take the groundwater to meet with the type of wells and springs. Specified parametres in EIA are pH, Temperature, TDS, Conductivity, Fluoride, Nitrate, DO, Hardness, Turbidity, Colour, Chloride, and Arsenic (see **Table 5.7.2**).

(c) Frequency of Monitoring

Frequency of monitoring of groundwater shall be at least on quarterly basis. Water quality parametres shall be determined with reference to the drinking water quality.

(3) Monitoring of Landfill Gases

Landfill gasses include harmful substances such as hydrogen sulphide, methane gas, etc. Monitoring of landfill gasses is essentially required to protect the health and safety of operation staff and the neighbouring residents. The concentration and odour from the gasses shall be monitored and analysed periodically in order to grasp the conditions of the landfill and the potential impact to the environment. The data can also be used to determine the state of stabilisation of the landfill.

(a) Monitoring Points

Monitoring of landfill gasses shall be made at the final disposal site and the detailed measuring points will be decided in the action plan.

(b) Sampling/Monitoring Conditions

Monitoring of landfill gasses shall be carried out by a portable gas detector, sampling at site and laboratory analysis. Special monitoring on a calm day after the rain may be required. The monitoring/sampling conditions shall be recorded in conformity with the requirements stipulated. Specified parametres in EIA are hydro sulfide (H_2S), methane gas (CH_4) and ammonia (NH_3).

(c) Frequency of Monitoring

Frequency of monitoring of landfill gasses shall be at least on a quarterly basis. In addition, the daily observation of odour and gas by smelling is important for the operators during implementation of the landfill work.

(4) Monitoring of Odour

The landfill activities should be carried out properly and managed effectively to reduce the emission of the unpleasant odour and minimise the impact to the surrounding residents.

(a) Monitoring Points

The state or degree of unpleasantness can only be determined by smelling the air depending on the prevailing atmospheric conditions. The measurement of odour can only be expressed in distance from the source where the odour can be detected.

(b) Sampling/Monitoring Conditions

The smell or unpleasantness will have to be determined by odour concentration and substance, i.e., how bad it smells and what does it smell like.

(c) Frequency of Monitoring

Offensive odour shall be monitored daily by smelling or as-and-when necessary for some specific offensive odour substances as long as it is not having a major impact or nuisance to the communities.

(5) Monitoring of Noise and Vibrations

The landfill activities should be carried out properly and managed effectively to reduce the excessive noise and vibration caused by the vehicles and operation of machinery and landfill equipment. The noise and vibration levels should be minimal and comply with the relevant regulation as set out for the protection of occupational safety and health. The measurement method must be in accordance with internationally accepted protocols and procedures.

(a) Monitoring Point

The noise and vibration monitoring measurement should be carried out at or near the generation source. Other monitoring locations could be along the perimetre of the landfill or at nearby residential areas.

(b) Sampling/Monitoring Conditions

Sampling and monitoring conditions for noise and vibration shall be decided in the action plan.

(c) Frequency of Monitoring

The recommended frequency of monitoring should be carried out not less than once a year. Quarterly monitoring is recommended in the EIA.

5.7.3 Environmental Monitoring for Post-Closure of Final Disposal Site in Gondlanwala and Chianwali

Post-closure monitoring shall be applied for Gondlanwala and Chianwali sites after the completion of the safety closure process. According to the Punjab Solid Waste Management Guideline 2011, the duration of post-closure monitoring is 25 years, and the specified monitoring items are groundwater, surface water, landfill gas, and erosion and settlement. Frequency of monitoring is not mentioned in the Guideline, so that it can be suggested once in a year. Monitoring method and sampling point is same as the operational phase.

5.7.4 Environmental Monitoring for Collection and Transport Work

For the collection and transport work, a clean environment around garbage containers is important. Dirty environment with garbage scattered around the containers takes more time for collection and transport compared to the container and its neighbouring area kept clean. Another problem is that dirty containers and unsanitary environment around the container can be the origin of foul odour and vectors.

Waste separation at household level is essential for separate collection and intermediate treatment. Practice of waste separation at household level will be gradually increased during implementation of the Master Plan. Therefore, ratio of waste separation at household level is recorded periodically, and the monitoring result shall be utilised for the planning of awareness programme.

(1) Monitoring of Cleanness of Garbage Container

(a) Monitoring Points

All or selected garbage containers in Gujranwala will be monitored.

(b) Sampling/Monitoring Conditions

Sanitary workers and UC members in each area can be in charge of this monitoring. Problems and feedback will be given to residents by UC members.

(c) Frequency of Monitoring

The recommended frequency of monitoring is daily.

(2) Monitoring of Waste Separation at Household Level

(a) Monitoring Points

Monitoring points shall be selected in the Urban and Pre-Urban areas. Different type of areas should be monitored, such as high/low density area.

(b) Sampling/Monitoring Conditions

Samples are selected by gender, age, income level, and area.

(c) Frequency of Monitoring

The recommended frequency of monitoring should be annually. Residents practicing waste separation in their household will be interviewed. Whether or not the respondent agrees or disagrees with waste separation, his reason or opinion shall be utilized for the awareness programme.

5.7.5 Environmental Monitoring for Intermediate Treatment (Compost Facility)

In this section, the environmental monitoring of intermediate processes is discussed, especially about the compost facility. Basically, the compost facility is harmless to the environment, and not dangerous in the labours working process. However, drainage water and odour (ammonia) from the facility shall be monitored.

(1) Monitoring of Drain Water from the Facility

(a) Monitoring Points

Several points of the drainage connected to the compost facility shall be monitored.

(b) Sampling/Monitoring Conditions

Water samples shall be tested and evaluated in accordance with the National Environmental Quality Standards for municipal and liquid industrial effluents. Sampling and monitoring conditions for drains will be decided in the action plan.

(c) Frequency of Monitoring

The recommended frequency of monitoring is quarterly, probably the same with the quarterly monitoring in the landfill site.

(2) Monitoring of Odour (Ammonia Odour)

(a) Monitoring Points

The odour of ammonia shall be measured around the compost facility.

(b) Sampling/Monitoring Conditions

The measurement method must be in accordance with the internationally accepted protocols and procedures.Sampling and monitoring conditions for odour will be decided in the action plan.

(c) Frequency of Monitoring

The recommended frequency of monitoring is quarterly, probably the same with the quarterly monitoring in the landfill site.

5.7.6 Schedule of Monitoring

Monitoring is to be implemented in accordance with the schedule shown in **Table 5.7.3**. Timing of monitoring implementation is the same as the timing of service or start of operation.

Table 5.7.3 Implementation Schedule of Environmental Monitoring Plan

	Short-term			Mid-term						Long-term					
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
(1) Short-Term Plan (2016-2018)															
Monitoring of Collection and Transport	▨	▨	▨												
Monitoring of final disposal in Bhakhraywali			▨												
Post-Closure monitoring of Gondlanwala and Chianwali			▨												
(2) Mid-Term Plan (2019-2024)															
Monitoring of final disposal in Bhakhraywali				▨	▨	▨	▨	▨	▨						
Post-closure monitoring of Gondlanwala and Chianwali				▨	▨	▨	▨	▨	▨						
Monitoring of Collection and Transport				▨	▨	▨	▨	▨	▨						
Monitoring of Intermidiate Process (Compost Facility)						▨	▨	▨	▨						
(3) Long-Term Plan (2025-2030)															
Monitoring of final disposal in Bhakhraywali										▨	▨	▨	▨	▨	▨
Post-closure monitoring of Gondlanwala and Chianwali										▨	▨	▨	▨	▨	▨
Monitoring of Collection and Transport										▨	▨	▨	▨	▨	▨
Monitoring of Intermidiate Process (Compost Facility)										▨	▨	▨	▨	▨	▨

