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

FINAL REPORT
VOLUME 2 MAIN REPORT

NOVEMBER 2015

CTI ENGINEERINGINTERNATIONAL CO., LTD.

NJS CONSULTANTS CO., LTD.

EX RESEARCH INSTITUTE LTD.

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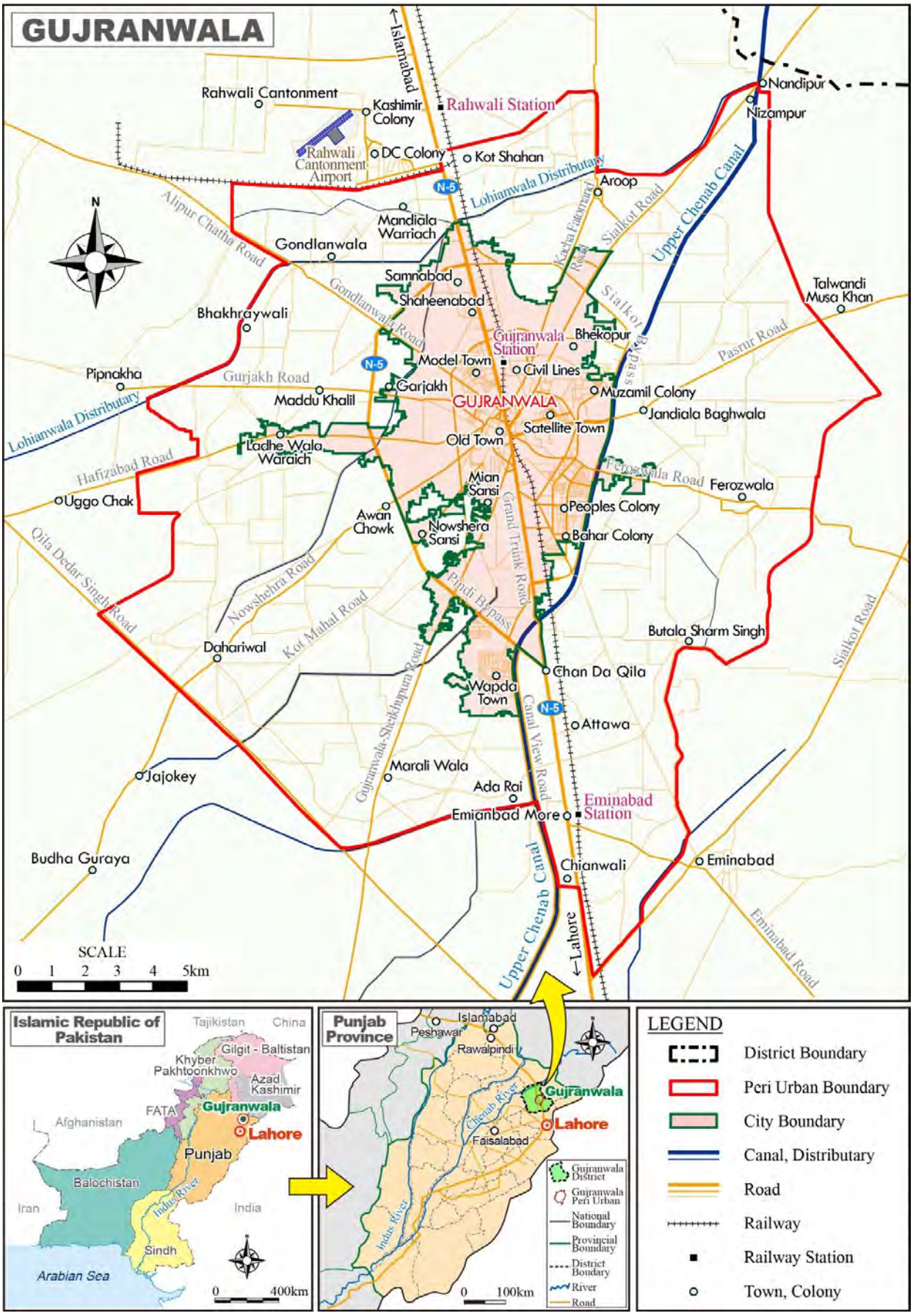
All Pakistan Rupee amounts including project costs shown in this report are stated in 2015 prices unless otherwise indicated. The amounts are estimated on the basis of foreign prices by applying the interbank currency exchange rates as of 1st of September 2015, namely; USD1 = Rs. 102.92 = JPY 121.22.



LOCATION MAP

COMPOSITION OF FINAL REPORT

PROJECT
FOR
INTEGRATED SOLID WASTE MANAGEMENT
MASTER PLAN IN GUJRANWALA

FINAL REPORT

VOLUME 2

MAIN REPORT

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ABBREVIATIONS AND ACRONYMS

3R	:	Reduce, Reuse, Recycle
ADB	:	Asian Development Bank
ATP	:	Affordability to Pay
BHUs	:	Basic Health Units
BOD	:	Board of Directors
BOT	:	Build-Operate-Transfer
CBO	:	Community-Based Organization
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
DGKCC	:	D.G. Khan Cement Company (Pvt.) Ltd.
DHQ	:	District Headquarters
DO	:	District Officer
EAD	:	Economic Affairs Division
EDO	:	Executive District Officer
EIA	:	Environment Impact Assessment
EIRR	:	Economic Internal Rate of Return
ENERCON	:	National Energy Conservation Centre
EOI	:	Expression of Interest
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 Organization
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
HDPE	:	High Density Polyethylene
HPM	:	Hedonic Pricing Method
HQ	:	Headquarters
IEC	:	Information, Education and Communication
IEE	:	Initial Environmental Examination
IPC	:	Inter Provincial Coordination
ISWM	:	Integrated Solid Waste Management
JCC	:	Joint Coordinating Committee
JICA	:	Japan International Cooperation Agency
KOICA	:	Korean International Cooperation Agency
LCL	:	Lahore Compost (pvt.) Ltd.

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
NCCW	:	National Council for Conservation of Wildlife
NDM	:	National Disaster Management
NEP	:	National Environmental Policy
NEPRA	:	National Electric Power Regulatory Authority
NEQS	:	National Environmental Quality Standards
NGO	:	Non-Governmental Organization
NPV	:	Net Present Value
NRSP	:	National Rural Support Programme
NTN	:	National Text Number
O&M	:	Operation and Maintenance
OPE	:	Organization Pan Environment
P&D	:	Planning and Development
Pak-EPA	:	Pakistan Environmental Protection Agency
PCSIR	:	Pakistan Council of Scientific & Industrial Research
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
RFID	:	Radio-Frequency Identification Device
RHC	:	Rural Health Centre
RPF	:	Refuse Paper & Plastic Fuel
Rs.	:	Pakistan Rupee
SAAMA	:	Service and Asset Management Agreement
SEA	:	Strategic Environmental Assessment
SECP	:	Securities and Exchange Commission of Pakistan
SIE	:	Small Industrial Estate
SLF	:	Sanitary Landfill
SMS	:	Short Message Service
SNS	:	Social Networking Service
SOP	:	Standard Operation Procedures
SPV	:	Special Purpose Vehicle
STEPS	:	Social Transmission & Environmental Protection Society
SWM	:	Solid Waste Management
TMA	:	Tehsil Municipal Administration
TOR	:	Terms of Reference
USD	:	United States Dollar

UU	:	The Urban Unit
WACS	:	Waste Amount and Composition Survey
WASA	:	Water and Sanitary Agency
WB	:	The World Bank
WBS	:	Work Breakdown Structure
WSS	:	Water Supply, Sewerage and Sanitation
WTP	:	Willingness to Pay
ZSD	:	Zoological Survey Department

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. (Refer to the attached ***ANNEX 1*** and ***ANNEX 2***, the first amendment made on the 23rd of August 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 (see, ***ANNEX 3***).

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 JICA Project Team started the first field work in Pakistan on 3 March 2014 and completed it on 17 April 2014 to collect relevant data and information. Subsequently, a Joint Coordinating Committee (hereinafter referred to as "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 on 19 December 2014 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 4*** in this report.

The fourth visit was made between 5 May 2015 and 17 June 2015 to submit the Interim Report comprising the Master Plan. The third JCC meeting was held on 8 June 2015 to discuss the contents of the Master Plan (see the minutes of the meeting in ***ANNEX 5***.). The fifth visit was started from 22 July 2015 and end up to 7 September 2015. In this last visit, the Draft Final Report was being made and the fourth JCC meeting was held on 2 September 2015. After going back to Japan, the Draft Final Report will be finalised and submitted to the Pakistani side in October. The Final Report is to be submitted within two (2) months after receiving JICA's comments on the Draft Final Report.

A meeting as a kick-off event was held on 27 March 2014, and the second stakeholder meeting was held on 9 June 2015 after submission of the Interim Report. The last stakeholder meeting was held on 3 September 2015 in the presence of Finance Minister of the Government of the Punjab to explain the contents of the Master Plan.

1.3 Administration of the Project

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

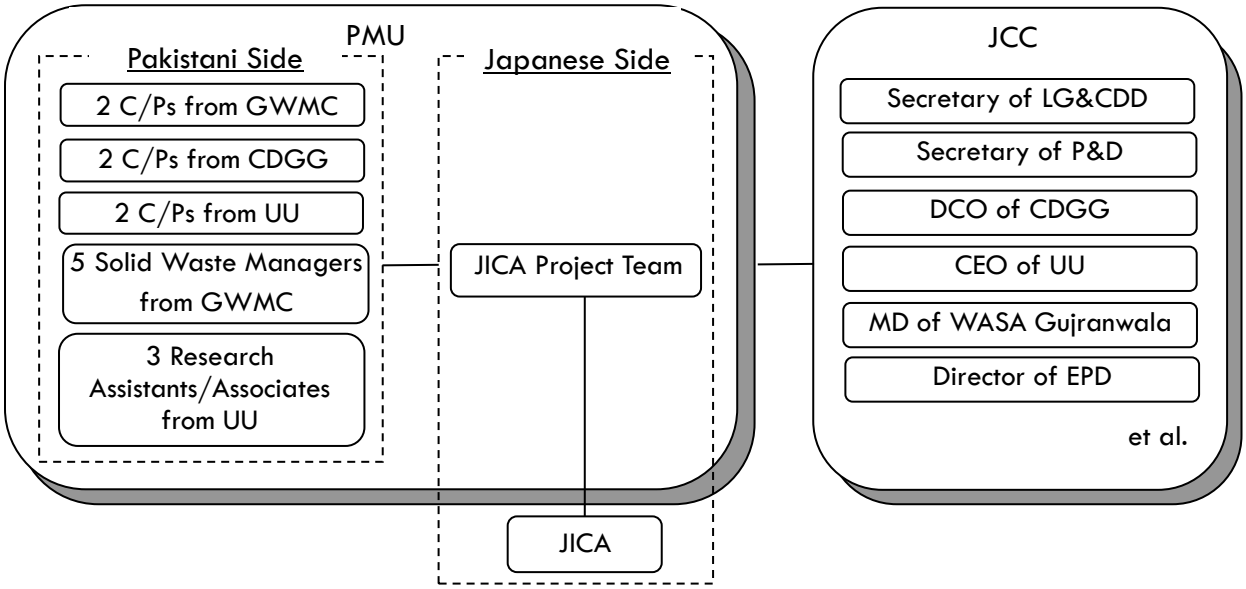


Figure 1.3.1 Organizational Chart of the Project

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-organizational 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
Imtiaz Malik	Executive District Officer (EDO) (MS: Municipal Services), City District Government Gujranwala (CDGG)
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 Associate, 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
Shunsuke HORI	Intermediate Treatment and 3R Promotion / Administrative Coordinator 2[*1]
Keigo ITO	Intermediate Treatment and 3R Promotion / Administrative Coordinator 2[*2]
Shinsuke OKAMOTO	Environmental Education
Takehiko OGAWA	Economic and Financial Analysis
Hisato TAKEDA	Environmental and Social Considerations[*3]
Yasumi TSUTSUI	Environmental and Social Considerations[*4]
Keiko TSUJI	Institutional Strengthening / Administrative Coordinator 1[*5]
Tomoe KUMAGAI	Institutional Strengthening / Administrative Coordinator 1[*6]

Note: [*1]The assignment was started from March 2014 and ended to December 2015.
[*2] The assignment was started from February 2015.
[*3] The assignment was started from March 2014 and ended to April 2014.
[*4] The assignment was started from August 2014.
[*5] The assignment was started from March 2014 and ended to June 2015.
[*6] The assignment was started from August 2015.

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

	Role	Name	Company	2014 JFY2013 2	3	JFY2014 4	5	6	7	8	9	10	11	12	2015 JFY2014 1	2	3	JFY2015 4	5	6	7	8	9	10	11	M/M 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	3/17 41 (1.37)		5/7	6/11 36 (1.20)		7/22	9/4 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)		5/9	6/17 40 (1.33)		8/1	9/4 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	5/9	6/12 35 (1.17)		8/1	9/4 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 9/13 10 (0.33) 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 34 (1.13)	3/28 7 (0.23)					7/22 35 (1.17)	9/4 10 (0.33)			2.30 (0.57)	
	Environmental Education	Mr. Shinsuke OKAMOTO	EX		3/15 22 (0.73)	4/5										2/12	3/13 30 (1.00)						8/5 2 (0.07)	8/29 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)					7/25	9/7 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 27 (0.90)	9/25				2/27	4/2 35 (1.17)					8/11	9/4 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)									1.67 (0.87)	
	Institutional Strengthening / Administrative Coordinator 1	Ms. Tomoe KUMAGAI	EX																				8/5 25 (0.83)	8/29			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)					12 (0.60)		10 (0.50)		2.00
	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)														0.10
	Institutional Strengthening / Administrative Coordinator 1	Ms. Tomoe KUMAGAI	EX																				4 (0.20)				0.20
																									Subtotal		4.30

Reports	▲Inception Report(Mar)	Progress Report(Dec)▲	Interim Report(Apr)▲	Draft Final Report(Sep)▲	▲Final Report(Nov)
Seminar/JCC Affiliate Consultation	◆JCC(1)	◆JCC(2) ★Stakeholders Meeting(1)	◆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

This chapter presents the current condition of SWM mainly in terms of technical, financial and institutional aspects based on the results of the site surveys, such as waste amount and composition survey, incoming waste survey, time and motion study, and waste picker survey.

First of all, the survey on generated waste amount and composition in the city at present are explained in **Section 2.2** while the survey took place in three seasons. 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**.

Finally, from the institutional point of view, the analysis and evaluation of the present arrangements, not only for institutional but also organizational and human resource management aspects, are carried out and described in **Section 2.8**. The current conditions of hospital and industrial, and construction and demolition waste are additionally described in **Section 2.9.**

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 first field survey was conducted from 13 to 20 October 2014, the second field survey was from 9 to 16 February 2015 and the third field survey was conducted from 18 to 25 May 2015.

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. The detailed method is presented in ***Volume 3, Supporting Report, Section A: Waste Amount and Composition Analysis, Section 3.2.***

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 0.26 kilogrammes per capita per day (kg/c/d) to 0.48 kg/c/d, as shown in **Figure 2.2.1.** The waste generation per unit for each generation source applied for this master plan study is to be used an average of the first two survey results since the third survey was conducted in May and the final data compilation was completed in July 2015. That time was when the master plan was already drafted and it was therefore impossible to fit the final survey results in the master plan formulation. Considering the results of the last survey, the adoption of the first two data is acceptable for planning purpose since the tendency of each generation amount is almost similar to that of the previous two survey results. The detailed results are presented in ***Volume 3, Supporting Report, Section A: Waste Amount and Composition Analysis, Section 3.3.***

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	3rd Survey 18-25 May 2015	Average
Household	High Income	person	0.46	0.46	0.48	0.47
	Middle Income	person	0.41	0.36	0.29	0.35
	Low Income	person	0.40	0.40	0.33	0.38
	Rural Area	person	0.33	0.36	0.26	0.32
Commercial	Restaurants	establishment	11.0	20.0	16.4	15.8
	Others	establishment	2.10	2.10	1.50	1.90
Markets (Food, Vegetable, etc.)		market	200	360	923	494
Institution		establishment	4.70	9.00	3.70	5.80
Street Sweeping		m	0.61	0.19	0.20	0.33
Park		park	9.4	10.0	14.5	11.3

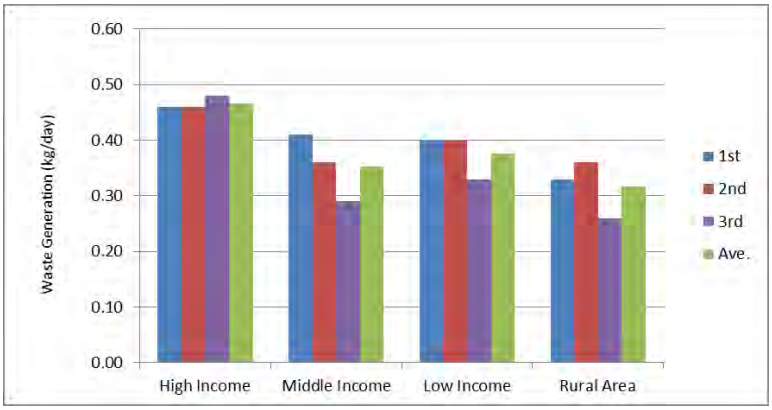


Figure 2.2.1 Waste Generation per Capita in Household in Gujranwala

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:

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

Then the physical composition of waste is sorted into the following 16 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. Sieve Remaining*
16. Miscellaneous

Note*: Sieve remaining was added from the second survey.

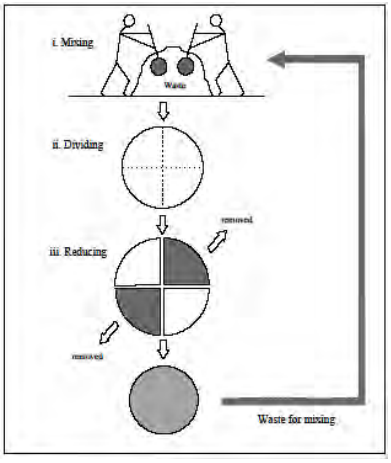


Figure 2.2.2 Method of Physical Composition Analysis

(3) Survey Result

The average waste composition in the first, second and third survey season was adopted to calculate the physical composition of waste. The results are summarised as an average of the three results in **Figure 2.2.3** Physical Composition of Each Generation Source (Average)

Table 2.2.4, and presented also in **Figure 2.2.3**. From these tables and figures, the characteristics of the three survey results are summarised as follows:

- The highest percentage of waste composition is kitchen waste from households (58-69%), restaurants (85%) and markets (61%) followed by paper (4-11%) or plastics (5-11%).
- High percentage of grass and wood from institutions (45%), street sweeping (8%) and parks (56%) can be observed because they might include garden waste.
- Except the waste from street sweeping, the ratio of organic waste is quite high at 70 to 98%.
- The ratio of recyclable material such as paper, plastic, metal and glass from households varies from 4% to 6%, and its average is around 3.7% considering the rate of population for each income group (Detailed discussions are presented in **Section 4.3**).

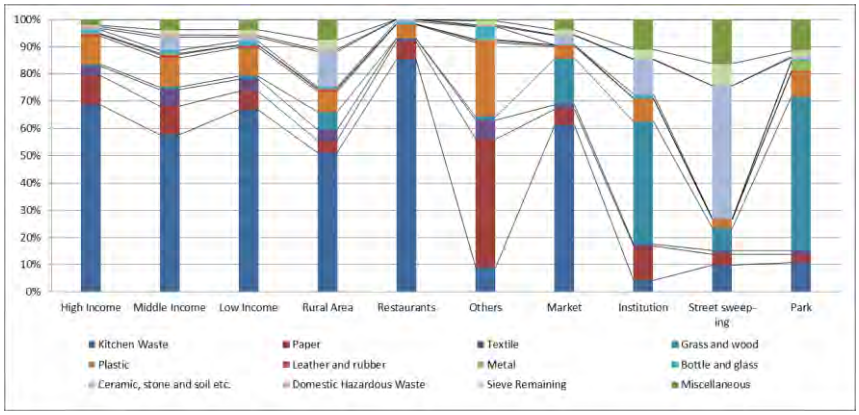


Figure 2.2.3 Physical Composition of Each Generation Source (Average)

Table 2.2.4 Waste Composition of Each Generation Source (Average of the Three Survey Results)

(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		68.7	57.8	66.9	51.1	85.4	9.0	61.1	4.3	9.8	10.8
Paper	Paper (recyclable/clean)	4.3	3.5	2.6	2.9	4.8	26.7	3.0	8.7	1.5	1.2
	Paper (others)	6.4	7.0	4.0	1.5	1.7	20.4	2.8	3.8	2.6	1.8
	Subtotal-Paper	*10.7*	*10.5*	*6.6*	*4.4*	*6.5*	*47.1*	*5.8*	*12.5*	*4.1*	*3.0*
Textile		2.6	3.4	6.0	4.6	4.0	1.1	6.9	1.7	0.8	1.3
Grass and wood		0.5	0.8	1.0	1.1	6.5	0.1	1.3	16.9	44.9	8.3
Plastics	Plastic (recyclable)	1.3	1.2	1.0	1.7	0.1	4.0	0.4	1.0	0.1	4.8
	Plastic (non-recyclable)	8.9	9.4	9.4	5.8	5.1	23.3	4.1	7.4	3.0	4.2
	Subtotal-Plastic	*10.2*	*10.6*	*10.4*	*7.5*	*5.2*	*27.3*	*4.5*	*8.4*	*3.1*	*9.0*
Leather and rubber		0.8	0.8	1.2	0.9	0.8	0.1	0.6	0.4	0.0	0.1
Organic Waste - Subtotal		**96.9**	**94.6**	**87.1**	**90.5**	**74.3**	**98.3**	**92.2**	**90.4**	**70.9**	**26.7**
Metal	Metal (recyclable)	0.3	0.4	0.1	0.4	0.0	0.3	0.0	0.2	0.0	0.2
	Metal (non-recyclable)	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	3.4
	Subtotal-Metal	*0.3*	*0.4*	*0.1*	*0.4*	*0.0*	*0.6*	*0.0*	*0.2*	*0.0*	*3.6*
Bottle and glass	Bottle and glass (recyclable)	0.6	0.8	0.8	0.2	0.5	3.4	0.1	0.5	0.1	0.3
	Bottle and glass (non-recyclable)	0.7	0.5	0.7	0.4	0.4	1.0	0.	0.9	0.0	0.2
	Subtotal-Bottle and glass	*1.3*	*1.3*	*1.5*	*0.6*	*0.9*	*4.4*	*0.2*	*1.4*	*0.1*	*0.5*
Ceramic, stone and soil etc.		0.5	0.5	4.5	1.4	13.0	0.8	0.2	3.4	12.6	48.8
Inorganic Waste - Subtotal		**2.4**	**2.1**	**6.2**	**3.0**	**14.0**	**1.7**	**5.2**	**3.6**	**14.2**	**48.9**
Domestic Hazardous Waste		0.7	0.6	1.1	0.7	0.6	0.0	0.6	0.2	0.2	0.1
Sieve Remaining		0.0	0.6	1.7	1.9	3.6	0.0	1.4	2.0	3.5	8.1
Miscellaneous		0.0	2.1	3.9	3.9	7.5	0.0	0.6	3.8	11.2	16.2
Total		**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Note: Totals may neither become 100% nor always be equal to the sum of the subjected column due to rounding off to the first decimal point.

Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 1-3). (This work was subcontracted to the company by the JICA Project Team under the Project.)

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 2.2.4.** As shown in the following figure, commercial waste especially those from restaurants have the highest apparent specific gravity of about 0.56 ton/m^3 while the other commercial waste from shops have the lowest. The apparent specific gravity of household is at around 0.28 ton/m^3.

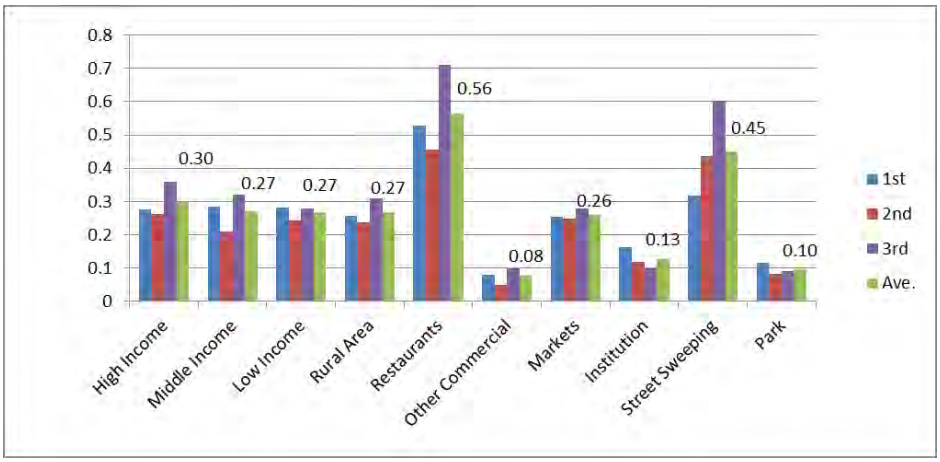


Figure 2.2.4 Apparent Specific Gravity

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 are carried out for the waste discharge sources/types specified in **Table 2.2.5**. 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 2.2.5 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 16)
- 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, and the detailed daily schedule of the survey is as shown in ***Volume 3, Supporting Report, Section A: Waste Amount and Composition Analysis, Section 4.2***.

(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-component analysis for each generation source in the first (13-20 October 2014), second (9-16 February 2015) and third (9-16 May 2015) seasons are shown in **Table 2.2.6** and **Figure 2.2.5**. The three components exhibit almost the same tendency, i.e., the ratio of moisture, ash and combustible ranges from around 68% to 73%, 5% to 13% and 20% to 22%, 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, which contains much organic waste such as vegetable waste.

Table 2.2.6 Results of Three-Component Analysis of Each Generation Source (Average)

Type of Waste Generation Source		Moisture (%)	Ash (%)	Combustible (%)
Household	High Income	73.2	4.7	22.1
	Middle Income	70.2	8.9	20.9
	Low Income	69.3	8.5	22.1
Markets (Food, Vegetable, etc.)		67.7	12.8	19.5

Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 1-3). (This work was subcontracted to the company by the JICA Project Team under the Project.)

The average results of the Carbon and Nitrogen (C/N) analysis for each generation source in the first, second and third seasons are shown in **Table 2.2.7**. The three components exhibit almost the same tendency, i.e., the ratio of Carbon, Nitrogen and C/N Ratio ranges from around 45% to 53%, 0.34% to 0.44% and 119 to 177, respectively. Wastes from the middle income groups in residential areas showed the highest C/N ratio while the lowest income groups in residential area showed the lowest percentages of the ratio.

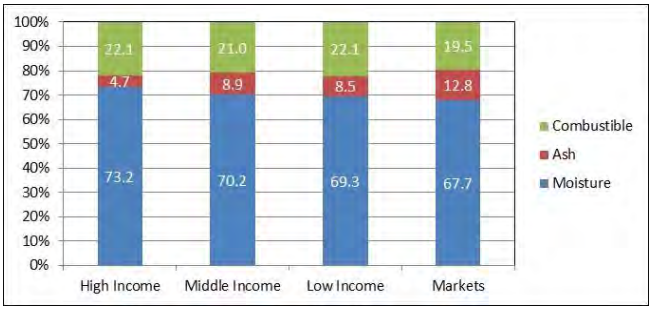


Figure 2.2.5 Results of Three-Component Analysis

Table 2.2.7 Results of Carbon and Nitrogen Analysis of Each Generation Source (Average)

Type of Waste Generation Source		Carbon (%)*	Nitrogen (%)*	C/N
Household	High Income	52.2	0.42	148
	Middle Income	51.5	0.34	177
	Low Income	49.6	0.44	119
Markets (Food, Vegetable, etc.)		49.8	0.43	152

Note:* Carbon content (%) = (100-ash %) /1.83, Nitrogen (%) = (C/N) / Carbon (%)
Source: Lean & Green (Pvt) Limited, Waste Amount and Composition Survey Report (Season 1-3). (This work was subcontracted to the company by the JICA Project Team under the Project.)

2.3 Waste Collection and Transportation

2.3.1 Time and Motion Study for Collection Work

(1) General

There is no organized 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 were evaluated as the basic data for the waste collection and transportation plan while the second survey was implemented from 31 March to 8 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 accessible to 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. In particular, 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**. As mentioned above, due to the different types of services allotted to each vehicle, 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 detail in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 2.1.4***.

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* (T/S)	Mini-dumper* (D/S)
1.	Average Waste Handling Amount (kg)	14,345	3,686	2,800	2,050
2.	Average Mileage (km)	141	48	53	88
3.	Average Fuel Consumption (litres)	35	16	9	13
4.	Average Number of Trips (times/day)	5.0	1.8	5.1	4.2
5.	Average Number of Crews (persons)	1.0	2.5	2.6	2.0
6.	Average Loading Time (minutes: min.)	36	213	260	251
7.	Average Travelling Time (min.)	385	275	229	333
8.	Average Unloading Time (min.)	39	14	24	30
9.	Average Total Operating Time (min.)	460	502	512	615
10.	Average Mileage per Unit Fuel Consumption (km/litre)	4.1	3.2	5.9	6.8
11.	Average Waste Handling Amount per Unit Distance (kg/km)	103	78	53	23
12.	Average Waste Handling Amount per Loading Time (kg/hr)	25,141	1,043	646	490
13.	Average Waste Amount per Travelling Time (kg/hr)	2,226	806	734	396
14.	Average Waste Handling Amount per Total Time (kg/hr)	1,866	441	328	200
15.	Average Waste Handling Amount per Unit Fuel Consumption (kg/litre)	417	246	311	158

Note:* Mini-dumpers that go to the transfer station are indicated as "T/S", and mini-dumpers that go to the disposal site are indicated as "D/S".

Table 2.3.2 Key Factors affecting Operation Time during the Survey

Objective	Arm-roll truck	Tractor trolley	Mini-dumper (T/S)	Mini-dumper (D/S)
Loading Time	36 minutes (min.) (8% of total time)	3:33 (hr:min.) (42% of total time)	4:20 (hr:min.) (51% of total time)	4:11 (hr:min.) (41% 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. e) Residents are reluctant to place the container near to their houses. It sometimes takes time to change the location of a container.	a) Lack of designated crew for loading. b) Delay due to late sweeping of roads/ streets by sanitation staff. c) Timing of traffic congestion at school and office site. d) Routes to access the containers are also used by mini-dumpers. e) Traffic congestion at School and Office timing f) In UC-19 & 46, handcarts are also unloaded from mini-dumpers and tractor trolleys.		

Objective	Arm-roll truck	Tractor trolley	Mini-dumper (T/S)	Mini-dumper (D/S)
Traveling Time	6:25 (hr:min.) (84% of total time)	4:35 (hr:min.) (55% of total time)	3:49 (hr:min.) (45% of total time)	5:33 (hr:min.) (54% 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. d) Engine problem in Hino-14	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. c) Steering lever of TT-451 was broken and it took 90 minutes to repair it. d) Waste collection route by TT-451 was not appropriate: streets were narrow so that it is difficult for the vehicle to turn the corner and it also causes traffic congestion problem.	a) Most drivers made first trip with partially filled dumper. b) Travelled at slow speed to avoid the littering of waste.	
Unloading Time	39 minutes (8% of total time)	14 minutes (3% of total time)	24 minutes (4% of total time)	30 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. b) Steering wheel of TT-6946 was broken and it took 6 days to repair c) Fuel tank of TT-6946 was leaked.	a) Delay due to dumping of other mini-dumpers at the transfer station. b) GAJ-49 spends 40 minutes for hauling the waste to Gondlanwala.	

(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 is recommendable among three types of vehicles.
- Average mileage per unit fuel consumption of the tractor trolley is as low as 3.2 km/litre and the traveling performance as well as waste handling amounts are low. In addition, most of the tractor trolleys are aging, so that maintenance costs would increase. Tractor trolley shall therefore be replaced with other appropriate types of vehicle such as compactors as soon as possible from the viewpoint of cost-effectiveness.
- Loading efficiency of mini-dumper (T/S) is quite low at 311 kg/litre due to the large number of collection points and door-to-door operation. The loading efficiency must be improved by increasing to two sanitary workers and asking cooperation from the residents on the method of discharging waste from their households.
- Loading efficiency of mini-dumpers (D/S) is quite low at 158 kg/litre due to the large number of collection points and door-to-door operation. In addition, the vehicle has limited collection capacity and goes to the landfill site directly so that the loading efficiency of mini-dumper (D/S) is worse than that of mini-dumpers (T/S). Thus, using a mini-dumper on door-to-door

collection is not recommended. A 4 m^3 compactor is recommended for door-to-door collection because this compactor has almost the same body length and fuel consumption as the mini-dumper, and it has 4 times capacity of mini-dumper.

- 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.
- Not only repair and maintenance equipment for tire puncture, etc., should also be made available at the GWMC garage but also the drivers are obliged to conduct checking the vehicles at the start of operation to prevent causing 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.
- Adopting the radio-frequency identification device (RFID) would be useful for monitoring the operation status. The system will help to check the waste transportation efficiency.
- 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 2.9.3**.

(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 and normally 6 - 7 handcarts are deployed

in each union council (UC). 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 part of the 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. 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 35 mini-dumpers and 26 units of arm-roll trucks 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 rikshaw.
- 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 with donkey carts and handcarts for the collection of waste.

(2) Service Area

GWMC collects garbage from 64 union councils (UCs) and the present service area for waste collection is demarcated by the same UCs' boundary as shown in **Figure 2.3.2**. 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 which includes private housing societies, open lands, green lands, etc. **Table 2.3.3** shows the area and population 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 currently 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 Population, and their Percentage

Service Coverage	Area (km^2)	Population*	Percentage of 64 UCs (%)		Percentage of 98 UCs (%)	
			Area	Population	Area	Population
64 UCs						
Served	22.6	747,192	34.8	36.4	6.9	25.2
Partially served	26.7	878,752	41.1	42.8	8.1	29.7
Unserved	15.7	427,721	24.1	20.8	4.8	14.4
Sub-Total	*65.0*	*2,053,665*	*100.0*	*100.0*		
34 UCs in peri-urban area Unserved	262.6	909,749	-	-	80.2	30.7
Total	327.6	2,963,414	-	-	100.0	100.0

Note: *The population is estimated as the figures as of 2014.

After GWMC's commencement of operation, the UCs were divided into 8 zones for management purposes, as shown in **Figure 2.3.1**.