5.7.7 Planning Direction of the Master Plan

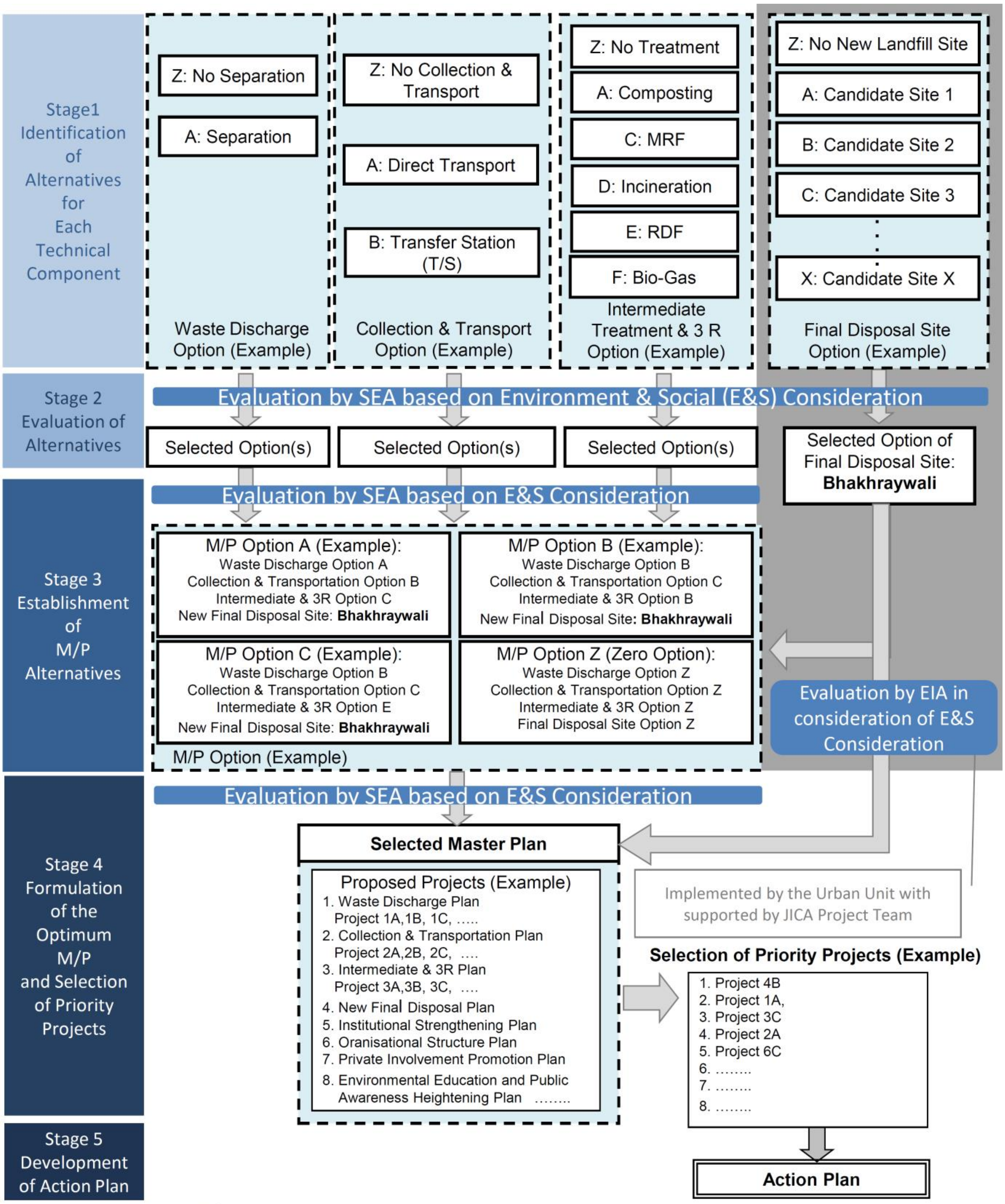
Since this Project involves the preparation of a master plan, the Strategic Environmental Assessment (SEA) principle is conducted on the IEE level (Category B of the JICA Guidelines) to apply for decision-making of planning. Though both EIA and SEA are the tools for assessment of environmental and social impacts, in most cases, EIA deals with impact from a single project. On the other hand, SEA deals with the comprehensive impacts of projects which cover a wide area (such as the master plan), and complicated impacts from a combination of plural projects, so that public consultation is significant.

One of the important principles in SEA is "Zero Option". SEA provides an alternative option for the project, and it always has to take into account the case of "no project" implemented in the process of preparing alternatives.

Figure 5.7.1 shows the planning direction of the master plan of this project. In the whole process, selection and decision-making, environmental and social consideration is carried out using the JICA Environmental Checklist for Waste Management.

Firstly, possible options are listed in each sector comprising the Master Plan, such as Collection and Transport, Intermediate Treatment and 3R, and Final Disposal Site. According to the SEA strategy, each section must have a "Zero Option" which means no action will be made. For example, "Collection and Transport" has the options of "Present Level Collection and Transport", "Direct Transport", "No Transfer Station for Mini-dumpers," and "No Intermediate Treatment Facilities and "No. 3R activities by GWMC", and so on.

Secondly, the best options are selected from each sector in terms of SEA. All the selected options are satisfied with the check items in Environmental and Social Considerations. Thirdly, some drafts of the Master Plan are formulated in combination with the options selected by the previous process. Needless to say, one of the drafts of the Master Plan is "Zero Option". Fourthly, the best Master plan is formed. The final stage is the preparation of "Action Plan". The Master plan includes many main and sub-projects which break the components of the Master Plan down to the feasible action level. Therefore, a schedule is necessary for alignment and timing of implementation of these main and sub-projects, and the projects with timetable is called the "Action Plan".



remarks)
SEA: Strategic Environmental Assessment
EIA: Environmental Impact Assessment
E&S Consideration: Environmental and Social Consideration based on JICA guidelines

Figure 5.7.1 Planning Procedure of the Master Plan with Environmental and Social Considerations

5.8 Institutional Strengthening and Organisation Plan

5.8.1 Development of Alternative for Institutional Strengthening and Organisational Plan

(1) Options for Private Sector Involvement

There is a wide variety of Public-Private-Partnership (PPP) options which can be implemented to make maximum use of the private sector involvement scheme. Out of the following options, the optimum private sector involvement plan will be selected.

Licensing (Private Subscription): Licensing or private subscription allows qualified private service providers licensed by an authority to compete for the delivery of solid waste management collection services in a specific zone. Under this arrangement, waste generators make contracts with individual private service providers. No firm has the monopoly in a specific zone, and each firm collects service charges from its customers or subscribers. The license is utilised to guarantee that a licensed service provider operates in accordance with the operational standards, and might be withdrawn if the service provider's performance is poor.

Service Contract: Service contract is a finite-term contract for a private firm to provide solid waste services, and an authority pays the firm for charges in response to the services to be delivered. Part of solid waste management services such as collection and transportation of wastes and management of a sanitary landfill site can be contracted out to a private operator for a certain period. In case of a service contract, collection vehicles are basically owned by an outsourced private firm, and a guaranteed payment from the authority to the service provider is clearly defined in the contract document. While the authority is responsible for charge collections, the service provider has to bear the operational risks.

Franchise: Franchise is a contract through competition in a finite-term to grant a private firm an exclusive monopoly to deliver a specific type of solid waste services within a specific zone. The awarded private franchisee directly collects its own revenue from waste generators within the designated zone. The franchisee pays a franchise fee to cover the authorities' costs of managing and monitoring the performance of the solid waste management services.

Management Contract: Management contract is a contract entrusting a specific solid waste management service under private management for a certain period of time, for which a management fee is paid to the management contractor. The management fee could be paid in accordance with the performance of the management contractor. Although a management contract could be an attractive first step to the full-scale private sector involvement, it does not directly lead to the investment on the improvement of solid waste management services due to the relatively shorter contract term. A management contractor is required to mainly focus on improving its services to existing customers rather than on enlarging the service coverage such as delivering the services to the lower-income area.

Lease Contract: Lease contract grants a private operator full control over delivering specific solid waste management services in exchange for use of the fixed assets whose ownership and responsibilities belong to the authority.

Concession: Concession is a long-term contractual arrangement in which a private operator is awarded an official license to provide specific solid waste management services over a longer period of time in exchange for a negotiated fee. A concession agreement stipulates the rights and obligations of the awarded concessionaire who retains ownership of the principal assets. Normally, during an average period of 25 years, the concession contract transfers all responsibilities for capital investment and operation and maintenance to a private concessionaire. While the fixed assets legally remain the property of the authority, the concessionaire might pay a fee to use them.

Build-Operate-Transfer (BOT) Contract and Its Variations: Build-Operate-Transfer (BOT) contract and its variations are options which are similar to concession and are primarily suitable for large-scale investments on facilities such as sanitary landfill sites. During a relatively longer period of up to 30 years, depending upon the size of the investment which has to be amortised, a BOT operator provides a wide range of solid waste management services in exchange for guaranteed service fees in the contract, although the operator accepts the risk to design, build and operate the facilities at the agreed standards of services in exchange for a guaranteed cash flow.

Full Privatisation: Full privatisation is the most radical form of private sector involvement in which existing operations and assets for the solid waste management services are sold to the private sector, in some cases, with a limited term license.

Table 5.8.1 shows a variety of possible PPP options with the comparison of asset ownership, operations and maintenance, capital investment, commercial risks and duration of contract.

Table 5.8.1 Comparison of Possible PPP Options

Option	Asset Ownership	Operations and Maintenance	Capital Investment	Commercial Risks	Duration of Contract
Service Contract	Public	Public and Private	Public	Public	1-2 Years
Franchise	Public	Public and Private	Public	Public	1-5 Years
Management Contract	Public	Private	Public	Public	3-5 Years
Lease Contract	Public	Private	Public	Public and Private	8-15 Years
Concession	Public	Private	Private	Private	25-30 Years
BOT and Its Variations	Public and Private	Private	Private	Private	20-30 Years
Full Privatisation	Private or Private and Public	Private	Private	Private	Indefinite

Source: Public-Private Partnership Handbook, Ministry of Finance, Singapore, 2004

Out of the above possible options, the BOT-related PPP options have a wide range of varieties and can be applied in different forms to different phases and facilities of solid waste management services. **Table 5.8.2** shows possible BOT-related PPP options with the comparison of asset ownership, operations and maintenance, capital investment, commercial risks and duration of contract.

Table 5.8.2 Comparison of Options for BOT and Its Variations

Acronym	Name of Option	Brief contents of the option
DB	Design-Build	One entity enters a contract with the owner to provide both architectural/engineering design services and construction services.
BOT	Build-Operate-Transfer	A concession is granted to a constructor to design, finance, maintain, and operate a facility for a period of time. The constructor recoups the cost of the project by collecting tolls during the life of the concession period.
BTO	Build-Transfer-Operate	A private developer finances and builds a facility and, upon completion, transfers legal ownership to the sponsoring government agency. The agency then leases the facility back to the developer under a long-term lease. During the lease, the developer operates the facility and earns a reasonable return from user charges.
BOOT	Build-Own-Operate-Transfer	Ownership of the facility rests with the constructor until the end of the concession period, at which point ownership and operating rights are transferred to the host government.
BOO	Build-Own-Operate	Resembles outright privatisation. Projects of this type are often let with no provision for the return of ownership to government.

Acronym	Name of Option	Brief contents of the option
DBO	Design-Build-Operate	The contractor is responsible for the design and construction of a facility. Upon completion transfer of legal ownership to the sponsoring government agency. The contractor is also responsible for Operating and Maintaining the facility for the stipulated period.
DBFO	Design-Build-Finance-Operate	A constructor is responsible for the design, construction, maintenance, and financing. The constructor is compensated by specific service payments from government during the life of the project.
BLTM	Build-Lease-Transfer-Maintain	In this type of arrangement, a facility is typically designed, financed, and constructed by the private sector and is then leased back to government for some predetermined period of time at a pre-agreed rental.
LROT	Lease-Renovate-Operate-Transfer	This model is for facilities that need to be modernised. The private sector constructor pays a rental to government and agrees to renovate the facility. In exchange, the constructor is granted a concession to operate the facility for a fixed period of time and to charge a fee for the service.

Source: NETAP Regional Solid Waste Management Project: Regional Guideline

5.8.2 Evaluation of Alternatives

(1) Criteria for Selecting Optimum PPP Scheme

The following criteria are employed in an attempt to select the best and optimum option for the private sector involvement scheme in providing the solid waste management services. However, when applying these criteria, the current site-specific conditions of Nairobi City should be carefully taken into account. Choosing the optimum private sector involvement option is one of the most crucial decisions before formulating the organisational and legal contents of the Master Plan as it indicatively defines the major conditions between the public sector and private sector. However, as the decision-making process depends on various factors, no substantial solution can be applied. A broad range of the past experiences indicate that a mere copying of approaches that have been successful in other countries will tend to fail when they are not properly adapted to the local and site-specific situation.

Effectiveness: Effectiveness is the quantitative degree of increasing the service coverage and qualitative significance of improving the quality of services through involving the private sector.

Competition and Efficiency: By using the private sector expertise and experiences on cost saving, the private sector involvement will significantly improve the efficiency of SM services through a competitive business environment.

Accessibility to Capital Investment: The private sector involvement can enlarge the access to capital and financial resources for procurement of collection vehicles as well as human capital for expertise and skills.

Accountability and Transparency: Accountability and transparency under the private sector involvement depends on the degree to which the procurement process is open to competitive market forces.

Sustainability: By properly sharing the risk factors between the public sector and the private sector, the private sector involvement will sustainably function in the long run.

Equity: The level of equity in universally providing SWM services to all uses under the private sector involvement is also one of the important evaluation criteria.

However, when applying the above criteria for selecting the optimum private sector involvement option, the current site-specific conditions of Gujranwala City and beneficiaries should be carefully taken into account. For example, it has been already found that the willingness to pay for SWM services in Gujranwala is relatively lower than in Lahore. Therefore, it is easily envisaged that the full-scale private sector involvement option which requires the introduction of the relatively higher level of the user charging system will be rather difficult in Gujranwala where beneficiaries' willingness to pay is low.

Since the selection of the optimum private sector involvement option is closely related to the formulation of the appropriate organisational and legal mechanisms for providing the sustainable SWM services, the success of the private sector involvement by LWMC should not be simply replicated by GWMC. In this sense, the progress of the consultancy works rendered by LWMC in the field of the private sector involvement should be carefully monitored in the course of the subsequent study.

(2) Factors to Consider for Designing Optimum PPP Scheme

The following factors should be carefully taken into account in designing a full-scale private sector involvement plan.

Duration of Contract: The contract period should be in such a term which allows the depreciation of vehicles and equipment used to achieve the service level in the contract. A limited contract period would be a disincentive for the service provider to make investment on new and replaced vehicles as it feels the risk of termination of the contract before depreciating vehicles and repayment of its loans.

Mitigation of Long-Term Risk: Although the duration of a contract should be reasonably long, another risk on the contract term to be considered would be the long-term contract risk. If a private service provider is awarded a long-term contract, it might put the private company into a monopoly position so that there will be no alternative service providers where it is rather difficult for the authority to keep the service level satisfactory.

Step-wise Approach: It is better to start the private sector involvement with a step-wise approach, and expand the degree of the involvement of private companies in a gradual manner, so that the financial and service-quality risks by the private sector involvement can be minimised and subsequent contractual arrangements can be modified to improve the performance of the private operator.

Continuous Competition: Competition is widely regarded as a key to successful private sector involvement. Continuous competition in the tendering process ensures competitively-priced services by the private service provider. It is beneficial to divide a large-scale city-wide service into several zone-based contracts so that there will be competition among the private service providers. If private service providers compete with each other in different zones, the performance and level of services can be compared, and if one service provider fails, others can take over the service.

Size of Zone: It is also important to take into account the size of the service zone to be outsourced to a private service operator.

(3) Selection of General Framework for PPP

(a) Service Contract for Collection and Transport

GWMC once tried to introduce the service contract following the LWMC model. However, due to the following reasons, GWMC gave up outsourcing and continues to provide collection and transportation service directly.

One reason is too little population for scale of economy to work. As a result, for a contractor to make a profit the contracting amount has to be relatively higher than that of LWMC. Thus, it is necessary to wait for the population of Gujranwala to reach a certain level where economy of scale works. Taking into account of the Lahore case where one collection and transportation zone has approximately 4 million population, it is advisable to start outsourcing in 2022 when the population of Gujranwala reaches approximately 4.6 million according to population projection.

Another reason is very cheap local cost compared to outsourcing cost to a foreign company, not only because the market of Gujranwala is too small for economy of scale to work, but the local cost of labour is fundamentally cheap in Gujranwala. Currently, there is no private provider for collection and transport. This means that if GWMC outsources the service, it is necessary to contract out the service to a Lahore or international company whose service is far more expensive than that of direct service. Thus, for now it is cheaper for GWMC to provide the service directly. However, as the production of machinery and equipment is localised and gets cheaper, it is possible for Lahore or international companies to provide service at cheaper rate in the future.

The last reason is too low willingness to pay. According to the survey, it is less than 50 rupees per month which is too little for the private sector to run its business. In order to introduce outsourcing, public awareness raising is essential. Thus, targeting at the year of 2022, it is quite important to carry out awareness raising programme intensively so that WTP will at least reach the level where outsourcing is possible.

Considering the reasons mentioned above, it is recommended to introduce ***service contract for collection and transportation service***. The service contract may be the key instrument used in municipal SWM after the operations are unbundled, enabling the municipality to let areas or parts of the service to small- and medium-sized enterprises. In relation to SWM, a service contract is often a preferred method of contracting an operator for collection services in middle-income areas.

The service contract is not ambitious: It is often short in duration (1-3 years), and control is still firmly lodged with the municipality. Duration must be sufficient to allow contractors to fully write-off the cost of any equipment purchased (such as collection vehicles). Conversely, the duration will determine the level of investment and therefore the standard of service provided.

The municipality retains ownership and control of all capital assets and property, and must finance fixed assets and working capital. The municipality establishes the performance criteria, evaluates the bids, selects and supervises the contractor and monitors the work to be carried out to ensure the contractor meets the performance specification. For the contracting of solid waste collection services (that do not always raise revenue), the municipality must ensure that it has sufficient revenue to pay the contractor, This must be calculated to include depreciation, interest on borrowing, salaries, consumables, insurance and profit.

Under the service contract, the contractor is normally responsible for managing personnel and services. To ensure the service contract results in greater efficiency, it should be awarded through competitive bidding, and this can be compared against the public sector costs through a benchmarking process. The selected contractor is obliged to carry out the service to the specification established in the agreement, and agrees to a fee for the service on a lump sum, unit cost or other basis. Unlike more complex form of private sector participation, to the contractor, the municipality is still the client and the source of payments. The commercial risk for the private operator is that the municipality may default on payment.

The service contract is relatively simple to arrange, resembling the traditional construction contracts with which municipal engineering departments are familiar. The service contract does not bring with it the risk, and therefore does not need the complex regulatory environment critical to the concession. Municipalities are therefore able to embark on improvements much more quickly and not be concerned with the impact of the operating environment outside their control. The short duration means they can review the work done and make decisions easily, and the timeframe can adapt to electoral cycles.

(b) Direct Management by GWMC of Final Disposal

For final disposal, management of new landfill site, it is recommended to keep ***the direct management by GWMC***. It is because the private sector tends to prioritise the economic benefits to environmental protection. Naturally, the private sector pursues to maximise its profit by minimising the cost which, in this case, the management cost of landfill site. As a result, poorly managed landfills have the potential of causing a number of issues. One is pollution of the local environment such as contamination of groundwater or aquifers or soil contamination by leachate. The local roadd and water courses can also be contaminated by wheels of collection vehicles when they leave poorly managed landfills. Another is de-facto open dumping. This may occur if the private sector accepts waste without limit and keep it for a long time.

(c) BOT for Intermediate Treatment

Currently, composting is not a common practice in Gujranwala. Due to the lack of awareness and understanding on compost, the market price of compost is low compared to its production cost. As a result, farmers are not willing to produce compost. However, composting is globally well recognised environmentally friendly practice with no side effect. This means once residents realise its benefit and usefulness, it is possible for the private sector to make profit. Therefore, in order to promote composting, public involvement is essential. Thus, for composting, ***BOT between GWMC and the private sector*** is recommended. Following the case of Lahore, GWMC should provide a land and certain amount of organic waste in return for a certain percentage of the annual profit. The same can be applied to the RDF plant.

5.8.3 Identification of Priority Projects for Institutional and Organisational Plan

(1) Organisational Restructuring

(a) Organisational Restructuring

In order to implement the Master Plan, it is necessary to restructure and strengthen the organisation of GWMC. Basic direction is summarised as follows.

Strengthening of Operation (Field) Unit

As the zone coverage of waste collection and transportation expands from 8 to 16 zones, it is necessary to increase senior (Sr.) managerial positions from two (2) to four (4) and assistant (Asst.) managers from 11 to 28, as shown in **Table 5.8.4** below.