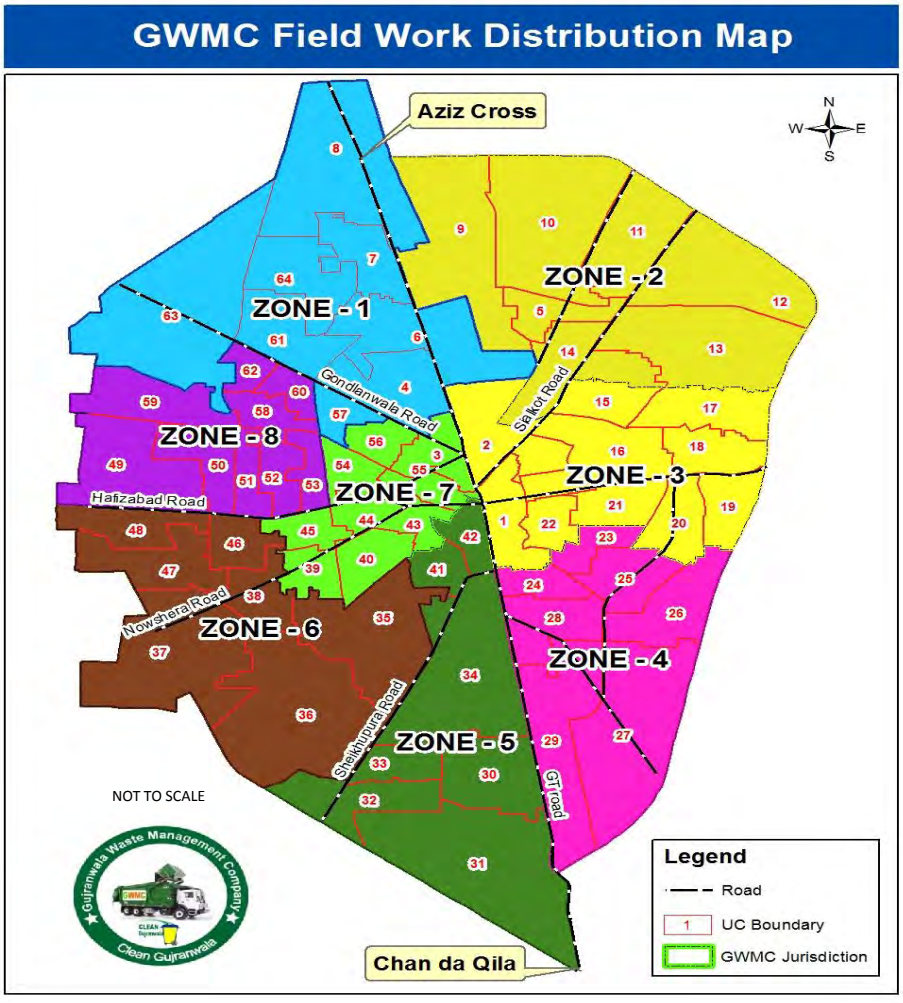


Figure 2.3.1 Zoning Map of GWMC Service Area

Source: GWMC

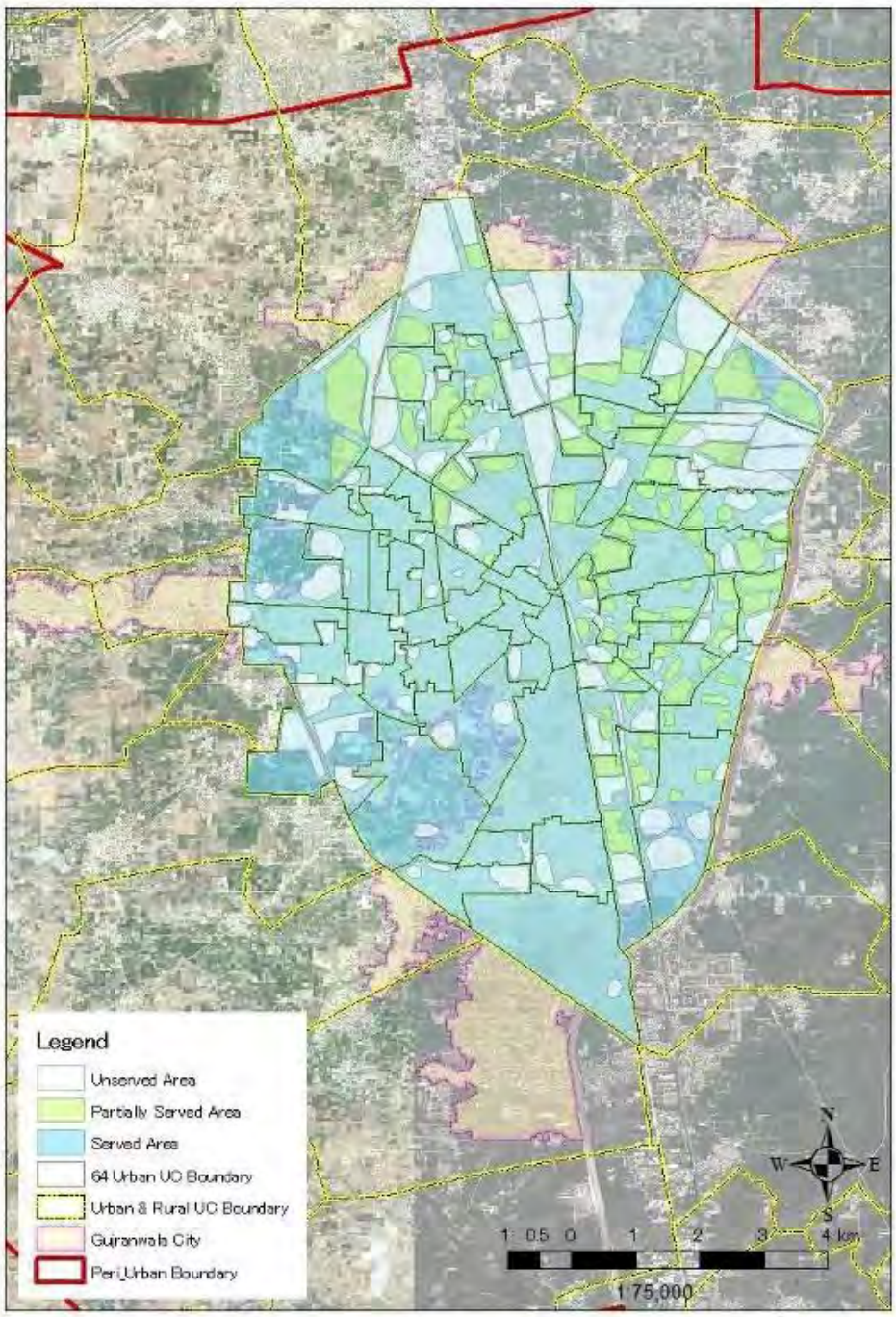


Figure 2.3.2 Service Area Map of Waste Collection in Union Councils

Source: GWMC

(3) Location of Garbage Containers

Some 216 sets of $5m^3$ containers and 15 sets of $10m^3$ garbage containers were allocated in Gujranwala City as of January 2015, as shown in **Table 2.3.4.** 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.

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 the location of containers is determined by the infrastructure conditions and residents' consent of each UC since 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 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.

(4) Transfer Station

(a) Function of Transfer Station

There are five (5) transfer stations/masonry enclosures in the city; namely, the Khiali, Garjakh, and General bus stations, DHQ Hospital and Khan Mahal. They are called transfer stations, but the containers are put on the concrete floor surrounded masonry walls, practically, and only receive garbage from the surrounding UCs. Once a container is filled with the garbage, an arm-roll truck dispatches another empty container and hauls the filled container. There is no function such as transfer of garbage from other.

(b) Location and Operation Status on each Transfer Station

Figure 2.3.3 shows the location of transfer stations in Gujranwala City, and the status on each transfer station is summarised in **Table 2.3.5** (Detailed features of the transfer stations are described in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 2.2.4.***).

Figure 2.3.3 Location of Transfer Stations in Gujranwala City

Source: GWMC, April 2014.

Table 2.3.5 Summary of the Status on Each Transfer Station

No		Location	Start operation	Floor area	Physical features	Placement of containers	Covered UCs	Handling waste amount	Working hours	Supervisors
(1)	Khiali Transfer Station	Centre of the commercial area	2008	50 m^2	The roof was covered with vinyl sheets.	2	3 to 4 UCs	12 m^3	6 a.m. to 3 p.m.	1
(2)	Garjakh Transfer Station	-ditto-	2008	50 m^2	No roof and no sidewalls.	2	3 UCs	16 m^3	-ditto-	1
(3)	General Bus Station (Masonry Enclosure)	General Bus Station	2008	110 m^2	The roof is being covered with vinyl sheets.	1	General Bus Station, 1 UC (#4)	4 m^3	-ditto-	None
(4)	DHQ Hospital (Masonry Enclosure)	Main Road along the DHQ Hospital	2008	38 m^2	-ditto-	1	DHQ Hospital (Municipal waste)	5 m^3	-ditto-	None
(5)	Khan Mahal (Masonry Enclosure)	Southwest of the GWMC workshop	2008 (closed within a couple of weeks)	-	-	-	-	-	-	-

(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 2.3.4** 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**.

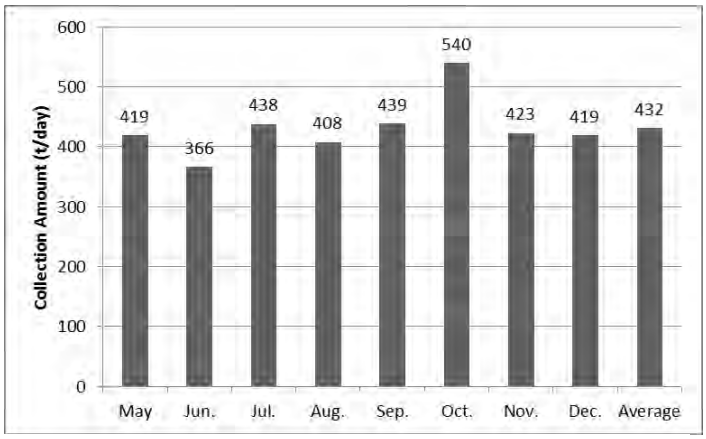


Figure 2.3.4 Total Waste Collection Amount (May - December 2014)

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-ul-Azha*, the festival of sacrifice for Muslims), butchered and ate many goats or sheep resulting in a quite large amount of leftovers in the city.

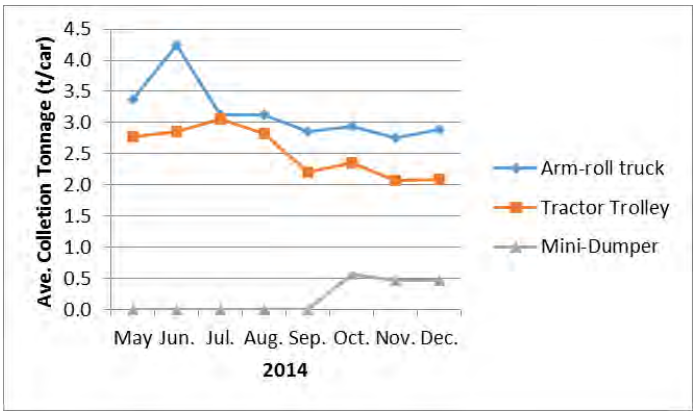


Figure 2.3.5 Average Daily Collection Tonnage per Arm-roll Truck/Tractor Trolley

Figure 2.3.5 and **Table 2.3.6** are reflected in the average daily tonnage per arm-roll truck/tractor trolley.

Table 2.3.6 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 2.3.7** 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 2.3.7 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

(b) Collection Ratio

There is no data regarding collection ratio. According to the interview survey for waste managers, the collection seems to be sixty (60) percent in Gujranwala City in the end of December 2014.

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, 603 tons since the number of containers before December 2014 was about 201; that is, 201 units × 3 tons = 603 tons. According to the interview survey for waste managers, approximately 1,000 tons of waste is generated in the city as 0.55 kg/capita/day was considered. Based on the result of the interview, it is assumed that 60% (603/1,000) 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 4.3**.

(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 2.3.8 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 Services and Assets Management Agreement (SAAMA).

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 2.3.8 List of Vehicles in GWMC

Type of Vehicle	Number of Vehicle	Procurement Year
Arm-roll truck (5m^3)	22 (22)	2007 - 2011
Arm-roll truck (10m^3)	4 (4)	2001 - 2002
Tractor trolley	37 (36)	1977 - 2007
Mini-dumper	35	2014
Mechanical sweeper	4 (4)	2011
Tractor with bucket, 4×4	3 (3)	2008
Tractor with bucket, 2×2	4 (4)	1998, 2000
Tractor with blade	4 (4)	1988
Rikshaw	2 (2)	-
Water sprinkler	2 (2)	2009
Spray machine	1 (1)	2014
Water bowser	1 (1)	1968
Total	119 (83)	-

Note: Figures in parentheses indicate the number of vehicles inherited from CDGG.
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 truck technicians, three tractor technicians, one electrician, four welders, seven helpers, one washman, one assistant washman, three security guards, one painter and one office boy are being assigned as of June 2015.

Photo 2.3.1 Current Situation of Vehicle Workshop

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 2.3.1** shows the current situation of the 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 2.3.9 shows the operation and maintenance (O&M) expense paid by CDGG from 2006 to 2013. Most vehicles were repaired in 2006 and the repaired vehicles did not cause big problem during operation. Therefore, it might help to reduce the repair cost and the O&M expenditure was almost half figure of 2006 in three years starting from 2007 to 2009. Since most of the vehicles were made in the year 2000 and utilised for almost 10 years, these vehicles should have been renewed in the term of 2012-2013. In addition, vehicles procured in 2009 are also broke down in this duration. This is the reason the O&M expense of 2012-2013 was therefore getting higher than that of 2011-2012 and the O&M expense is doubled in a year.

Table 2.3.9 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
Note: There is no data available in 2009-2010.

(8) NGO

There was one NGO, OPE (Organization Pan Environment), which worked in UC No. 8 (Shaheenbabad) during 2008 to 2010. The organization 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 2.3.6**. 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**.

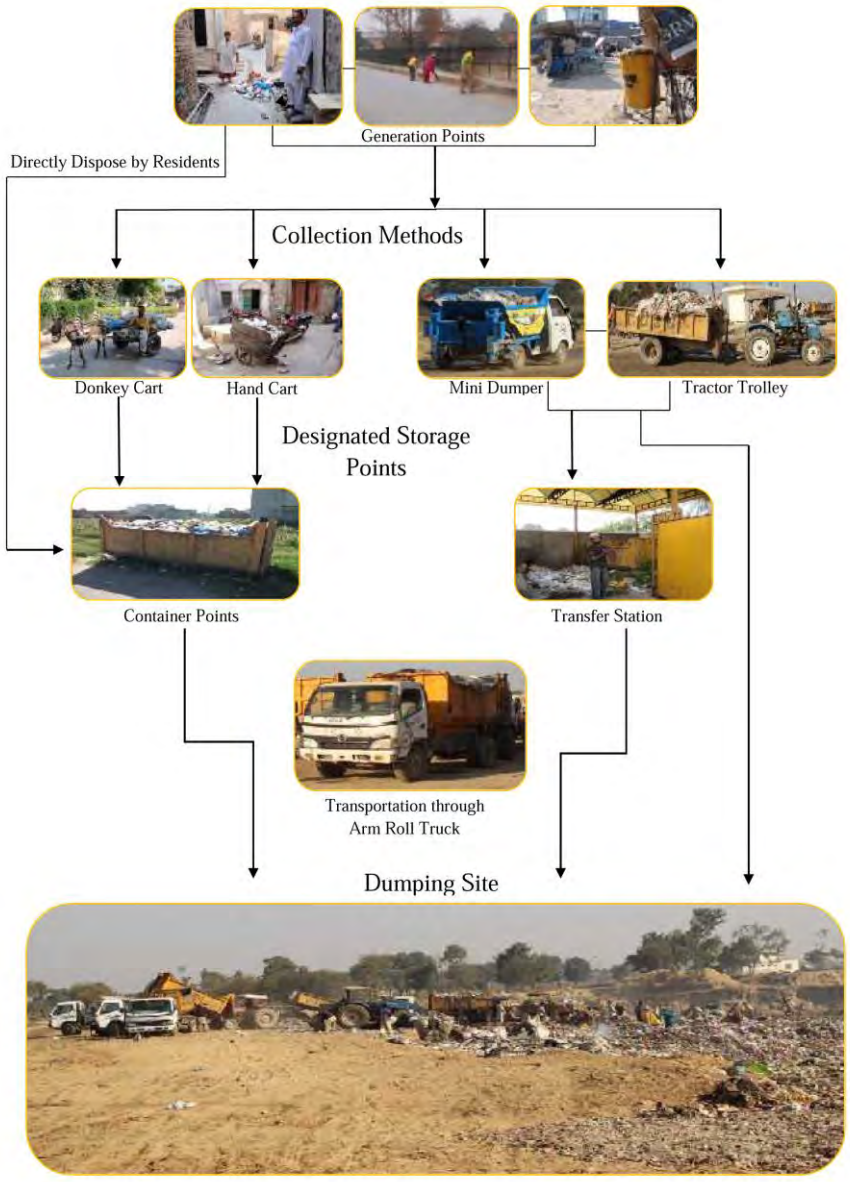


Figure 2.3.6 Waste Collection and Transportation Scheme Conducted by GWMC

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 2.3.10**. Around 60 tons of waste were collected by the activity in a day in the latest five months. Roughly 7% of waste generation is being collected under the activity.

Table 2.3.10 Waste Amount Collected by the One Time Cleaning Activity

Month	Sep. 2014	Oct. 2014	Nov. 2014	Dec. 2014	Jan. 2015	Average
Waste Amount per Day (ton/day)	77	77	52	52	43	60

(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 nearly 800 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 organization and budget for solid waste collection are also limited. Therefore, the current situation of data management, facility operation and the organization has not improved.

Figure 2.3.7 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 mean that these illegal dumping sites are located in areas where collection service is poor. 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 2.3.11 shows the list of illegal dumping sites in the towns as of August 2014. 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 2.3.11 Number of Illegal Dumping Sites in the Towns

Town	Number of Illegal Dumping Site
Aroop	292
Qila Didar Singh	67
Nandi Pur	111
Khiali Shahpur	329
Total	799

Source: GWMC, August 2014.

Photo 2.3.2 View of Illegal Dumping Sites in Gujranwala City

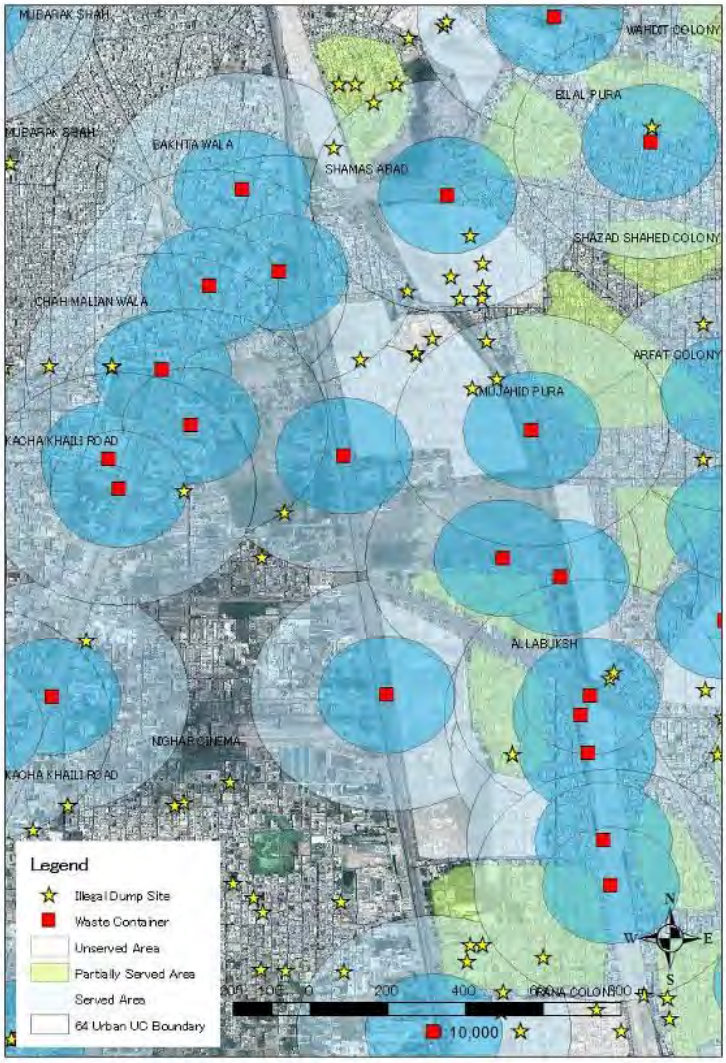


Figure 2.3.7 Relationship between Container and Illegal Dumping Site

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

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. Although GWMC plans to adopt $12m^3$ or $19m^3$ sized compactors in future, the gross vehicle weight for each car is more or less 18 tons or 26 tons and it can be measured within the loading limit of this weighbridge.

The gross weight of each vehicle is measured by the weigh bridge. The tareweight of each vehicle is measured beforehand and registered in the weighbridge computer program. Incoming waste amount of each vehicle is measured automatically by subtracting the tareweight of the encoded vehicle from the gross weight of the incoming vehicle. This type of computerised weighbridge measuring method is common in Pakistan nowadays. It is easy for GWMC to maintain the weighbridge in case of malfunction of the weighbridge. Thus, the weighbridge is suited for the project.

GWMC does not accept the waste carrying into the landfill site by private companies. If the private companies come to dispose the waste in the landfill site, GWMC refuses to accept/dispose the waste in the site.

The general plan and specifications of the weighbridge are presented in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 2.5.2.***

(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 2.3.3** shows the installed weighbridge.

Photo 2.3.3 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. Inadequate management of waste containers	Discharged waste by the residents overflows around the container. In addition, some residents misbehave the waste disposing to the container. As a result, the waste is scattered around the containers and it causes odour and deteriorates the environment in the city.	Implementation of the education program is required to raise awareness of the waste generators to discharge waste properly into the waste container. In addition, the collection work should be regulated to clean-up around the container by the collection worker and/or by street sweeper.
5. 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.
6. 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.
7. 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.

Problem	Description of Problem	Issues for Solving the Problems
8. 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 GWMC 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

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 14 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 2.4.8**.

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.

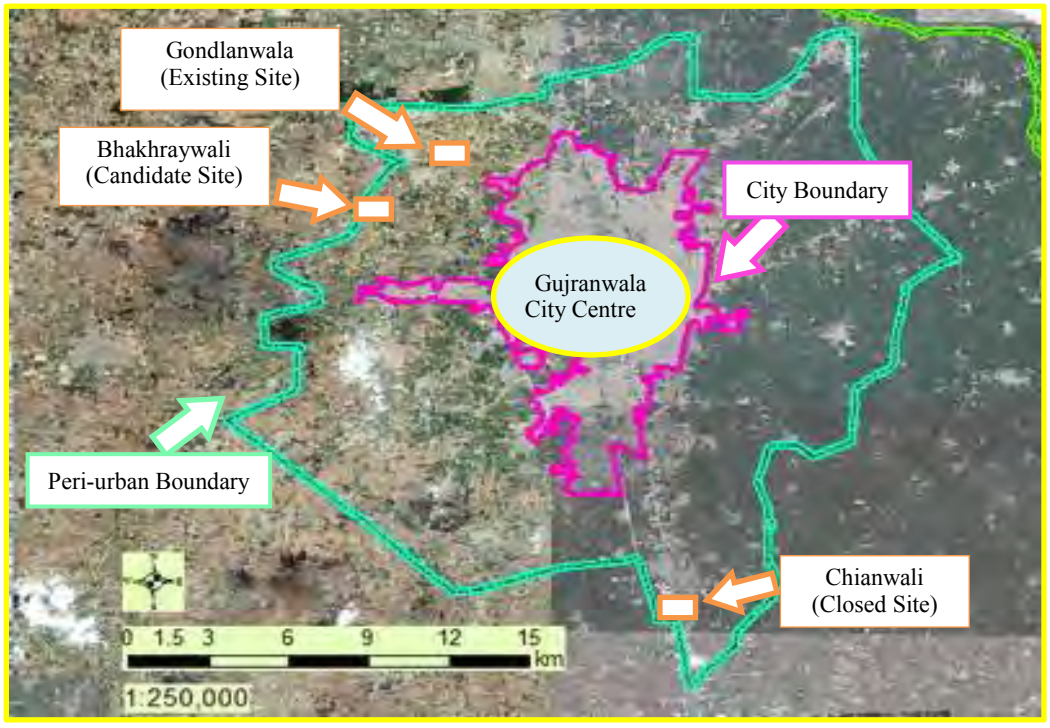


Figure 2.4.1 Location Map of Final Disposal Sites

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 worked daily in September 2014. 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 in 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.

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

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. Reference shall be made to the results of water quality tests delineated in **Subsection 2.4.5**.

(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 14 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 Month	2,600	2,137	2,062	2,001

Source: Record of SWM Section, CDGG

There were no vehicle lists available for the period of the above table. However, the vehicle list from the fiscal year 2006/2007 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**. 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 310 thousand cubic metres assuming that the bulk density of filled waste layer is 1.1 ton/m^3 obtained from the bulk density survey conducted in Chianwali and Gondlanwala disposal sites (see **Subsection 2.4.6** in detail).

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)	1.3	15.6	22.2	49.0	55.6	62.3	62.3	63.1	9.6
Cumulative Amount (1,000 ton)	1.3	16.9	39.1	88.1	143.7	206.0	268.3	331.4	341.0

(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 weighbridge data has been processed and analysed through the Incoming Waste Amount Survey under 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**. 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

Table 2.4.4 Monthly Annual and Cumulative Waste Disposal Amount at Gondlanwala

Month	Waste Disposal Amount at the Site	
	Monthly Amount (ton/month)	Cumulative Amount (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

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 2014 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 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.

(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.** 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	

(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 2.4.3** 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, on 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.

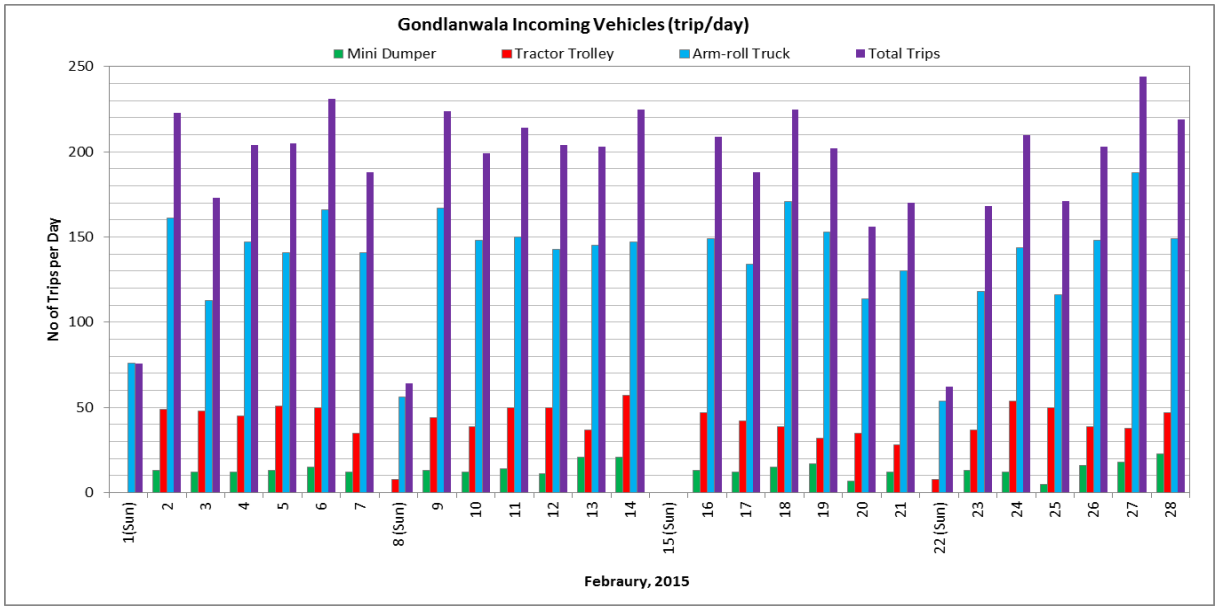


Figure 2.4.3 Daily Number of Incoming Vehicles by Arm-Roll Truck and Tractor Trolley to Gondlanwala Disposal Site (February 2015)

(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. 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/Manager Landfill. The organizational structure of landfill operation is as shown in **Figure 2.4.4**. The post of Operation General Manager is vacant as of end of July 2015. Besides the post shown in Figure, the sanitary workers and security guards are dispatched to the disposal site and the current total number is 17 people.

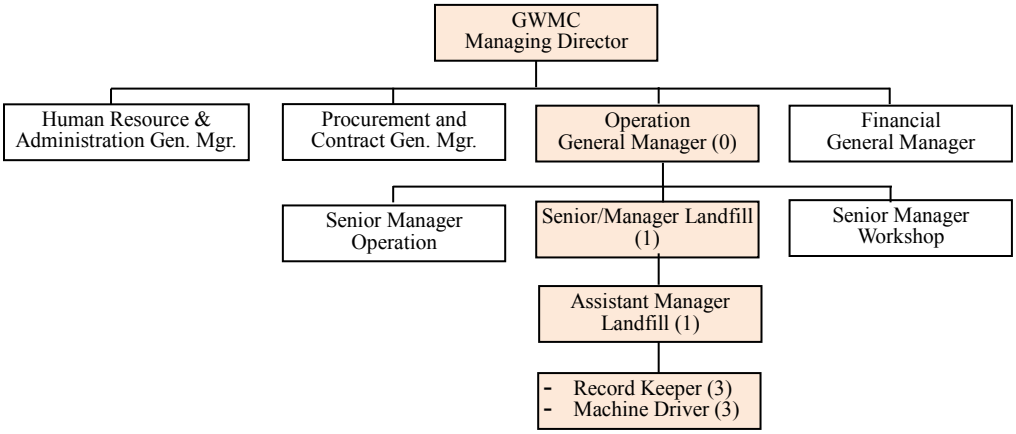


Figure 2.4.4 Organizational Structure for Landfill Operation

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 of Closed landfill site at Chianwali (Survey Area: approximately 8 ha) and Existing landfill site at Gondlanwala (Survey Area: approximately 7 ha), and the mapping work. The final products of topographic map, profiles and cross sectional drawings were submitted to the JICA Project Team in December 2014. Those output drawings were used for preparation of the preliminary design including the layout plan and cross section plan for the improvement works for Gondlanwala and safe closure work for Chianwali.

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 on 12 October and completed the boring test by the end of October 2014. The results of boring test and the laboratory test were submitted to the JICA Project Team in December 2014, and summarised below (See detail in ***Volume 3, Supporting Report, Section C: Final Disposal, Section 2.4.***).

- **Gondlanwala**: Five boreholes drilled at the site reveal that the main soil type at the site comprises of silty to fine sand, which is overlain by a thin layer of silty clay and clayey silt. Water table was encountered in the boreholes at about 9 m depth from the ground surface. The results of the field permeability tests (k* = 1.4×10^{-3} to 2.7×10^{-3} cm/sec) indicates a little high permeability for the design to prevent leachate infiltration into underground. *k: coefficient of permeability
- **Chianwali**: Six boreholes were drilled at the site exposed the main soil type comprise of old cohesive fill and silty clay, which is underlain by silty to fine sand. The groundwater was encountered in all the boreholes at an average depth of 6.4 m from ground surface. The results of the field permeability tests (k* = 4.4×10^{-4} to 8.5×10^{-3} cm/sec) indicates a little high permeability for the design to prevent leachate infiltration into underground.

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 carried out in three (3) seasons. The contractor conducted water sampling at the end of September 2014 for the monsoon season, at the end of January 2015 for the winter season and at the end of May 2015 for the summer season. 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) [Note: "COD" in this report is measured by using potassium dichromate unless otherwise indicated.], 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 ***Volume 3, Supporting Report, Section C: Final Disposal, Figure C.2.11 to Figure C.2.14***, 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 to surface water and groundwater respectively.

The results of the survey are described in ***Volume 3, Supporting Report, Section C: Final Disposal, Subsection 2.5.4,*** and major findings of the three seasons' test are summarised as follows:

- **Gondlanwala**: Surface water sample of GGW-1, leachate from the dump site, has reduced the water contamination level from 607mg/lit to 119mg/lit in terms of COD. Meanwhile, pH value has increased from 8.6 to 9.2 showing the transition of waste decomposition. Turbidity of three season samples of the shallow wells, GGW-2, GGW-4 and GGW-6, exceeds the drinking water standards of 5 NTU. Electric Conductivity of most of the groundwater samples are relatively high exceeding 1,000μS/cm. Animal husbandry nearby the wells would be a cause of groundwater contamination. Significant water pollution due to the influence of the existing disposal site could not be confirmed from the three season water quality test results.
- **Chianwali**: Surface water sampling point of the drainage ditch, CSW-1, CSW-2 and CSW-3, are contaminated by sewage from the surrounding area resulting high values of COD and BOD_5. Groundwater contamination is observed at the sampling point of CGW-2, which exceeds the standard values by Turbidity and Arsenic. In addition, the value of Electric Conductivity is also high at more than 1,800μS/cm in three seasons. However, significant water pollution due to the influence of the former disposal site could not be confirmed from the three season water quality test results.

2.4.6 Landfill Waste Bulk Density Survey

The survey was carried out on 10 February 2015. The purpose of the survey is to find out the bulk density of landfill waste which will be used for the Bhakhraywali landfill planning. 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.

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:

$$\text{Chianwali } (1{,}121 \text{ kg/m}^3) > \text{Gondlanwala } (668 \text{ kg/m}^3)$$

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 Gondlanwala disposal site. The results of the survey are described in detail in ***Volume 3, Supporting Report, Section C: Final Disposal, Subsection 2.6.3.***

2.4.7 Incoming Waste Composition Survey

The waste composition data plays a crucial role in planning and designing of solid waste system. The objectives of the incoming waste composition survey are to determine the composition of waste collected from Gujranwala waste collection area and hauled to Gondlanwala for disposal, and to estimate the potential amount of resource or recyclable materials mixed in the incoming waste at the existing disposal site.

The incoming waste composition survey was conducted from 9-12 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. 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.

The weighted average percent composition of Gujranwala waste being disposed is shown in **Figure 2.4.5**. 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).

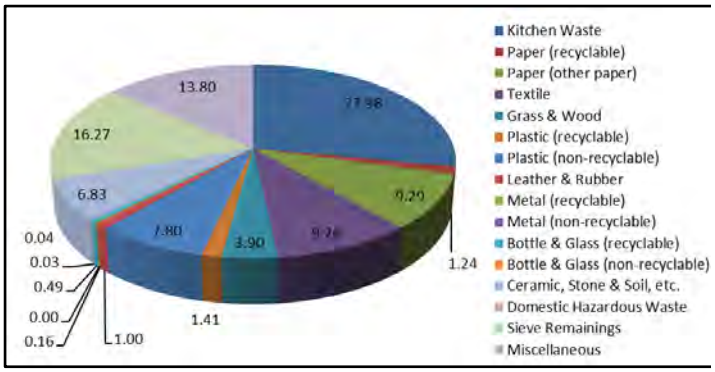


Figure 2.4.5 Average Waste Composition of Incoming Waste at Gondlanwala

The results of the survey are described in ***Volume 3, Supporting Report, Section C: Final Disposal, Subsection 2.7.3,*** and the following conclusions can be drawn from the analysis of the incoming waste composition survey conducted at the Gondlanwala disposal site:

- The incoming waste for disposal at Gondlanwala has 32% of organic waste represented by kitchen waste, grass and wood. The organic waste ratio becomes more than 50% in case sieve remaining and miscellaneous wastes are included. These wastes have a high potential of waste reduction or waste division for final disposal by means of biodegradable treatment if GWMC manages to collect organic waste separately.
- The combustible waste ratio represented by plastics, paper, etc., account for almost 34%. As well as organic waste, these combustible wastes have a high potential for waste reduction and heat recovery by treatment as a resource 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.

2.4.8 Current Status of Planning of Final Disposal Site by Pakistani Side

This subsection describes the activities related with the selection of candidate final disposal site by referring to the site selection report prepared by UU.

(1) Implementation Status of Selection of Final Disposal Site

(a) 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.

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

(i) 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.

Major factors considered during the landfill site selection are Airports, Flood plains, Wetlands, Fault zones, Seismic zones and Unstable zones (See detail in ***Volume 3, Supporting Report, Section C: Final Disposal, Subsection 2.8.1.***). Apart from the above, many other factors are also taken into consideration prior to the selection of potential site for the Landfill.

(ii) 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:

Negative Mapping

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

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 survey of the landfill site was commenced with a careful desk study leading to a specific sitting criteria presented in ***Volume 3, Supporting Report, Section C: Final Disposal, Table C.2.15***. 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 these factors.

(iii) 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 ***Volume 3, Supporting Report, Section C: Final Disposal, Figure C.2.17***. Further, using the Geographic Information System (GIS) tool, sites were identified with measuring the distance from major road.

(iv) 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 ***Volume 3, Supporting Report, Section C: Final Disposal, Table C.2.15*** and the computed results are as presented in **Figure 2.4.6.** 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. The details of scoring of each site are presented in ***Volume 3, Supporting Report, Section C: Final Disposal, Tables C.2.17 and C.2.18***.

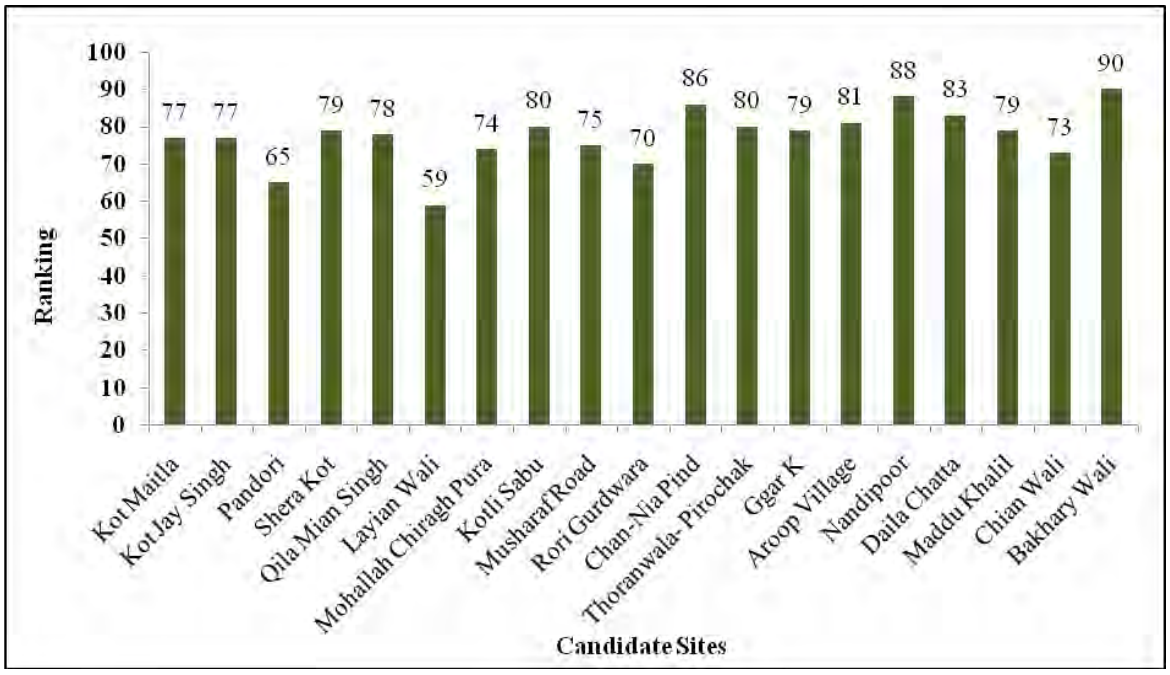


Figure 2.4.6 Ranking of Candidate Sites according to the Set Criteria

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

(v) 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 as shown in **Table 2.4.6**.

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

Table 2.4.6 Outline of Top-Ranked Sites for Final Disposal of Waste in Gujranwala

Site Name	Bhakhraywali	Nandipur	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 **Chapter 5**.

The EIA report was submitted to Environmental Protection Department (EPD) in May 2015. After filing EIA report to EPD, a letter for confirmation of completeness for purpose of initiation of review process under Regulation 9 (1) (a) of the IEE/EIA Regulation, 2000 was marked on dated 03 June 2015. According to this letter EPD reserves the right to require the proponent to submit additional information at any stage during the review process.