Table 5.8.3 Proposed Number of Staff in the Operation Unit

Number of Personnel	Position	Responsiblity
4	Sr. Manager	4 zones for each Sr. Manager
20	Asst. Manager	1 zone for each Asst. Manager plus 4 additional zones
6	Asst. Manager	Road: 4 Asst. Managers in urban and 2 in rural area
2	Asst. Manager	Maintenance

Establishment of Manager Complaint Management under GM Operations

Currently, the Manager Communication Unit is in charge of complaint management. It is recommended to establish a Manager Complaint Management Unit to be in charge of the call centre which is directly under GM Operations. In this way, GM Operations can handle complaints directly and thus promptly. In addition, this call centre function should be outsourced and the Manager Complaint Management Unit concentrate on management and supervision.

Establishment of Intermediate Treatment Unit under Operations Department

Though full privatisation is proposed by the MP, it is still necessary for GWMC to supervise intermediate treatment facilities such as compost and RDF plants. Accordingly, it is recommended to rename the Sr. Manager for Landfill position into Sr. Manager for Disposal position and establish the Asst. Manager for Landfill and Asst. Manager for Intermediate Treatment positions under him/her.

Establishment of Communication Unit under GM Operations (Shift from Human Resources & Administration Department)

The Master Plan emphasises the necessity of public awareness raising especially at schools. It is advisable to establish the Environmental Education Unit led by the Assistant Manager for Environmental Education specifically in charge of public awareness raising. Another Assistant Manager (for Public Relations) shall concentrate more on general public communications such as media relations.

Strengthening of P&C Department for PPP Introduction of Collection and Transport

The population of Gujranwala is predicted to reach 4.6 million in 2025, which is almost equivalent to that of one waste collection zone in Lahore. Thus, it can be said that it is feasible to introduce the service contract system for waste collection and transportation since the economy of scale starts to function at this population level. Accordingly, it is necessary to assign one Sr. Manager for PPP and three (3) Asst. Managers for PPP to handle this system.

Establishment of Monitoring & Evaluation Department under GM

The Monitoring & Evaluation Department should be totally independent from other departments to carry out its function as a focal point to check performance of GWMC. It is advisable to assign three (3) Managers in charge of 1) KPI, 2) Finance and 3) Environmental monitoring. In order to establish a mechanism of feedback, it is also recommended to have regular meetings of Directors to review the monitoring results and to take countermeasures.

The organograms of years 2018 (start of the Master Plan), 2022 (start of preparation of service contract and tariff charging system) and 2030 (completion of the Master Plan) are shown in **Figure 5.8.1** to **Figure 5.8.3** .

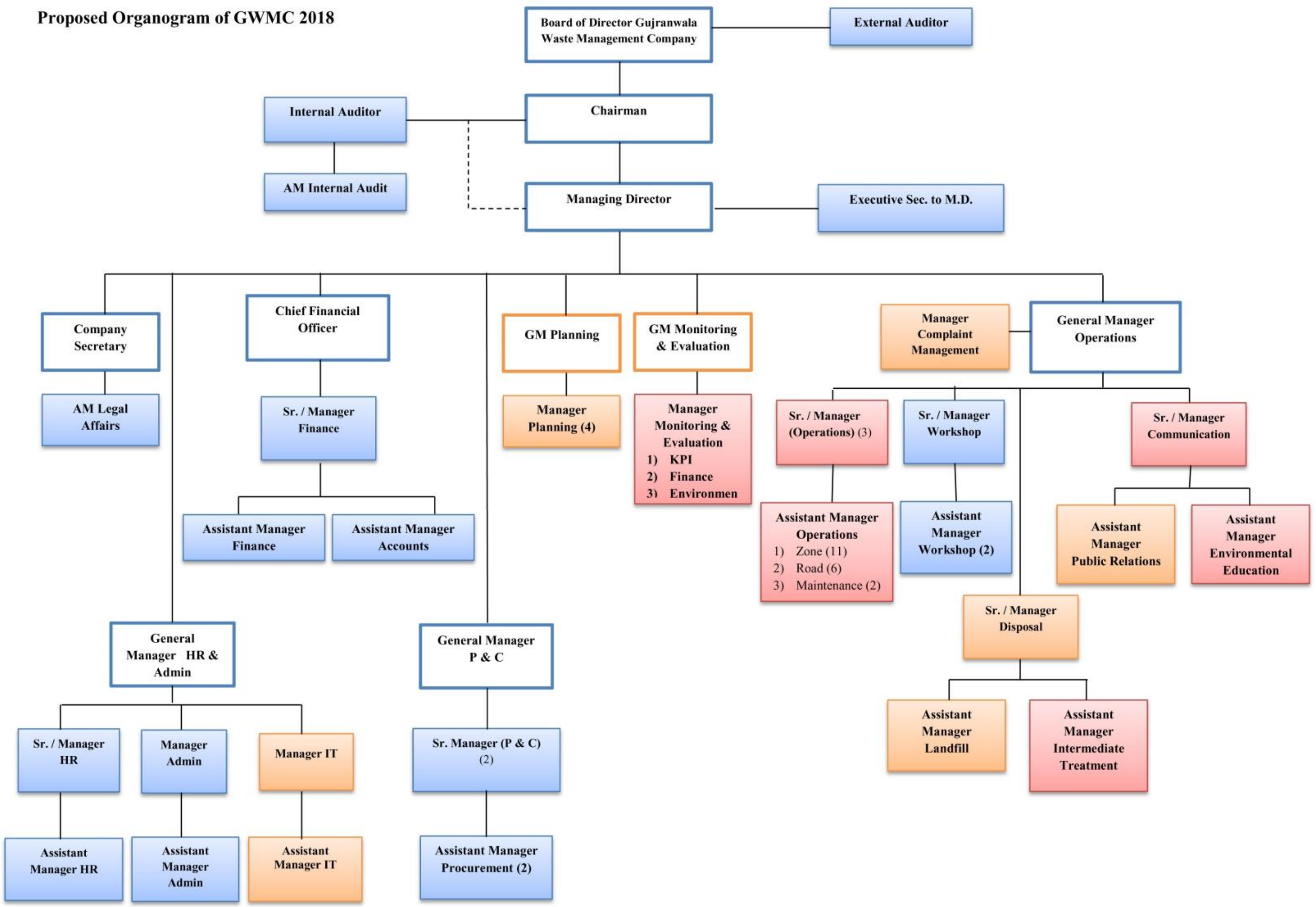


Figure 5.8.1 Project Organisation of GWMC 2018

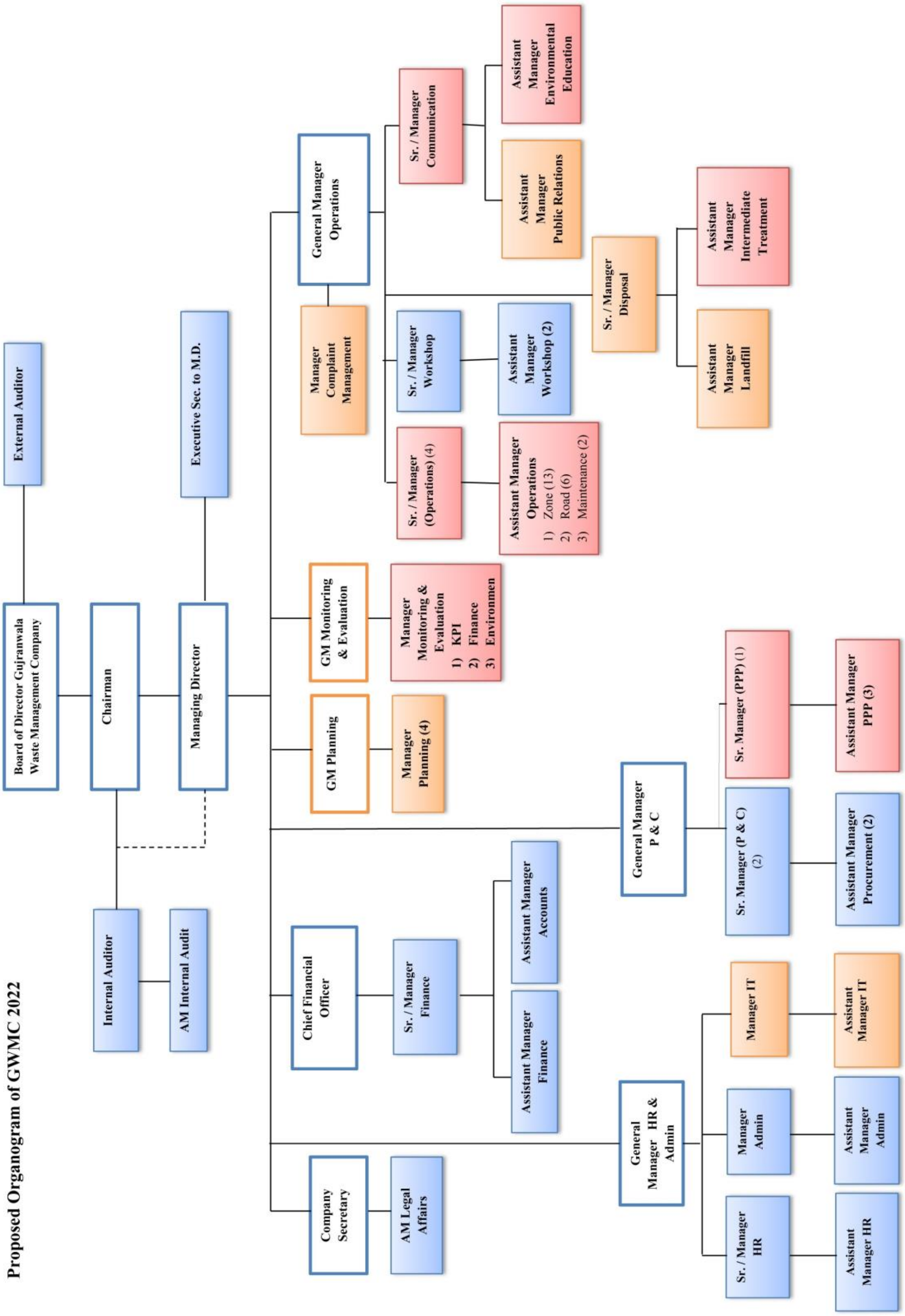
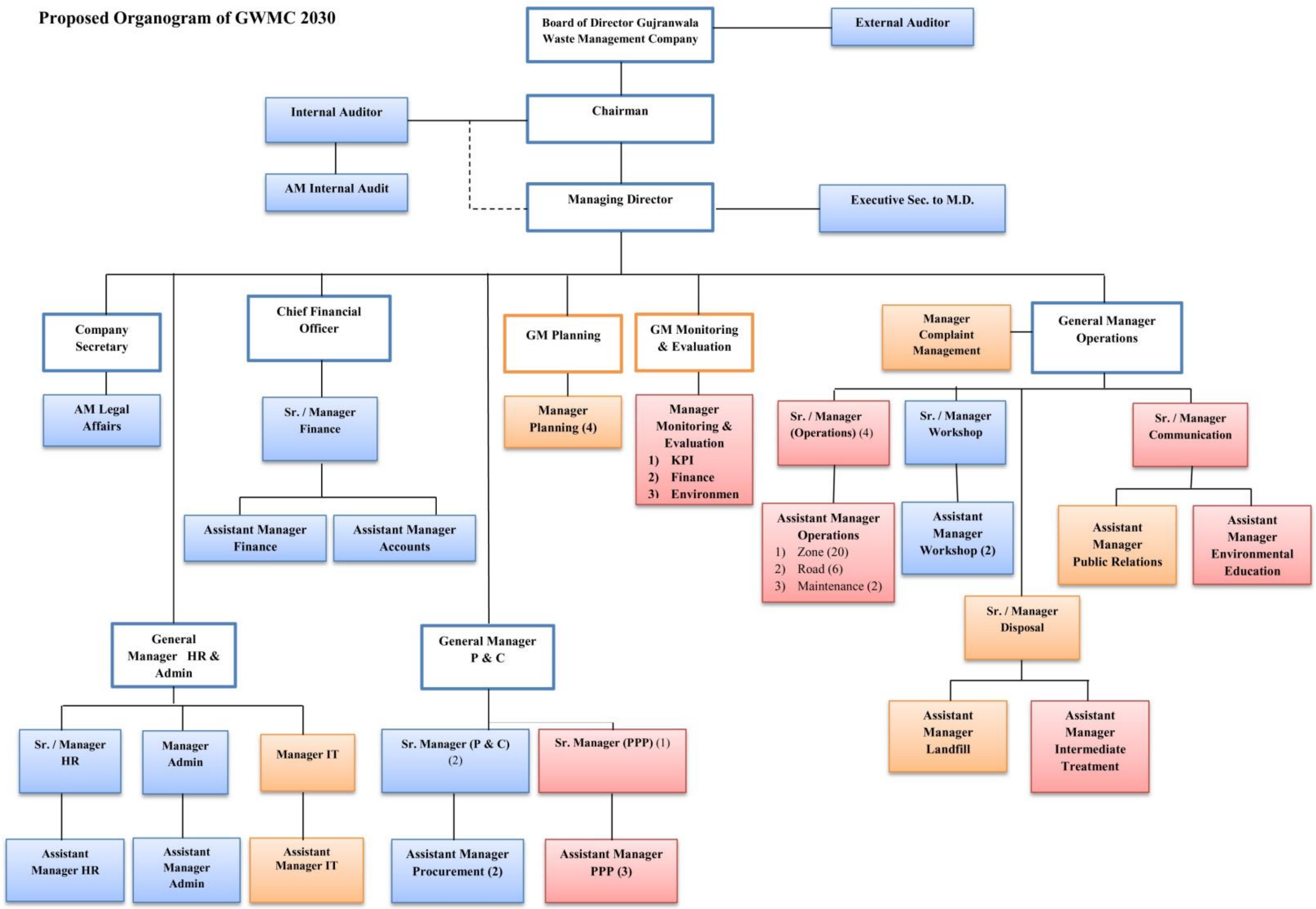


Figure 5.8.2 Project Organisation of GWMC 2022



Proposed Organogram of GWMC 2030

Figure 5.8.3 Project Organisation of GWMC 2030

(b) Improvement of Working Environment for Managerial Staff

Currently, GWMC is suffering from the lack of human resources as well as the capacity of existing human resources. Most of competent persons prefer to work in Lahore than in Gujranwala. Thus GWMC must overcome this challenge. In order to attract human resources with adequate expertise on solid waste management in this competitive market, the working environment must be attractive enough. Therefore, it is advisable to introduce the following systems:

(i) Performance Based Salary

Currently, GWMC just adapted the LWMC salary scale and there is an annual salary increase automatically. This situation can be described as socialistic. Therefore, in order to motivate staff by bringing in competition and eventually providing better service, GWMC should come up with its own salary scale and performance measurement system. As a result, staff working harder can receive higher salary and feel more appreciated. In this way, GWMC should grow out from seniority to merit oriented system and enjoy fresh blood.

(ii) Provision of Social Welfare and Old Age Benefits to Secure the Minimum Quality of Life of Workers

In addition to awarding outstanding performance, it is also important to provide enough social welfare in order to secure the minimum quality of life of staff. In this way, workers can concentrate on working and not worrying about immediate needs.

(c) Improvement of Working Environment for Technical Staff

(i) Performance Based Salary

Similar to the case of managerial staff, it is advisable to introduce performance based salary in technical staff. For now, however, as technical personnel still belong to CDGG, it is difficult to change their salary scale. Thus, first of all it is necessary to wait for CDGG staff to retire and to outsource the service to contractors gradually. In this way, GWMC can measure their performance directly and change a contractor if the contractor fails to fulfil its mandate.

(ii) Organisation of Sanitary Staff

Currently, there are more than 1,600 sanitary workers but there is no organisational structure. This situation is not preferable as there is no reporting line. In order to organise the sanitary workers and supervise and measure teir performance, it is recommended to group sanitary workers into about 20 and one of them becomes the leader. It is also preferable if the groups are allocated according to each Urban Unit. Accordingly, in order to streamline their workflow, it is necessary to review collection routes.

In addition, it is also necessary to make a guideline for technical staff to provide uniform service to all residents. This guideline should include the following items:

- Filling out daily driving report
- Safe driving
- Safe operation,
- Response to vehicle accidents, breakdowns and fires

(iii) Provision of Incentives Such as Monthly Award for Outstanding Performance

In addition to performance based salary system, it is also effective to provide special incentives such as monthly award for outstanding sanitary workers. Currently there are more than 1,600 sanitary workers and they are not evaluated personally. As a result, they do not pay much attention to their work. In order to prevent this situation, it is advisable to group them as mentioned above and give the best sanitary workers' award monthly or annually based on their performance. In addition to appreciate sanitary worker leaders, it is also advisable to give him/her small gifts as a leader such as photo display in the entrance of GWMC.

(iv) Gifts and Incentives on Eid and Christmas

In general, festive seasons are difficult to afford with technical workers who are low-incomers. Thus even if small, gifts on Eid and Christmas are very much appreciated and foster affection to GWMC.

(v) Provision of Social Welfare and Old Age Benefits to Secure the Minimum Quality of Life of Workers

One of the main reasons why sanitary workers of CDGG are not willing to be transfer to GWMC is because of generous social welfare and pension promised by CDGG. In order to facilitate the smooth transfer of CDGG sanitary workers to GWMC, it is recommended that equivalent social welfare and pension system be provided.

(vi) Health Screening and Other Facilities

Waste collection is a heavy manual labour and involves risks of injuries and infections. Therefore, it is also important to pretect and promote workers health condition by providing regular health check-ups and health facilities such as rest rooms.

(2) Human Resources Development

(a) Implementation of Comprehensive Capacity Development Programme (CCDP)

A major challenge to the human resources development plan in the Master Plan is how to incorporate the improvement of individual capacities into the organisational capacities of GWMC required for providing the service contract system. Another challenge is how to upgrade the capacities and motivation of the staff of GWMC in response to the massive human resources development demand of the new organisation. Based on the wide range of capacity gap assessment on human resources for the improvement of the current solid waste management system, the human resources development plan has been identified as a comprehensive capacity development programme required for the restructuring of GWMC, thereby identifying the following eight (8) modular human resources development projects.

However, it is acknowledged that "human resources development project approach" based on a single human resource development project alone does not comprehensively solve the constraints of the solid waste management services. Since "human resources development programme approach" is the process of managing a portfolio of multiple inter-dependent projects, the programme approach can be used for the management of the identified multiple modular projects. The programme approach provides the human resources development plan with a common platform to implement these modular projects under the Comprehensive Capacity Development Programme (CCDP). The CCDP acts as a key pre-condition to maximise the sustainability of the city-wide solid waste management services.

The proposed CCDP should be implemented with full-scale technical assistance by an external donor organisation. The overall goals of the proposed CCDP are to create the new organisational structure of the GWMC as well as to upgrade the technical and managerial capacities for the staff of the GWMC, thereby upgrading the comprehensive capacity to implement the Master Plan.

The outline of the proposed 3-year Comprehensive Capacity Development Programme (CCDP) is given in **Table 5.8.4** The concept of the detailed modular training projects under the CCDP are shown in **Table 5.8.5** to **Table 5.8.12**. The cost of implementation of the CCDP is estimated at approximately at 39,400 USD (Rs. 400 million).