For Public hearing, approved notice form agency has been publicised 30 days before in English and Urdu national and local newspaper on dated 14 July, 2015 for hearing on 17 August 2015 at 11:00 AM in Rachna Pearl Hotel, G.T. Road Gujranwala, as required under section 12 (3) of Punjab Environment Protection Act, 1997 (amended 2012) and also under IEE/EIA Regulation, 2000. The EIA for construction of Bhakhraywali sanitary landfill

facilities is in the public consultation in addition to the further review by the agency for final approval.

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.

As of September 2015, the negotiation for the land procurement has been completed and agreed between GWMC and eleven landowners. GWMC is scheduling to complete the contract signing and payment immediately after execution of the project budget.

(2) 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.

2.4.9 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 ***Volume 3, Supporting Report, Section C: Final Disposal, Subsection 2.9.1***.

2.4.10 Evaluation of Final Disposal Condition

The problems and issues in relation to final disposal activities under the current situation are summarised in **Table 2.4.7**. 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 2.4.7 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	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

Problem	Description of Problem	Issues for Solving the Problems
	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.	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

2.5.1 Waste Picker Survey

The Waste Picker Survey is one of the field surveys within the framework of the Project. 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. The survey was carried out in December 2014. The total number of samples is 40: 20 for Gondlanwala Disposal Site, 5 for low income area, 10 for middle income area and 5 for high income area in Gujranwala City.

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. 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.

In Gujranwala town areas, the total recovery amount is estimated at 149 kg/day/waste picker. 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.

On the other hand, the total recovery amount is estimated at 141 kg/day/waste picker in Gondlanwala disposal site. 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.

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 around 70 ton/day (approximately 800 pickers × 82 kg/day waste in city and 60 pickers × 55 kg/day waste at the dump site). The amount recovered by the waste pickers in addition to the material recycling is contributing to the waste diversion or reduction of landfill amount. The detail of the survey results and analysis is presented in ***Volume 3, Supporting Report, Section D: Intermediate Treatment and 3R Promotion, Subsections 2.1.3 and 2.1.4.***

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**. Under such circumstances, it is found that there are no laws and regulations related to 3R activities in Punjab, to support GWMC's 3R activities and promotion.

(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 shopkeepers go to these commercial shops to buy the recyclables.

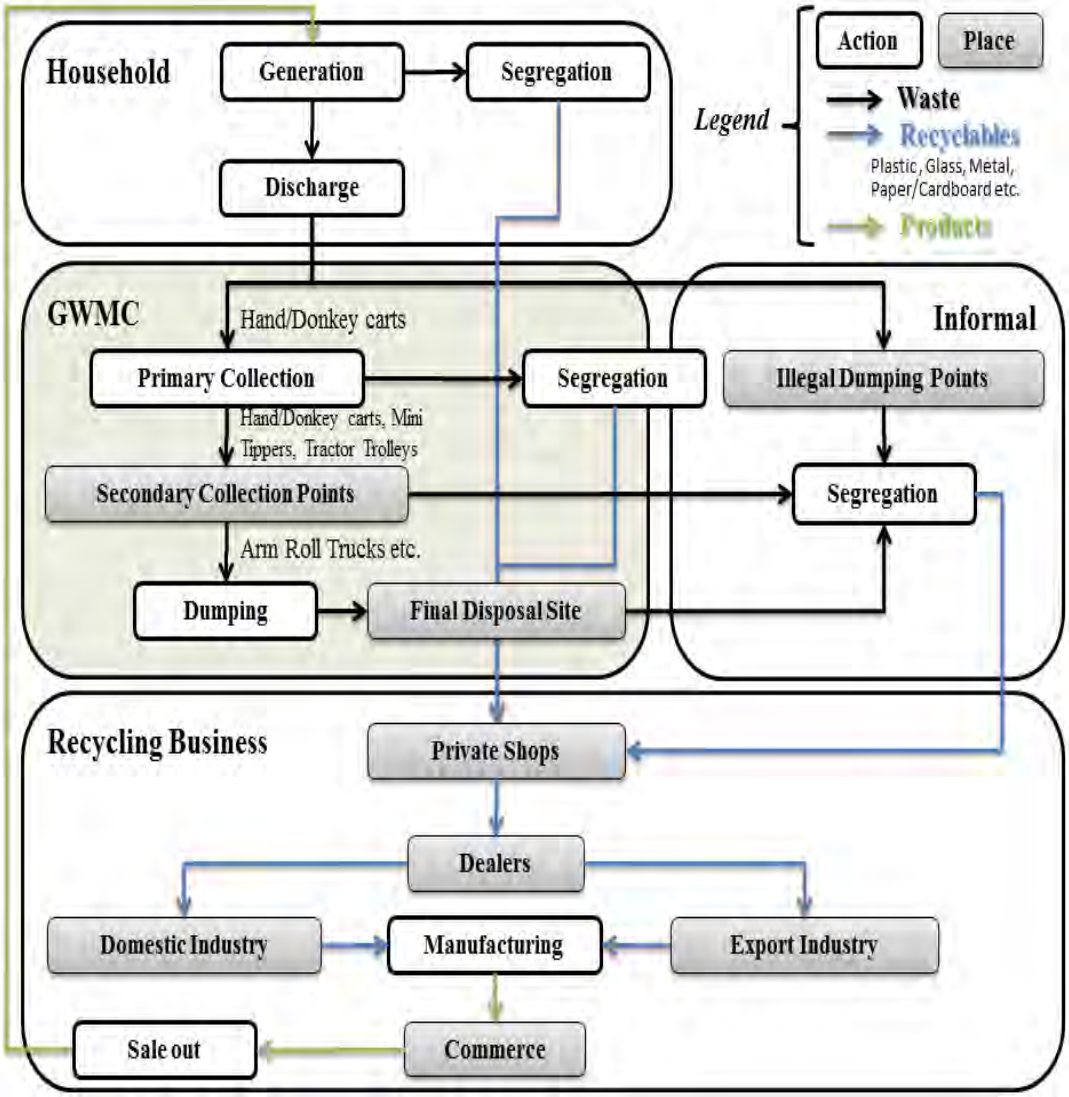


Figure 2.5.1 Material Flow of Recyclables in Gujranwala

(3) Waste Picking

There are two types of 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 waste carried by trucks or trolleys of GWMC, and hence 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.

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 2.5.1**). 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 2.5.1 Number of Waste Pickers at Container and Final Disposal Sites

Town / Road / Place	Number of Containers*	Number of Waste Pickers
Aroop Town	48	89
Khiali Town	57	114
Nandipur Town	51	95
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 December 2014.
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 recycling firms and problems have also been examined.

(1) Recycle Private Shops and Dealers

There are more than 700 private recycle shops and dealers in Gujranwala City. Basically, private recycle shops (see **Photo 2.5.1**) collect recyclables from households, commercial establishments, waste pickers, street hawkers (see **Photo 2.5.2**) 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 2.5.1 Recycle Private Shop, UC No.54

Photo 2.5.2 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 2.5.2**.

Table 2.5.2 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. The minimum number of shops and dealers is 398 and 312, respectively because of the purpose and procedure of this survey. The detailed breakdown of the number of shops and dealers in each UC is shown in ***Volume 3, Supporting Report, Section D: Intermediate Treatment and 3R Promotion, Table D.2.5.*** 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.

(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 2.5.3**.

Table 2.5.3 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)

Industry Sector	Recyclables	Destination	Final Products
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 recycled goods 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 Affairs Department, 2002).

(4) NGO

There are three (3) NGOs related to the environment sector in Gujranwala, namely; Organization Pan Environment (OPE), Gujranwala Environmental Organization (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 (80% by SWM, CDGG and 20% by OPE). 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 gives 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 No. 90 and UC No. 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.

(6) Farmer

In Gujranwala District, large cultivated lands spread in the peri-urban UCs. **Table 2.5.4** shows the cultivated area of each crop in Gujranwala City and Sadar Tehsil. The major crops occupy approximately 95% cultivated area 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 potassium 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. So far there is no data available for a chloride ion concentration in compost in Gujranwala. However, it is assumed that as the salt in compost comes from food waste, the salinity of a dish will be less than 1% that becomes delicious, and there are not large amounts of the food waste mixed in the total amount of organic waste.

The interview survey conducted in peri-urban areas with the local farmers showed that they are well aware about the benefits of applying organic fertilizer or compost for healthy and eco-crops. Cow dung is used as a base fertilizer after cropping or before seeding by the interviewee farmer. The cow dung softens the soil and the farmers use it in combination with chemical fertilizers for more yields in short time. The farmers want to see the effects of compost application on test yards at the compound of the proposed compost plant in Gujranwala. In addition, 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 2.5.4 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

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 Lahore Compost Company and D.G. Khan Cement Company

There are companies for composting and RDF (Refuse Derived Fuel) production, namely; the Lahore Compost Company (hereinafter referred to as "LCC") and D.G. Khan Cement Company (hereinafter referred to as "DGKCC") in Lahore, Punjab. The JICA Project Team visited the plants and equipment of the LCC and DGKCC together with members of GWMC in 2014 and 2015. Salient features of the plants are summarised in **Table 2.5.5** and **Table 2.5.6.** Some photos of the on-going LCC Plant and DGKCC Plant are shown in **Photo 2.5.3** and **Photo 2.5.4.**

Compost produced at the LCC Compost Plant seems not to go well because it was observed that a half or more of the compost products were remaining unsold. One of the reasons seems to include that the trust of the users (farmers and inhabitants) about the compost is not obtained, according to the interview survey. Interview results with the LCC and DGKCC are also shown in the table below.

Table 2.5.5 Salient Features of the Lahore Compost Plant

Project Overview	Descriptions
Contracting parties	City District Government Lahore and Lahore Compost (pvt.) Ltd. (LCL)
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
Major merits of compost*/RDF	• Compost is cheaper than other chemical fertilizer, and is useful in long term for soils and crops, increasing the soil porosity and nutritional supply of plants. Compost is environmental friendly. • Compost can reduce waste amounts on the landfill site drastically. • RDF is cheaper than other fuel types. • RDF reduces waste amounts and a burden on the landfill site, and increases its life span.
Major points to be addressed*	• Bulk density of Lahore compost products was simply measured at the office of GWMC and the results reveals more than 1.0 t/m^3, that may be higher than a density of real compost. • Organic matter of the Lahore compost is around 15% which is smaller than 35%-40% of organic matter in Japan in general. It is advised that quality of LCL products should be improved in terms of high organic contents. • Although the LCL has the licence of compost production from the Agricultural Department Directorate of Soil Fertility Punjab, it is suggested that the quality control of LCL should be required to be improved. • Besides acquiring the quality control of LCL, IEC (Information, Education and Communication) programmes on effectiveness and safety of LCL is further needed to the famers. • Although the LCL has currently a contract for RDF sale with Lafarge Group, the LCL may need to consider contracts with other enterprises to expand a sale market for RDF.

Source: Interview results with Lahore Compost Company (Pvt) Ltd.
Note: * This means the results of the interview with Lahore Compost Company (Pvt) Ltd.

		
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	**RDF materials**	**Organic compost product**

Photo 2.5.3 Composting Process under Operation of LCC Plant

Table 2.5.6 Salient Features of the D.G. Khan Cement RDF Plant

Project Overview	Descriptions
Contracting parties	Lahore Waste Management Company and D.G. Khan Cement Company (Pvt.) Ltd. (DGKCC)
Description of service	Establishment of 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 DGKCC
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
Major merits of the Plant*	• RDF is cheaper than other fuel types and contributes the reduction of waste amounts incoming to a final landfill site and then its life span. • DGKCC has an advantage to transport the lighter combustible fluff after bailing to transport them to their own plant at Kallar Kahar. • The owner company of Nihat Group which has more than 25 industries in the country uses the RDF at their own kilns. • An energy pilot project for waste biogas is in progress and DGKCC intends to produce electricity energy to consume for the plant use which depends on feasibility. For this reason, DGKCC does not need to search for other market of RDF to meet their fuel demand.
Major points to be addressed*	• Currently a big amount of organic waste is being landfilled. • Only some number of cement companies such as Lafarge, DGKCC, Lucky Cement, etc.

Project Overview	Descriptions
	use RDF materials in their kiln in combination with other fuels. • As RDF that contains plastics, rubbers and leathers, etc. produces toxic gases on burning, proper operation and management of the combustion temperature should be crucial for the air pollution control technology.

Source: Interview results with the D.G. Khan Cement Company for RDF Plant.
Note: * This means the results of the interview with the D.G. Khan Cement Company for RDF Plant.

		
RDF Product Plant	**Input waste into the RDF plant**	**Magnetic separator**
		
Main equipment (vibratory screen, wind shifter, baler unit)	**Vibratory screen**	**RDF material before baler unit**

Photo 2.5.4 RDF Material Product under Operation of D.G. Khan Cement Company

2.5.5 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 2.5.7**. 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 2.5.7 Identification of Problems and Issues in Intermediate Treatment and 3R Promotion

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.
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	Instead of imposing a limit on their work to improve operation efficiency, GWMC should provide alternative opportunities for them to make a living. The countermeasure for Problem 1 in this table must be considered first to determine

Problems	Description of Problem	Issues for Solving the Problems
	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.	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.
5. Not well known quality & effect of compost products of the Lahore Compost / RDF Plant	Compost produced at the Lahore Compost Plant seems not to go well because a half or more of the compost products seem to remain unsold. The users do not trust the safety and quality of compost produced at the plant.	A regular quality control in the compost production process should be carried out. A periodical quality inspection system by the public institutions or agencies should also be established for certification of the compost products. Additionally, it is needed to perform a continuous IEC activity on the needs of 3R and the running the compost plant for the integrated solid waste management project in Gujranwala.
6. Lack of laws and regulations related to 3R	There is no enforced legal system such as laws and regulations on SWM and 3R activities in Gujranwala, Punjab, to support GWMC's 3R activities and promotion.	As legal background to organize or ask for join of waste generators or recycling people to the programs on SWM, recycling laws are needed to be legislated leading to weak legal status of the concerned organisations and sectors for 3R activities.

2.6 Environmental Education and Public Awareness Raising

2.6.1 Public and Establishment Awareness Survey

Awareness survey was planned to identify the current status of waste management practices by two key stakeholders: Households (include households targeted in waste amount and composition survey) and Business entities/commercial establishment (markets, schools and universities, offices, restaurants, hotels, shops, factories, and hospitals). 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.

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, i.e., high, middle and low, since income greatly influences the type and volume of waste. Likewise, the number of target commercial establishments is determined to represent the whole area of Gujranwala City and a total of 50 samples are surveyed. The number of samples per area per income level and per commercial category is listed in ***Volume 3, Supporting Report, Section E: Environmental Education and Public Awareness Raising, Tables E.2.1 and E.2.2***.

Although survey items differ considerably since each entity has its own unique characteristics, the items are categorised into four (4) parts: General Information (location, general information, etc.), Description of Interviewed Subject (number of members, type of dwelling, household income, etc.), Solid Waste Conditions (waste container used, waste discharge habit, separation and recycling, charge paid, etc.) and Awareness on SWM Issues (concept of SWM in the city and willingness to pay). The detailed survey items of the questionnaires are shown in ***Volume 3, Supporting Report, Section E: Environmental Education and Public Awareness Raising, Table E.2.3.***

The survey was carried out from late September to November 2014 and a summary of the survey is presented in the following sections (See detail in ***Volume 3, Supporting Report, Section E: Environmental Education and Public Awareness Raising, Subsection 2.1.3.***)

(1) Households

As a result, 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. 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.

(a) 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. 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.

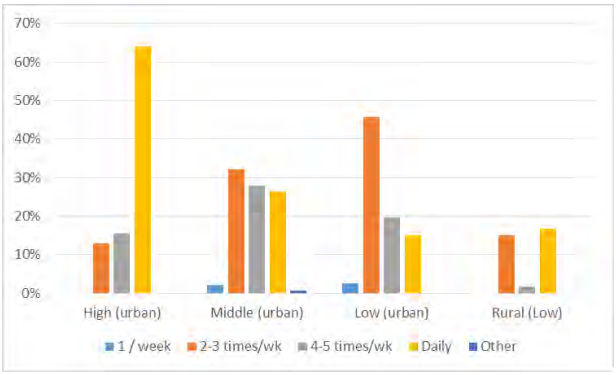


Figure 2.6.1 Frequency of Waste Collection

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.

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. 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.

(b) Willingness to Pay (WTP) for Waste Collection Services

Since the amount of money that one is willing to pay was asked from the respondents who want to avail themselves 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.

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

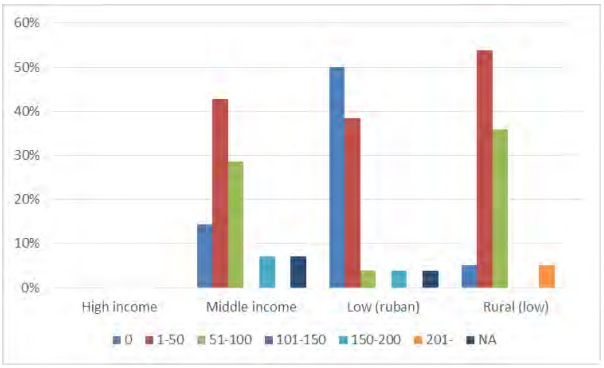


Figure 2.6.3 Willingness to Pay for Waste Collection Services by Income Group

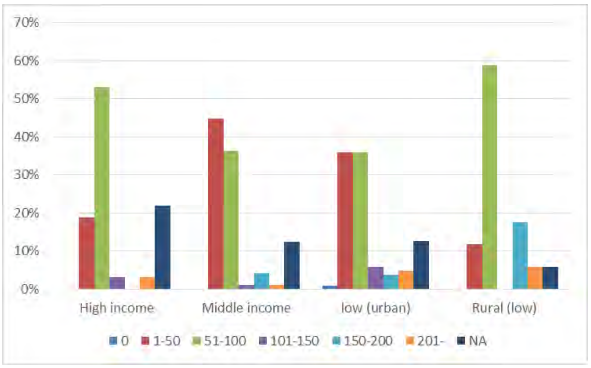


Figure 2.6.2 Current Tip Paid to Collection Workers per Month by Income Group

In addition, 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.

(c) Recycling Behaviour

Figure 2.6.5 to Figure 2.6.7 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.

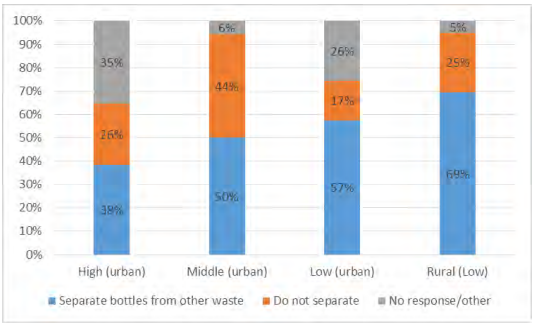


Figure 2.6.5 Recyclable Separation (Bottles) by Income Group

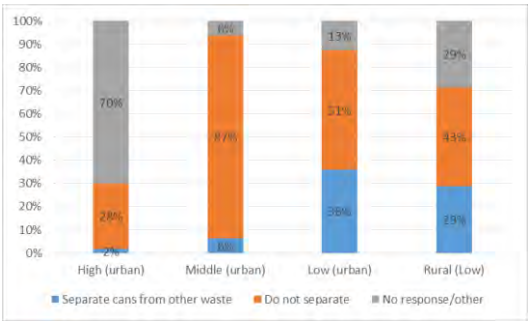


Figure 2.6.4 Recyclable Separation (Cans) by Income Group

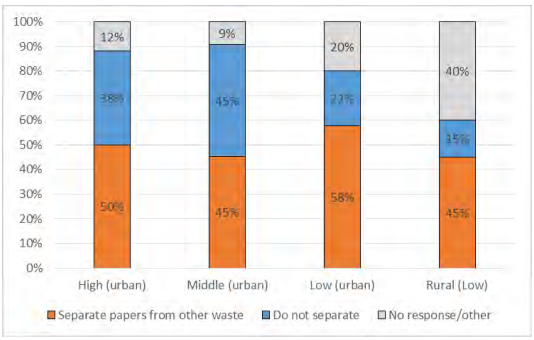


Figure 2.6.7 Recyclable Separation (Papers) by Income Group

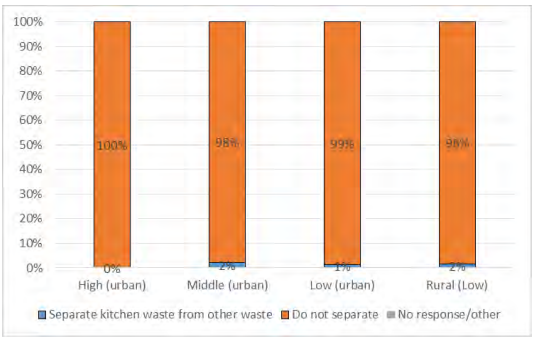


Figure 2.6.6 Recyclable Separation (Kitchen Waste) by Income Group

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

(2) 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."

(a) Accountability on the Results of Survey

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.

(b) 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. A result of questions regarding satisfaction with the current waste collection service varies depending on business types where restaurants and hospitals have good ratio of satisfaction of the services while 70% of factory says 'not satisfied.'

(c) Recycling Behaviour

Recycling practice among business establishments is very low. The only exception done at restaurants is bottle recycling (100%) and can (60%). 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.

(3) Conclusion

Considerable number of residents and business establishments surveyed expressed un-satisfaction on their waste collection service, 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.

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, Organization Pan Environment (OPE), Nayab Welfare Society, Gujranwala Environmental Organization, 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 Masjid). 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

Interviews with the District Officer for Environment indicate the lack of commitment in environmental education in the Government, which appears to be the hindering issue and leads to the poor public awareness also analysed by the Public Awareness Survey. 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 2.6.1**.

Table 2.6.1 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 activity has 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 students.	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 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 Aspect

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 per cent 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	Area (km^2)	Estimated Population Density for Year 2014 (1000 persons per km^2)
Nandi Pur Town	15	379,980	400,000	12.2	32.8
Khiali Shah Pur Town	13	339,930	357,840	19.8	18.1
Aroop Town	17	426,920	449,410	23.4	19.2
Qila Didar Singh Town	19	417,680	439,680	9.6	45.8
Total	64	1,564,510	1,646,930	65.0	25.3

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. The scope of MICS 2007-08 was further expanded to more than 70 indicators and coverage level. The results of the 2007-08 survey as well as the 2011-12 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.

Recently, the results of the latest MICS 2011-12 have been compiled. The detailed comparison of the results of the major social indicators for Punjab Province as well as Gujranwala under MICS 2007-08 and MICS 2011-12 are presented from **Table F.2.4** to **Table F.2.15** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***. 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.

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 2.7.4**.

Table 2.7.4 Major Road Network in Gujranwala in 2008

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 2.7.5**.

Table 2.7.5 Number of Educational 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 and other information is separately discussed in **Subsection 2.9.1**.

2.7.5 Economic and Financial Situation of GWMC

(1) Budget Allocation Mechanism of GWMC

The operational budget and the investment budget for GWMC are being allocated from the budget of CDGG which almost depends on the subsidies from the Government of the Punjab (GOPb) and the regular budget of GOPs itself, respectively. For the financial year 2015-16, the total budget allocated from CDGG and GOPb is approximately Rs. 504 million and Rs. 730 million, respectively. Out of the operational budget from CDGG, 75.6 percent of the budget is allocated for salary-related expenses and the remaining 24.4 percent is earmarked for other operating costs. **Table 2.7.6** gives a snapshot of the GWMC budget for SWM services. In addition to the below regular budget of GWMC, approximately, Rs. 1.2 billion of the development scheme of the sanitary landfill site is being submitted to GOPb through the PC-1 (Planning Commission 1) format under 2015-2016 financial year budget of GOPb.

Table 2.7.6 Budget for SWM Services of GWMC

Expenditure Item	2014-2015 Revised Budget		2015-2016 Budget Estimates	
	Budget (Rs. 1,000)	Share (%)	Budget (Rs. 1,000)	Share (%)
Total Expenditure of GWMC	956,968	100.0	1,233,612	100.0
Budgetary Allocation from CDGG for Operating Expenditure	482,968	50.5	503,612	40.8
Salary-related Expenditure	346,208	71.7	380,532	75.6
Other Operating Expenditure	136,760	28.3	123,080	24.4
Budgetary Allocation from GOPb for Investment Expenditure	474,000	49.5	730,000	59.2

Source: Revised Budget for 2014-2015 and Budget Estimates for 2015-2016, 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 organization 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 is subject to the approval of independent organizations 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 needs 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.

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 2.7.7**. 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 2.7.7 Identification of Problems and Issues on Economic and Financial Aspect

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 investments of SWM services.	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.
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	GWMC should explore the possibilities of involving the private sector in SWM services to provide efficient services cost-effectively with minimum costs.

Problem	Description of Problem	Issues for Solving the Problems
	looking towards improvement of its SWM services through outsourcing to the private sector.	The objectives of involving the private sector include 1) enhancing efficiency; and 2) mobilise the investment resources of the private sector.

2.8 Institutional Strengthening and Organizational Restructuring

2.8.1 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 2.8.1**.

Table 2.8.1 Other Federal Legislations Related to Solid Waste Management

Name of Regulation	Year	Major Issues related to Solid Waste Management
Pakistan Penal Code	1860	・ 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.
The Factories Act	1934	・ Regulations on labour factories ・ Disposal of waste and effluents has to be arranged.
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.
Environmental Tribunal Rules	1999	・ Organization and procedures/rules (updated in 2012)
Review of IEE/EIA	2000	・ Regulation on Environmental Impact Assessment (EIA)

Name of Regulation	Year	Major Issues related to Solid Waste Management
Regulations		・ 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
Pollution Charge for Industry Rules	2001	・ Calculation and collection of charges
Provincial Sustainable Development Fund Board Rules	2001	・ Rules on constitution and meetings of the Board
NEQS Rules	2001	・ Self-monitoring and reporting by industrial units ・ 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 six laws and regulations in **Table 2.8.2** are most noteworthy in the Province of Punjab. (See detail in ***Volume 3, Supporting Report, Section H: Institutional Strengthening and Organizational Restructuring, Subsection 2.1.2.***)

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.

Table 2.8.2 Important Laws and Regulations Concerning Solid Waste Management in Punjab Province

Name of Regulation	Year	Main Contents
Punjab Environmental Protection Act	2012	・ Following the enactment of PEPA 1997, the Punjab Environmental Protection Act was approved in 1997 and subsequently amended in 2012. ・ This Act defines several types of waste and stipulates powers and functions of the Council and Agency at the provincial level. ・ In general, powers and functions of the Provincial Government were slightly

Name of Regulation	Year	Main Contents
		weakened compared to the Federal Government.
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.
Hospital Waste Management Rules	2005	・ These Rules were formulated to deal with hospital waste in response to Section 31 of PEPA 1997. ・ The rules clearly state that hospitals are responsible for the management of waste generated within their premises.
Solid Waste Management By-Laws, City District Government Lahore	2005	・ These By-Laws hold responsible for the sanitation of the area within its jurisdiction the City District Government Lahore and the City District Government shall therefore arrange for sweeping and cleaning of public streets, and removal and carriage of refuse. ・ The City District Government will provide landfills and other facilities for the disposal of waste. ・ The local by-laws also contain the prohibition against depositing refuse, building materials, etc., in any public place and sets out fines for the violation of these rules.
Punjab Municipal Solid Waste Management Guidelines	2011	・ 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.
Punjab Municipal Solid Waste Management Act (Draft)	2013	・ Provision of 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. ・ Obligation to apply for a licence and prohibits certain activities relating to waste such as littering in any public place and burning of waste. ・ Establishment of the Punjab Waste Management Commission that shall cover Preparation of a Provincial Waste Management Plan, Giving general or specific directions to a Local Government, Proposal to the Government such as tariffs, rates, fees, charges and penalties, and etc. ・ Every local government is responsible to prepare a Waste Management Plan. ・ This Act is still in the process of legislation.

2.8.2 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 2020.

Its development plan encompasses areas of agriculture, manufacturing, poverty reduction, improvement of public services delivery, governance and civil services reforms, infrastructure improvement and education 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.

(2) Overview of National Policy

There are five (5) national policies related to solid waste management. The detail of each policy is described in ***Volume 3, Supporting Report, Section H: Institutional Strengthening and Organizational Restructuring, Subsection 2.2.1.***

(a) 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. 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.

(b) 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).

(c) 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.

(d) 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.

(e) 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.

(3) Overview of Provincial Policy

There are two provincial policies related to solid waste management.

(a) 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. 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, such as community participation, social and environmental considerations, environmental education, and so on are applicable to solid waste management.

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.

(b) 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 by minimising negative externalities associated with unregulated waste dumping, establishing and strengthening the institutional arrangements for landfill site selection, development, operation, maintenance and post closure, and improving 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.

2.8.3 Organizations Related to Solid Waste Management

There are several organizations 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.

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.

(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, and the city area and 34 union councils in Sadar area is the Project area:

- 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
- Khiali Shahpur 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 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 2.8.1**). Before the declaration of the District as City District, all functions under the Municipal Services category including solid waste management were performed by the Tehsil 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.

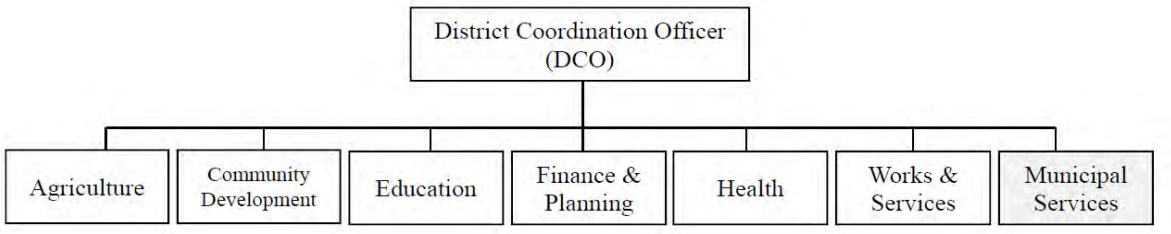


Figure 2.8.1 Organizational Chart of CDGG as of March 2015

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 tehsils, solid waste is managed by the respective TMAs.

Figure 2.8.2 illustrates the organizational 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.

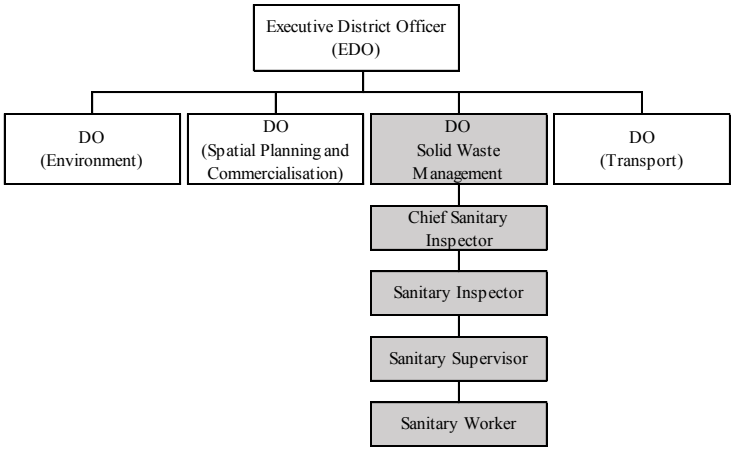


Figure 2.8.2 Organizational Structure of the Municipal Services of CDGG as of March 2015

As for capacity development of staff of CDGG, only 7 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 that they could not manage increasing waste by themselves. 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 2.8.3 below illustrates the organizational 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.

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.

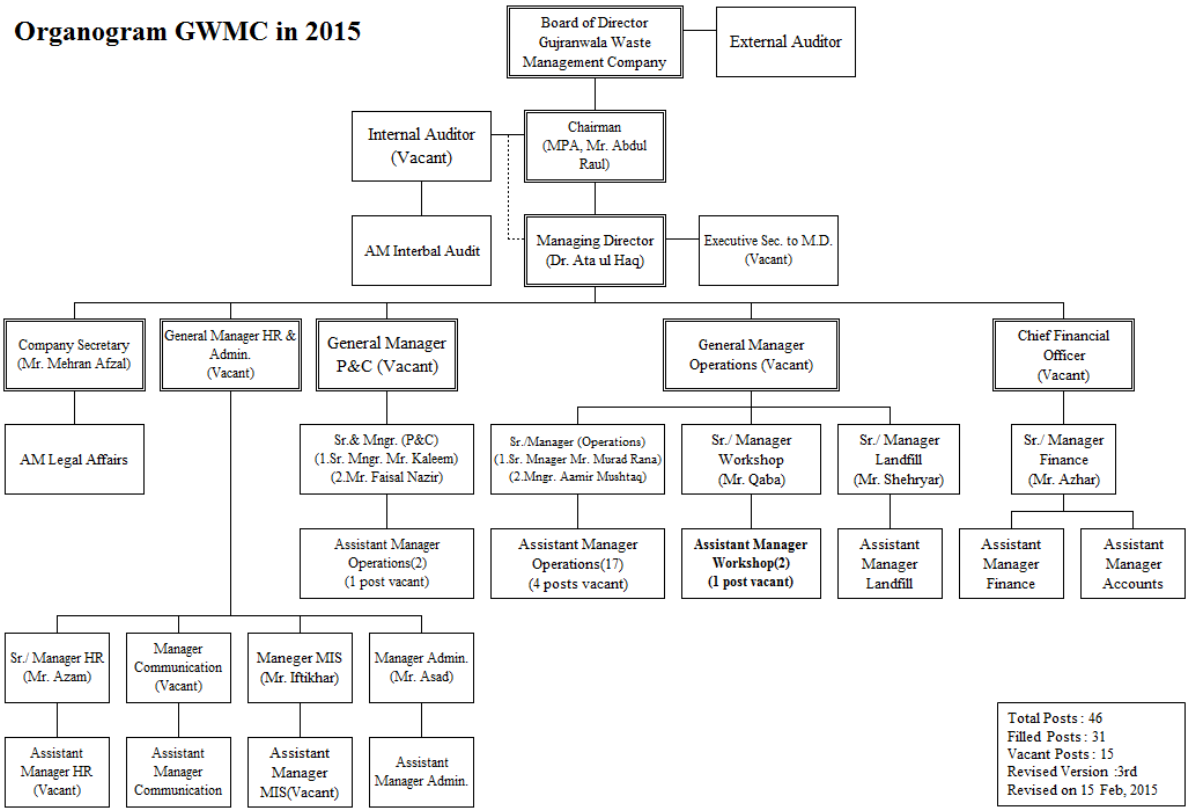


Figure 2.8.3 Organogram of Gujranwala Waste Management Company as of February 2015

Since GWMC is a new organization, 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 filling 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.

The capacity of CDGG and GWMC under the status quo is sumarrised in ***Volume 3, Supporting Report, Section H: Institutional Strengthening and Organizational Restructuring, Table H.2.2.***

2.8.4 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 listed below according to donor, namely; the Government of Japan, the Asian Development Bank and the World Bank. The detail of each plan is described in ***Volume 3, Supporting Report, Section H: Institutional Strengthening and Organizational Restructuring, Subsection 2.4.1.***

Government of Japan

- Improvement of Garbage Collection and Disposal in Rawalpindi City (1996)
- Dispatch of Short-Term Expert on Solid Waste Management (2002)
- Dispatch of Long-Term Expert on Municipal Waste Management (2003-2005)
- Project for Solid Waste Management in Pakistan (2005-2006)
- Capacity Building for Solid Waste Management (2006-2009)
- Data Collection Survey on Solid Waste Management in Punjab Province (2009-2010)

Asian Development Bank (ADB)

- Southern Punjab Basic Services Project (2005-2009)
- Rawalpindi Environment Improvement Project (2006-2011)

The World Bank (WB)

- Punjab Municipal Services Improvement Project (2006-2010)
- KOICA-World Bank Joint Study on Solid Waste Management in Punjab (2006-2007)

(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.

(a) Laws and Regulations Related to Private Sector Involvement

Major laws and regulations related to private sector involvement in Pakistan are as follows, and the detailed remarks are described in ***Volume 3, Supporting Report, Section H: Institutional Strengthening and Organizational Restructuring, Table H.2.3.***

- Pakistan Policy on Public-Private Partnership (2010)
- Protection of Economic Reforms Ordinance (1999)
- Companies Ordinance (1984)

- Labour Policy (2010)
- Punjab Procurement Rules (2014)

(b) Examples of Private Sector Involvement in Solid Waste Management in Punjab Province

There are private sector involvement projects/programmes in the Punjab Province, as listed below. The detailed descriptions of each project are described in ***Volume 3, Supporting Report, Section H: Institutional Strengthening and Organizational Restructuring, Table H.2.4.***

- Tehsil Municipal Administration Gujrat
- Lahore Sanitation Programme
- Cantonment Board Lahore
- Chaklala Waste Management, Rawalpindi
- Lahore Compost Plant
- Metropolitan Corporation Lahore (MCL)

(c) 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 ***Volume 3, Supporting Report, Section H: Institutional Strengthening and Organizational Restructuring, Figure H.2.4.*** (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.

According to the Services and Asset Management Agreement (SAAMA) 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. The detailed discussion is made in ***Volume 3, Supporting Report, Section H: Institutional Strengthening and Organizational Restructuring, Subsection 2.4.2.***

(d) Analysis and Recommendation on Private Sector Involvement

From the above-mentioned examples, factors for success and failure of private sector involvement can be summarised as shown in **Table 2.8.3**.

Table 2.8.3 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 Organization

In Gujranwala, there are two types of civil organizations; namely, Community-Based Organization (hereinafter referred to as "CBO") and Non-Governmental Organization (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 Organization. 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 827 CCBs but 750 CCBs were abolished due to budgetary constraints of the government. As of January 2015, only 77 CCBs were operating although no official records exist in terms of their current activities.

(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
- Gaoshala
- Block B, C, D, Shaheen Abad
- 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.

2.8.5 Evaluation of Institutional Strengthening and Organizational Restructuring

The problems and issues in relation to institutional strengthening and organizational restructuring under the current situation are summarised in **Table 2.8.4**. These items will be the basic elements to develop the plans, programmes and projects to comprise the institutional strengthening and organizational plan in the Integrated Solid Waste Master Plan in Gujranwala.

Table 2.8.4 Identification of Problems and Issues on Institutional Strengthening and Organizational Restructuring

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. All four manager positions 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;
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
		and • 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 ***Volume 3, Supporting Report, Section H: Institutional Strengthening and organizational Study***.
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, GWMC should provide good service enough for residents to appreciate the service.

2.9 Hospital, Industrial, and Construction and Demolition Waste Management

2.9.1 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, according to 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 include 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 2.9.1** shows the flow diagram of hospital waste.

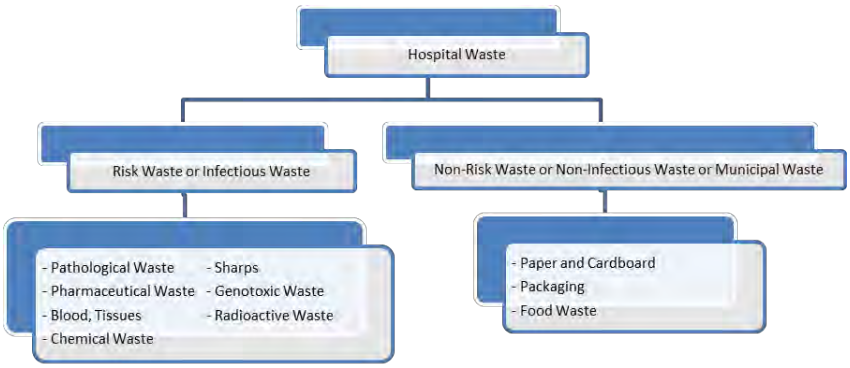


Figure 2.9.1 Flow Diagram of Hospital Waste

(2) Current Situation

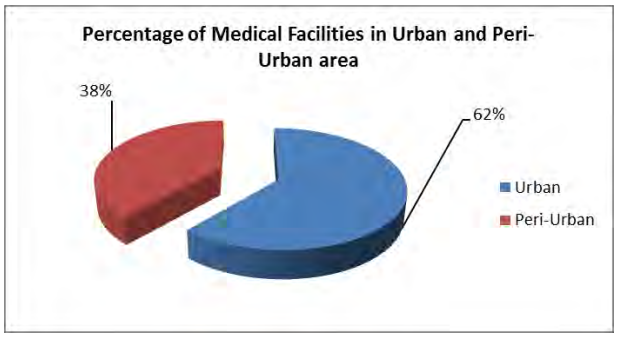


Figure 2.9.2 Percentage of Medical Facilities in Urban and Peri-Urban Area of Gujranwala

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. As a result of the site survey, the total number of medical facilities in Gujranwala is 1,372: 844 in urban (62%) and 528 in peri-urban (38%) as shown in **Figure 2.9.2**. The detailed results are presented in ***Volume 3, Supporting Report, Section I: Hospital, Industrial, and Construction and Demolition Waste Management, Subsection 2.1.1***.

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 gives 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 around 40 contracts 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 2.9.1**). A.T. Waste Management's truck visits with the Gujranwala twice a week. Therefore, in almost all the contracted hospitals a store room is present where they store the medical waste for 3 days as the collection truck visits Gujranwala only two times a week, i.e., Tuesday and Friday (See **Photo 2.9.2**).

Photo 2.9.1 Colour-coded Bags for Waste at a Hospital

Photo 2.9.2 Storeroom for Waste at a Hospital

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. 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 and GWMC have 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 with 32 medical institutions are summarised in ***Volume 3, Supporting Report, Section I: Hospital, Industrial, and Construction and Demolition Waste Management, Table I.2.2***.

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.

2.9.2 Current Situation of Industrial Waste

(1) Category of Industrial Waste

According to the Punjab Environmental Protection Act (PEPA) 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 2.9.3**.

Industrial waste may be toxic or not depending on the nature of waste. **Figure 2.9.3** shows the flow diagram of industrial waste.

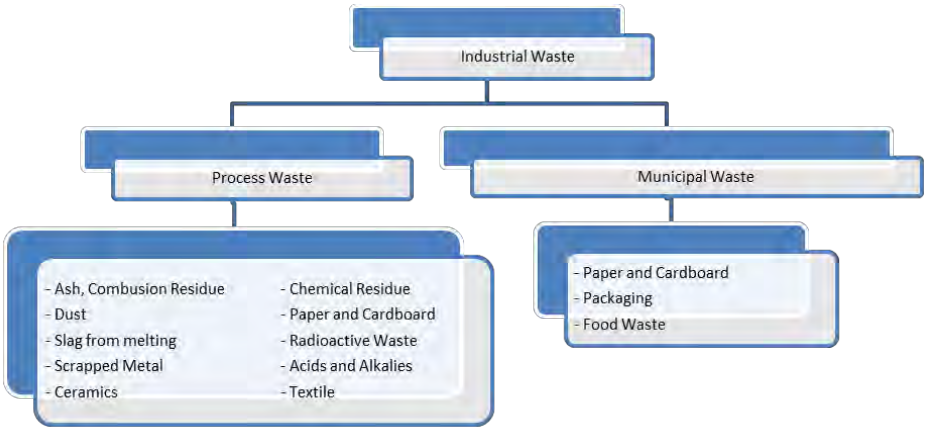


Figure 2.9.3 Flow Diagram of Industrial Waste

(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. Industries that are registered with GCCI have a National Tax Number (NTN) and are taxpayers to FBR (Federal Board of Revenue). The detailed results of the survey are presented in ***Volume 3, Supporting Report, Section I: Hospital, Industrial, and Construction and Demolition Waste Management, Subsection 2.1.2***.

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 2.9.4** shows the locations of 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

Figure 2.9.4 Location Map of Small Industrial Estates (SIEs)

industry or in another industry as described in **Subsection 2.5.1, Item (3)**. The results of the interviews are as shown in summarised in ***Volume 3, Supporting Report, Section I: Hospital, Industrial, and Construction and Demolition Waste Management, Table I.2.4***.

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 profit 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. 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 their waste to the GWMC containers.

2.9.3 Current Situation of 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 2.9.1.**

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 2.9.1 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

Activities	Sources
	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) Composition 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/rubble 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” and clearly state that the builder shall be responsible for the disposal of debris/waste from construction site to the waste disposal site (Clause 9.2.1 (iii) f.), and also that the builder shall be responsible to restore the area in front of his/her plot after construction, as prescribed by the District Government site (Clause 9.2.1 (iii) g.). The detail of the legal situation is

discussed in ***Volume 3, Supporting Report, Section I: Hospital, Industrial, and Construction and Demolition Waste Management, Subsection 2.1.3***.

2.9.4 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 2.9.2.** 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 2.9.2 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 of the smaller medical facilities is established in the urban and peri-urban areas 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.
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	It is the duty of industrial departments to collect the data and update the inventory of industries based on cooperation from them. It is essential to obtain the data for estimating the amount of waste produced

Problem	Description of Problem	Issues for Solving the Problems
	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.	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

As a result of a series of discussions and meetings between the JICA Project Team and the Pakistani side, 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 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 organizing 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 conduct 3R (Reduce, Reuse, Recycle) activities. 2) To comply with the local government's waste collection procedure. 3) To avoid littering waste. 4) 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 decided, as follows:

"Transformation of Gujranwala to the Cleanest City of Punjab"

(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
- Securing of a proper sanitary landfill site

- Strengthening of SWM financial capacity
- 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 Monitoring Plan

Programme 7: Institutional Strengthening and Organizational 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 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.

(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. 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

The objective of Final Disposal Plan is to 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 be formulated until 2030 for 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 safe post-closure plan of the former landfill site in Chianwali shall be included as an integral part 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 safe post-closure of the former landfill site shall be carried out to attain the satisfactory level for mitigating 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 be 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 promotion.
- 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 appropriate quality control of compost shall be indispensable to maintain the proposed central compost and RDF plant to be operated by a new compost company of Special Purpose Vehicle in Gujranwala.
- The awareness raising and IEC campaign on the intermediate treatment and 3R promotion activities shall be exercised upon public, schools and stakeholders in Gujranwala by continuous lead of GWMC.
- The recycling law shall be enacted or legislated to promote 3R activities and formalise the rapidly growing informal resource recovery activities.

(4) Environmental Education and Public Awareness Raising Plan

(a) Objective

The objective of the Environmental Education and Public Awareness Raising Plan 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 organizational 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 Monitoring Plan

(a) Objective

The objective of Environmental Monitoring Plan is to monitor the environmental quality 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 Monitoring shall be applied for not only the proposed landfill site at Bhakhraywali 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 Organizational Plan

(a) Objective

The Institutional Strengthening and Organizational Plan have three objectives as follows:

- To comprehensively reorganize 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 organization in charge of solid waste management services, the function of the GWMC should be comprehensively reviewed in terms of organizational and individual capacity assessment, as follows:

- Responsibilities and obligations of the new organization should not be fragmented or overlapping among the staff and workers;
- Linkages and coordination arrangements between different departments in the new organization should be efficient and effective;
- The organizational 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; and
- Integrated By-Law should be translated in Urdu.

(c) Planning Strategy

The organization of GWMC shall be restructured comprehensively for effective and efficient service provision based on the following concepts:

- An efficient and rationalised organizational 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 organizational 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, re-use, and recovery as well as inculcating the culture of waste reduction and proper storage among producers and consumers.

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 following 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. **Section 4.4** to **Section 4.10** present the contents of each component of the master plan, which include development of alternatives for each plan, evaluation of the alternatives and selection of priority projects. Recommendations on hospital and industrial, and construction and demolition waste are discussed in **Section 4.11**.

Based on these considerations and evaluations of each components of the master plan, master plan alternatives are developed based on the combination of some of the 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 4.12**. The evaluation of these alternatives is then carried out and the optimum master plan is selected in **Section 4.13**. The optimum master plan is then evaluated from the technical point of view, economic and financial aspects, and institutional and organizational aspects in **Section 4.14**, and the future waste stream of the optimum plan is presented in **Section 4.15**.

The formulated Master Plan should be monitored and evaluated in terms of operation and effect indicators proposed in **Section 4.16** and the implementation schedule and cost, and plan of operations of the Master Plan is presented in **Section 4.17**. Finally, priority projects are selected in **Section 4.18**.

4.2 Socioeconomic Aspect

4.2.1 Population Projection

(1) Past Spatial Development and Population in Gujranwala

Information on the past spatial development and population of Gujranwala were obtained from the "Proposed Peri-Urban Structure Plan Gujranwala City". **Figure 4.2.1** gives a graphic presentation of the area developed from 1914 to 2009. The early stage development occurred in the west side of the city. Development of the east side of the city took place after the 1950s. The built-up area has expanded to the north-west side of the city and the north and south areas along the G.T. Road. **Figure 4.2.2** graphically illustrates the past population in the "Proposed Peri-Urban Structure Plan Gujranwala City". This graph shows a rapid growth of population from 224 thousand in 1971 to 1.13 million in 1998.

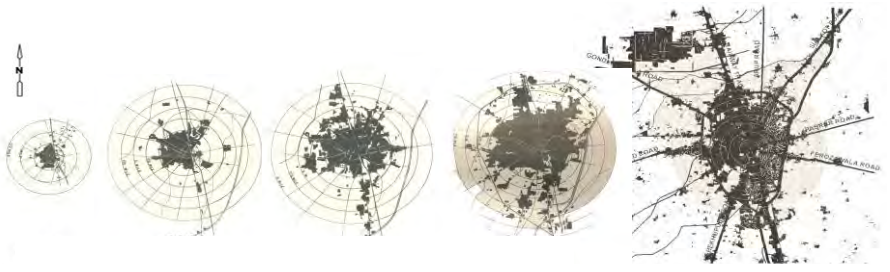


Figure 4.2.1 Gujranwala Historical Growth (Built-up Area)

Source: Proposed Peri-Urban Structure Plan Gujranwala City (Modified by JICA Project Team)

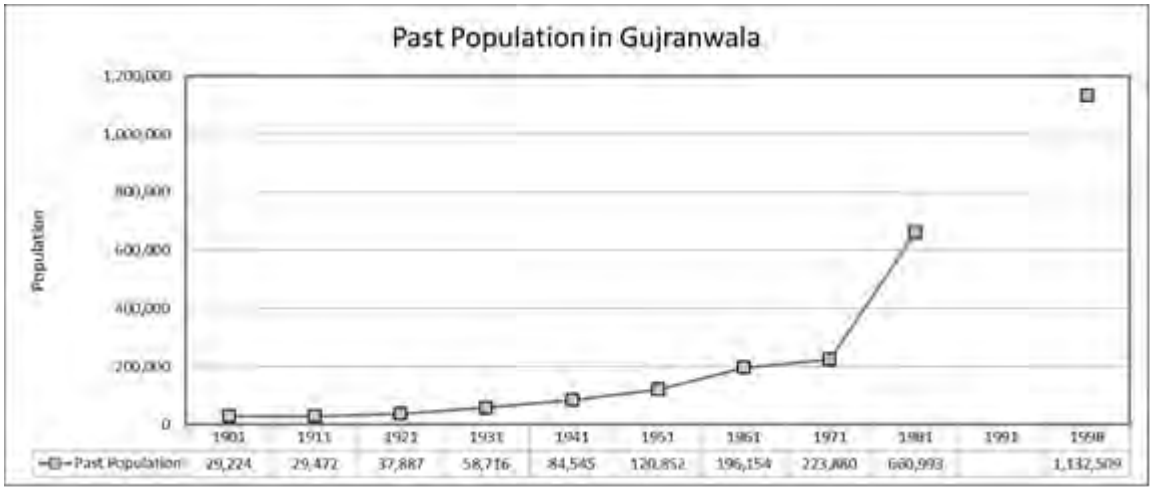


Figure 4.2.2 Past Population in Gujranwala (1901-1998)

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 of 1998, population of the 64 urban UCs and 34 peri-urban UCs covered in the ISWM Master Plan is approximately 1.13 million and 0.61 million, respectively, as shown in **Table 4.2.1**, and the total population was 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 Didar Singh	19	337,348
	Aroop	17	254,329
	Khiali Shah Pur	13	276,132
	Nandi Pur	15	264,700
Total for 64UCs		64	1,132,509
Peri-Urban	Qila Didar Singh	6	101,488
	Aroop	8	217,500
	Khiali Shah Pur	12	154,715
	Nandi Pur	8	138,391
Total for 34UCs		34	612,094
Total for 98 UCs		**98**	**1,744,603**

Source: Population Census of 1998

(3) Projection of Future Population in the 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. On the other hand, the population growth rate in the Punjab Province during the same period is estimated at 2.64% (Note[*1]). UU and LWMC carried out population projections in connection with the formulation of the outsourcing plan of waste collection services in the 64 UCs of Gujranwala (Note[*2]). The population projection in the report was carried out for the city area in the 64 UCs for the period of 2012-2019. By analysing the projected population, the annual growth rate could be 3.2%. Considering the rapid growth of the city in the recent years, the annual population growth rate of 3.79% is adopted for the estimation of future population in the Project. Population projection is carried out based on the population census in 1998 as the base year.

Table 4.2.2 shows the summary of the population projection. As a result of population projection, total population in the 64 urban UCs and 34 peri-urban UCs increases from 3.2 million in 2014 to 5.7 million in 2030. **Figure 4.2.3** shows the projected population in comparison with the 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 98 UCs in Gujranwala

Urban UC and 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 Didar 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 Didar 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**

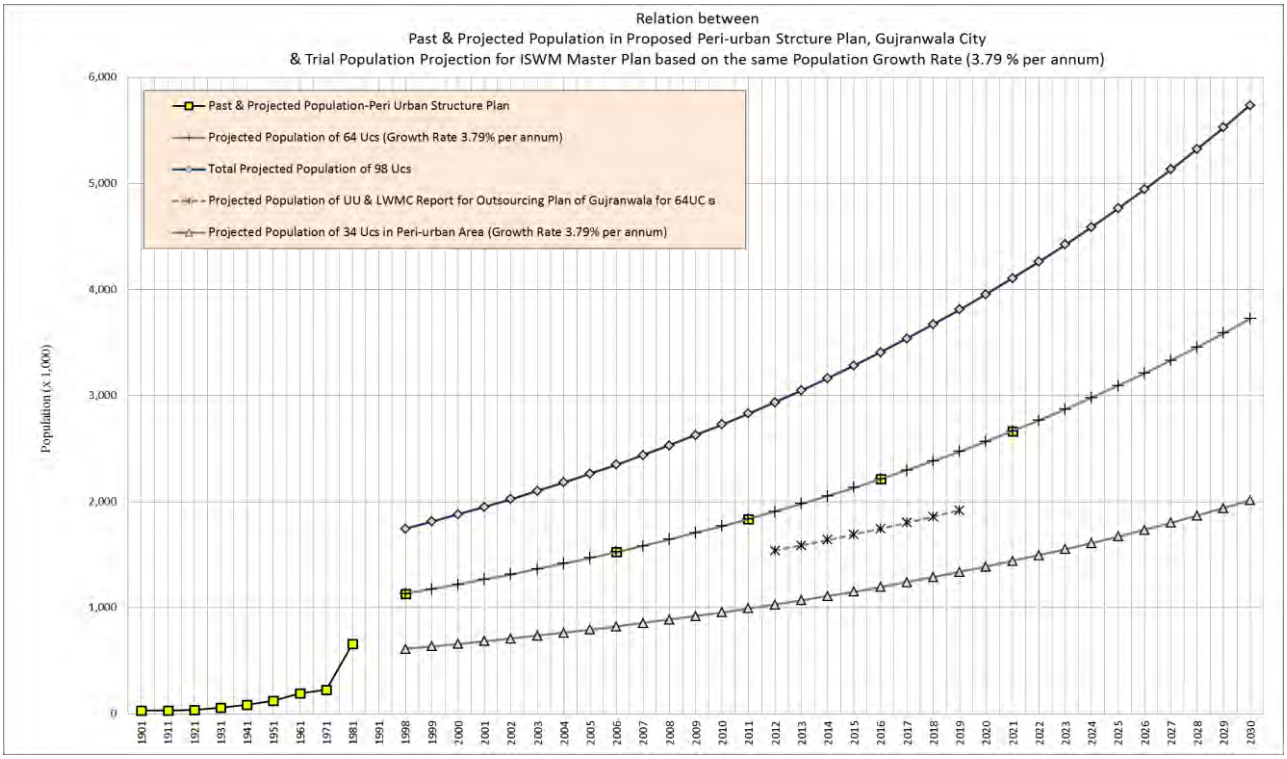


Figure 4.2.3 Past Population (1901-1998) and Projected Population (1999-2030)

(1) Adjustment of Future Population in the Project Area of 98 UCs

The peri-urban boundary line crosses the area of 18 peri-urban UCs and splits each UC area into inside and 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 5.4 million in 2030, which is 1.8 times of the population after 16 years.

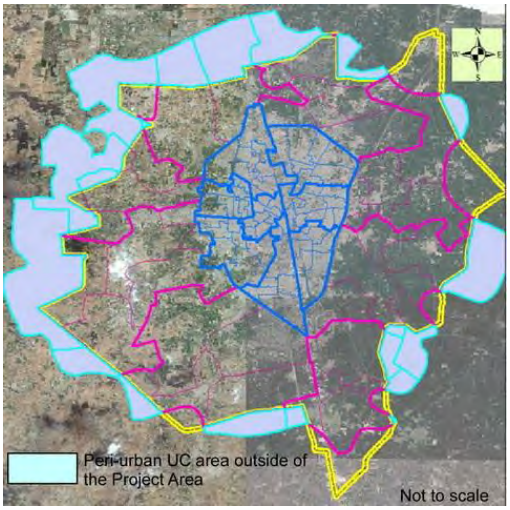


Figure 4.2.4 Peri-Urban UCs Split into Inside and Outside of the Project Area

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	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	1,650
Total Project Area	**2,964**	**3,076**	**3,192**	**3,313**	**3,439**	**3,569**	**3,704**	**3,845**	**3,991**	**4,142**	**4,299**	**4,462**	**4,631**	**4,807**	**4,988**	**5,177**	**5,374**

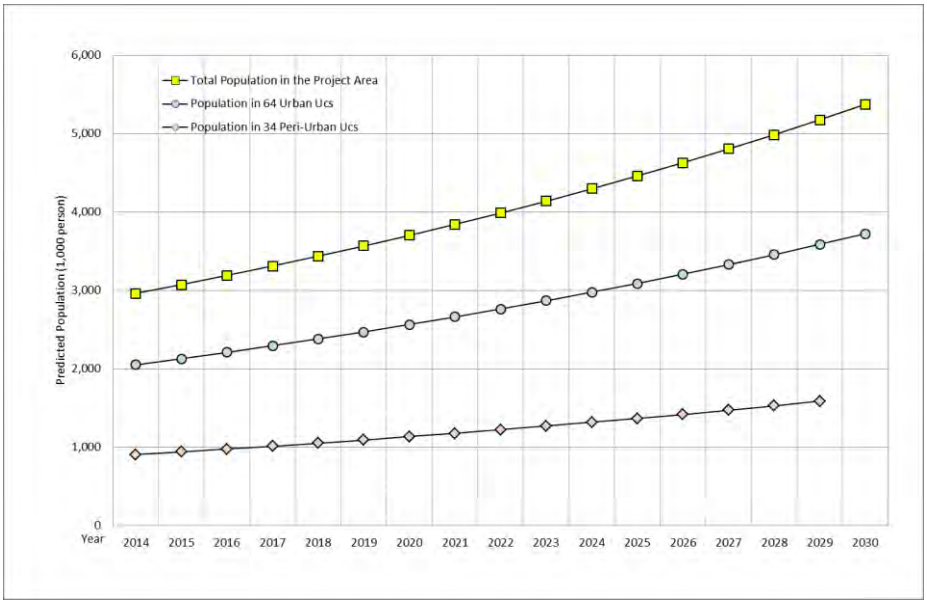


Figure 4.2.5 Trend of Estimated Population in the Project Area for ISWM Plan

The population of each UC/Town is shown in ***Volume 4, Data Book, Section C, C.3 Population Projection in 98 UCs and C.4 Population Projection in ISWM Project Area.***

4.2.2 Economic Projection

Pakistan's economic record during 2009-2013 has been 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 entire country of Pakistan and Punjab have been growing at the almost same pace. **Table 4.2.5** and **Table 4.2.6** give the comparison of long-term past GDP real growth rate record among Punjab, the rest of Pakistan and Pakistan during 1973-2000 and 2000-2011, respectively. The figures indicate that the GDP real growth rates of Punjab and the whole Pakistan are almost same during the past long-term record in 1973-2000 and the recent record in 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 Considerations

As many as six categories of issues, such as Law and Regulation, EIA Process, SEA, Public Disclosure, Environmental Monitoring, and Workers in Risk, must be considered for the formulation of the 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 to 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 the master plan formulation. 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 **Chapter 5**) 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 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: 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 benefit both Gujranwala and themselves.

4.3 Present and Future Waste Amounts and Composition

Future waste amount is 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 are 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.

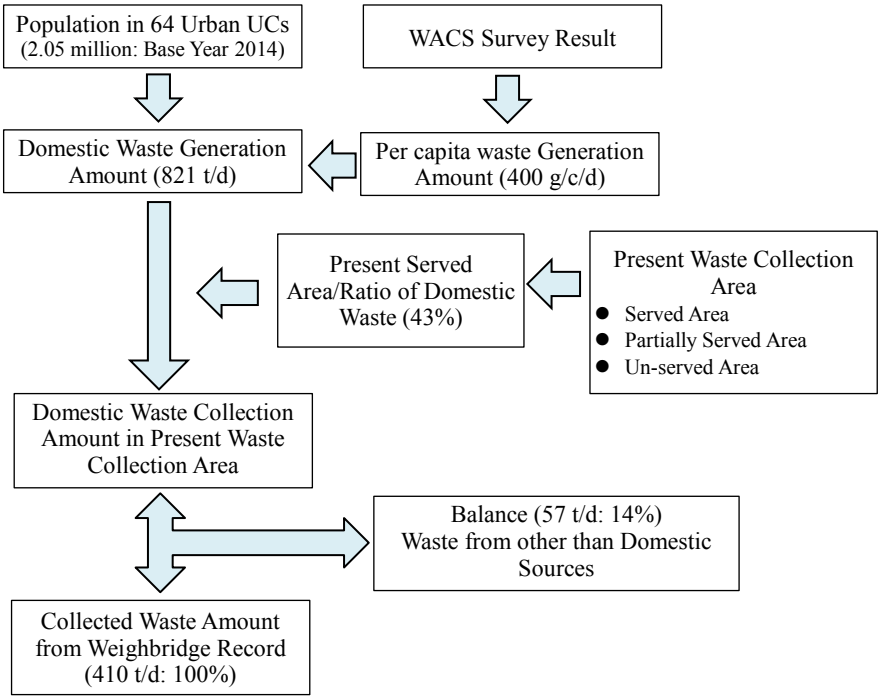


Figure 4.3.1 Flowchart for Confirmation of Present Waste Amount (2014)

(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 10-30 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 area. **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 Ratio 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 each income group obtained from the number of UCs in order to determine 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 while the third waste amount survey result is shown for the reference. As a result, the per capita waste generation rate for 64 urban UCs is adopted at 0.40 kilogramme 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)					
	1st WACS Survey	2nd WACS Survey	Average	Income Group Ratio	Weighted Average	3rd WACS Survey*
High income area	0.46	0.45	0.46	10%	0.40	0.48
Middle income area	0.41	0.36	0.39	60%		0.29
Low income area	0.40	0.40	0.40	30%		0.33
Rural area	0.33	0.36	0.35	100%	0.35	0.26

Note:* The third waste amount survey result is not used for the formulation of the master plan since the last result was obtained on July 2015 that was almost the final stage of the project.

(2) Daily Average Incoming Waste Amount at Gondlanwala Temporary Disposal Site

GWMC carries out waste collection services within the area of 64 urban UCs and the collection service in 34 peri-urban UCs is basically not carried out at present. GWMC started weighing incoming waste amount at the Gondlanwala temporary disposal site since September 2014 by the weighbridge 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 with 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 Didar Singh, Khiali 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 Didar 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 in 2014 is estimated at approximately 2.05 million. 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 estimated waste generation amount in the service area 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 adjusted with the Project Area presented in **Subsection 4.2.1,** 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 disposable 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 the 64 urban UCs and 350 g/c/d in the 34 peri-urban UCs are still low compared with those of the neighbouring developing countries. Considering the said situations, the minimum increase rate of 1% per annum is assumed as the per capita waste generation rate. The per capita waste generation rate in 64 urban UCs and 34 peri-urban UCs are as summarised in **Table 4.3.5**.

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

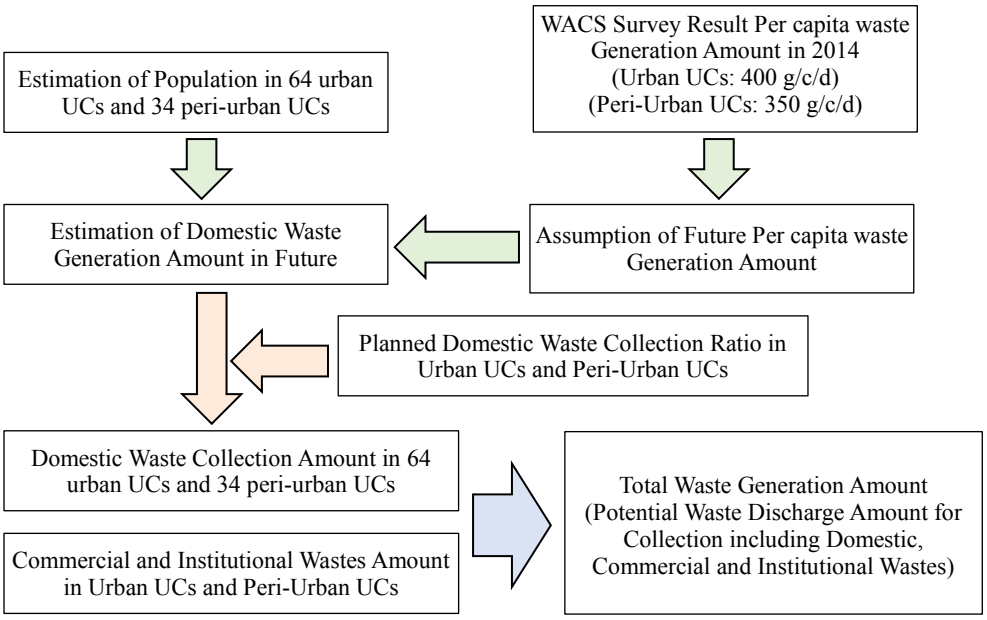


Figure 4.3.2 Flowchart for Estimating Future Waste Generation Amount

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 rate which was determined after several discussions among the parties concerned. The waste collection rate in the 64 urban UCs is set at 100% in 2018 and the collection rate of 34 peri-urban UCs is 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% for the area of 64 urban UCs and 12% for the area of 34 peri-urban UCs in 2014. With regard to the mixed ratio of 34 peri-urban UCs set at 12%, it was determined by the relation of per capita waste generation ratio in the area of 64 urban UCs and that of 34 peri-urban area. In addition, the economic growth in the area brings about more discharged amounts 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 compared with that of the year 2015 as summarised the mixed ratio of commercial and institutional waste in **Table 4.3.7**.

Table 4.3.6 Planned Domestic Waste Collection Rate

(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: %)

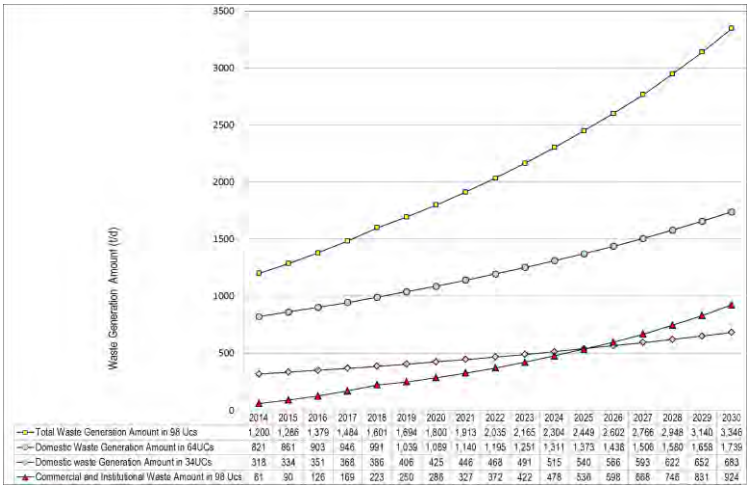
UCs	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Urban UCs	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Peri-urban UCs	12	13	14	15	16	17	17	18	19	20	21	22	23	24	24	25	26

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 1,200 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	61	90	126	169	223	250	286	327	372	422	478	536	598	668	746	831	924
Total Project Area	1,200	1,285	1,380	1,483	1,600	1,694	1,800	1,913	2,035	2,165	2,304	2,449	2,602	2,766	2,948	3,140	3,346



Unit: t/d

Figure 4.3.3 Domestic Waste Generation Amount and Collected Commercial Waste Amount in 98 UCs

Note: Domestic waste generation amount is estimated by the per capita waste generation rate and the population of each year. Commercial waste amount is estimated based of the proportion to the domestic waste collection amount of each year.

The domestic waste generation amount of each UC/Town is shown in ***Volume 4, Data Book, Section C, C.5 Domestic Waste Amount Projection in ISWM Project Area.***

4.3.3 Domestic Waste Composition

Table 4.3.9 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 is categorised for consideration in material recovery, composting and RDF treatment as shown in **Table 4.3.10**. 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 the present estimated waste amount in each stage of operation. As of 2014, the waste amount is estimated at 1,200 t/d for waste generation, 724 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. The flow and waste amount in 2014 are shown in **Figure 4.3.4**.

Table 4.3.11 Waste Amount for Major Elements in Waste Management Stream in 2014

Item	2014
Total Waste Generation Amount (t/d)	1,200
Uncollected Waste Amount (t/d)	724
Waste Collection Ratio in 64 Urban UCs (%)	54
Waste Collection Ratio in 34 Peri-urban UCs (%)	0
Waste Discharge Amount for Collection (t/d)	476
Waste Generation Prevention Amount (t/d)	0
Recovery Amount of Resource Materials (t/d)	66
Intermediate Treatment Amount (Composting/RDF) (t/d)	0
Waste Collection Amount (t/d)	410
Recovery of Resource Materials at Disposal Site (t/d)	4
Waste Disposal Amount (t/d)	406

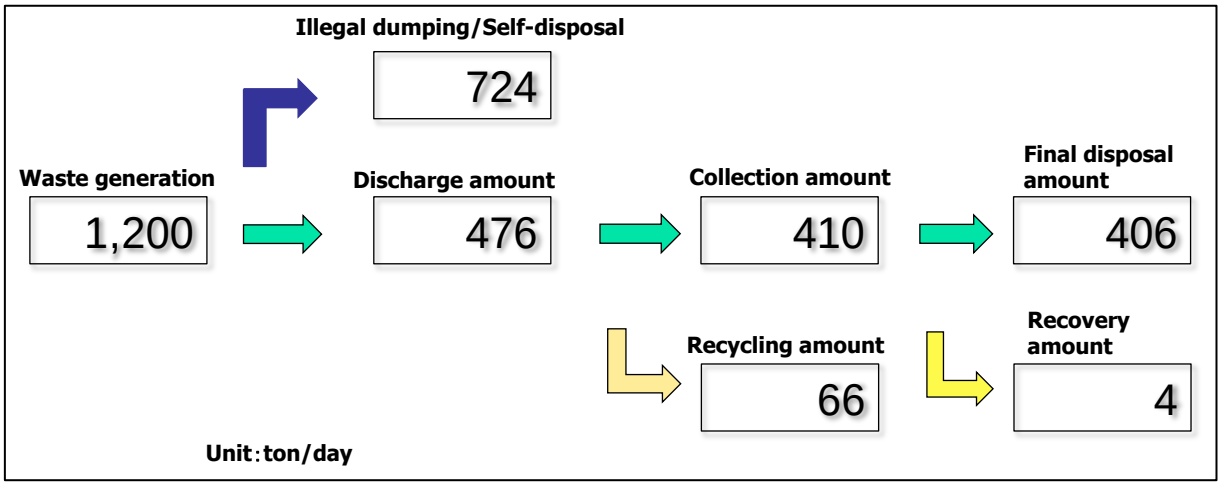


Figure 4.3.4 Waste Management Flow and Estimated Waste Amount in 2014

4.4 Waste Collection and Transportation Plan

4.4.1 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.

Source separation is also beneficial for the residents who segregate valuables and sell them to waste pickers or junk shops in the city at present. If source separation is disseminated to the residents, they will have opportunities to earn money from the waste which they used to dispose as the garbage.

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 only when it becomes full of waste. It is difficult to separate organic waste from the other wastes. 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 promote such a new system to the residents. However, it is assumed that the issue can be solved by conducting public awareness campaigns, monitoring the disposal method around the container or introducing a different type of container on site. In this sense, public campaigns to support this effort should be started in the early stage to build understanding about the importance of proper solid waste management among the residents.

Since one of the ultimate purposes in integrated solid waste management (ISWM) is the recycling of waste, source separation matches with the goal of the ISWM. Therefore, source separation activity for waste collection starts from the Mid-Term, i.e., 2019 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 it as categories. However, there is a general tendency to categorise the residents based on the street condition seen in almost all areas of the city 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 is wider than that of middle income and low income group. Since 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 the 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 streets.

(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 areas 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 areas 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 in the low income group area of 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 and increase in 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 using mini-dumpers has some alternatives depending on the combination of auxiliary equipment, i.e., (i) mini-dumper + arm-roll truck, (ii) mini-dumper + compaction unit + arm-roll truck, (iii) mini-dumper + 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 and its function will decrease 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 + Compactor

Mini-dumpers dump collected waste into a 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 4.4.1** illustrates the flow chart of a combination of collection method on each operation stage, and all cases for comparison of each waste collection and transportation alternative are shown in **Figure 4.4.2.**

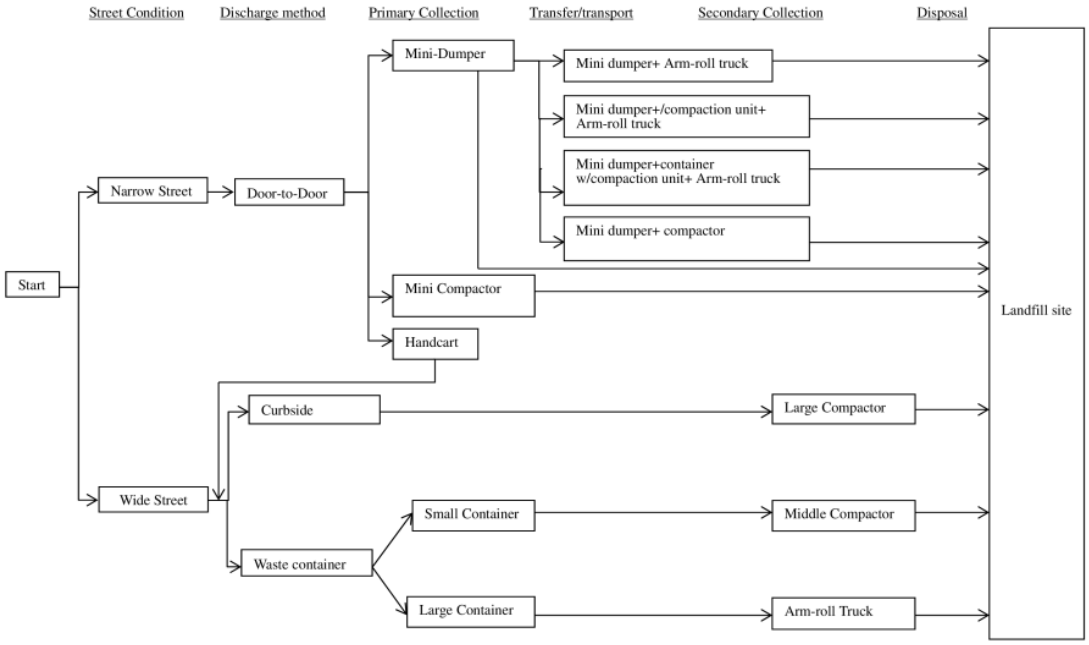


Figure 4.4.1 Flowchart of Combination of Collection Method of Each Operation Stage

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			compactor
Case 2-2	Wide street	waste container	small container		compactor
Case 2-3	Wide street	waste container	large container		arm-roll truck

Figure 4.4.2 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 as shown in **Table 4.4.1** are set. The waste collection and transportation method on a narrow street applies the optimal case in the table.