Table 5.8.4 Outline of Comprehensive Capacity Development Programme

Item No.	**Modular HRD Project**	**Training No.**	**Specific Subjects for Human Resources Development**	**Target**			
				GWMC Managerial Staff	**Sanitary Worker Leader**	**Private Sector**	**CBO NGO**
1	Overall Management	1-a	Overall capacity for SWM	●			
		1-b	Capacity for SWM information system	●	●		
2	Collection and Transport	2-a	Capacity to efficiently operate collection and transport services	●	●		
		2-b	Capacity to maintain collection vehicles and equipment	●	●		
3	Intermediate Treatment	3-a	Capacity to implement 3R	●		●	●
		3-b	Capacity to operate intermediate treatment facilities	●			
		3-c	Capacity to maintain intermediate treatment facilities	●			
4	Sanitary Landfill Site	4-a	Capacity to select candidate sanitary landfill sites	●			
		4-b	Capacity to operate sanitary landfill sites	●			
		4-c	Capacity to implement EIA and monitor environment for sanitary landfill sites	●			
		4-d	Capacity to design sanitary landfill sites	●			
5	PPP Contractual Management	5-a	Capacity to manage PPP tender and procurement procedures	●		●	
		5-b	Capacity to provide franchised collection services	●		●	
		5-c	Capacity to provide service contracts for sanitary landfill management	●			
6	Financial Management	6-a	Capacity to implement proper financial management	●			
		6-b	Capacity to finance SWM projects	●			
		6-c	Capacity to collect and manage service fees	●			
		6-d	Capacity to manage SWM special account and revolving funds	●			
7	Organisational and Legal Improvement	7-a	Capacity to improve organisation for SWM	●			
		7-b	Capacity to improve legal system for SWM	●			
		7-c	Capacity to monitor and enforce SWM regulations	●			
8	Community Participation	8-a	Capacity to primary collection at community and raise public awareness	●		●	●

Table 5.8.5 Concept of Module Training Programme for CCDP (Module 1)

Module:	**Module 1**	**Training No.:**	**1-a, 1-b**
Title of Training Programme:	**Overall Management Capacity for SWM**		
Target:	**GWMC Staff**		
Lecturers:	**Urban Unit**	**Type of Training:**	**Capacity Development**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**4 Years**

Objectives and Outlines:

The provider of SWM services in local governments needs to develop effective management capabilities. These management capabilities should include:

- An efficient organisational structure with clear reporting lines, rational departmentalisation, reasonable spans of control and number of levels of managers and supervisors, and appropriate senior management structure;
- A clear assignment and delegation of responsibilities, and adequate authority to managers and supervisors with accountability for individual performance;
- Procedures to clearly set and monitor objectives from the strategic level down to middle management and supervisors;
- Effective planning and policy formulation; and
- Effective integration of financial planning into the planning process, implementing budgetary planning and control, and appropriate accounting systems.

Description of Training Programme:

The following capacities in the field of overall management for solid waste management services will be upgraded through the training programme:

- Basic understanding on management (organising, staffing, directing, controlling)
- Type of organisation (functional type, project type, matrix type)
- Major constraints for efficient organisation:
  - ► Over-staffing and overlapping of responsibilities
  - ► Broad span of controls
  - ► Decision-making mechanism
  - ► Allocation of duties
  - ► Number of staff
  - ► Training programmes
  - ► Motivation and incentives
  - ► Coordination and communication
  - ► Unclear mandates and job description
  - ► Monitoring and assessment
  - ► Standardisation of working procedures and manuals
- Understanding basic information on the service area (population, socio-economic profile, natural condition, map and GIS)
- Coordination with national and municipal policies (national SWM policies, SWM legal framework, subsidies from the central government, environmental impact assessment, land acquisition and compensation, licensing for private waste service providers)

Table 5.8.6 Concept of Module Training Programme for CCDP (Module 2)

Module:	**Module 2**	**Training No.:**	**2-a, 2-b**
Title of Training Programme:	**Capacities for Collection and Transport**		
Target:	**GWMC Staff, Private Sector Staff**		
Lecturers:	**Urban Unit**	**Type of Training:**	**Capacity Development**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**4 Years**

Objectives and Outlines:

- The primary objective of the collection and transportation of wastes is to increase the collection service coverage in order to maintain public health and cleanliness, and to protect the people’s environment.
- The GWMC is required to provide a minimum level of service throughout the city, and the minimum level of service is defined as collection service to be conducted once a week from communal collection points.
- A collection and transportation system which is the most economical and efficient as well as the least socially and environmentally harmful, should be adopted, in comparison with possible technical options such as station type and door-to-door type collection as well as direct and indirect transport methods.
- GWMC should promote and make the maximum use of private sector involvement in terms of collection services with full control by the private sector.
- In this connection, the staff of the private sector will also be invited for this programme.

Description of Training Programme:

The following capacities in the field of collection and transport will be upgraded through the training programme:

- Establishing a collection system
  - ► Clarifying the responsibility for collection
  - ► Establishing organisations responsible for collection

- Formulating collection plans
  - ► Assessing the current situation
  - ► Appropriate planning an implementation

- Expanding the coverage of collection services
  - ► Upgrading collection equipment
  - ► Promoting the involvement of CBOs/NGOs in primary collection
  - ► Outsourcing collection services to the private sector

- Improving collection efficiency
  - ► Improving collection methods
  - ► Reviewing collection routes
  - ► Improving personnel management methods
  - ► Replacement and improvement of equipment
  - ► Improving the maintenance system
  - ► Ensuring compliance with discharge rules
  - ► Collection cost analysis
  - ► Improving the quality of collection service
  - ► Improving public area sanitation

Table 5.8.7 Concept of Module Training Programme for CCDP (Module 3)

Module:	**Module 3**	**Training No.:**	**3-a, 3-b, 3-c**
Title of Training Programme:	**Capacity on Intermediate Treatment and 3R Promotion**		
Target:	**GWMC Staff, Private Sector Staff, Representatives of CBOs/NGOs**		
Lecturers:	**Urban Unit**	**Type of Training:**	**Capacity Development**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**4 Years**

Objectives and Outlines:

- The objective of the Waste Reduction Plan is to lighten the cost burden to GWMC through reduction of solid waste amount for collection and disposal.
- The objective of the Recycling Plan is to save finite resources and minimise landfill space as a result.
- The objective of the Intermediate Treatment Plan is stabilisation and reduction of residuals in addition to resource recovery through waste conversion.
- Waste reduction shall be carried out for domestic, commercial and other business wastes, and formulation of the Waste Reduction Plan shall take public participation into consideration.
- GWMC shall have the primary responsibility for promotion, guidance and assistance to the community groups, enterprises, recycling companies, etc., for organising the recycling groups and operations.
- The staff of the private sector and the representatives of CBOs/NGOs will be also invited to this programme.

Description of Training Programme:

The following capacities in the field of 3R and Intermediate Treatment will be upgraded through the training programme:

- Introducing and Improving Proper Intermediate Treatment
  - ► Volume reduction (Introducing and improving size-reduction facilities, Introducing and improving the compaction process)
  - ► Waste reduction (Introducing and improving incineration facilities, Collection of recyclables, Introducing and improving compost facilities)
  - ► Stabilisation and detoxification
  - ► Energy recovery
  - ► Introducing facilities to select recyclables
  - ► Promoting the purchase of recycled products

- Promoting Recycle
  - ► Promoting source separation of recyclables
  - ► Promoting community-based collection of recyclables
  - ► Institutionalising informal collection activities
  - ► Introducing separate collection of waste
  - ► Introducing facilities to select recyclables
  - ► Promoting the purchase of recycled products

- Promoting waste reduction
  - ► Promoting waste reduction at home
  - ► Promoting waste reduction at establishments
  - ► Introducing separate collection of waste
  - ► Introducing facilities to select recyclables

Table 5.8.8 Concept of Module Training Programme for CCDP (Module 4)

Module:	**Module 4**	**Training No.:**	**4-a, 4-b, 4-c, 4-d**
Title of Training Programme:	**Sanitary Landfill Site Management**		
Target:	**GWMC Staff**		
Lecturers:	**Urban Unit**	**Type of Training:**	**Capacity Development**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**4 Years**

Objectives and Outlines:

- Disposal of waste is problematic due to lack of space remaining at disposal sites and improper controls on dumping procedures. The latter causes odour, litter and smoke nuisance as well as posing health risks to nearby communities.
- Disposal of waste is a component of all waste management systems. Properly sited and managed waste disposal sites are protective of public health and the environment. Waste disposal sites are operations that can be designed to accommodate recovery of recyclable materials by the informal sector. Final disposal involves getting rid of all wastes that are not reused, recycled, processed or treated.
- The sanitary landfill is evaluated to be the most appropriate disposal method from both economic and environmental viewpoints. Therefore, the final disposal plan shall be formulated for the construction and operation of a sanitary landfill.
- The scale of sanitary landfill facilities and their operation shall take financial availability into consideration. At the same time, the design should be examined also from the environmental and social points of view. Due to financial constraints concerning SWM financing, a phased construction of the disposal site also shall be considered.
- The programme shall contribute to the upgrading in the field of the enhancement of the management of the sanitary landfill site.