Table 4.4.1 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 + container w/ compaction unit + Arm-roll truck
Case 1-4			Mini-dumper + 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 in 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 by compaction unit. Necessary area of the transfer station is smaller than in 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 Case 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, UC No. 52. However, the land got full of garbage and seemed to be like a temporary landfill site. Unloaded waste on the ground has been 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.

Figure 4.4.3 Tentative Location of 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 4.4.3** shows the tentative location of the transfer station.

(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 4.4.2** 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 4.4.2 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
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	777,498

Note: Vehicle, compaction unit and container cost are based on quotation from the supplier.

The necessary number of mini-dumpers per case is considered as follows:

Case 1-1: Container 10m^3 / (Mini-dumper 1m^3 × 5 trips) = 2 Mini-dumpers

Case 1-2: Container 10m^3 / (Mini-dumper 1m^3 × 5 trips) / Compaction unit (0.5m^3) = 4 Mini-dumpers

Case 1-3: Container 10m^3 / (Mini-dumper 1m^3 × 5 trips) / Compaction unit (0.5m^3) = 4 Mini-dumpers

Case 1-4: Compactor 13m^3/ (Mini-dumper 1m^3 × 5 trips) = 3 Mini-dumpers

Case 1-5: There is no mini-dumper in this case.

Waste hauling cost of each case is estimated. **Table 4.4.3** shows the cost comparison 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 4.4.3 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	777,498	-	1,910,360	4,222,114
Case 1-2	3,068,512	777,498	630,000	1,910,360	6,386,370
Case 1-3	3,068,512	777,498	630,000	1,910,360	6,386,370
Case 1-4	2,301,384	777,498	-	2,288,240	5,367,122
Case 1-5	1,204,628	-	-	-	1,204,628

Table 4.4.4 shows the result of the comparison in each case. Case 1-5 is the 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 4.4.4 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. Construction of the transfer station is not applied in this case.

(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 4.4.2** are evaluated and the optimal case is set as the waste collection and transportation method on a wide street. **Table 4.4.5** 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 4.4.5 Summary of Each Case on a Wide Street

Item	Waste discharge	Secondary Collection
Case 2-1	Curbside	Compactor
Case 2-2	Small Container	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 it 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 is currently applying this method.

(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 at the station.
- Currently, illegal dumping on the open plots is one of the serious issues in the city. It is assumed that there would be some people who throw the waste other than the designated day. The open plots are similar to the illegal dumping sites.
- 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, wastes that do not go into the container are scattered around the container making the place 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 4.4.6** shows the annual cost of each item. Based on the table, a middle compactor is the most economical vehicle among the three.

Table 4.4.6 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.)
Compactor (7 m^3)	4,500,000	8	562,500	225,000	282,240	396,000	1,465,740
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 = 5,040 units
Case 2-3: Large container 5m^3 × 5 trips/day × 6 days × 4 weeks × 12 months = 7,200 units

Table 4.4.7 shows the annual cost for each case. Case 2-1 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 4.4.7 Annual Cost for Each Case

Item	Vehicle Cost (Rs.)	Container Cost (Rs.)	Total Cost (Rs.)
Case 2-1	1,465,740	-	1,465,740
Case 2-2	1,465,740	35,280,000 (7,000 × 5,040)	36,745,740
Case 2-3	1,647,860	360,000,000 (50,000 × 7,200)	361,647,860

Table 4.4.8 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 4.4.8 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. Construction of the transfer station is not applied in this case.

(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.

Currently, waste collection is conducted in 64 UCs. **Figure 4.4.4** shows the planned waste collection area. GWMC is divided into 8 zones in 64 UCs and collects waste in each zone. 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. The population in 98 UCs will be 5,373,752 in 2030, and the collection area and its population in each zone are presented in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Table B.4.9 to Table B.4.11***.

Table 4.4.9 to Table 4.4.12 show the summary of planned waste collection population and amount. Total waste collection amount in 98 UCs is 3,904 tons/ day in 2030 on the assumption that waste generation per capita is related with the economic growth and 1% increment in each year is estimated and added on waste amount per capita. Also, it is assumed that commercial and other economic activities will increase in the city in the future. The detailed discussion is made in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.6.***

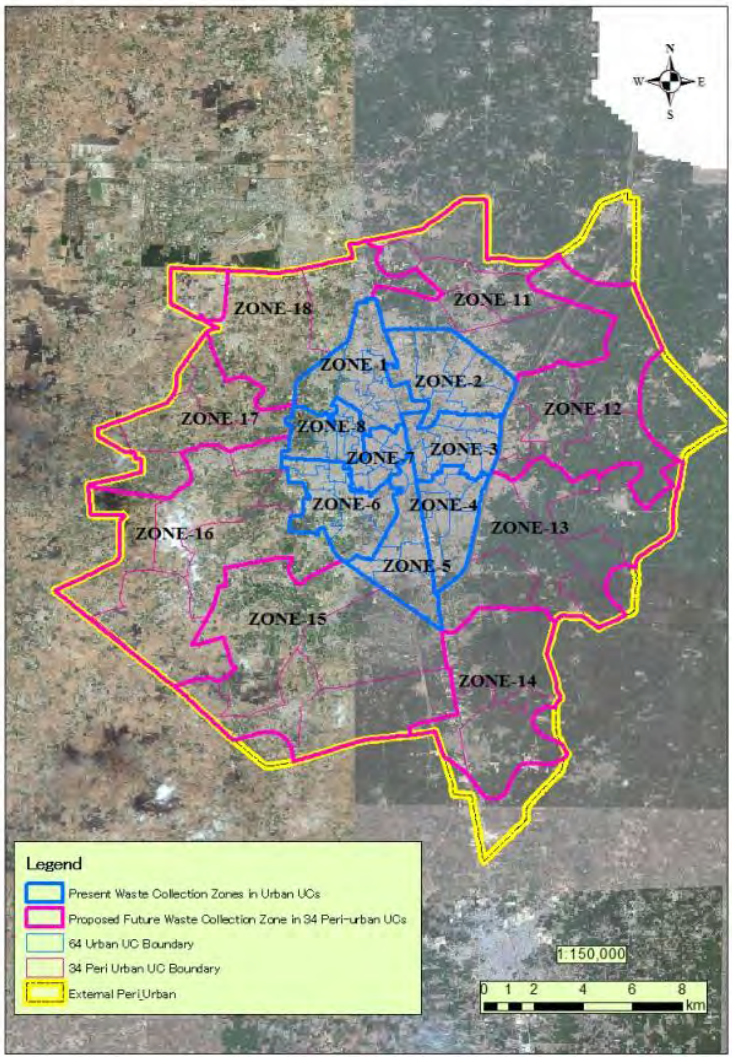


Figure 4.4.4 Planned Waste Collection Area

Table 4.4.9 Summary of Planned Waste Collection Population and Amount (Year 2014-2018)

Item		2014	2015	2016	2017	2018
64 UCs	(1) Population	2,053,665	2,131,495	2,212,272	2,296,117	2,383,140
	(2) Waste amount per capita per day (kg/day)	0.4	0.404	0.408	0.412	0.416
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	821	861	903	946	991
	(4) Collection ratio (domestic) (%)	43	57	71	85	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	353	491	641	804	991
	(6) Commercial ratio (%)	14	15	16	17	18
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	57	86	121	164	217
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	410	577	762	968	1,208
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	478	673	889	1,129	1,410
34 UCs	(1) Population	909,749	944,230	980,015	1,017,159	1,055,710
	(2) Waste amount per capita per day (kg/day)	0.35	0.354	0.358	0.362	0.366
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	318	334	351	368	386

Item		2014	2015	2016	2017	2018
	(4) Collection ratio (domestic) (%)	0	0	0	0	0
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	0	0	0	0	0
	(6) Commercial ratio (%)	12	13	14	15	16
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	0	0	0	0	0
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	0	0	0	0	0
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	0	0	0	0	0
98 UCs	(10) Total waste collection amount (ton/day) (10) = 64UCs(8)+34UCs(8)	410	577	762	968	1,208
	(11) Required waste collection amount (ton/day) (11) = 64UCs(9)+34UCs(9)	478	673	889	1,129	1,410
	(12) Waste collection rate* (%) (12) = (10)/(11)	43	57	71	85	100

Note:* Target waste collection area from 2014 to 2018 is 64 UCs. Thus, the waste collection rate shown on this table is for 64 UCs.

Table 4.4.10 Summary of Planned Waste Collection Population and Amount (Year 2019-2022)

Item		2019	2020	2021	2022
64 UCs	(1) Population	2,473,459	2,567,203	2,664,502	2,765,486
	(2) Waste amount per capita per day (kg/day)	0.42	0.424	0.428	0.432
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	1,039	1,089	1,140	1,195
	(4) Collection ratio (domestic) (%)	100	100	100	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	1,039	1,089	1,140	1,195
	(6) Commercial ratio (%)	19	20	21	22
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	243	271	302	336
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	1,282	1,360	1,442	1,531
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	1,496	1,586	1,683	1,786
34 UCs	(1) Population	1,095,723	1,137,253	1,180,352	1,225,086
	(2) Waste amount per capita per day (kg/day)	0.37	0.374	0.378	0.382
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	406	425	446	468
	(4) Collection ratio (domestic) (%)	10	20	30	40
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	41	85	134	187
	(6) Commercial ratio (%)	17	17	18	19
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	7	15	25	36
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	47	100	158	223
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	55	117	185	260
98 UCs	(10) Total waste collection amount (ton/day) (10) = 64UCs(8)+34UCs(8)	1,329	1,459	1,601	1,754
	(11) Required waste collection amount (ton/day) (11) = 64UCs(9)+34UCs(9)	1,551	1,703	1,868	2,046
	(12) Waste collection rate (%) (12) = (10)/(11)	78	81	84	86

Table 4.4.11 Summary of Planned Waste Collection Population and Amount (Year 2023-2026)

Item		2023	2024	2025	2026
64 UCs	(1) Population	2,870,301	2,979,086	3,091,988	3,209,171
	(2) Waste amount per capita per day (kg/day)	0.436	0.44	0.444	0.448
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	1,251	1,311	1,373	1,438
	(4) Collection ratio (domestic) (%)	100	100	100	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	1,251	1,311	1,373	1,438
	(6) Commercial ratio (%)	23	24	25	26
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	373	413	457	504
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	1,624	1,724	1,830	1,942
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	1,895	2,011	2,135	2,265
34 UCs	(1) Population	1,271,514	1,319,707	1,369,721	1,421,632
	(2) Waste amount per capita per day (kg/day)	0.386	0.39	0.394	0.398
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	491	515	540	566
	(4) Collection ratio (domestic) (%)	50	60	67	73
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	245	309	362	413
	(6) Commercial ratio (%)	20	21	22	23
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	49	65	79	94
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	295	374	441	507
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	344	436	514	592
98 UCs	(10) Total waste collection amount (ton/day) (10) = 64UCs(8)+34UCs(8)	1,919	2,098	2,271	2,449
	(11) Required waste collection amount (ton/day) (11) = 64UCs(9)+34UCs(9)	2,239	2,447	2,649	2,857
	(12) Waste collection rate (%) (12) = (10)/(11)	89	91	93	94

Table 4.4.12 Summary of Planned Waste Collection Population and Amount (Year 2027-2030)

Item		2027	2028	2029	2030
64 UCs	(1) Population	3,330,800	3,457,034	3,588,055	3,724,039
	(2) Waste amount per capita per day (kg/day)	0.452	0.457	0.462	0.467
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	1,506	1,580	1,658	1,739
	(4) Collection ratio (domestic) (%)	100	100	100	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	1,506	1,580	1,658	1,739
	(6) Commercial ratio (%)	27	28	29	30
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	556	614	677	745
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	2,062	2,194	2,335	2,484
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	2,405	2,560	2,724	2,898
34 UCs	(1) Population	1,475,513	1,531,433	1,589,474	1,649,713
	(2) Waste amount per capita per day (kg/day)	0.402	0.406	0.41	0.414
	(3) Waste generation amount (ton/day) (3) = [(1)×(2)]/1,000	593	622	652	683

Item		2027	2028	2029	2030
	(4) Collection ratio (domestic) (%)	80	87	93	100
	(5) Waste collection amount-Domestic (ton/day) (5) = [(3)×(4)]/100	474	541	606	683
	(6) Commercial ratio (%)	24	24	25	26
	(7) Commercial waste (ton/day) (7) = {(3)/[100 - (6)]/100×(6)}	112	132	154	179
	(8) Total waste collection amount (ton/day) (8) = (5)+(7)	586	673	760	862
	(9) Required waste collection amount (ton/day) (9) = (8)/(6/7)	684	786	886	1,006
98 UCs	(10) Total waste collection amount (ton/day) (10) = 64UCs(8)+34UCs(8)	2,648	2,867	3,094	3,346
	(11) Required waste collection amount (ton/day) (11) = 64UCs(9)+34UCs(9)	3,089	3,345	3,610	3,904
	(12) Waste collection rate (%) (12) = (10)/(11)	96	97	99	100

(7) Required Number of Planned Waste Collection Vehicles, Containers and Workers for Waste Collection and Transportation

(a) Proposed Type of 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 4.4.13** 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 4.4.13 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	37
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 were 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. In this master plan, five types of collection methods are utilised as follows:

- Narrow Street (road width approximately 4 metres, Case 1-5) – Compactor ($4m^3$);
- Wide Street (road width more than 4 metres, Case 2-2) – Compactor ($7m^3$) + $0.8m^3$ Container;
- Major Road (G.T. Road and Bypass road, etc.) – Compactor ($13m^3$) + $0.8m^3$ Container;
- Narrow Street in densely populated area (road width less than 3 metres) – Mini-dumper + Door-to-Door collection; and
- Large Waste Generators – Arm-Roll Truck ($5m^3$) + $5m^3$ Container.

Table 4.4.14 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. The detailed discussion is made to determine the necessary number of collection vehicles in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.7, Item (1).***

Table 4.4.14 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

(b) Waste Loading Capacity and Number of Trips

Table 4.4.15 shows waste loading capacity and number of trips of each vehicle. The bulk specific gravity is set as 0.5m^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 0.5m^3 per ton. This ratio is applied in the master plan. The detailed discussion on each condition is made in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.7, Item (2).***

Table 4.4.15 Waste Loading Capacity and Number of Trips of Each Vehicle

Item	Waste Loading Capacity (ton/vehicle)	Number of trips
Arm-roll truck (5 m^3)	2.5	5
Arm-roll truck (10 m^3)	5.0	5
Tractor Trolley	1.6	3
Compactor (13 m^3)	6.5	1
Compactor (7 m^3)	3.5	2
Compactor (4 m^3)	2.0	3
Mini-dumper (1 m^3)	1.0	4

(c) Necessary Number of Waste Collection Vehicles

Table 4.4.16 and **Table 4.4.17** show the total number of vehicles in 64 UCs and 34 UCs, respectively. The total number of vehicles in 64 UCs becomes 449 in 2030 while that of 34 UCs is 151 in 2030. The detailed discussion is made in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.7, Item (3).***

Table 4.4.16 Total Number of Vehicles Required in 64 UCs (Year 2016-2030)

64 UCs			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Existing	Arm-roll truck	10.0 m^3	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	22	22	22	0	0	0	0	0	0	0	0	0	0	0	0
	Tractor trolley	3.2 m^3	37	37	37	0	0	0	0	0	0	0	0	0	0	0	0
	Mini-dumper	1.0 m^3	35	35	35	35	35	35	35	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	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	0	0	0	5	5	5	5	5	5	5	6	6	6	6	6
	Compactor	13.0 m^3	13	28	68	78	93	93	108	117	128	140	148	160	171	189	206
	Compactor	7.0 m^3	38	58	98	98	98	112	112	120	126	135	145	153	164	172	181
	Compactor	4.0 m^3	0	0	40	40	40	40	40	40	40	40	40	40	40	40	40
	Mini-dumper	1.0 m^3	0	0	0	0	0	0	0	0	0	0	0	2	6	10	13
Total			149	183	303	256	271	285	300	310	323	341	356	375	397	423	449

Table 4.4.17 Total Number of Vehicles Required in 34 UCs (Year 2016-2030)

34 UCs			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Existing	Arm-roll truck	10.0 m^3	0	0	0	4	4	4	0	0	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	0	0	0	22	22	22	0	0	0	0	0	0	0	0	0
	Tractor trolley	3.2 m^3	0	0	0	37	37	37	0	0	0	0	0	0	0	0	0
	Mini-dumper	1.0 m^3	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0
	Arm-roll truck	5.0 m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Compactor	13.0 m^3	0	0	0	0	0	12	24	29	36	42	48	54	61	66	73
	Compactor	7.0 m^3	0	0	0	0	0	15	15	23	30	35	40	46	53	61	70
	Compactor	4.0 m^3	0	0	0	0	0	0	0	0	0	0	1	3	4	6	8

34 UCs			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Mini-dumper	1.0 m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total			0	0	0	63	63	90	39	52	66	77	89	106	118	133	151

(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 in considering 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 4.4.18 shows the existing containers in the city and the applied container in the master plan. The concept of bulk specific gravity is the same as the waste collection and transportation vehicles.

Table 4.4.18 Existing Containers in the City

Item	Capacity (m^3)	Capacity (ton)
Existing Containers in the city	5.0	2.5
	10.0	5.0
Applied Containers in the Master Plan	0.8	0.4

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 4.4.19 and **Table 4.4.20** show the total number of containers in 64 UCs and 34 UCs, respectively. 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. The detailed discussion is made in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.7, Item (4).***

Table 4.4.19 Total Number of Containers Required in 64 UCs (Year 2016-2030)

64 UCs		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0
	5.0 m^3	195	195	195	30	30	30	30	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0	30	30	30	30	30	30	30	30
	0.8 m^3	950	1,650	2,250	3,600	3,815	4,070	4,325	4,600	4,890	5,205	5,545	5,883	6,271	6,694	7,362
Total		1,155	1,855	2,455	3,630	3,845	4,100	4,355	4,630	4,920	5,235	5,575	5,913	6,301	6,724	7,392

Table 4.4.20 Total Number of Containers Required in 34 UCs (Year 2016-2030)

34 UCs		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Existing	10.0 m^3	0	0	0	10	10	10	0	0	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	90	80	70	0	0	0	0	0	0	0	0	0
Master Plan	10.0 m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5.0 m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0.8 m^3	0	0	0	0	0	300	750	900	1,105	1,350	1,505	1,730	1,990	2,225	2,520
Total		0	0	0	100	90	380	750	900	1,105	1,350	1,505	1,730	1,990	2,225	2,520

(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.

Table 4.4.21 shows the necessary number of workers for waste collection. For achieving the waste collection and transportation, GWMC requires 390 workers in 2016 and 1,852 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 4.4.21 Necessary Number of Workers for Waste Collection (Year 2016-2030)

Item		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
64 UCs	Driver	155	190	270	216	231	245	256	270	283	301	316	335	357	383	409
	Sanitary Worker	163	233	473	472	502	530	556	587	617	656	689	728	772	824	876
	Sanitary Supervisor	64	64	64	64	64	64	64	64	64	64	64	64	64	64	64
	Sanitary Inspector	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
34 UCs	Driver	0	0	0	63	63	90	39	52	66	77	89	103	118	133	151
	Sanitary Worker	0	0	0	26	26	80	78	104	132	154	178	206	236	266	302
	Sanitary Supervisor	0	0	0	34	34	34	34	34	34	34	34	34	34	34	34
	Sanitary Inspector	0	0	0	8	8	8	8	8	8	8	8	8	8	8	8
Total	Driver	155	190	270	279	294	355	295	322	349	378	405	438	475	516	560
	Sanitary Worker	163	233	473	498	528	610	634	691	749	810	867	934	1,008	1,190	1,178
	Sanitary Supervisor	64	64	64	98	98	98	98	98	98	98	98	98	98	98	98
	Sanitary Inspector	8	8	8	16	16	16	16	16	16	16	16	16	16	16	16
Grand Total		309	495	815	891	936	1,059	1,043	1,127	1,212	1,302	1,386	1,486	1,597	1,720	1,852

(f) Implementation Cost for Waste Collection and Transportation

Tables 4.4.22 and 4.4.23 show the total cost of waste collection and transportation vehicles and containers. Total cost of waste collection and transportation vehicles is Rs. 11,891,465,000 in the master plan while total cost of waste collection and transportation

container is Rs. 574,308,000 in the master plan. The detailed discussion is made in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.7, Items (6), (7) and (8).***

Table 4.4.22 Total Cost of Waste Collection and Transportation Vehicles and Containers (Year 2016-2023)

(Unit: thousand Rs.)

Year		2016	2017	2018	2019	2020	2021	2022	2023
Vehicle									
	Procurement Cost	173,000	228,000	688,000	92,000	138,000	240,900	248,400	237,200
	Maintenance Cost	27,605	41,387	76,627	72,595	79,786	92,828	105,825	116,610
	Operating Cost	121,564	146,175	235,964	261, 758	276,109	302,350	277,837	297,687
Total		322,169	415,562	1,000,591	426,173	493,905	636,078	632,062	651,497
Container									
	Procurement cost	16,800	19,600	16,800	37,800	7,000	22,400	20,160	24,200
	Maintenance Cost	1,402	2,382	3,222	5,040	5,341	6,328	7,105	8,000
	Total	18,202	21,982	20,022	42,840	12,341	28,728	27,265	32,200

Table 4.4.23 Total Cost of Waste Collection and Transportation Vehicles (Year 2024-2030)

(Unit: thousand Rs.)

Year		2024	2025	2026	2027	2028	2029	2030	Total
Vehicle									
	Procurement cost	278,6500	337,800	451,600	512,800	537,200	624,600	651,200	5,439,200
	Maintenance Cost	128,371	140,372	151, 030	163,548	176,960	192,412	209,200	1,776,568
	Operating Cost	319,308	342,025	362,767	388, 212	415,493	447,381	481,247	4, 675,697
Total		726,179	820,197	965,397	1,064,560	1,129,653	1,264,393	1,341,647	11,891,465
Container									
	Procurement cost	25,200	25,200	26,880	30,800	35,600	65,800	83,100	457,340
	Maintenance Cost	8,756	9,477	10,170	10,958	11,865	12,787	14,135	116,968
Total		33,956	34,677	37,050	41,758	47,465	78,587	97,235	574,308

(8) Street Cleaning

According the interview survey with a waste manager, GWMC conducts street sweeping on middle sized roads 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 covered with 64UCs so that the total length of the mechanical and manual sweeping is not grasped by GWMC.

(a) Street Cleaning Length

In this master plan, 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 for street cleaning is estimated at 2,600 km. (See detail in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.8, Item (1).***)

(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 4.4.24** shows the number of street cleaning equipment. Two mechanical sweepers and four road washers are deployed in the master plan.

Table 4.4.24 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	1,248	2,496	665	Once a week
Road washer	4	1,248	4,992	2,600	Once in two weeks

Table 4.4.25 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 4.4.25 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

Currently, GWMC utilises 980 street sweepers on site who are involved cleaning in main roads and they will shift to cleaning work for narrow streets. The labour cost for street sweepers are approximately Rs. 200 million per year and it will be continuously paid by CDGG. Therefore, this expense is excluded from financial analysis in the master plan.

(c) Implementation Cost for Street Cleaning

Table 4.4.26 and **Table 4.4.28** show the total cost of street cleaning. The total cost for street cleaning is Rs. 316,398 thousand in total. (See detail in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.8, Items (3) and (4).***)

Table 4.4.26 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 4.4.27 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	84,200
Total	29,597	8,397	54,995	21,795	12,595	24,595	21,795	316,400

(9) Bulky Waste

There are 36 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 deployed on the wheel loader. 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.

(b) Implementation Cost for Bulky Waste

Table 4.4.28 and **Table 4.4.29** show the project cost for bulky waste. The total cost for collecting bulky waste is Rs. 97,343 thousand in total. (See detail in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.9.***)

Table 4.4.28 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 4.4.29 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	47,250
Total	19,930	4,130	4,130	4,130	4,130	4,130	4,130	97,350

(10) Illegal Dumping Site

There are nearly 800 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 2015. According to the survey, there are 799 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. As a result of estimation, there are still 21,739 tons of waste at the sites, which should be the target collection amount of illegal dumping sites. (See detail in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.10, Item (1).***) The waste collection amount from illegal dumping sites are not taken into account for the incoming waste amount of the final landfill site because the estimated total waste amount of illegal dumping are negligible compared to the daily incoming waste amount.

(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. The detailed discussion is made in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.10, Item (3).***

(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. The assigned vehicles and workers conduct only the cleaning work and are excluded from the regular waste collection work.

(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.

(iii) Cost Comparison of the Two Options

Based on the necessary vehicles and workers, cleaning cost for illegal dumping sites in the city is estimated for the both cases. **Table 4.4.30** shows the comparison of cost for the cleaning work. The cost of outsourcing of cleaning the sites is more expensive than the work GWMC conducts by itself. The master plan adopts conducting the work of cleaning of illegal dumping sites by GWMC. The project cost is therefore Rs. 23,773,000 as shown in **Table 4.4.31.**

Table 4.4.30 Comparison of Cost for the Cleaning Work

(Unit: thousand Rs.)

Item	Total Cost in three years
Work conducted by GWMC	23,773
Outsourced work	34,022

Table 4.4.31 Project Cost for Cleaning the Illegal Dumping Sites in the City (Year 2016-2018)

(Unit: thousand Rs.)

Item	2016	2017	Total
Clean-up of illegal dumping sites	22,382	1,391	23,773

(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. For instance, GWMC estimates the necessary cost such as fuel cost etc. for C&D waste carriage per ton. Once collected C&D waste is collected and measured on weighbridge at landfill site, a contractor will pay the bill at GWMC head office.

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. 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) Implementation Cost

C&D waste consists of rocks, sand and concrete, etc., generated from construction sites so that the compactor is not suitable for C&D waste collection. 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. For reducing the idle time on trucks, three 5-ton trucks and one wheel loader for the collection work are deployed.

Based on the necessary number of vehicles and workers, C&D waste collection cost is estimated at Rs. 7,690,126 per annum. Based on the implementation cost, GWMC should consider outsourcing of the C&D waste collection work to a private company and set the schedules for charges of C&D waste.

(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. Based on the annual number of vehicles in the master plan including waste collection and transportation vehicles, vehicles for bulky waste and vehicles for street sweeping, the required number of parking area is estimated.

The existing garage could accommodate only approximately 100 vehicles; therefore, the same capacity as the existing parking area will be secured. The existing garage has no pavement and no roofing in parking area, so the repair work should be performed in the existing garage. As for new parking garages, for security reasons, one guardhouse is built and steel fence is installed around the facility. The place where vehicles are parked is to be covered with a steel skeleton building for protection against rain and its area with asphalt-pavement is to be 6,000 m^2. The annual number of vehicles and required number of parking area is estimated as shown in **Table 4.4.32**. The detailed discussion is made in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.12.***

Table 4.4.32 Annual Number of Vehicles in the Master Plan (Year 2014-2030)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of Waste Collection Vehicles	96	121	155	190	310	325	340	383	343	370	397	426	457	490	527	568	612
Required Number of Parking Area	2	2	4	4	4	4	4	4	4	4	4	5	5	5	6	6	6

Based on the necessary items, the procurement cost, and operation and maintenance cost for the parking area are estimated. In this master plan, 10% of land rental is set as the operating cost. Due to weather condition or status of use in the parking area, the maintenance cost varies. Thus, 5% of procurement cost is set as the maintenance cost in this master plan. **Table 4.4.33** and **Table 4.4.35** show the implementation cost of the parking area. The detailed discussion is made in ***Volume 3, Supporting Report, Section B: Waste Collection and Transportation, Subsection 4.1.12, Item (1).***

Table 4.4.33 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	126,424	3,546	393,510	4,662	4,662	4,662	4,662	4,662

Table 4.4.34 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	1,090,096
Maintenance Cost	2,430	2,430	2,430	2,430	2,430	2,430	2,430	40,746
Operating Cost	2,232	2,790	2,790	2,790	3,348	3,348	3,348	36,270
Total	4,662	248,250	5,220	5,220	297,414	5,778	5,778	1,119,112

(13) Project Cost

As a result of the above estimation, **Table 4.4.35** and **Table 4.4.36** show the project cost of waste collection and transportation. The total cost of waste collection and transportation is Rs. 14,020,790,000 in the master plan.

Table 4.4.35 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	40,283	47,972	8,817	78,785	85,986	98,768	112,395	123,180
Operating Cost	139,260	162,875	252,784	278,398	292,929	320,659	296,146	315,996
Total	587,925	458,447	1,429,249	486,983	523,915	707,357	677,101	700,576

Table 4.4.36 Project Cost of Waste Collection and Transportation (Year 2024-2030)

(Unit: thousand Rs.)

Year	2024	2025	2026	2027	2028	2029	2030	Total
Procurement Cost	314,700	606,030	520,880	552,800	864,436	702,400	743,500	7,172,436
Maintenance Cost	134,941	146,942	159,180	171,698	185,110	200,562	217,350	1,886,599
Operating Cost	337,617	360,892	384,252	409,697	437,536	469,424	503,290	4,961,755
Total	813,258	1,113,864	1,064,312	1,134,195	1,487,082	1,372,386	1,464,140	14,020,790

4.4.2 Evaluation of Alternatives

(1) Planning Concept

Door-to-door collection and container collection are proposed in the waste collection and transportation plan of the Master Plan. To adapt the waste collection and transportation system with the other ISWM activities especially the Intermediate Treatment and 3R Promotion Plan, the introduction of separate waste collection must be evaluated. Alternate-day collection shall also be evaluated to analyse the efficiency of waste collection and transportation operation and cost effectiveness.

(2) Options for Mixed Waste Collection and Separate Waste Collection

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 2019. 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 colours for the residents to easily identify the appropriate container. Wastes from these containers are collected on alternate days. For example, organic waste is collected on Monday, Wednesday and Friday, and the other container

Table 4.4.37 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

is collected on Tuesday and Thursday. The containers of $5m^3$ are placed at the large waste discharge points such as shopping malls or markets in the city. The containers are collected once the container is full of waste. 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 4.4.37** 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.

(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 4.4.38** 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 4.4.38 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) Advantages and Disadvantages of Each Option

Table 4.4.39 shows the advantages and disadvantages of each alternative measure. Both separation at source and no source separation systems will 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 the separation of organic waste from mixed waste.

Table 4.4.39 Advantages and Disadvantages of Each Alternative

Option	Advantages	Disadvantages	Project Cost (Rs. million)	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.	14,021	Better
No Source Separation	- Residents do not need to change their disposal method.	- The environmental condition does not change.	14,017	Fair

Option	Advantages	Disadvantages	Project Cost (Rs. million)	Evaluation
	- The city becomes cleaner. - All types of waste are disposed in one container. - No need to procure arm-roll trucks and large containers. Therefore, the project cost is cheaper than that of separation at source.	- The system has a negative impact on environmental and social conditions. - The system does not correspond to the 3R system.		
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 conditions.	3,624	Bad

(e) Selection of the Optimum Option

Source separation is adopted in the master plan by reasons 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 Intermediate Treatment and 3R Promotion 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.

(3) Options for Daily Collection and Alternate-Day Collection

Currently, GWMC provides the waste collection and transportation service on a daily basis. The application of alternate-day waste collection is, therefore, a new system for the city. For comparison, the advantages and disadvantages of daily collection and alternate-day collection are shown in **Table 4.4.40** below. As shown in this table, the most advantageous feature of the alternate-day collection is its economical aspect; that is, fuel consumption in the alternate-day collection is almost half of that of the daily collection, since the travel distance by the alternate-day collection within the collection area is almost one-half of that of the daily collection.

According to the results of the Time and Motion Study, the total travel distance of tractor trolley is 44km per day in two trips for collection. Out of 50km, the travel distance for collection work is 3km. Also, based on the same survey results, the travel distance ratio of waste collection operation to the total distance in one day is 3km/44km; say: 7%. Therefore, about 3.5% of collection distance can be saved with the introduction of alternate-day collection of waste. Once the collection vehicles are replaced with compactors, the benefit of alternate-day collection will increase significantly for more savings on fuel cost.

Table 4.4.40 Advantages and Disadvantages of Daily Collection and Alternate-Day Collection of Waste

Option	Advantages	Disadvantages
Daily Collection	- Container collection is carried out before garbage generates odour. - By the door-to-door collection service, only one day amount of waste is stored by household residents in their houses.	- Collection vehicle travels more distance for loading waste to the full capacity. - Daily collection operation could be nuisance to the residents.
Alternate-Day Collection	- Collection vehicle travels less distance for loading waste to the full capacity. - Residents are free from the nuisance of daily collection operation.	- Odour might be generated from the containers in the 2nd day. - By the door-to-door collection service, the household residents must store garbage for two days in their houses.

(4) Necessity of Implementation of a Pilot Project for the Introduction of Separate Collection and Alternate-Day Collection

A challenging attempt has to be carried out for the improvement of waste collection service of GWMC in relation to the implementation of relevant projects. Separate collection and alternate-day collection are the new attempts to upgrade the SWM services under the ISWM master plan in Gujranwala.

In the Intermediate Treatment and 3R Promotion Plan, a compost plant is proposed to start operation in Year 2020 (see **Subsection 4.6.2**). To assure a certain level of quality of the produced compost, organic waste must be segregated from the discharged wastes from the households. The introduction of separate collection is thus strongly recommended.

Separate collection is a totally new system to the residents of Gujranwala. Considering the low awareness of the public regarding SWM, it is recommended that a small scale of separate collection will firstly be carried out as a pilot project in a selected area before the new system is applied to the whole city. The separate collection is therefore scheduled to start in 2019 with the use of organic waste at the new compost plant that will be operated from 2020. As for the separate collection of combustible waste, the pilot operation will start in 2028 and shall last for one year to prepare for the full operation in the following year since combustible waste separate collection of raw materials for the RDF is scheduled to start in 2029.

Regarding alternate-day collection, GWMC should also prepare for the introduction of this new collection service in addition to the implementation of the pilot separate collection project. A representative collection area in terms of development status of town shall be selected as the model area to conduct the pilot operation in 2016.

The pilot operation for separate collection and alternate-day collection needs the cooperation of all waste generators such as households, workplaces and so on in the pilot operation area. Environmental education programmes and orientation/guidance programmes in relation to specific methods of separate collection and alternated-day collection should be carried out in the communities prior to the pilot operation. The pilot operation must be evaluated upon completion and feedbacks shall be gathered for improving the methods, as required. After establishment of a good practice model, the procedure should be introduced to the adjacent area and then, gradually to all areas. Detailed plan for Implementation of a Pilot Project for the Introduction of Separate Collection and Alternate-Day Collection is described in ***Subsection 6.2.2 Project for Introduction of Separate Collection and Alternate-Day Collection through Implementation of a Pilot Project.***

4.4.3 Identification of Project Components for Waste Collection and Transportation Plan

(1) Short-Term Plan (2016-2018)

The projects in the Short-Term period, i.e., from 2016 to 2018, are described as the action plans or Priority Projects in **Chapter 6**. The proposed projects are as follows:

- Introduction of Separate Collection and Alternate day Collection through Implementation of Pilot Project
- Increase of Waste Collection Rate in 64 UCs up to 100% in 2018
- Conducting Street Cleaning in 64 UCs
- Collection of Bulky Waste
- Cleaning Up of Illegal Dumping sites in 64 UCs
- Construction and Demolition Waste Collection
- Construction of Parking Area

(2) Mid-Term Plan (2019-2024)

(a) Planning/Implementing for the Method of Separate Collection in 98 UCs

The new collection system of separate collection and alternate-day collection is to be introduced in all the collection zones in accordance with the good practices established in collection Zone 6. The implementation of the new system in 2019 is intended as the activity in the transition period toward full-scale operation prior to the start of operation of the compost plant in 2020. Separate collection will be practiced basically for i) biodegradable waste, ii) recyclable materials (paper, plastics, glass and metals), and iii) other residual waste. Two types of waste container are allocated for separate collection. One is for biodegradable waste, and the other is for recyclable materials and other residual wastes. The planning/implementation shall be carried out by the following key factors for the implementation in 98 UCs.

- 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 litre 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;
- Orientation/education of participating waste generators;
- Dissemination of the activity in 98 UCs;
- Procurement and/or dispatch of vehicles, receptacles/containers, and staffing for separate collection operation; and
- Evaluation of the project implementation and feed-back for improvement.

(b) Increase of Waste Collection Rate in 34 UCs from 0% to 60% 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 8 zones of the peri-urban area.

(c) 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.

(d) 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 Punjab Government from 2019 to 2024.

(e) 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.

(f) Conducting 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.

(g) 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.

(h) Collection of Construction and Demolition Waste

GWMC is obliged to collect construction waste generated from construction sites. The collection work is separate from 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 changes.

(i) Construction of Parking Area

GWMC is obliged to construct necessary parking areas. Collection vehicles will increase gradually for the waste collection activity. Necessary facilities shall be allocated by GWMC.

(3) Long-Term Plan (2025-2030)

(a) Introduction of Separate Collection through the Implementation of Designated Pilot Project Area in 2028 and Promotion of Separate Collection to Other Zones in 2029

GWMC has to introduce the separate collection of combustible wastes in the designated area on the short term. This additional separation method is to be introduced in 2028 since the separate collection of wastes targeted for the waste collection and transportation will start on a full scale in 2029 when the RDF facility starts operation. Once the optimum promotion method is established during probation period, it is introduced to the other areas from 2029.

(b) 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 8 zones in the peri-urban areas.

(c) 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.

(d) 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 Punjab Government from 2025 to 2030.

(e) 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.

(f) Conducting Street Cleaning in 64 UCs

GWMC is obliged to conduct street cleaning in 64 UCs. GWMC has to procure the necessary street cleaning vehicles.

(g) Collection of Bulky Waste

GWMC is obliged to collect bulky waste. GWMC has to procure necessary waste collection vehicles for bulky waste.

(h) 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. Preparation for the tender of outsourcing, conducting the tender and selection of the contractor shall be conducted by GWMC as the part of their daily work. Procurement cost for necessary numbers of waste collection equipment is allocated on **Item (d)** above.

(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 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.

(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.

4.4.4 Implementation Schedule of Waste Collection and Transportation Plan

Figure 4.4.5 shows the implementation plan for the master plan. GWMC needs to monitor the waste collection and transportation work from 2016 to 2030.

Time Framework of the Master Plan		Short-Term Plan Period											Mid-Term Plan Period						Long-Term Plan Period					
Year		2016				2017				2018			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4											
WBS for Short-Term Plan																								
S-1-1	Introduction of Separate Collection and Alternate-Day Collection through Implementation of Pilot Project																							
S-1-2	Increase of Waste Collection Rate in 64 UCs up to 100% in 2018																							
S-1-3	Conducting Street Cleaning in 64 UCs																							
S-1-4	Collection of Bulky Waste																							
S-1-5	Cleaning up of Illegal Dumping Sites in 64 UCs																							
S-1-6	Collection of Construction and Demolition Waste																							
S-1-7	Construction of Parking Area																							
WBS for Mid-Term Plan																								
M-1-1	Planning/Implementing for the Method of Separate Collection in 98 UCs																							
M-1-2	Increase of Waste Collection Rate in 34 UCs from 0% to 60% in 2024																							
M-1-3	Sustaining the Waste Collection Rate in 64 UCs with 100% in 2024																							
M-1-4	Procurement of Waste Collection Vehicles and Containers in 98 UCs																							
M-1-5	Monitoring on Improvement of Waste Collection and Transportation in 98 UCs																							
M-1-6	Conducting Street Cleaning in 64 UCs																							
M-1-7	Collection of Bulky Waste																							
M-1-8	Collection of Construction and Demolition Waste																							
M-1-9	Construction of Parking Area																							
WBA for Long-Term Plan																								
L-1-1	Introduction of Separate Collection through Implementation of Designated Pilot Project Area in 2028 and Promotion of Separate Collection to Other Zones in 2029																							
L-1-2	Increase of Waste Collection Rate in 34 UCs to 100% in 2030																							
L-1-3	Sustaining Waste Collection Rate in 64 UCs from the Current with 100% in 2030																							
L-1-4	Procurement of Waste Collection Vehicles and Containers in 98 UCs																							
L-1-5	Monitoring on Improvement of Waste Collection and Transportation in 98 UCs																							
L-1-6	Conducting Street Cleaning in 64 UCs																							
L-1-7	Collection of Bulky Waste																							
L-1-8	Outsourcing the Waste Collection and Transportation Service to a Private Company in 2025																							
L-1-9	Collection of Construction and Demolition Waste																							
L-1-10	Construction of Parking Areas																							

Figure 4.4.5 Implementation Schedule of the Waste Collection and Transportation Plan

4.4.5 Project Cost of Waste Collection and Transportation Plan

Table 4.4.41 shows the project cost for the Master Plan. The total cost of waste collection and transportation is Rs. 14,021 million.

Table 4.4.41 Total Cost of the Waste Collection and Transportation Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 1: Waste Collection and Transportation Plan																	
Short-Term Plan																	
S-1-1	Introduction of Separate Collection and Alternate day collection through Implementation of Pilot Project	143,825	82,343	40,823	20,659												
S-1-2	Increase of Waste Collection Rate in 64 UCs up to 100% in 2018	1,640,399	286,028	394,639	966,732												
S-1-3	Conducting Street Cleaning in 64 UCs	80,384	67,328	6,528	6,528												
S-1-4	Collection of Bulky Waste	31,990	23,730	4,130	4,130												
S-1-5	Cleaning Up of Illegal Dumping Sites in 64 UCs	23,773	22,382	1,391													
S-1-6	Collection of Construction and Demolition Waste	23,070	7,690	7,690	7,690												
S-1-7	Construction of Parking Area	523,480	126,424	3,546	393,510												
	Sub-Total	2,475,821	587,925	458,447	1,429,249												
Mid-Term Plan																	
M-1-1	Planning/Implementing for the Method of Separate Collection in 98 UCs	GWMC															
M-1-2	Increase of Waste Collection Rate in 34 UCs from 0% to 60% in 2024	GWMC															
M-1-3	Sustaining Waste Collection Rate in 64 UCs with 100% in 2024	GWMC															
M-1-4	Procurement of Waste Collection Vehicles and Containers in 98 UCs	3,702,854				463,973	500,995	658,478	652,222	675,697	751,379						
M-1-5	Monitoring on Improvement of Waste Collection and Transportation in 98 UCs	GWMC															
M-1-6	Conducting Street Cleaning in 64 UCs	91,844				6,528	6,528	32,397	6,397	6,397	29,597						
M-1-7	Collection of Bulky Waste	40,580				4,130	4,130	4,130	4,130	4,130	19,930						
M-1-8	Collection of Construction and Demolition Waste	46,140				7,690	7,690	7,690	7,690	7,690	7,690						
M-1-9	Construction of Parking Area	27,972				4,662	4,662	4,662	4,662	4,662	4,662						
	Sub-Total	3,909,190				486,983	523,915	707,357	677,101	700,576	813,258						
Long-Term Plan																	
L-1-1	Introduction of Separate Collection through Implementation of Designated Pilot Project Area in 2028 and Promotion of Separate Collection to Other Zones in 2029	GWMC															
L-1-2	Increase of Waste Collection Rate in 34 UCs to 100% in 2030	GWMC															
L-1-3	Sustaining Waste Collection Rate in 64 UCs from the Current with 100% in 2030	GWMC															
L-1-4	Procurement of Waste Collection Vehicles and Containers in 98 UCs	6,853,227										845,397	992,277	1,095,360	1,165,253	1,330,193	1,424,747
L-1-5	Monitoring on Improvement of Waste Collection and Transportation in 98 UCs	GWMC															
L-1-6	Conducting Street Cleaning in 64 UCs	144,172										8,397	54,995	21,795	12,595	24,595	21,795
L-1-7	Collection of Bulky Waste	24,780										4,130	4,130	4,130	4,130	4,130	4,130
L-1-8	Outsourcing the Waste Collection and Transportation Service to a Private Company in 2025	GWMC															
L-1-9	Collection of Construction and Demolition Waste	46,140										7,690	7,690	7,690	7,690	7,690	7,690
L-1-10	Construction of Parking Area	557,660										248,250	5,220	5,220	297,414	5,778	5,778
	Sub-Total	7,635,979										1,113,864	1,064,312	1,134,195	1,487,082	1,372,386	1,464,140
	Grand Total	14,020,790	587,925	458,447	1,429,249	486,983	523,915	707,357	677,101	700,576	813,258	1,113,864	1,064,312	1,134,195	1,487,082	1,372,386	1,464,140

4.5 Final Disposal Plan

4.5.1 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 4.5.1**) 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 4.5.1** and **Figure 4.5.1** 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 with 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 4.5.2** and in **Figure 4.5.1**. Leachate in the pond shall be circulated in the dumpsite by a temporary pump and hose for reducing leachate amount by evaporation. Major work item procedures are as follows:

- Place the leachate mains of 200 mm dia. or larger diametre PVC (Polyvinyl-Chloride) 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 4.5.1**;

- 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. 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 work procedures, at least, shall be required:

- Construct a temporary approach road leading to the landfill area. The minimum width shall be 3m 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 2m 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, the measures to lower the water level (groundwater table) in the landfill area by installation of a pumping system and its operation are effective to direct the groundwater flow from the peripheral zone to the side of the landfill site. 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. 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 4.5.1 Collapse of Gondlanwala Landfill Site

Photo 4.5.2 Leachate Condition of Gondlanwala Landfill Site

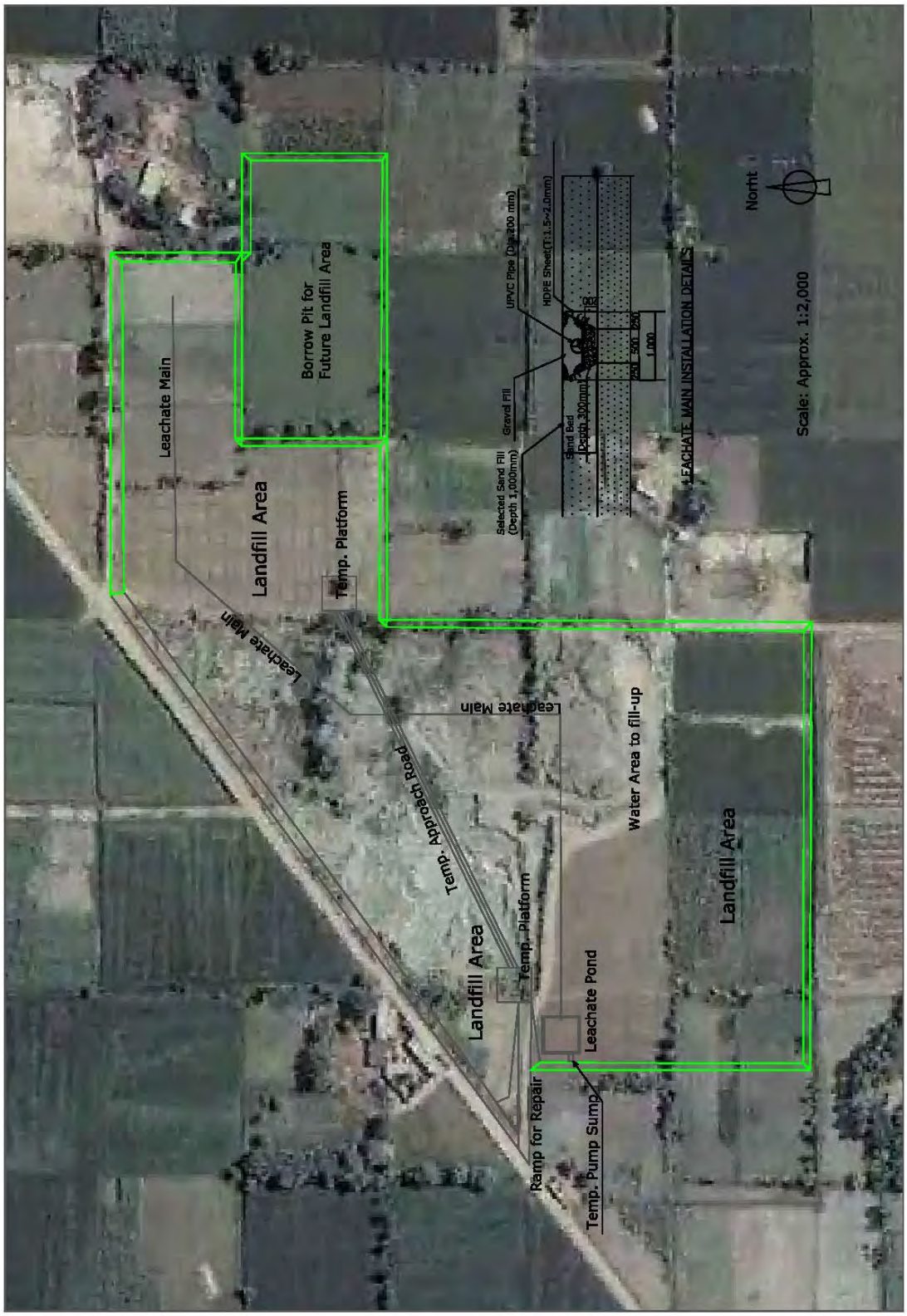


Figure 4.5.1 Urgent Improvement Plan for Gondlanwala Landfill Site

4.5.2 Development of Alternatives for the 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 **Section 4.3** 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 4.5.1**. 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 4.5.1 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 4.5.2** 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 to 365,000 m^3/year in 2017 from 148,000 m^3/year in 2014. In Bhakhraywali disposal site, the landfill volume

of 453,000 m^3/year in 2018 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 4.5.2 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.

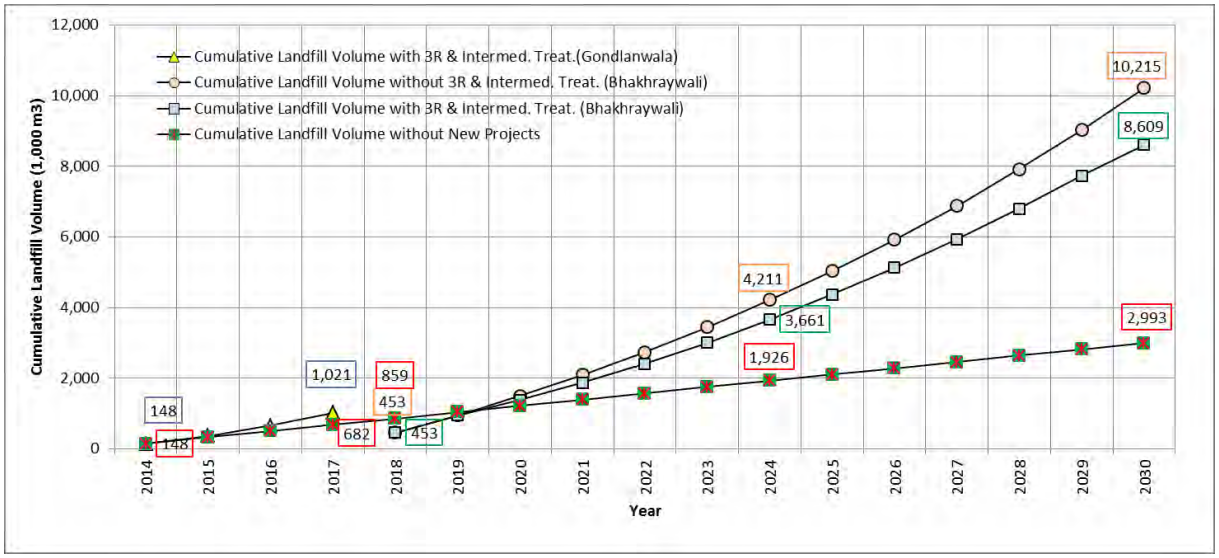
(3) Cumulative Landfill Volume

The cumulated annual landfill volume for each year is as shown in **Table 4.5.3** and the annual trend graph is shown in **Figure 4.5.2**. 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 4.5.3 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	1,021													
With 3R (Bhakhraywali)					453	950	1,385	1,869	2,407	3,002	3,661	4,367	5,122	5,931	6,801	7,728	8,609
Without 3R (Bhakhraywali)					453	950	1,495	2,089	2,736	3,442	4,211	5,038	5,926	6,882	7,915	9,022	10,215
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 4.5.2 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 for filling up to the existing ground, 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 4.5.3** or in **Figure 4.5.2** above. On the other hand, the lifetime of Bhakhraywali which will start landfill operation in 2018 will end in 2021 for the case of with or 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 4.5.4** are proposed for the Gondlanwala site taking into account the circumstance of the neighbouring area.

Table 4.5.4 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 shall 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** 4.5.5 are proposed for the Bhakhraywali site taking into account the circumstance of the neighbouring area.

Table 4.5.5 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 11 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^3or the cumulative volume of 6,600,000 m^3 to accommodate landfill from the middle of 2024 to the middle of 2028. **Stage-3:** Development: Development of 20 ha landfill area to secure 2,800,000 m^3or the cumulative volume of 9,400,000 m^3 to accommodate landfill from 2028 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. 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 the beginning of 2024 to the middle of 2027. **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 the middle of 2027 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 includes 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 stipulate 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.

4.5.3 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 4.5.2**. 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 social 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 pump well, 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.

4.5.4 Identification of Project Components for Final Disposal Plan

(1) Project Components for Final Disposal Plan

The project components for final disposal are formulated to tackle the measures against the problems and issues defined in **Subsection 2.4.10.** 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 sanitary land facilities. The Urban Unit (UU) carried out the study for landfill site selection and prepared the report as described in **Section 2.4**. The evaluation factors for siting adopted in the report composed of the key items derived from the provisions in "Punjab Waste Management Act 2013". These evaluation factors are the field of area size, location, environment, society and economy, and so forth. Studying the site selection procedures and the conclusions of the report, it is considered that the site at Bhakhraywali is the most feasible site for development of sanitary landfill 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 location of the three sites is shown in **Figure 4.5.3** to **Figure 4.5.6.**

Figure 4.5.3 Location of Bhakhraywali Sanitary Landfill Development Project

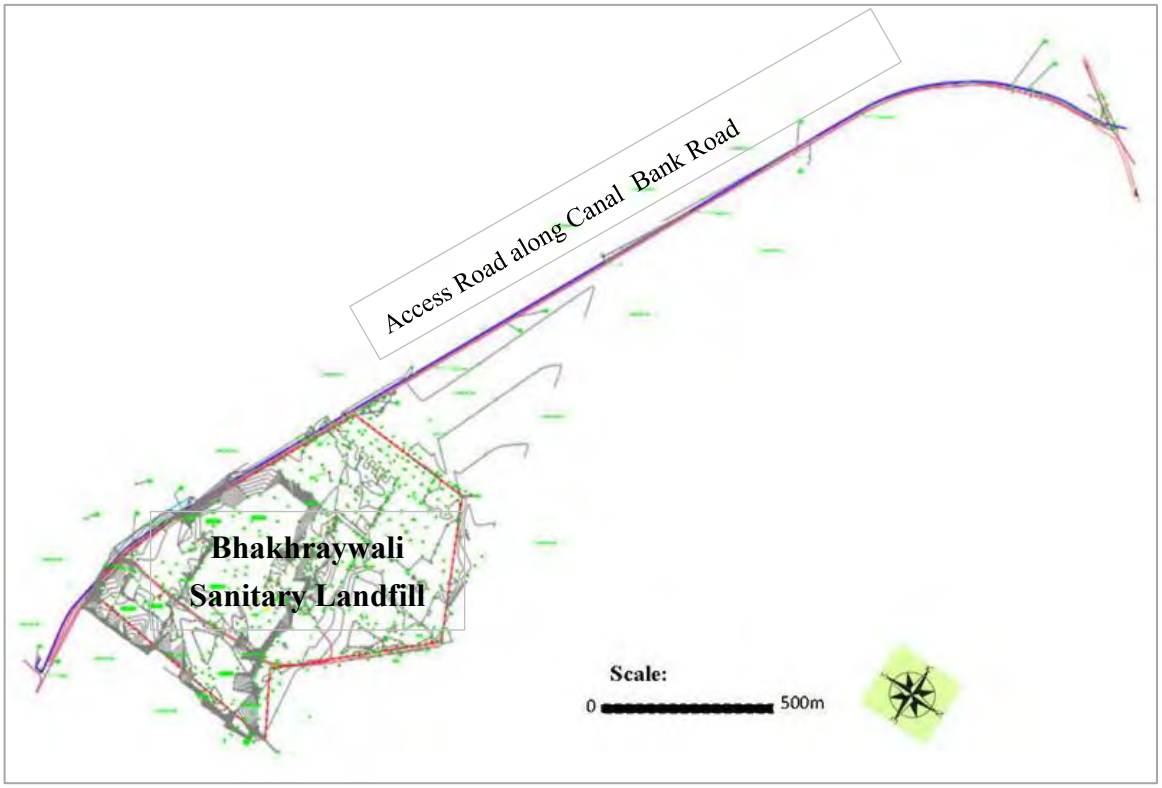


Figure 4.5.4 Access Road of Bhakhraywali Sanitary Landfill Facility

Figure 4.5.5 Location of Gondlanwala Disposal Site Improvement Project

Figure 4.5.6 Location of Chianwali Safe Closure Project

(2) Short-Term Plan (2016-2018)

The projects in the Short-Term period, i.e., from 2016 to 2018, are described as the Action Plans of Priority Projects in **Chapter 6**. The proposed projects are as follows:

- Procurement of Sanitary Landfill Site
- Engineering Service for Sanitary Landfill Facilities (Stage 1)
- Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywali
- Procurement of Landfill Machinery
- Operation and Maintenance of Landfill Facilities
- Improvement Work of the Existing Landfill in Gondlanwala
- Safe Closure of the Landfill Site in Gondlanwala
- Safe Closure of the Landfill Site in Chianwali
- Monitoring of Final Disposal in Bhakhraywali
- Post-Closure Monitoring of Gondlanwala and Chianwali Landfill Sites

(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 the **Project for Operation and Maintenance of Landfill Facilities in Chapter 6**.

(b) Monitoring of Final Disposal in Bhakhraywali

Monitoring of the final disposal activities shall be in accordance with the requirements stated in the **Project for Monitoring of Final Disposal in Bhakhraywali in Chapter 6**.

(c) Post-Closure Monitoring of Gondlanwala and Chianwali Landfill Sites

Monitoring and maintenance of the closed sites shall be in accordance with the requirements stated in the **Project for Post-closure Monitoring of Gondlanwala and Chianwali in Chapter 6**.

(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 the **Project for Engineering Service for Sanitary Landfill Facilities (Stage 1) in Chapter 6**.

(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 2023. The construction work shall be carried out in accordance with the requirements stated in the **Project for Construction of Sanitary Landfill Facilities (Stage 1) in Chapter 6**.

(f) Procurement of Additional Landfill Machinery

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 the **Project for Operation and Maintenance of Landfill Facilities in Chapter 6**.

(b) Monitoring of Final Disposal in Bhakhraywali

Monitoring of the final disposal activities shall be in accordance with the requirements stated in the **Project for Monitoring of Final Disposal in Bhakhraywali in Chapter 6**.

(c) Post-Closure Monitoring of Gondlanwala and Chianwali Landfill Sites

Monitoring and maintenance of the closed sites shall be in accordance with the requirements stated in the **Project for Post-Closure Monitoring of Gondlanwala and Chianwali in Chapter 6**.

(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 the **Project for Engineering Service for Sanitary Landfill Facilities (Stage 1) in Chapter 6**.

(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 the **Project for Construction of Sanitary Landfill Facilities (Stage 1) in Chapter 6**.

(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:

- Five (5) units of Bulldozer (Chain Dozer) including two (2) units of replacement;
- Three (3) units of Wheel Dozer including one (1) unit of replacement; and
- Two (2) units of Excavator including one (1) unit of replacement.

4.5.5 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 **Figure 4.5.7.**

The major activities in the Mid-Term period from 2019 to 2024 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 Long-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.

4.5.6 Implementation Schedule of Final Disposal Plan

The implementation schedule of the Final Disposal Plan is illustrated in **Figure 4.5.7**.

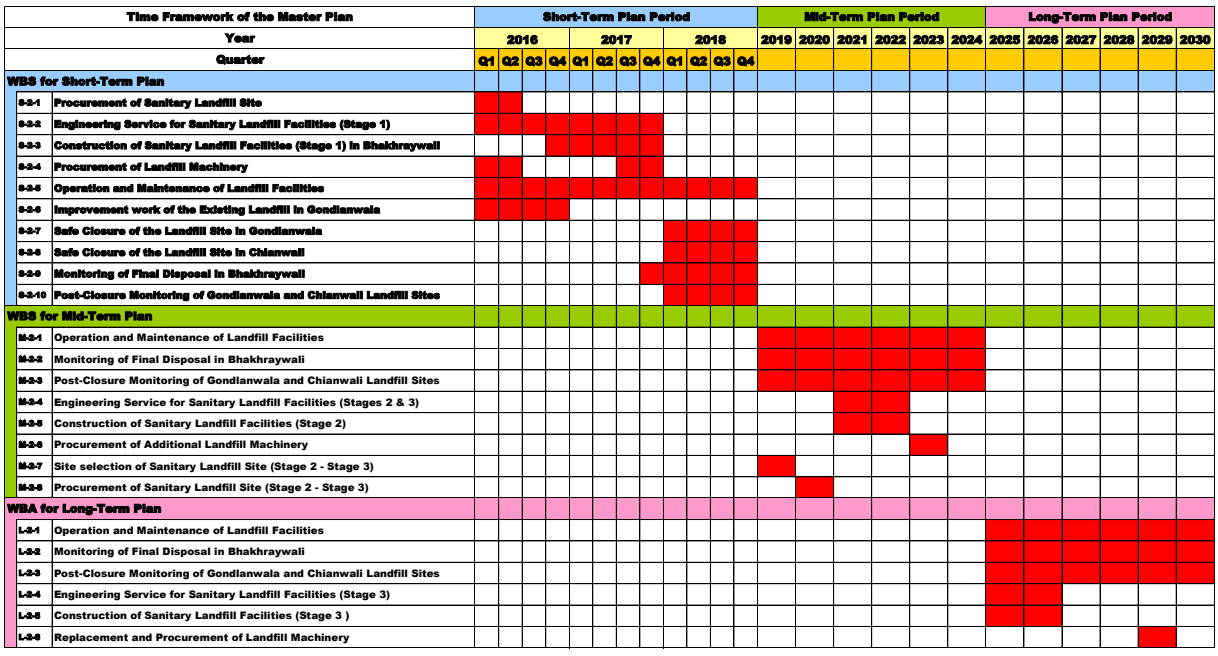


Figure 4.5.7 Implementation Schedule of the Final Disposal Plan

4.5.7 Project Cost of Final Disposal Plan

Investment cost, and operation and maintenance cost for the period from 2016 to 2030 are shown in **Table 4.5.6.** The estimated total cost of the Final Disposal Plan for 15 years is estimated at Rs. 4,883 million.

The details of cost estimate of final disposal plan is shown in ***Volume 4, Data Book, Section C, :C.6 Construction Cost of Final Disposal Facilities.***

Table 4.5.6 Total Cost of the Final Disposal Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 2: Final Disposal Plan																	
Short-Term Plan																	
S-2-1	Procurement of Sanitary Landfill Site	150,000	150,000														
S-2-2	Engineering Service for Sanitary Landfill Facilities (Stage 1)	99,680	49,840	49,840													
S-2-3	Construction of Sanitary Landfill Facilities (Stage 1) in Bhakhraywall	996,502	492,751	504,051													
S-2-4	Procurement of Landfill Machinery	70,350	31,500	38,850													
S-2-5	Operation and Maintenance of Landfill Facilities	72,151	18,669	21,859	31,623												
S-2-6	Improvement Work of the Existing Landfill in Gondlanwala	55,902	55,902														
S-2-7	Safe Closure of the Landfill Site in Gondlanwala	26,196			26,196												
S-2-8	Safe Closure of the Landfill Site in Chianwall	34,544			34,544												
S-2-9	Monitoring of Final Disposal in Bhakhraywall	GWMC															
S-2-10	Post-Closure Monitoring of Gondlanwala and Chianwall Landfill Sites	GWMC															
	Sub-Total	1,505,625	798,662	614,600	92,363												
Mid-Term Plan																	
M-2-1	Operation and Maintenance of Landfill Facilities	268,887				32,831	31,547	32,553	33,637	94,533	43,786						
M-2-2	Monitoring of Final Disposal in Bhakhraywall	GWMC															
M-2-3	Post-closure Monitoring of Gondlanwala and Chianwall Disposal Sites	GWMC															
M-2-4	Engineering Service for Sanitary Landfill Facilities (Stage 2)	97,408						48,704	48,704								
M-2-5	Construction of Sanitary Landfill Facilities (Stage 2)	996,502						492,751	504,051								
M-2-6	Procurement of Additional Landfill Machinery	87,450								87,450							
M-2-7	Site selection of Sanitary Landfill Site (Stage 2 - Stage 3)	GWMC															
M-2-8	Procurement of Sanitary Landfill Site (Stage 2 - Stage 3)	300,000					300,000										
	Sub-Total	1,750,548				32,831	331,547	574,008	586,392	181,983	43,786						
Long-Term Plan																	
L-2-1	Operation and Maintenance of Landfill Facilities	357,579										44,779	48,786	106,567	50,431	51,606	55,710
L-2-2	Monitoring of Final Disposal in Bhakhraywall	GWMC															
L-2-3	Post-closure Monitoring of Gondlanwala and Chianwall Landfill Sites	GWMC															
L-2-4	Engineering Service for Sanitary Landfill Facilities (Stage 3)	97,408										48,704	48,704				
L-2-5	Construction of Sanitary Landfill Facilities (Stage 3)	996,502										492,751	504,051				
L-2-6	Replacement and Procurement of Landfill Machinery	174,300														174,300	
	Sub-Total	1,626,389										586,234	598,521	106,567	50,431	225,906	55,710
	Grand Total	4,882,562	798,662	614,600	92,363	32,831	331,547	574,008	586,392	181,983	43,786	586,234	598,521	106,567	50,431	225,906	55,710

4.6 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)**. 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.

4.6.1 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 4.6.1.**

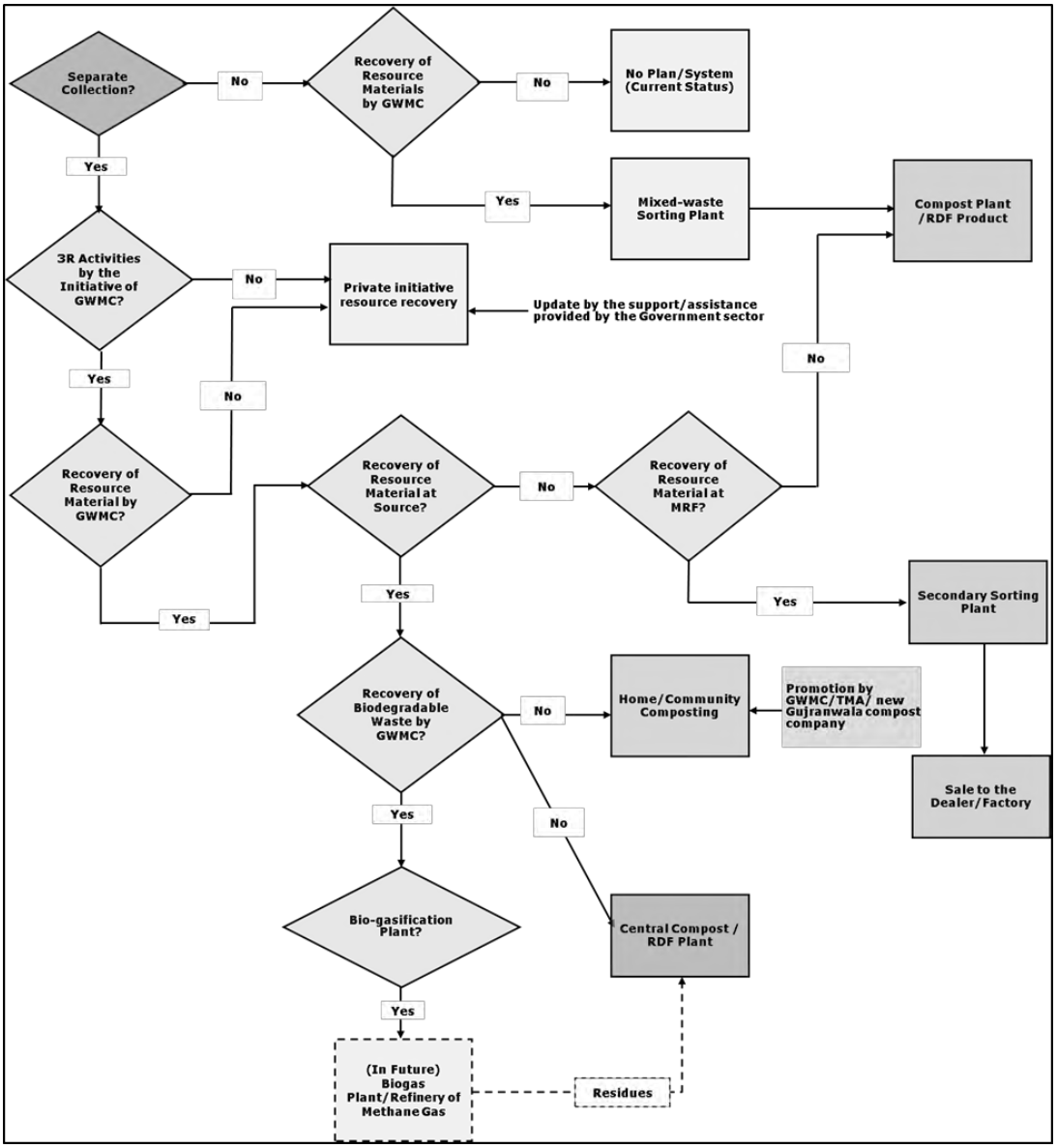


Figure 4.6.1 Flowchart of Selection of Intermediate Treatment and 3R Activity

(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 (Refuse Derived Fuel); 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, quantitative economic factor, etc. The following descriptions present the development of the plan and the evaluation for selecting the best option of intermediate treatment facility.

(c) Qualitative Evaluation of Intermediate Treatment Options

Table 4.6.1 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. Details of each option are discussed in ***Volume 3, Supporting Report, Section D: Intermediate Treatment and 3R Promotion, Subsection 4.1.1.*** As a whole, 1) waste characteristics; 2) higher water content due to high ratio of commingled food waste 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. Municipal waste incineration in Gujranwala City is disadvantageous. Considering the impacts to environment, Option 2: Composting, and Option 5: RDF, are the more environment-friendly intermediate treatment systems. As stated earlier, the development of intermediate treatment is obliged to take consideration of the privatisation. As for sales and marketing of the RDF products of the proposed Gujranwala compost/RDF company, it is necessary for GWMC/SPV to push forward the contract negotiation with the existing or new cement companies in near future (by year 2019). 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 4.6.1 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
	-	A	A	B	A	A
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 Hard disposal of digestive liquid after having gasified.
	B	A	A	A	A	A
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
	B	A	B	B	A	B

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
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.**
	B	A	B	B	A	A
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.
	-	A	B	B	A	B
Policy of GWMC	GWMC recommends Option 2: Composting, and Option 5: RDF, as the most practical/reliable intermediate treatment facilities through privatisation in Gujranwala.					
	-	A	B	B	A	B
Evaluation Results	-	**A**	B	B	**A**	B

Legend: A：Suitable, B: Not suitable
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.

(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 by 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 activated formal and informal commercial and industrial societies for recycling of recyclable materials.

Figure 4.6.2 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.

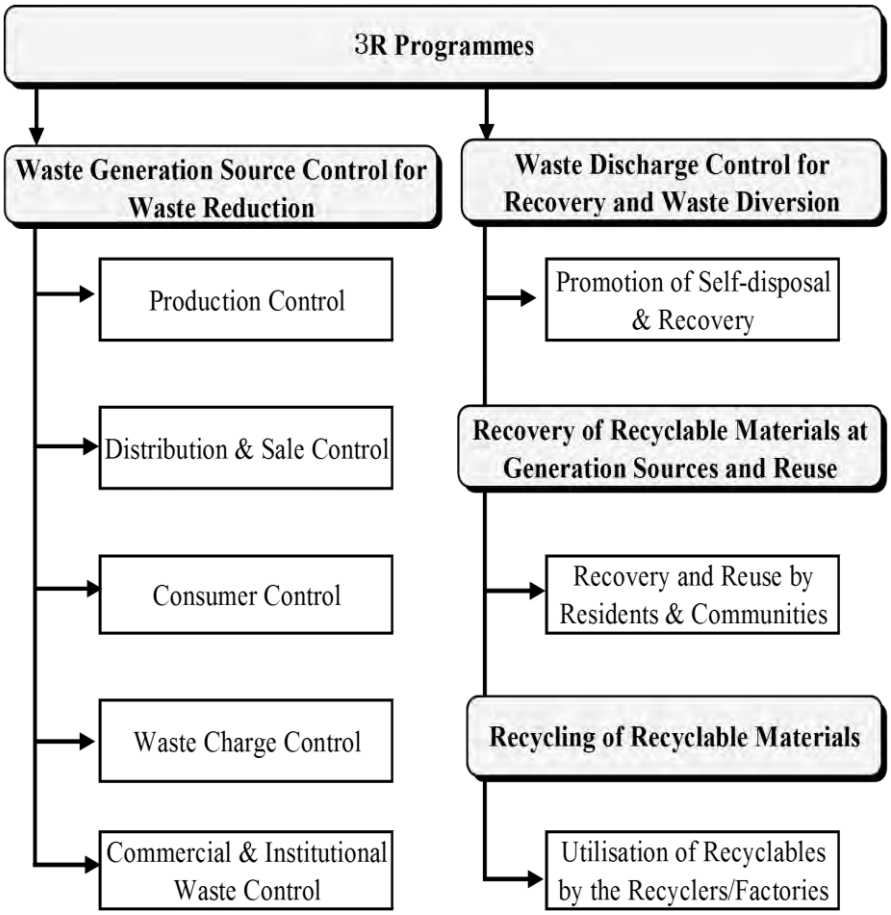


Figure 4.6.2 Conceptual Flow of Implementation of 3R Programmes

(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 4.6.2**. Those technical options are described in the following paragraphs.