Description of Training Programme:

The following capacities in the field of 3R and Intermediate Treatment will be upgraded through the training programme:

- Landfill Design
- Environmental Impact Assessment (EIA) for Sanitary Landfill
- Proper Operation of Final Disposal Sites
    - ► Control and management of incoming vehicles
    - ► Securing cover soil
    - ► Securing and maintaining heavy machinery
    - ► Training and allocating engineers
    - ► Operating and maintaining environmental pollution control facilities
    - ► Securing of operating capital
    - ► Establishing the monitoring framework
    - ► Outsourcing to the private sector
    - ► Waste picker control
    - ► Landfill leachate and gas
- Access Road
- Environmental Monitoring
    - ► Groundwater Monitoring
    - ► Quality and Treatment of Leachate
- Handling of Industrial Wastes

Table 5.8.9 Concept of Module Training Programme for CCDP (Module 5)

Module:	**Module 5**	**Training No.:**	**5-a, 5-b, 5-c**
Title of Training Programme:	**Public-Private Partnership**		
Target:	**GWMC Staff, Private Sector Staff**		
Lecturers:	**Urban Unit**	**Type of Training:**	**Capacity Development**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**4 Years**

Objectives and Outlines:

- There are wide modes and types for of the private sector involvement based on the particular situation of the service area for the solid waste management. It is essential to opt for the most acceptable and carefully-designed private sector involvement promotion plan taking into account the basic advantages of the private sector involvement over the service provision by the public sector alone.
- The private sector is regarded as a more efficient service provider than the public sector. It is generally believed that the private sector can provide an equivalent level of the service at a relatively lower cost.
- The involvement of the private sector can enlarge the access to capital such as procurement of collection vehicles required for the improvement of solid waste management services

This programme will contribute to the upgrading of the capacities to select and design the most suitable PPP options as well as to acquire the knowledge on contracting procedures on PPP projects.

Description of Training Programme:

The following capacities in the field of PPP will be upgraded through the training programme:

- Possible PPP Options
  - ► Short-term and Mid-term PPP Projects: Service Contract, Management Contract, etc.
  - ► Long-term PPP Projects: Lease, Concession, BOT and its Varieties, etc.
- Advantages and Risks of PPP Projects
  - ► Advantages of PPP Projects
  - ► Risks of PPP Projects
- Selection Criteria of PPP Projects
- Mitigation Measures of PPP Risks
- International Experiences and Lessons Learned
- Contractual Issues for PPP Projects
  - ► Preparation of Expression of Interests and Pre-qualification
  - ► Preparation of Tender Documents
  - ► Preparation of Bids
  - ► Clarifications and Feedback to Tender Documents
  - ► Bid Bond
  - ► Submission of Bids
  - ► Tender Evaluation and Selection of Private Service Provider

Table 5.8.10 Concept of Module Training Programme for CCDP (Module 6)

Module:	**Module 6**	**Training No.:**	**6-a, 6-b, 6-c, 6-d**
Title of Training Programme:	**Financial Management**		
Target:	**GWMC Staff**		
Lecturers:	**Urban Unit**	**Type of Training:**	**Capacity Development**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**4 Years**

Objectives and Outlines:

- Achieving the sustainable solid waste management requires the allocation and management of adequate financial resources.
- The long-term sustainability of waste management facilities requires that cost recovery frameworks are secured in place to ensure the proper operation and maintenance of those facilities.
- Legal and institutional structures for financing and recovering costs for waste management are in place at national and local levels.
- Accounting, budgetary and management systems for the solid waste management are in place at the local level.
- The proper level of the tariff as well as the efficient tariff charging system is also critical for the sustainable provision of solid waste management services.

This programme will significantly contribute to the upgrading of the financial management capacity in these fields.

Description of Training Programme:

The following capacities in the field of financial management will be upgraded through the training programme:

- Ensuring proper financial management
  - ► Clarification of SWM costs and expenses
  - ► Clarification of budget and income
  - ► Understanding on the financial management for balancing revenue and expenditure
  - ► Understanding on the special account for SWM
- Ensuring the financial arrangement for the cost recovery
  - ► Proper assessment of understanding of the fixed cost, variable cost, total cost and the break-even point
  - ► Proper planning of the tariff level
  - ► Proper planning of the charging system
  - ► Understanding of the cross-subsidy system by the tariff differentiation
- Increasing access to investment financing from various funding option
  - ► Public financing options
  - ► Private financing options
  - ► PPP financing options
- Other Analytical Tools
  - ► Value for Money Analysis
  - ► Willingness to Pay Survey
  - ► Affordability to Pay Survey

Table 5.8.11 Concept of Module Training Programme for CCDP (Module 7)

Module:	**Module 7**	**Training No.:**	**7-a, 7-b, 7-c**
Title of Training Programme:	**Organisational and Legal Improvement**		
Target:	**GWMC Staff**		
Lecturers:	**Urban Unit**	**Type of Training:**	**Capacity Development**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**4 Years**

Objectives and Outlines:

- Organisational and institutional strengthening is essential for sustainable improvements in providing solid waste management services
- However, due to the low priority and lack of funds to the solid waste management sector, the organisational capacity for providing the solid waste management services is rather weak in developing countries. The public sector is normally not provided with sufficient resources to keep fulfilling its mandates, while the private sector is not successfully filling the gap between the current insufficient coverage by the public sector and the required level of services. It is critical to build the sustainable organisational structure as well as establishment the related organisational reform.
- The lack of effective legal framework as well as the institutional capacity to enforce the acts, regulations and by-laws in the field of solid waste management is also one of the major constraints.

Description of Training Programme:

The following capacities in the field of organisational and institutional reforms will be upgraded through the training programme:

- Improvement in the organisational aspect
  - ► Assessment of organisational capacities
    - Organisational structure
    - Decision-making mechanism
    - Coordinating ability
    - Job classification
    - Number of staff
    - Human resources development and training opportunities
  - ► Defining job descriptions within organisations
  - ► Ensuring appropriate personnel distribution in both quality and quantity
  - ► Development of organisational management capacity

- Improvement in the institutional aspect
  - ► National SWM policies
  - ► Laws, regulations, by-laws, ordinances related to SWM
  - ► Environmental impact assessment system
  - ► SWM planning
  - ► Category, classification and coding system of wastes
  - ► Construction standards for treatment and disposal facilities
  - ► Monitoring and law enforcement mechanism
  - ► Partnership with the private sector and communities

Table 5.8.12 Concept of Module Training Programme for CCDP (Module 8)

Module:	**Module 8**	**Training No.:**	**8-a**
Title of Training Programme:	**Community Participation**		
Target:	**GWMC Staff, Private Sector Staff, Representatives of CBOs/NGOs**		
Lecturers:	**Urban Unit**	**Type of Training:**	**Capacity Development**
Funding Sources:	**Urban Unit / GWMC**	**Duration:**	**4 Years**

Objectives and Outlines:

- The objective of the community participation promotion is to raise awareness of the residents for their cooperation in the solid waste management. The community participation should be designed to promote a better understanding of citizens through public and school environmental education by establishing a workable implementation system.
- The GWMC's own awareness of the requirements of a new solid waste management strategy is to be raised through a programme of seminars and workshops directed at GWMC managerial staff. This should be made prior to a public announcement by GWMC on the implementation of the Master Plan.
- Following its decision to implement the Master Plan, the GWMC has to inform the public of the measures it proposes taking to improve SWM services in the city and of its proposals to increase the existing charge levels to pay for the services. A properly structured communications strategy is to be proposed.
- A public education and awareness programme should accompany the GWMC's announcement of the Master Plan. Any attempt to introduce such a programme before the GWMC has spelt out the steps it is to take to improve solid waste management conditions in the city would be futile.

The programme will significantly contribute to upgrading the methodologies to promote community participation and to raise public awareness in the solid waste management services.

Description of Training Programme:

The following capacities in the field of community participation will be upgraded through the training programme:

- Raising Public Awareness
  - Improving solid waste education
  - Disseminating information on the proper store and discharge of waste
  - Improving methods for guiding the residents
- Proper Discharge Methods
  - Selecting proper discharge methods
  - Developing discharge rules and ensuring compliance with them
- Environmental Education
  - School education
  - Community education
- Partnership
  - Partnership with CBOs
  - Reflection of input from communities in policies, systems and services
  - Establishment of effective communication channels
  - Information networks (information and communication technologies)
- Assistance to Communities
  - Selection of suitable primary collection equipment
  - Financial assistance to procurement of collection equipment

(3) Legal and Institutional Reform

Currently there is no single comprehensive by-law in Gujranwala and the Committee of the Punjab Province is drafting a solid waste management law based on Municipal Solid Waste Rules 2014 (Draft) of India. This law should integrate the latest version of laws and regulations related to solid waste management in Punjab Province as well as adapt applicable clauses from Indian MSW rules so that it becomes one single comprehensive law to comply with.

In order to enforce the laws and regulations, first of all, CDGG/GWMC officials should have enough understanding of the legal matters involved. Therefore, it is necessary to provide training on legal matters to CDGG and GWMC staff.

From the perspective of residents, it seems that most of residents are not aware of even the existence of laws and regulations. Therefore, in order to make them understand and comply with the law, it is advisable to interpret the law in Urdu.

In addition to awareness raising, it is necessary to exercise enforcement power for punishment of offences against the laws and regulations in order to prevent free riders of solid waste management services. For this purpose, CDGG/GWMC should procure some enforcement officers.

5.9 Recommendations on Hospital and Industrial, and Construction and Demolition Waste Management

5.9.1 Hospital Waste Management

Recommendations in hospital waste management are as follows:

- It is necessary to treat infectious waste separately from domestic waste. The inappropriate disposal of infectious waste not only causes direct damage to the health of waste collection staff in hospitals and waste pickers, etc., on disposal sites, but also the re-use of medical implements such as syringes, etc., can adversely affect ordinary patients.
- Segregating potentially infectious material from MSW waste at the point of generation may apply and in this way both volume and cost can be reduced.
- GWMC should make plans/guidelines and provide the services to the medical facilities by charging service fee. In this way GWMC can generate revenue.

Training should be given to the sweepers on how to handle hospital wastes since these are toxic and hazardous. Sweepers are unaware of the diseases spread through direct contact with medical waste; if they know they will definitely use personal protective equipment.