Table 4.6.2 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	Primary 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

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 in Gujranwala. Recovered recyclable wastes collected are then brought to the dealers handling waste and finally to factories. Due to the picking-out

action for recyclable materials in the course of loading waste to the vehicles, the efficiency of waste collection as a whole becomes improved.

Option 2

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. Final waste separation is carried out at sorting process at the proposed central compost plant. 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.

(d) Initiatives of GWMC for 3R Promotion 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 Promotion 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 (50-100 target households and communities) which shall involve the waste generators, waste pickers, private shops and so on;
- Demonstration of 3R at pilot workplaces (around 10 target markets/hotels/restaurants for organic wastes, and 50 establishments/shops/schools etc.) 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.

As for the above, the number of the demonstration of 3R at both pilot areas and pilot workplaces is to be discussed and determined by GWMC. For instance, as pilot UCs of Zone 6, the pilot area has 50-100 households per group and 5 groups per UC. Similarly, the pilot workplace has around 10 markets/hotels/restaurants for organic wastes, and 50 establishments/shops/schools etc. for recyclables.

(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 4.6.3.**

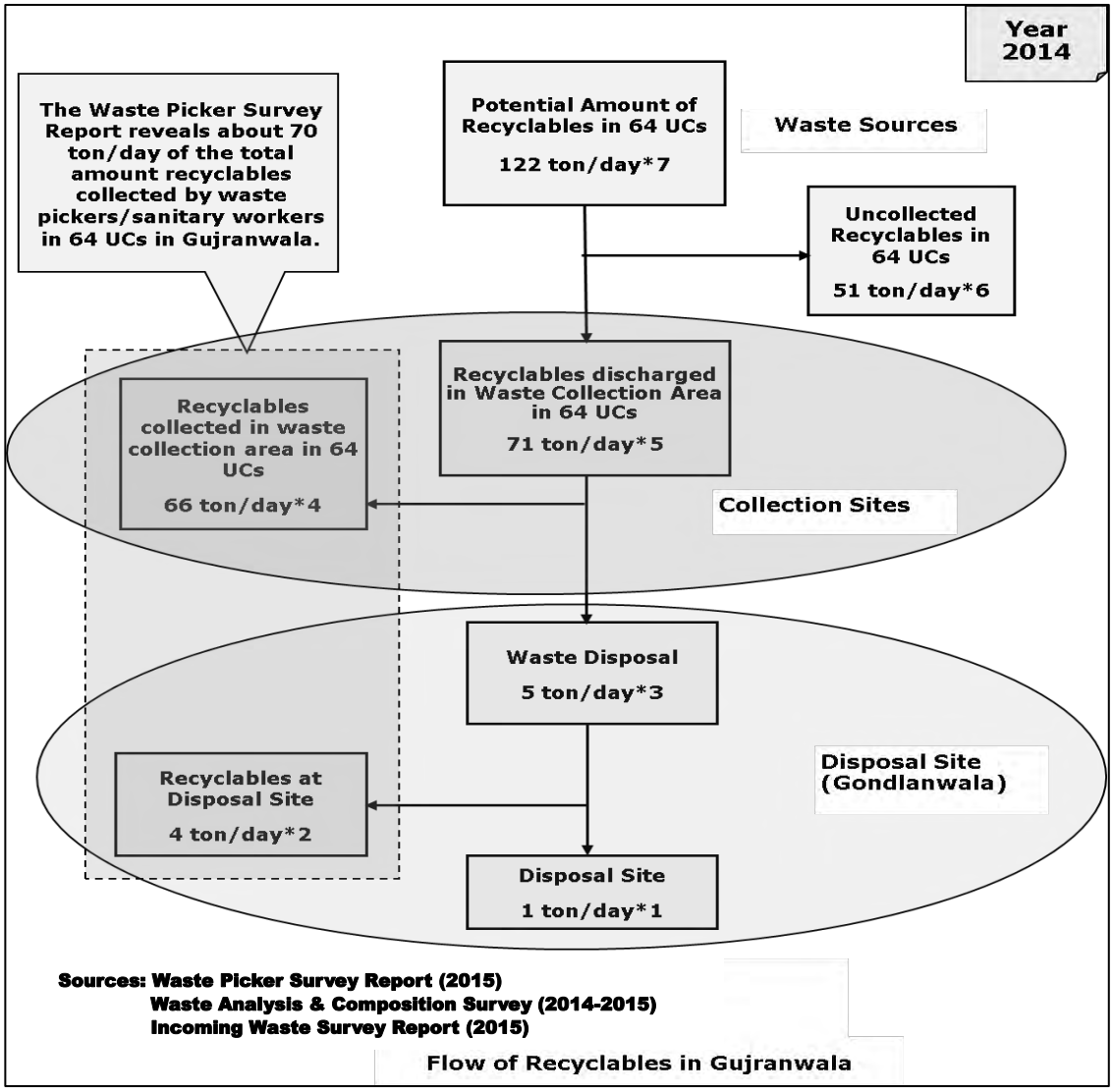


Figure 4.6.3 Flow of Recyclables in Gujranwala

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, the results of WACS (2014/2015) and records of weighbridge at Gondlanwala, approximately 122 ton/day of potential amount of recyclables are assumed to be segregated collected in 64 UCs.

4.6.2 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 4.6.3 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 were 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) Proposed Central Compost and RDF Plant in Gujranwala

(a) Simulation Study on Feasible Compost Amounts and RDF Amounts for the Proposed Plant

Feasible input waste amounts for composting are estimated at 250 ton/day while RDF production in two cases, 250 ton/day and 500 ton/day, is not feasible. Therefore, a subsidy may be necessary to promote the RDF. Simulation results of the proposed Central Compost Plant including RDF product in Gujranwala are presented in **Table 4.6.4**. The input waste amount of 250 ton/day is basically derived from the experience of the Lahore Compost Plant, and 20 ton/day is assumed as the small scaled amount for the compost plant for reference. Two (2) different cases for the RDF plant were simulated, 250 ton/day and 500 ton/day.

Table 4.6.4 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	17.2	OK.
	20*	10	3.7	-
RDF Plant	250	100	N.G.	Subsidy may be required.
	500	200	N.G.	

Notes: N.G. means there is no computation result.
* An input of 20 ton/day waste amount was proposed to simulate IRR evaluation as a small scale initial production of composting but it was not feasible.
Base on the interview results with the Lahore Compost Company (LCC) or the D.G. Khan Cement Company (DGKCC), the rates of production amount by input amount at plant are given as approximately 50% for compost from the LCC and approximately 40% for RDF from the DGKCC, respectively.

(b) Location and Required Area of the Proposed Plant

The proposed central compost and RDF plant is to be built adjacent to the proposed landfill site in Bhakhraywali and adjoining vacant lands, according to the Managing Director (MD) of GWMC. The required land area of the proposed facilities is about 7 hectares (ha) including land spaces for office, parking, workshop, store house, bagging unit, composting/RDF plant, windrows field, etc.as a final development scale of the plant. Major factors are considered during the landfill site selection as follows: airports, flood plains, wetlands, fault zones, seismic zones, unstable areas, and environmental degradation (see details in ***Volume 3, Supporting Report, Section C: Final Disposal, Subsection 2.8.1.***). It is recommended that the required land area of 7ha should be procured at the initial stage of the planning of the proposed facilities in 2019.

(c) Necessity of Proper Quality Control of the Products and IEC Activities

Saleability of the compost produced by the Lahore Compost Company (LCC) seems to be poor. According to the results of the interview survey with the farmers at Bhakhraywali, one of the reasons seems to include the lack of trust of the farmers due to lack of information on the produced composts. In other words, securing proper quality of the products of composting and disseminating their advantages is indispensable to obtain the trust of users. To ensure the quality of compost products, the following measures should be taken into consideration:

- Collection of organic materials by separation at source;
- Establishment of a test farm for quality control of compost and IEC activities; and
- Accreditation of the products by official certificates.

Regarding public relations, information, education and communication (IEC) activities are required through the operation of a test farm since the primary target of dissemination are the farmers. Details of the above measures are given in ***Volume 3, Supporting Report, Section D: Intermediate Treatment and 3R Promotion, Subsections 5.2.1 and 5.2.2*** and summarised as follows:

(i) Collection of Organic Materials by Separation at Source

Organic waste is to be separated and collected by source separation in each household and this activity of separate collection system shall start in 2019 based on the Waste Collection and Transportation Plan described in ***Volume 3, Supporting Report, Section B, Subsection 4.2.2***. The separate collection system will be conducted mainly with the installation of containers in the main markets, restaurants, hotels, parks and roadsides for the organic wastes from the residential houses. To introduce this new system, firstly, a pilot project shall be carried out in Zone 6.

(ii) Establishment of a Test Farm for Quality Control of Compost and IEC Activities

It is proposed that a small scaled pilot farm having approximately 1,000m^2 is built within the premises of the plant to test the growth of crops including the effect of compost and the issues on crop cultivation for the purpose of quality control of the compost. The quality control should be carried out in the test farm to remove foreign matter as well as manage the moisture content, composting temperature, oxygen concentration in compost heaps, maturation degree, etc., in order to propose a plan for the efficient production of a good compost. Farmers are to be invited to the farm to witness the effects of compost and learn how the compost quality is controlled in the production process. This procedure is expected to result in the recognition of the effectiveness of composts and make them acceptable to the farmers based on the yield and quality of the crops in the test farm and of course depending on the price of compost. The effectiveness of compost will be tested for about one year period. However, the pilot farm will be extended more and continued to further crop cultivation for quality control of the compost, if the owner of the proposed compost plant, i.e., Special Purpose Vehicle (SPV) wishes.

(iii) Accreditation of the Products by Official Certificates

It is indispensable to assure the quality of compost products periodically and officially to widen the acceptability of compost as soil conditioner used together with chemical fertilizers. The LCC has a licence for compost production issued by the Directorate of Soil Fertility, Agricultural Department Government of the Punjab. The proposed SPV (Special Purpose Vehicle) for the proposed Gujranwala Central Compost Company is thus also obliged to obtain a licence for compost production from the above Department. With

regard to the test certificate, there are some private laboratories and agencies of quality assurance tests like the PCSIR (Pakistan Council of Scientific & Industrial Research). The establishment of an official quality assurance system would make the farmers understand that the use of compost is effective and safe.

In terms of RDF products, the quality is important as well. At the Lahore Compost Plant, some foreign matters are observed in the final product of RDF or RPF (Refuse Paper & Plastic Fuel; paper, plastic, textile, etc. are used as fuel in Pakistan.) and they reduce the calorific value. According to the waste segregation programme to be performed by GWMC in the master plan, well-segregated waste is supposed to be transported to the proposed Gujranwala Compost/RDF plant which shall start production of RDF in 2030. It is, therefore, emphasised as the experience obtained from the Lahore RDF plant that the waste materials of paper and plastics after separation should be segregated again at the plant in Gujranwala.

(d) Operation Schedule of the Proposed Plant

According to the proposed waste flow plan of the ISWM in Gujranwala City, for the waste recovery amount with high organic content, the proposed central compost plant is designed to receive 250 ton/day of wastes including market biodegradable wastes for the final sorting process by 2018 and construction in the Year 2019. The 250 ton/day of waste is possible to be derived from the actual organic waste recovery amount in the LCC whose operation started in 2006 for the production of 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, and sieving screen at the plant, bagging unit near storehouse, turner at windrow, etc. Similarly, the same sorting unit and baling unit for 250 ton/day will also be used in the proposed RDF plant after enlargement of the proposed Gujranwala central compost plant in 2030. Raw materials for the RDF consist of papers, plastics and other combustible materials are planned to be separated in 2030 when the RDF plant starts operation. Details including investment cost and operation and maintenance cost are given in ***Volume 3, Supporting Report, Section D: Intermediate Treatment and 3R Promotion, Section 4.5***.

(e) Preliminary Cost Estimates for the Plant

(i) Compost Section

The equipment to be used at the plant will be considered based on the equipment of the plant managed by Lahore Compost Company (LCC). The total project cost for compost production estimated with preliminary specifications is approximately Rs. 1,025 million up to the year of 2030. The initial investment cost in 2018-2019 is assumed to be about Rs. 442 million and the second investment cost for enlargement including the cost for detailed design in 2028-2029 will be around Rs. 74 million while annual cost for operation and maintenance expenses will be about Rs. 46 million.

(ii) RDF Section

The RDF project cost estimated with the preliminary specifications seems to be approximately Rs. 140 million [the initial investment cost of about Rs. 44 million (10 years)], annual about Rs. 17 million of the administrative and maintenance expenses. RDF products will be sold to the cement factories. The current selling price of comingled municipal solid waste by LWMC to an ex-factory is Rs. 53 per ton. The transport cost of RDF products to the cement factory in Kallar Kahar is Rs. 900/ton and the cement factory in Multan sells them at Rs. 5,000/ton. The transportation cost in Gujranwala shall be determined depending on the terms and conditions of the contract.

(f) Application of PPP Scheme

The MD of GWMC has informed that GWMC intends that the proposed central compost and RDF plant managed by the SPV (Special Purpose Vehicle) in Gujranwala is to be setup and managed by privatisation. Composting is globally well recognised as an environmentally friendly practice with no side effect. Once residents realise its benefit and usefulness, it is possible for the private sector to make profit.

In order to promote composting, public involvement is essential. The simulation results of economic internal rate of return (EIRR) as presented in the above **Item (a)** show that the establishment of a central compost plant will be feasible if the production capacity is satisfactory and the quality of products is assured. Therefore, instead of the PPP as the optimum private sector involvement plan of the central compost and RDF plant in Gujranwala, BOT (Build-Operate-Transfer) is recommended. Following the case of LCC as the pioneer compost plant company based on the BOT in Pakistan, it is suggested that GWMC should provide the land and a certain amount of organic waste in turn for a certain percentage of the annual profit under the newly contracted company for the compost plant enterprise. The same can be applied to the RDF plant.

(g) Salient Features of the Proposed Central Compost and RDF Plant by SPV

Salient features of the proposed Gujranwala central compost plant managed by the SPV are shown in **Table 4.6.5.**

Table 4.6.5 Salient Features of Proposed Gujranwala Central Compost and RDF Plant by SPV

Project Name		Project Overview	Descriptions
Proposed Gujranwala central compost and RDF plant by SPV		Contracting parties	GWMC, and a special purpose vehicle (SPV) for a central compost and RDF plant
		Location	in and/or around the proposed final landfill site in Bhakhraywali
		Selection of PPP*	BOT*basis between GWMC and the private sector is recommended.
	Compost Section	Total land area for the Plant	7 hectares
		Description of service	Establishment of compost plant in 2020 including RDF from 2030
		Operation period	2020 – 2035 (16 years: Service lifespan of the plant)
		Plant capacity	Input waste: 250 tons/day
		Staff involved	Project manager, supervisor, mechanics, engineers, biochemist, marketing representative, labour, etc.
		Equipment	Imported plant containing all equipment sorting conveyors, trammel screen, shredder, turner, bagging unit, etc.
		Facilities	Administrative office, screening bagging and store unit, waste sorting unit, RFID and weight record room with weight bridge platform, windrow field, laboratory, guard office, car parking area, fencing, green belt zone, pilot farm field, etc.
		Machinery	Wheel loader, tractor and trolley, stitching and bagging unit, generating set, etc.
		Compost preparation time	60~90 days
		Production amount	125 tons/day of compost
	Compost and RDF Section	Total plant area	7 hectares (no extension area for RDF, the same area as compost)
		Operation period	2030 -
		Description of service	Extension work for RDF section of the waste sorting house from 2030
		Plant capacity	Input waste: 250 tons/day for compost, 250 tons/day for RDF
		Staff involved	Project manager, supervisor, mechanics, engineers, marketing representative, labour, etc.
		Additional equipment	Equipment of sorting line conveyors, baler, shredder, etc.
		Additional extension facilities	Extension work for waste sorting house for RDF production
		Production amount	125 tons/day of compost, 100 tons/day of RDF

Notes: This proposed Gujranwala Central Compost & RDF Plant is planned to have a composting section and an RDF section in the same plant site after the year of 2030.
Construction of the proposed Gujranwala Central Compost & RDF Plant for producing compost and RDF may require an EIA/IEE based on the final decision of the Environment Protection Department (EPD) of the Government of the Punjab.

(2) Home and Community Composting in 34 UCs

Although home composting and community composting will not be conducted so much in 64 UCs, they will be carried out mainly in the 34 UCs. Home composting is to be made in each house and community composting with the group composting. Home and community composting in the 34 UCs is to be carried out through the self-disposal system in collaboration with the community level in Sadar Tehsil in Gujranwala. According to the proposed waste flow in the 34 UCs, organic waste recovery amounts are to be produced for small-scaled composting starting from a small amount in 2019, 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. A new Gujranwala central compost company which shall be fully responsible for the management of the new compost company is to be responsible for selling compost as assistance to GWMC. Therefore, the central compost plant enterprise with GWMC will be assigned to advise the related consumers such as households, communities, etc. in the 34 UCs. Sadar Tehsil Municipal Administration (TMA) is to manage the activity of not only composting but also segregation of recyclable materials at sources and primary waste collection in designated areas, and the community-based composting through IEC (Information, Education and Communication) campaign.

4.6.3 Identification of Project Components for Intermediate Treatment and 3R Promotion Plan

(1) Short-Term Plan (2016-2018)

The projects in the Short-Term period, i.e., from 2016 to 2018, are described as the Action Plans of Priority Projects in **Chapter 6**. The proposed projects are as follows:

- Awareness and IEC Campaign on Resource Recovery
- Implementation of Simplified WACS
- Preparation for PPP and Formation of a Committee of the BOD of GWMC
- Implementation of Land Preparation by GWMC
- Engineering Service for Detailed Design of a Compost Plant by SPV

(2) Mid-Term Plan (2019-2024)

(a) IEC Campaign on Resource Recovery at Source/Registration of Waste Pickers and Recycling Industries

During the Mid-Term Plan (2019-2024), the IEC campaign on resource recovery at source is to be conducted together with the Communication Unit of GWMC under the Environmental Education and Public Awareness Raising Plan in the IWSM master plan. The Communication Unit, the focal point of GWMC, will be the leading agency on the necessity of IEC campaign on 3R, resource recovery, targeting expanded numbers of primary school teachers and students and the general public than cases in the Short-Term Plan. This unit will serve as both information dissemination point and where the general public can make inquiries about solid waste management in GWMC. The details of staffing and costing of the Communication Unit are as given in ***Volume 3, Supporting Report, Section E: Environmental Education and Public Awareness Raising Plan, Subsection 4.3.3.***

As for the registration of waste pickers, it is required to organise an informal sector of waste picking by creating a centralised database of waste pickers and designing and issuing identity cards to all of them. It will help to authorise waste pickers to collect waste and therefore protect their source of living against harassment from the police, municipal workers and the public. It may also be possible to introduce the social security schemes for the waste pickers,

and the education scholarship scheme for children of waste pickers. This will help integrate waste pickers into the door-to-door collection system of solid waste management.

(b) Purchase of Land for the Compost Plant

Following the action in the Short-Term Period for GWMC's implementation of land preparation (approximately 7 ha) for the compost plant project, the Board of Directors (BOD) of GWMC has to settle the payment issue with the owners of the above land by the beginning of 2019 based on the TOR which shall be prepared by the BOD of GWMC in 2017, so that the new compost company (the SPV: Special Purpose Vehicle) will be able to start the construction work for the compost plant in the payment settled land area without any delay in its implementation.

(c) Construction Work for the Gujranwala Compost Plant owned by SPV including Procurement of Equipment

The SPV shall require the contractor to start the civil and appurtenant works and the procurement of equipment in the compost plant area in Bhakhraywali and complete them by the end of 2019, so that all the required buildings and appurtenant facilities including necessary equipment are ready for operation in 2020.

(d) Operation and Maintenance of the Compost Plant

Operation and maintenance (O&M) of the compost plant in Bhakhraywali shall be in accordance with the requirements stated in the O&M manuals (2020-2024). The manuals are to be prepared in the detailed design stage during the Short-Term Plan.

(e) Monitoring of Implementation of the Compost Plant

Monitoring of the implementation of the compost plant facilities shall be in accordance with the requirements of a checklist of the operation and maintenance work in the Mid-Term Plan (2019-2024). The checklist shall be prepared during the detailed design in 2018.

(3) Long-Term Plan (2025-2030)

(a) IEC Campaign on Resource Recovery at Source/Registration of Waste Pickers and Recycling Industries

Refer to the contents of the above **Item (2), Mid-Term Plan (a)** for the Long-Term Plan.

(b) Engineering Service for Detailed Design of the RDF Plant owned by SPV

Engineering services including detailed design of the extension works for the waste sorting facility for the RDF in Bhakhraywali and preparation of tender documents for the contractor shall be carried out in 2028 in the Long-Term Period (2025-2030).

(c) Construction of the RDF Plant owned by SPV including Procurement of Equipment

Following the detailed design in **Item (2)**, construction of the extension works required for the additional part of the waste sorting facility in Bhakhraywali is to be started in 2029 and completed by the end of 2029. In addition to the extension of civil works for the waste sorting facility for the RDF, procurement of additional equipment for the RDF is to be carried out within the year of 2029, so that the plant will be ready to start the RDF operation in 2030.

(d) Operation and Maintenance of the Compost & RDF Plant

The operation and maintenance of the compost and RDF plant shall be in accordance with the requirements stated in the operation and maintenance manuals for the project after 2030. In order to conduct operation and maintenance properly, the manuals shall be prepared in accordance with the requirement of the plant under the TOR for SPV basis.

(e) Monitoring of Implementation of the Compost & RDF Plant

Monitoring of the compost plant is to be carried out during the Long-Term Period. The maintenance work schedule is to start in 2025 in Bhakhraywali and for RDF production will commence in 2030. The monitoring work shall consist of the activities of regular observation on mainly the safety of workers and environmental monitoring for the plant and windrow field, test farm, odour, water drain, environmental and social considerations, etc. in the complex of the plant site, based on the environmental checkpoint sheet.

(f) Preparation and Enactment of Recycling Laws in Punjab, Pakistan

Even though policies, draft acts, guidelines, regulations, and ordinances related to solid waste management exist, currently there is no recycling law in Gujranwala and the Punjab, Pakistan. From the perspective of residents, it seems that most residents are not even aware of the existence of laws and regulations. More frequent awareness raising and IEC campaigns should be conducted for the public including school teachers and students.

In Japan, the Ministry of Environment enforces several laws and regulations for establishing a recycling-based society, such as the Basic Environment Law (legislated in November 1993), the Basic Act for Establishing the Sound Material-Cycle Society (legislated in June 2000) and the Law for Promotion of Effective Utilisation of Resources (legislated in April 2006). Most of these recycling laws and acts were enacted in Year 2000 or later, while the Basic Environmental Law was legislated in 1993. In the Punjab, therefore, it will take some time to legislate and enact recycling laws and acts after the Municipal Solid Waste Rules are legislated. Although awareness raising and IEC campaign on 3R must be exercised continuously, it is assumed that the recycling law might be legislated in 2025 and 2026 of the Long-Term Period.

4.6.4 Implementation Schedule of Intermediate Treatment and 3R Promotion Plan

The implementation schedule of the Intermediate Treatment and 3R Promotion Plan is illustrated in **Figure 4.6.4**.

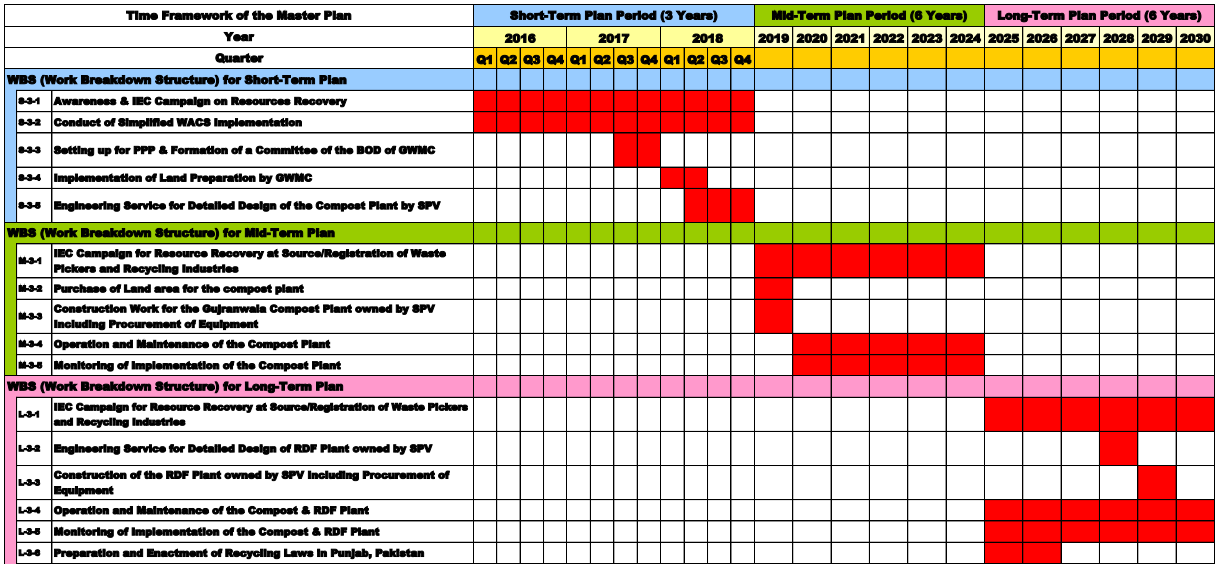


Figure 4.6.4 Implementation Schedule of the Intermediate Treatment and 3R Promotion Plan

4.6.5 Project Cost of Intermediate Treatment and 3R Promotion Plan

Table 4.6.6 shows the project cost for the Master Plan. The total cost of the Intermediate Treatment and 3R Promotion Plan is Rs. 1,025 million. It is assumed that Rs.1,025 million of the total project cost of the Intermediate Treatment and 3R Promotion Plan in the Master Plan consists of Rs. 42 million by local fund or GWMC's own resources and Rs. 983 million by Special Purpose Vehicle (SPV).

Table 4.6.6 Total Cost of the Intermediate Treatment and 3R Promotion Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 3: Intermediate Treatment and 3R Promotion Plan																	
Short-Term Plan																	
S-3-1	Awareness & IEC Campaign on Resources Recovery	0	0	0	0												
S-3-2	Conduct of Simplified WACS Implementation	0	0	0	0												
S-3-3	Setting up for PPP & Formation of a Committee of the BOD of GWMC	BOD/ GWMC	0	0	0												
S-3-4	Implementation of Land Preparation by GWMC	BOD/ GWMC	0	0	0												
S-3-5	Engineering Service for Detailed Design of the Compost Plant by SPV	40,000	0	0	40,000												
	Sub-Total	40,000	0	0	40,000												
Mid-Term Plan																	
M-3-1	IEC Campaign for Resource Recovery at Source/Registration of Waste Pickers and Recycling Industries	0				0	0	0	0	0	0						
M-3-2	Purchase of Land area for the compost plant	42,000				42,000	0	0	0	0	0						
M-3-3	Construction Work for the Gujranwala Compost Plant owned by SPV including Procurement of Equipment	360,000				360,000	0	0	0	0	0						
M-3-4	Operation and Maintenance of the Compost Plant	215,695				0	39,239	42,415	43,376	44,799	45,866						
M-3-5	Monitoring of Implementation of the Compost Plant	SPV				0	0	0	0	0	0						
	Sub-Total	617,695				402,000	39,239	42,415	43,376	44,799	45,866						
Long-Term Plan																	
L-3-1	IEC Campaign for Resource Recovery at Source/Registration of Waste Pickers and Recycling Industries	GWMC										0	0	0	0	0	0
L-3-2	Engineering Service for Detailed Design of RDF Plant owned by SPV	4,000										0	0	0	4,000	0	0
L-3-3	Construction of the RDF Plant owned by SPV including Procurement of Equipment	70,000										0	0	0	0	70,000	0
L-3-4	Operation and Maintenance of the Compost & RDF Plant	293,216										45,866	45,866	45,866	45,866	45,866	63,886
L-3-5	Monitoring of Implementation of the Compost & RDF Plant	SPV										0	0	0	0	0	0
L-3-6	Preparation and Enactment of Recycling Laws in Punjab, Pakistan	Punjab										0	0	0	0	0	0
	Sub-Total	367,216										45,866	45,866	45,866	49,866	115,866	63,886
	Grand Total	1,024,911	0	0	40,000	402,000	39,239	42,415	43,376	44,799	45,866	45,866	45,866	45,866	49,866	115,866	63,886

4.7 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.

4.7.1 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/sensitise the population. Population can be targeted through a group or organization 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 contents and 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, teacher's union, transport union, doctor's group or other organization, 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 auto rikshaw 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 campaign.

(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.

4.7.2 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 messages 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 4.7.1** gives a summary of the alternatives.

Table 4.7.1 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 and teachers	Limited, but covers good portion of students	Long-term	Influence in household as well
	b) Social	All member of society/general public	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.

4.7.3 Identification of Project Components for Environmental Education and Public Awareness Raising Plan

In identifying the project components for environmental education and public 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 437 public and 273 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 4.7.2 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 order to build bases for understanding the importance of proper waste management. 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 4.7.3** shows a summary of number of students and communication team members in the school programme.

Table 4.7.3 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	70	80	100	100	200	200	300	300	400	400	500	500	600	600	710
Number of Students	2,100	2,400	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 organize 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. This environmental facility can be established in mid-term, or in 2021, of the Master Plan to support the informal education program in schools as well as general public. Before opening up this facility, a) careful design, b) developing materials and guidelines similar to school program, and c) operation/coordination plan should be prepared.

(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 4.7.4** for short-term, and **Table 4.7.5** for mid- and long-term.

In the short-term plan, 70 schools will be targeted in the first year, and 80 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 4.7.4 Approximate Costs for the Short-Term Plan (Year 2016-2018)

Term/Year	Short-Term		
	2016	2017	2018
Number of Schools	70	80	100
Number of Students	2,100	2,400	3,000
Cost (Rs.)			
PR/Educational Materials (total)	25,200	28,800	36,000
Miscellaneous	860,000	240,000	300,000
Staff	1,752,000	1,828,800	1,905,600
Vehicle	1,250,000	0	0
Vehicle Maintenance	80,000	80,000	80,000
Total Expenditure	3,967,200	2,177,600	2,321,600

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 4.7.5 Approximate Cost for Mid and Long-Term Plans (Year 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
PR/Educational Materials (Rs. Total)	354,000	708,000	708,000	1,116,000	1,116,000	1,488,000	1,488,000	1,900,000	1,900,000	1,708,000	2,107,000	2,615,600
Room (Rs.)	0	0	100,000	100,000	100,000	100,000	100,000	200,000	200,000	200,000	200,000	200,000
Miscellaneous (Rs.)	950,000	900,000	900,000	1,850,000	1,350,000	1,800,000	2,300,000	2,400,000	2,250,000	2,700,000	2,700,000	3,195,000
Staff (Rs.)	1,982,400	2,059,200	2,160,480	3,461,760	3,659,040	3,856,320	4,053,600	4,291,680	4,560,360	5,069,100	6,684,660	8,401,500
Vehicle (Rs.)	0	0	0	625,000	0	0	0	1,250,000	0	625,000	0	0
Vehicle Maintenance (Rs.)	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000
Total Expenditure (Rs.)	3,366,400	3,747,200	3,948,480	7,232,760	6,305,040	7,324,320	8,021,600	10,121,680	8,990,360	10,382,100	11,771,660	14,492,100

(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 consequences 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 4.7.6**. 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 4.7.6 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 4.7.7**. Number of expected participants and target households were derived from the current estimated number of households in Gujranwala, which are 304,500. According to this, 50% households are expected to be a part of this effort by the end of the long-term plan (the year 2030).

Table 4.7.7 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
Target number of households	2,047	2,302	2,558	5,116	7,675	10,233	12,791	15,349	17,907	20,466	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	572,295	639,120	782,670	922,160	1,198,830	1,202,620
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	140,000	151,200	162,400	173,600	184,800	199,570	214,340	229,110	243,880
Total Expenditure (Rs.)	437,407	451,733	466,059	749,318	903,777	1,058,236	1,176,295	1,254,320	1,412,640	1,566,900	1,858,340	1,876,900

(3) Total Project Cost for Implementation of Environmental Education and Public Awareness Raising Plan

Based on the above, the total project cost of Environmental Education and Public Awareness Raising Plan between 2016 and 2030 is estimated at approximately Rs. 65 million and summarised as shown in **Table 4.7.8**.

Table 4.7.8 Project Cost for Implementation of Environmental Education and Public Awareness Raising Plan

Unit: thousand Rs.

Term/Year	Short-Term			Mid-Term						Long-Term						Total
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	
Informal Education	3,967	2,178	2,322	3,366	3,747	3,948	7,233	6,305	7,324	8,021	10,121	8,990	10,382	11,771	14,492	104,170
Periodical Events	287	301	315	437	452	466	749	904	1,058	1,176	1,254	1,412	1,566	1,858	1,876	14,114
Social Survey	0	0	0	0	1,375	0	0	0	0	1,375	0	0	0	0	1,375	4,125
Total	**4,254**	**2,479**	**2,637**	**3,804**	**5,574**	**4,415**	**7,982**	**7,209**	**8,383**	**10,573**	**11,376**	**10,403**	**11,949**	**13,630**	**17,744**	**122,411**

Note: Totals may not always be equal to the sum of the subjected column or row due to rounding off.

4.7.4 Implementation Schedule of Environmental Education and Public Awareness Raising Plan

The implementation schedule of the Environmental Education and Public Awareness Raising Plan is illustrated in **Figure 4.7.1**.

Time Framework of the Master Plan		Short-Term Plan Period												Mid-Term Plan Period						Long-Term Plan Period					
Year		2016				2017				2018				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4												
WBS for Short-Term Plan																									
S-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies																								
S-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students																								
S-4-3	Development and Implementation of Educational Programmes Targeting General Public																								
WBS for Mid-Term Plan																									
M-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies																								
M-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students																								
M-4-3	Development and Implementation of Educational Programmes Targeting General Public																								
M-4-4	Development and Implementation of Monitoring Plan																								
M-4-5	Development of Environmental Education Facility and its Utilisation Plan																								
WBA for Long-Term Plan																									
L-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies																								
L-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students																								
L-4-3	Development and Implementation of Educational Programmes Targeting General Public																								
L-4-4	Development and Implementation of Monitoring Plan																								
L-4-5	Managment of Environmental Education Facility and its Utilisation																								

Figure 4.7.1 Implementation Schedule of Environmental Education and Public Awareness Raising Plan

4.7.5 Project Cost of Environmental Education and Public Awareness Raising Plan

Table 4.7.9 shows the project cost for the Master Plan. The total cost of the Environmental Education and Public Awareness Raising Plan is Rs. 122 million.

Table 4.7.9 Total Cost of the Environmental Education and Public Awareness Raising Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 4: Environmental Education and Public Awareness Raising Plan																	
Short-Term Plan																	
S-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies	6,738	3,002	1,829	1,906												
S-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students	1,730	965	349	416												
S-4-3	Development and Implementation of Educational Programmes Targeting General Public	903	287	301	315												
	Sub-Total	9,370	4,254	2,479	2,637												
Mid-Term Plan																	
M-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies	18,738				2,062	2,139	2,240	4,307	3,990	4,000						
M-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students	13,240				1,304	1,606	1,606	2,966	2,466	3,288						
M-4-3	Development and Implementation of Educational Programmes Targeting General Public	3,613				437	452	466	609	753	896						
M-4-4	Development and Implementation of Monitoring Plan	1,375				0	1,375	0	0	0	0						
M-4-5	Development of Environmental Education Facility and its Utilisation Plan	400				0	0	100	100	100	100						
	Sub-Total	37,366				3,804	5,574	4,415	7,982	7,209	8,383						
Long-Term Plan																	
L-4-1	Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies	36,661										4,307	5,806	4,840	5,068	6,994	5,725
L-4-2	Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students	27,167										3,788	4,300	4,150	4,408	4,807	5,811
L-4-3	Development and Implementation of Educational Programmes Targeting General Public	7,998										1,003	1,070	1,213	1,363	1,629	1,633
L-4-4	Development and Implementation of Monitoring Plan	2,750										1,375	0	0	0	0	1,375
L-4-5	Managment of Environmental Education Facility and its Utilisation	1,100										100	200	200	200	200	200
	Sub-Total	75,675										10,573	11,376	10,403	11,049	13,630	17,744
	Grand Total	122,410	4,254	2,479	2,637	3,804	5,574	4,415	7,982	7,209	8,383	10,573	11,376	10,403	11,049	13,630	17,744

4.8 Economic and Financial Plan

4.8.1 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 optimum cost recovery, the tariff level should send clear signals to waste generators as well as GWMC, thereby efficiently providing SWM services. Users shall 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:** Operating costs, often called operating and maintenance expenditures, will be covered by the total revenue.
- **2nd Step:** Operating costs plus replacement costs often expressed as the depreciation of the capital replacement of existing facilities will be covered by the total revenue.
- **3rd Step:** Operating costs plus the depreciations of the capital replacement of existing facilities and part of new capital investment costs 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.