5.9.2 Industrial Waste Management

Recommendation in industrial waste management is as follows:

GWMC should prepare plans/guidelines and provide waste collection services to industries by charging some fee from the industries.

5.9.3 Construction and Demolition Waste Management

Recommendations in hospital waste management are as follows:

- On the basis of situation analysis it is recommended that provincial government should make some rule and regulations for Construction and Demolition (C&D) waste management in which rules and responsibilities should be clearly defined.
- As the generator itself is responsible for the management of the C&D waste, LWMC propose to set a tariff for the C&D waste collection service to the generator. Therefore, it is important that the provincial government or the city district government make some laws or by-laws to provide legal shelter for the GWMC and the penalties should be also incorporated in the laws or by-laws.
- LWMC proposed one time cleaning of the 46 sites filled with C&D waste by itself or by private contractor or to outsource the operations for the C&D waste collection. GWMC should use

LWMC's per ton and per kilometre calculated cost for the C&D waste from all the four towns of the city and also use recommendations from the LWMC plan stated below.

- It is recommended that City District Government/Gujranwala waste management company shall engage demolition contractors who have expertise, new techniques, tools, proper demolishing system, and health safety and environment working systems on board. For this, bidders shall be qualified technically in all towns and shall be called upon to bid on reserve prices set by the concerned department after having input from engineering wing.
- The demolition contractors shall be bound to barricade properly and dump the debris to the GWMC designated crushing site. This would be the stage when actual estimation of C&D waste should be designated by considering the following data:
    1. Amount of area demolished
    2. Exact percentage range for demolished material
    3. Exact percentage range for recycled material
    4. Exact percentage range for reusable material
    5. Revenue detail and bringing this demolishing activity in tax net in future

  After at least 2.5 years to 3.0 years, the exact form of data regarding Construction and Demolition Waste shall start to be developed.

ANNEX

THE URBAN UNIT
Urban Sector Planning & Management Services Unit (Pvt.) Ltd.
A Public Sector Company.

No: 9306

Date: 08-01-2015

1. The Secretary, LG&CD Department, Govt. of the Punjab, Lahore
2. The Managing Director, Gujranwala Waste Management Company (GWMC), Gujranwala
3. The Director (EIA), Environment Protection Department, Lahore
4. The Deputy Secretary, Local Government and Community Development, Lahore
5. The National Staff In-charge of Environment Sector, JICA Pakistan Office, Islamabad
6. Team Lead, JICA Study Team, JICA Pakistan Office, Govt. of Japan, Islamabad

Subject: **SECOND JCC MEETING ON PROJECT PROGRESS OF INTEGRATED SOLID WASTE MANAGEMENT MASTER PLAN STUDY IN GUJRANWALA CITY**

Japanese International Cooperation Agency (JICA), in collaboration with City District Government Gujranwala (CDGG) and the Urban Unit, is in process of conducting integrated solid waste management master plan study for Gujranwala. The JICA project team prepared a progress report on the subject project, for review of the said report by the Joint Coordination Committee (JCC). The meeting of JCC was held on **December 19, 2014** under the chairmanship of **Secretary P & D Department** in **Committee Room No. 1 of P & D Department.** The minutes of meeting are attached herewith for circulation among the JCC members for record keeping.

Regards,

DR. NASIR JAVED
CHIEF EXECUTIVE OFFICER

Copy:

The Secretary, P&D Department, Govt. of Punjab

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All correspondence must be addressed to the **Chief Executive Officer**

The Urban Unit

Record of Meeting

Subject:	Second Joint Coordinating Committee (JCC) Meeting on Project Progress of Integrated Solid Waste Management Master Plan Study for Gujranwala		
Date:	December 19, 2014	**Time:**	02:00 pm – 03:00 pm
Venue:	CR-1 of P&D Department		
Participants:	JCC Members, JICA Project Team, Urban Unit Team, GWMC Project Team, MD PMDFC, MD LWMC		

Sr. No.	**Discussion/Decision**
1.	Mr. Waseem Ajmal, Secretary P&D Department, Government of Punjab, chaired the meeting. The meeting started with the introduction of the Secretary P&D Department followed by all the participants. Dr. Nasir Javed highlighted the importance of first Solid Waste Management Master Plan in Punjab and Mr. Taki described JICA's Support for the project. Dr. Kiran Farhan, Sr. SWM Specialist, the Urban Unit, thanked all the participants and asked JICA team to present progress report of the Project. The JICA Project Team Leader, Mr. Masakazu Maeda gave a brief presentation on the progress of different activities designed for Integrated SWM Master Plan for Gujranwala. After the presentation the meeting was opened for discussion.
2	Dr. Nasir Javed, CEO, the Urban Unit, said that JICA was asked to install pilot scale Resource Recovery Facility that can be replicated to other areas. The Pilot Project has estimated cost of PKR 90 million for 200 tons/day. As financial assistance to the facility is out of scope of JICA side, it is therefore requested to the Government of Punjab to provide requisite finances if GWMC develops a PC-1 for this project as it will lead toward CM vision for improvement of SWM in Punjab. He also informed the chair that once the Master Plan is prepared; the implementation of Mater Plan will require additional finances. Mr. Waseem Ajmal said that one option is to develop the project on Public Private Partnership (PPP) whether outsourcing model, management contract with capital investment from the government or other options. The resource recovery project can become part of waste disposal plan and also fit in a long term plan of the GWMC. Mr. Shahid Fareed, Deputy Secretary LG, said that the government has initiated pilot projects for SWM in rural area. He further informed that LG have submitted a concept note on SWM to P&D for Punjab Municipal Services Improvement Project Phase II. He suggested that if the Urban Unit comes up with such proposal and if it qualifies the criteria LG will definitely support it. He added that additional finances are always required for the action plan and any such proposal will be supported by the department.

3. Mr. Asif Iqbal, Sr. Manager LWMC, pointed out that presentation on the Master Plan did not cover the Construction and Demolition (C&D) Waste, Green Waste, Hospital and Industrial Waste and only give recommendations on it. Dr. Ata ul Haq, MD GWMC, said that they already have a separate consultancy agreement with LWMC for various studies of SWM. GWMC team discussed item wise scope of work with LWMC and all those works that were not included in JICA scope are to be done by LWMC.

Mr. Waseem Ajmal said that the Master Plan has to cater the need of all and later on the government can decide the roles and responsibilities. This is the good opportunity that we can collect data from all the sources. He said that the cantonment area, private housing schemes and railway areas should also be reflected in the Master Plan.

Dr. Kiran explained that population projection is for whole 98 UCs and waste generation will be calculated for all and then waste characterization will lead to some suggestions which will cover all the population.

4. On question related to line of action for informal sector, Dr. Kiran replied that the survey has been conducted and that is already part of the Master Plan.

5. Mr Waseem Ajmal, asked the JICA team that 100% collection efficiency will be achieved by the year 2030, which is a very long time. He suggested that different models can be presented on how to reduce that time by providing short term and medium term plans.

Mr. Masakazu Maeda replied that it can be done but the selection of best suited option depends on the budget. He agreed that such implementation models will be part of the Master Plan.
Dr. Kiran highlighted that one of the objectives of this meeting is to decide on which lines the short and medium term plans will be developed and the JICA Project Team should opt for 100% collection efficiency for the short term plan. She requested JICA team to incorporate all these points in the interim report that will eventually reflect in the Master Plan.

6. On question related to a landfill candidate site, Dr. Ata ul Haq told the committee that the site has been selected and Environmental Impact Assessment (EIA) is in process. GWMC has requested LG Department to provide funds to acquire the land.

7. Dr. Kiran requested all the JCC members to provide valuable comments on the Progress Report, so if any improvement is required it may be incorporated in the Interim Report.

8. Mr. Taki, Sr. Representative JICA, concluded the meeting and thanked all the participants for this interactive session.

DR. NASIR JAVED
CHIEF EXECUTIVE OFFICER

List of Participants:-

Sr. No	Name	Designation	Organization
1	Mr. Waseem Ajmal Chaudhary	Secretary	Planning and Development Department
2	Dr. Nasir Javed	CEO	The Urban Unit
3	Mr. Motoo Taki	Senior Representative	JICA Pakistan Office
4	Ms. Nazia Saher	Program Officer	JICA Pakistan Office
5	Mr. Masakazu Maeda	Team Leader	JICA Project Team (JPT)
6	Dr. Ata ul Haq	MD	GWMC
7	Dr. Kiran Farhan	Sr. Specialist SWM	The Urban Unit
8	Mr. Murad Khan Rana	Sr. Manager Ops	GWMC
9	Mr. Masaharu Takasugi	Final Disposal Expert	JPT
10	Mr. Kazuhiko Nakamura	Collection and Transportation Expert	JPT
11	Mr. Aamer Nazeer	MD	PMDFC
12	Mr. Shahid Fareed	Deputy Secretary	LG&CDD
13	Mr. Nasim ur Reham	Director (EIA)	EPD
14	Mr. Asif Iqbal	Sr. Manager Ops	LWMC
15	Mr. Sohail Malik	Sr. Manager	LWMC
16	Mr. Hassan Illyas	Research Analyst	The Urban Unit
17	Mr. Sami Ullah	Research Associate	The Urban Unit
18	Mr. Umama Saleh	Research Associate	The Urban Unit
19	Mr. Arkham Wahid	Research Assistant	The Urban Unit
20	Ms. Hina Aslam	Waste Manager	GWMC
21	Ms. Hina Ishaque	Waste Manager	GWMC
22	Ms. Ambreen Ghazanfar	Waste Manager	GWMC
23	Ms. Aqsa Sadiq	Waste Manager	GWMC
24	Ms. Fatima.Zia	Waste Manager	GWMC