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. The details of each principle are explained in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect, Subsection 4.1.3, Item (1)***.

- Efficient allocation of resources
- Efficient supply of services
- Cost recovery
- Financial viability
- Horizontal equity
- Vertical equity and poverty alleviation
- Administrative and technical feasibility
- Polluter pays
- Avoiding illegal dumping
- Proportionality
- Transparency

The process of the tariff setting includes the following 3 steps:

- The analysis on the costs and revenues will be carried out by GWMC for estimating the required tariff level;
- GWMC will officially request the tariff setting for the tariff setting/revision committee which will be set up inside CDGG; and
- The tariff setting/revision committee will review and approve the request from GWMC.

(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 as per **Table 4.8.1**.

Table 4.8.1 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 minimal 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 difficult 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 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.

(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. The detailed discussion is made in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect, Subsection 4.1.3, Item (3)***.

(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. The detailed discussion is made

(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.

(iii) Price Cap 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.

4.8.2 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.

Based on the above assumptions, out of 3 alternative options for the cost recovery, the first option to cover the operation and maintenance cost is realistic and optimum option for the cost recovery for the evaluation in the master plan.

(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 4.8.2** shows alternative options for costing methods.

Table 4.8.2 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

Out of the alternative options for the tariff charging system listed in **Table 4.8.1**, 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 (2019-2021) in the high-income and middle-income areas 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 (2022-2024) 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 negotiation with the excise and taxation department of the provincial government should be commenced from 2016 to adjust the rate of the provincial property rate so as to add the surcharge for generating baseline stable revenue to fill the gap between the tariff revenue and the required revenue, thereby covering the operation and maintenance cost.
- In case of the non-payment of waste collection charges under the proposed tariff charging system, it should be explored that a sort of penalty for non-payers will be enforced so as to secure the horizontal equity among beneficiaries.
- The full-scale introduction of the recommended tariff charging system in all areas will be started from 2025.

Regarding the concrete tariff collection methods, since the variable-rate user charge system requires the identification of the income level, it is technically difficult to accurately grasp the income level of each household. Therefore, the following 2 options are recommended as possible concrete tariff collection methods under the variable-rate user charge system or flat-rate user charge system:

- To divide the entire project area into 3 zones in accordance with the results of the social survey (low-income area, middle-income area and high income area), thereby introducing the zone-wise variable-rate user charge system by dividing; and
- To estimate the weighted average tariff level in accordance with the results of the tariff review analysis under the financial evaluation, thereby introducing the flat-rate user charge system.

However, since the willingness to pay for SWM service charges is extremely low in the low-income area, the latter option to introduce the flat rate user charge system is not realistic.

(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

As it will be described in the following **Subsection 4.10.2, Item (3) Selection of General Framework for PPP**, when GWMC introduces the service contract in the course of implementation of the master plan, the problems, such as scale of the population, cheap local costs and low willingness to pay, should be overcome. The optimum option for the private sector involvement is thus selected in consideration of 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.

- 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.

Furthermore, there will be positive and negative effects of introducing the service contract through the private sector involvement in the field of collection and transport of wastes. **Table 4.8.3** indicates the positive and negative effects of the service contract with the private sector. In conclusion, it is estimated that the net effect of the service contract with the private sector is approximately 10 per cent compared with the current GWMC's direct service.

Table 4.8.3 Positive and Negative Effects of Service Contract with Private Sector

Item	Positive Effect (Reduction of Cost by Service Contract Compared with GWMC's Own Service)	Negative Effect (Increase of Cost by Service Contract Compared with GWMC's Own Service)	Net Effect (Reduction of Cost by Service Contract Compared with GWMC's Own Service)
Utilization of Facilities and Equipment of Private Service Providers	10.0%	0.0%	10.0%
Collection Efficiency of Wastes	10.0%	0.0%	10.0%
Collection Efficiency of Waste Charges	5.0%	0.0%	5.0%
Underutilization of Staff and Workers	0.0%	15.0%	-15.0%
Total	**25.0%**	**15.0%**	**10.0%**

4.8.3 Identification of Project Components for Economic and Financial Plan

(1) Short-Term Plan (2016-2018)

The projects in the Short-Term period, i.e., from 2016 to 2018, are described as the Action Plans of Priority Projects in **Chapter 6**. The proposed projects are as follows:

- Establishment of Sustainable Cost Recovery
- Implementation of Accurate Total Costing
- Introduction of Proper Tariff Charging System
- Implementation of Financially Efficient Private Sector Involvement

(2) Mid-Term Plan (2019-2024)

(a) Establishment of 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, a wide range of activities to accelerate the cost recovery in SWM services will be carried out. Especially, the mid-term financial monitoring is a key to the sustainable cost recovery in the long-term period.

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) Implementation of Accurate Total Costing

During the mid-term period from 2019 to 2024, the tariff will be partially charged in only high-income and middle-income areas from 2022, and therefore, the situation of the cost recovery will be slightly improved. During this period, there are various activities for the cost centre to support the cost recovery by estimating the total operation and maintenance cost. Although the full-scale 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.

(c) Introduction of Proper Tariff Charging System

During the mid-term period from 2019 to 2024, the tariff will be partially charged in only high-income and middle-income areas from 2022. There is a wide spectrum of activities in the field of preparatory activities for the partial introduction of the tariff system from 2022. The study on the tariff level based on the affordability to pay survey and the willingness to pay survey should be carried out during the early mid-term period.

To set up a regulatory organization on imposing and revising the tariff is another critical action to be taken during the early 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 organization of the provincial government.

The cross-subsidy system which provides financial assistance to poor households through transferring user charges from well-off households to poor households should be also studied by setting the tariff based on the proposed income-wise variable-rate user charges.

(d) Implementation of 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 2025. The monitoring system which contributes to the feedback mechanisms for improving the performance of the selected service provider will be established during the mid-term period.

(3) Long-Term Plan (2025-2030)

(a) Establishment of Sustainable Cost Recovery

During the long-term period from 2025 to 2030, the full-scale tariff system will be introduced from 2025 in all areas, and, therefore, the cost recovery for the operation of SWM services will be significantly attained. Accordingly, the cost recovery for the operation and maintenance cost in SWM services will be to a significant extent enhanced during the long-term period. The actual cost recovery should be partially achieved in accordance with the long-term cost recovery plan 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.

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) Implementation of Accurate Total Costing

During the long-term period from 2025 to 2030, in response to the full-scale introduction of the tariff system from 2025, the cost centre of GWMC is requested to implement its full-scale operations. 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) Introduction of Proper Tariff Charging System

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 2022 with the activities related to the introduction of the proper tariff system.

The trial introduction of the tariff system from 2022 will be carried out only in high-income and middle-income areas, while the full-scale introduction of the tariff system will be implemented from 2025, the former 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) Implementation of 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 2025 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.

4.8.4 Implementation Schedule of Economic and Financial Plan

The implementation schedule of the Economic and Financial Plan is illustrated in **Figure 4.8.1**.

Time Framework of the Master Plan		Short-Term Plan Period											Mid-Term Plan Period						Long-Term Plan Period					
Year		2016				2017				2018			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4											
WBS for Short-Term Plan																								
S-S-1	Establishment of Sustainable Cost Recovery (Preparatory Phase)																							
S-S-2	Implementation of Accurate Total Costing (Preparatory Phase)																							
S-S-3	Introduction of Proper Tariff Charging System (Preparatory Phase)																							
S-S-4	Implementation of Financially Efficient Private Sector Involvement (Preparatory Phase)																							
WBS for Mid-Term Plan																								
M-S-1	Establishment of Sustainable Cost Recovery (Phase 1)																							
M-S-2	Implementation of Accurate Total Costing (Phase 1)																							
M-S-3	Introduction of Proper Tariff Charging System (Phase 1)																							
M-S-4	Implementation of Financially Efficient Private Sector Involvement (Phase 1)																							
WBA for Long-Term Plan																								
L-S-1	Establishment of Sustainable Cost Recovery (Phase 2)																							
L-S-2	Implementation of Accurate Total Costing (Phase 2)																							
L-S-3	Introduction of Proper Tariff Charging System (Phase 2)																							
L-S-4	Implementation of Financially Efficient Private Sector Involvement (Phase 2)																							

Figure 4.8.1 Implementation Schedule of the Economic and Financial Plan

4.8.5 Project Cost of Economic and Financial Plan

Table 4.8.4 shows the project cost for the Master Plan. The total cost of the Economic and Financial Plan is Rs. 2 million.

Table 4.8.4 Total Cost of the Economic and Financial Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 5: Economic and Financial Plan																	
Short-Term Plan																	
S-S-1	Establishment of Sustainable Cost Recovery (Preparatory Phase)	GWMC															
S-S-2	Implementation of Accurate Total Costing (Preparatory Phase)	GWMC															
S-S-3	Introduction of Proper Tariff Charging System (Preparatory Phase)	186 (Included in GWMC's Staff Training Budget Module 6)	62	62	62												
S-S-4	Implementation of Financially Efficient Private Sector Involvement (Preparatory Phase)	196 (Included in GWMC's Staff Training Budget Module 6)			196												
	Sub-Total	382 (Included in GWMC's Staff Training Budget Module 5 and 6)	62	62	258	0	0	0	0	0	0	0	0	0	0	0	0
Mid-Term Plan																	
M-S-1	Establishment of Sustainable Cost Recovery (Phase 1)	GWMC															
M-S-1	Implementation of Accurate Total Costing (Phase 1)	GWMC															
M-S-3	Introduction of Proper Tariff Charging System (Phase 1)	624 (Included in GWMC's Staff Training Budget Module 6)				104	104	104	104	104	104						
M-S-4	Implementation of Financially Efficient Private Sector Involvement (Phase 1)	726 (Included in GWMC's Staff Training Budget Module 5)				121	121	121	121	121	121						
	Sub-Total	1,350 (Included in GWMC's Staff Training Budget Module 5 and 6)	0	0	0	225	225	225	225	225	225	0	0	0	0	0	0
Long-Term Plan																	
L-S-1	Establishment of Sustainable Cost Recovery (Phase 2)	GWMC															
L-S-2	Implementation of Accurate Total Costing (Phase 2)	GWMC															
L-S-3	Introduction of Proper Tariff Charging System (Phase 2)	504 (Included in GWMC's Staff Training Budget Module 6)										84	84	84	84	84	84
L-S-4	Implementation of Financially Efficient Private Sector Involvement (Phase 2)	GWMC															
	Sub-Total	504 (Included in GWMC's Staff Training Budget Module 6)	0	0	0	0	0	0	0	0	0	84	84	84	84	84	84
	Grand Total	2,236 (Included in GWMC's Staff Training Budget Module 5 and 6)	62	62	258	225	225	225	225	225	225	84	84	84	84	84	84

4.9 Environmental Monitoring Plan

4.9.1 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 Bhakhraywali, 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 Bhakhraywali, 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. EIA is required for construction of the final disposal site, and the construction of the proposed compost/RDF plant may require an EIA/IEE although the Environment Protection Department (EPD) of Punjab will be finally judged.

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 4.9.1**. 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 4.9.2**.

Table 4.9.1 Proposed Environmental Monitoring Plan in EIA Report for Bhakhraywali

Environmental Component	Parametres	Standard	Frequency
Ambient Air Quality	SPM, PM_{10}, SO_2, NO_2, CO, CO_2, Vapours	NEQS NSDWQ	Quarterly
Groundwater Quality	pH, Temperature, TDS, Conductivity, Fluoride, Nitrate, DO, Hardness, Turbidity, Colour, Chloride, Arsenic, etc.	NEQS NSDWQ	Quarterly
Noise Level	dB(A)	N/A	Quarterly
Smelly Gases (Landfill Gasses)	SO_2, H_2S, CH_4	NEQS	Quarterly
Effluent to Leachate Pond	BOD, COD, TOC, TSS, DO, Chloride, Sulphate, Turbidity, Conductivity, Oil and Grease, Colour, TIN, Heavy metals	NEQS	Quarterly
Influent to Leachate Pond	BOD, COD, TOC, TSS, DO, Chloride, Sulphate, Turbidity, Conductivity, Oil and Grease, Colour, 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
NSDWQ: National Standards for Drinking Water Quality
N/A: Not applicable
Source: EIA Report

4.9.2 Environmental Monitoring for the 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 4.9.2 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 4.9.2 Parametres for Leachate Monitoring

	Parametres Specified in EIA Report*	Recommended Parametres
General Items	COD, BOD_5, Total Suspended Solids, Electric Conductivity, Oil/Grease, Sulphate, Turbidity, Colour, 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 4.9.2**).

(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 hydrogen sulphide (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.

4.9.3 Environmental Monitoring for the Safe Post-Closure of Final Disposal Sites 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.

4.9.4 Environmental Monitoring for the 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.

4.9.5 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, odour (ammonia, etc.) from the facility shall be monitored.

(1) 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.

4.9.1 Implementation Schedule of Environmental Monitoring Plan

The implementation schedule of the Environmental Monitoring Plan is illustrated in **Figure 4.9.1**. Timing of monitoring implementation is the same as the timing of service or start of operation.

Time Framework of the Master Plan		Short-Term Plan Period											Mid-Term Plan Period						Long-Term Plan Period					
Year		2016				2017				2018			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4											
WBS for Short-Term Plan																								
S-0-1	Monitoring of Collection and Transport Work																							
S-0-2	Monitoring of Final Disposal Site in Bhakhraywall																							
S-0-3	Monitoring of Post-Closure Final Disposal Sites in Gondlanwala and Chianwall																							
WBS for Mid-Term Plan																								
M-0-1	Monitoring of Collection and Transport Work																							
M-0-2	Monitoring of Final Disposal Site in Bhakhraywall																							
M-0-3	Post-Closure Monitoring of Gondlanwala and Chianwall Landfill Sites																							
M-0-4	Monitoring of Intermidiate Process (Compost Facility)																							
WBA for Long-Term Plan																								
L-0-1	Monitoring of Collection and Transport Work																							
L-0-2	Monitoring of Final Disposal Site in Bhakhraywall																							
L-0-3	Post-Closure Monitoring of Gondlanwala and Chianwall Landfill Sites																							
L-0-4	Monitoring of Intermidiate Process (Compost Facility)																							

Figure 4.9.1 Implementation Schedule of the Environmental Monitoring Plan

4.9.2 Project Cost of Environmental Monitoring Plan

Table 4.9.3 shows the project cost for the Master Plan. The total cost of the Environmental Monitoring Plan is Rs. 22 million.

Table 4.9.3 Total Cost of the Environmental Monitoring Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost														
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 6: Environmental Monitoring Plan																	
Short-Term Plan																	
S-6-1	Monitoring of Collection and Transport Work	GWMC	0	0	0												
S-6-2	Monitoring of Final Disposal Site in Bhakhraywall	2,455	435	870	1,150												
S-6-3	Environmental Monitoring for Post-Closure Final Disposal Sitein Gondlanwala and Chianwall	140	0	0	140												
	Sub-Total	2,595	435	870	1,290	0	0	0	0	0	0	0	0	0	0	0	0
Mid-Term Plan																	
M-6-1	Monitoring of Collection and Transport Work	GWMC				0	0	0	0	0	0						
M-6-2	Monitoring of Final Disposal Site in Bhakhraywall	8,205				1150	1150	1585	2020	1150	1150						
M-6-3	Environmental Monitoring for Post-Closure Final Disposal Sitein Gondlanwala and Chianwall	840				140	140	140	140	140	140						
M-6-4	Monitoring of Intermidiate Process (Compost Facility)	GWMC				0	0	0	0	0	0						
	Sub-Total	9,045				1,290	1,290	1,725	2,160	1,290	1,290						
Long-Term Plan																	
L-6-1	Monitoring of Collection and Transport Work	GWMC										0	0	0	0	0	0
L-6-2	Monitoring of Final Disposal Site in Bhakhraywall	9,510										1585	2020	1150	1585	2020	1150
L-6-3	Environmental Monitoring for Post-Closure Final Disposal Sitein Gondlanwala and Chianwall	840										140	140	140	140	140	140
L-6-4	Monitoring of Intermidiate Process (Compost Facility)	GWMC										0	0	0	0	0	0
	Sub-Total	10,350										1,725	2,160	1,290	1,725	2,160	1,290
	Grand Total	21,990	435	870	1,290	1,290	1,290	1,725	2,160	1,290	1,290	1,725	2,160	1,290	1,725	2,160	1,290

4.10 Institutional Strengthening and Organizational Plan

4.10.1 Development of Alternative for Institutional Strengthening and Organizational 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 4.10.1 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 4.10.1 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 4.10.2** shows possible BOT-related PPP options with the comparison of asset ownership, operations and maintenance, capital investment, commercial risks and duration of contract.

Table 4.10.2 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.
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

4.10.2 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 Gujranwala City should be carefully taken into account. Choosing the optimum private sector involvement option is one of the most crucial decisions before formulating the organizational 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 organizational 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 the collection and transportation service by itself directly.

One reason is too little population for scale of economy to work. As a result, for a contractor to make a profit the contract 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 4.5 million of population, it is advisable to start outsourcing in 2025 when the population of Gujranwala reaches approximately 4.5 million according to population projection.

Another reason is the 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 will become 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 2025, it is quite important to carry out the awareness raising programme intensively so that WTP will at least reach the level where outsourcing is possible.

Considering the reasons mentioned above, these current constraints should be eliminated to introduce the PPP scheme into the ISWM projects in Gujranwala. Firstly, the population of Gujranwala is predicted to reach 4.5 million in 2025, which is almost equivalent to that of one waste collection zone at the time when a private service provider started operation in Lahore. Thus, it can be said that it will be feasible to introduce the service contract system for waste collection and transportation since the economy of scale starts to function at this population level, i.e., the year 2025. If some sort of the economy of scale is secured, private collectors who are interested in the SWM business will come to Gujranwala. Lastly, public awareness raising programmes that are proposed to start from 2016 will enhance the residents' as well as commercial entities' moral consciousness and intention towards improvement of the environment, and it will result in the increase of their WTP to a certain level.

Therefore, it is recommended to introduce ***service contract for collection and transportation service*** from year 2025. 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 the 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 that 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 forms 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 roads 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 keeps 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. The simulation

results of economic internal rate of return (EIRR) as presented in **Subsection 4.6.2** show that the establishment of a central compost plan will be feasible if the production capacity is satisfactory although the quality of the products should be assured. 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.

4.10.3 Identification of Project Components for Institutional and Organizational Restructuring Plan

(1) Organizational Restructuring

(a) Basic Direction of Organizational Restructuring

In order to implement the Master Plan, it is necessary to restructure and strengthen the organization 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 4.10.3** below.

Table 4.10.3 Proposed Number of Staff in the Operation Unit

Number of Personnel	Position	Responsibility
4	Manager	4 zones for each 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 concentrates 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 and 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

To commence the service contract from 2025, strengthening of the procurement and contract division is required for establishment of management system for tender preparation, selection of service providers, contracting with the selected tenderer and so on. Thus, it is necessary to assign one Sr. Manager for PPP and three (3) Asst. Managers for PPP to handle this system.

Establishment of Monitoring and Evaluation Department under GM

The Monitoring and 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 GWMC management sections in years 2018 (completion of the Action Plan), 2022 (start of preparation of service contract and tariff charging system) and 2030 (completion of the Master Plan) are shown in **Figure 4.10.1** to **Figure 4.10.3**. GWMC is basically in charge of management part of the SWM services only whereas the operation part is done by CDGG staff. Even though the work load of GWMC might decrease slightly if the collection and transportation work is contracted out to private sector, it is difficult to predict how many staff members can be reduced from this action. Therefore, keeping the status quo, the required number of GWMC staff and total number of GWMC staff by implementation of the master plan is estimated as presented in **Table 4.10.4**. Apart from road sweepers whose salaries are paid by CDGG, this table shows that the number of GWMC staff in 2030 will increase 5 times as many as that of the current numbers.

Table 4.10.4 Required Number of Managers and Total Number of GWMC Staff for Implementation of the Master Plan

Year	2015 (present)	2018	2020	2022	2030
Management Staff	46	66	70	72	75
Managing Director	1	1	1	1	1
General Managers	5	7	7	7	7
Managers	12	21	21	22	22
Assistant Managers	28	37	41	42	45
Operation and Maintenance Staff for Sanitary Landfill Management	15	24	24	24	34
Workers for Waste Collection	307	830	951	1,060	1,875
Total	368	920	1,139	1,156	1,984

Note: The number of "Workers for Waste Collection" indicates the number on the assumption that GWMC would carry out the waste collection and transportation services continuously and varies depending on the number of waste collection workers on private contractors.

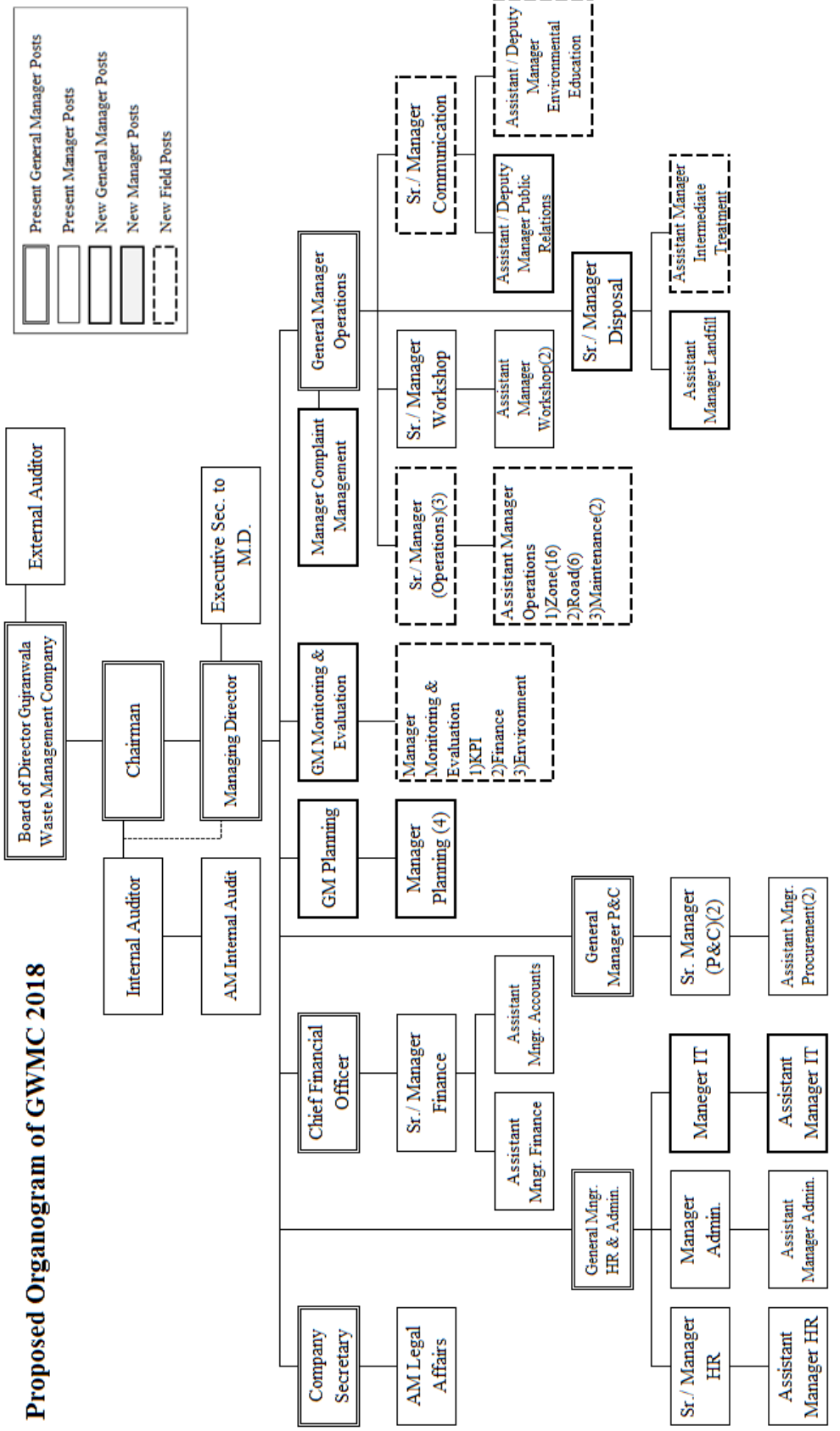


Figure 4.10.1 Project Organization of GWMC 2018

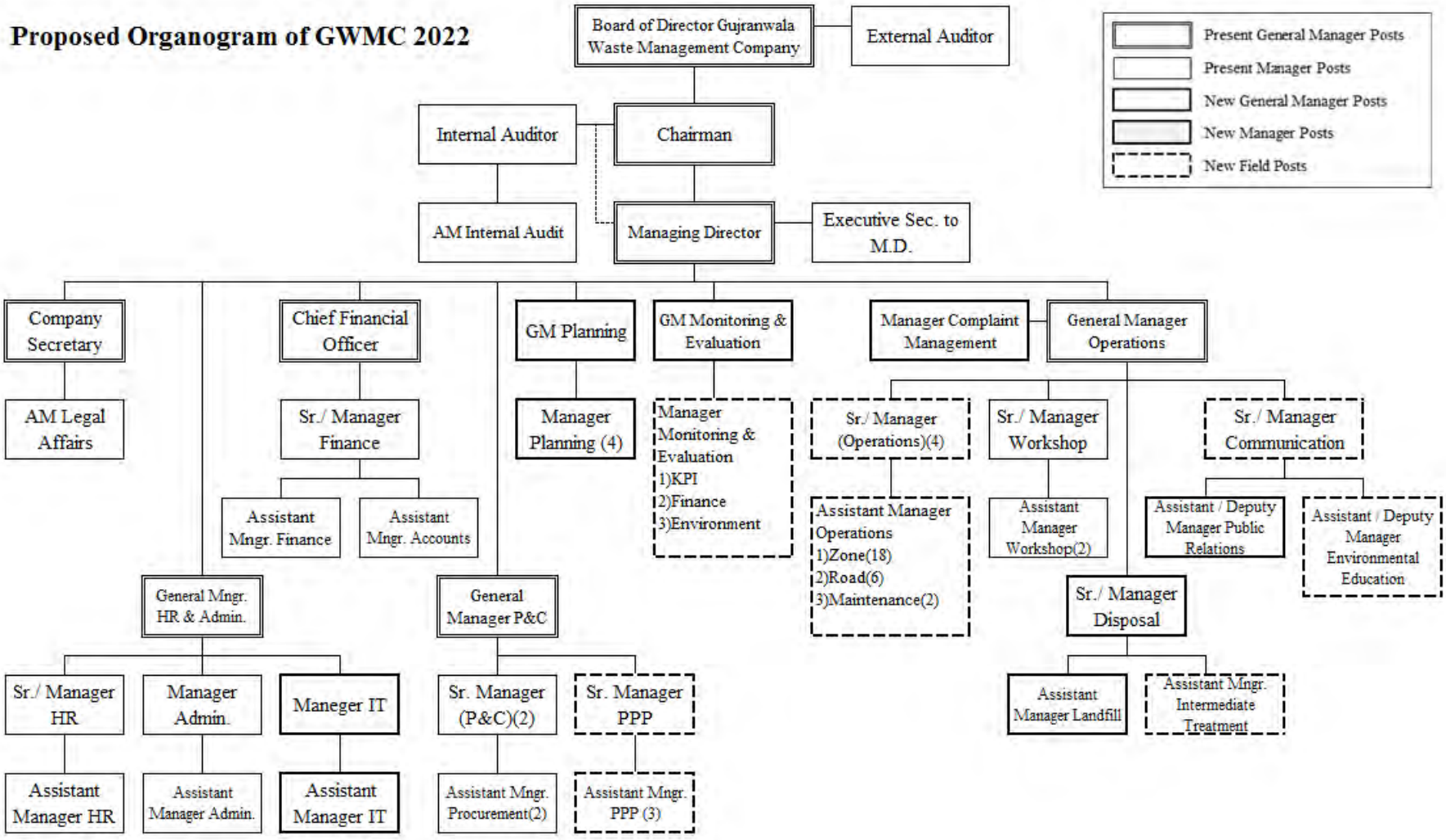


Figure 4.10.2 Project Organization of GWMC 2022

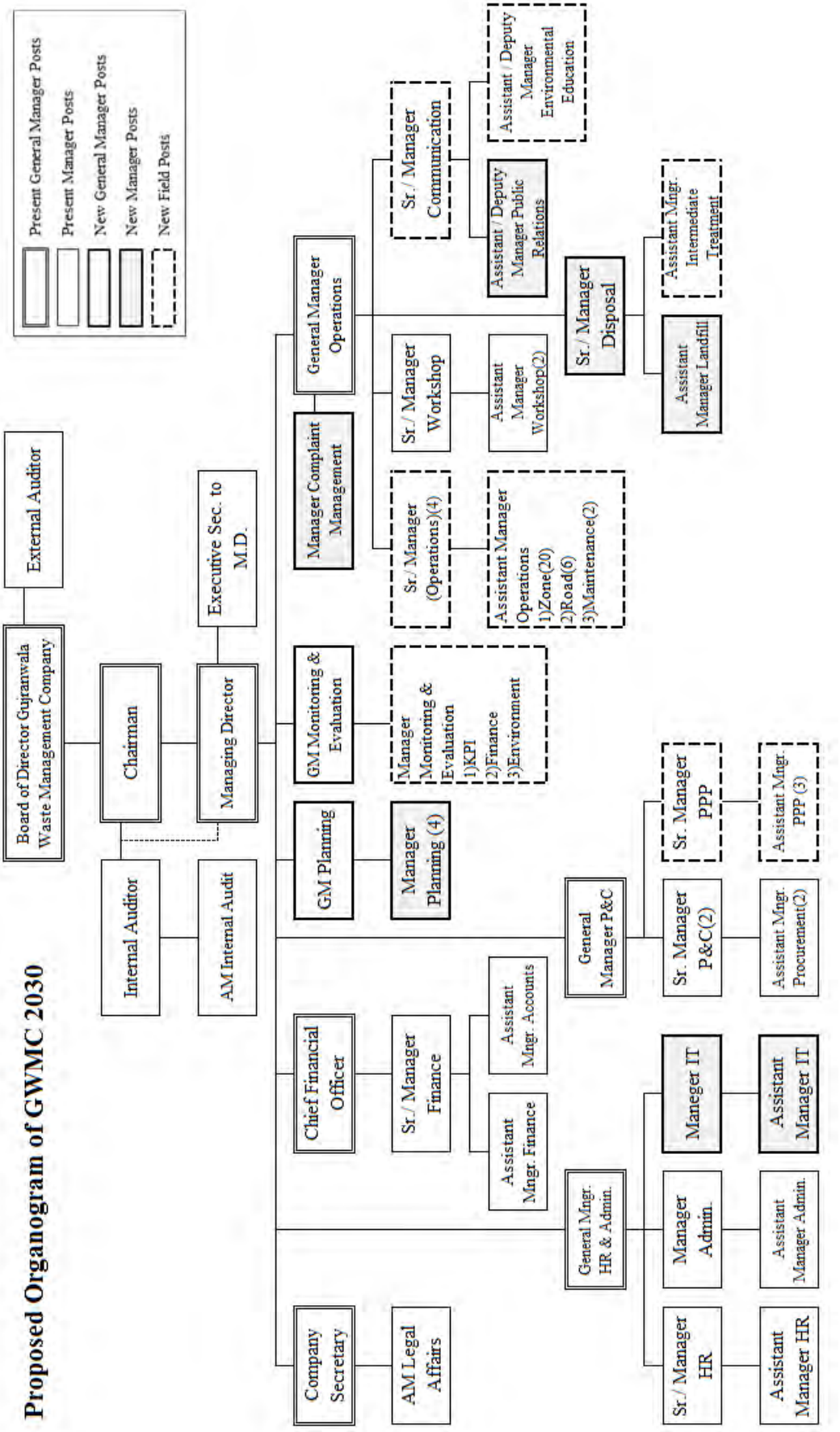


Figure 4.10.3 Project Organization of GWMC 2030

(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.

(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) Organization of Sanitary Staff

Currently, there are more than 1,600 sanitary workers but there is no organizational structure. This situation is not preferable as there is no reporting line. In order to organize the sanitary workers and supervise and measure their 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 transferred 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 protect and promote workers' health condition by providing regular health check-ups and health facilities such as rest rooms.

(2) Human Resources Development through 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 organizational 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 organization. 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 organization. The overall goals of the proposed CCDP are to create the new organizational 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 Comprehensive Capacity Development Programme (CCDP) is given in **Table 4.10.5.** The concept of detailed modular training projects under the CCDP is shown in ***Volume 3, Supporting Report, Section H: Institutional Strengthening and Organizational Restructuring, Subsection 4.3.2***. The cost of implementation of the CCDP is estimated at approximately Rs. 77 million.

Table 4.10.5 Outline of the Proposed Comprehensive Capacity Development Programme (CCDP)

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 and 3R Promotion	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 Management	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	Public – Private Partnership	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	Organizational and Legal Improvement	7-a	Capacity to improve organization 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	●		●	●

(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 the 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.

4.10.4 Implementation Schedule of Institutional Strengthening and Organizational Plan

The implementation schedule of the Institutional Strengthening and Organizational Plan is illustrated in **Figure 4.10.4**.

Time Framework of the Master Plan		Short-Term Plan Period												Mid-Term Plan Period						Long-Term Plan Period					
Year		2016				2017				2018				2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Quarter		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4												
WBS for Short-Term Plan																									
S-T-1	Improvement of Organisational Restructuring of GWMC																								
S-T-2	Capacity Development of GWMC Staff																								
S-T-3	Establishment of Gujranwala Solid Waste Management By-Law																								
WBS for Mid-Term Plan																									
M-T-1	Improvement of Organisational Restructuring of GWMC																								
M-T-2	Capacity Development of GWMC Staff																								
M-T-3	Establishment of Gujranwala Solid Waste Management By-Law																								
WBA for Long-Term Plan																									
L-T-1	Improvement of Organisational Restructuring of GWMC																								
L-T-2	Capacity Development of GWMC Staff																								

Figure 4.10.4 Implementation Schedule of the Institutional Strengthening and Organizational Plan

4.10.5 Project Cost of Institutional Strengthening and Organizational Plan

Table 4.10.6 shows the project cost for the Master Plan. The total cost of the Institutional Strengthening and Organizational Plan is Rs. 424 million.

Table 4.10.6 Total Cost of the Institutional Strengthening and Organizational Plan

WBS No.	WBS	Total Budget (Thousand Rs.)	Annual Cost													
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 7: Institutional Strengthening and Organizational Plan																	
Short-Term Plan																	
S-7-1	Improvement of Organisational Restructuring of GWMC	35,859	8,180	13,234	17,443												
S-7-2	Capacity Development of GWMC Staff	8,695	6,109	1,284	1,302												
S-7-3	Establishment of Gujranwala Solid Waste Management By-Law	0															
	Sub-Total	47,552	14,289	14,518	18,745												
Mid-Term Plan																	
M-7-1	Improvement of Organisational Restructuring of GWMC	120,472				16,999	17,833	19,316	20,838	21,941	23,486						
M-7-2	Capacity Development of GWMC Staff	30,594				12,447	382	385	18,063	1,168	1,148						
M-7-3	Establishment of Gujranwala Solid Waste Management By-Law	844				60	784										
	Sub-Total	151,910				29,496	18,999	19,701	38,001	23,109	24,604						
Long-Term Plan																	
L-7-1	Improvement of Organisational Restructuring of GWMC	157,379										24,977	29,662	29,668	31,841	34,034	38,196
L-7-2	Capacity Development of GWMC Staff	37,695										16,914	1,759	1,181	17,782		
	Sub-Total	224,964										41,891	30,420	30,848	49,592	34,034	38,196
	Grand Total	424,447	14,289	14,518	18,745	29,496	18,999	19,701	38,001	23,109	24,604	41,891	30,420	30,848	49,592	34,034	38,196

4.11 Recommendations on Hospital, Industrial, and Construction and Demolition Waste Management

4.11.1 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 municipal solid waste at the point of generation may apply and in this way both volume and cost can be reduced.
- The Gujranwala Waste Management Company (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.
- From 2016, based on the estimation of unit cost for collecting and disposing hospital wastes, GWMC should prepare the tariff setting plan for the hospital waste management with reference to waste generators' willingness to pay. The tariff collection method will be a direct collection system from waste generators by charging the individual tariff calculated from the estimated unit cost and the generated hospital waste amount.

4.11.2 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.
- From 2016, based on the estimation of unit cost for collecting and disposing industrial wastes, GWMC should prepare the tariff setting plan for the industrial waste management with reference to waste generators' willingness to pay. The tariff collection method will be a direct collection system from waste generators by charging the individual tariff calculated from the estimated unit cost and the generated industrial waste amount.

4.11.3 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 C&D waste, the Lahore Waste Management Company (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 the City District Government Gujranwala and GWMC 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.
- From 2016, based on the estimation of unit cost for collecting and disposing construction and demolition wastes, GWMC should prepare the tariff setting plan for the construction and demolition waste management with reference to waste generators' willingness to pay. The tariff collection method will be a direct collection system from waste generators by charging the individual tariff calculated from the estimated unit cost and the generated construction and demolition waste amount.

4.12 Development of the Master Plan Alternatives

4.12.1 Optimum Options for Each Component of the Master Plan

Based on the preconditions mentioned in the preceding sections, the ISWM Master Plan is to 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 4.4**, the following three options are considered:

- Door-to-door collection by using mini-compactors (Narrow streets); and Waste container (small type) by using compactor (Wide streets) based on waste separation at source.
- Door-to-door collection by using mini-compactors (Narrow streets); 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 4.5**, 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 4.6**.

- 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 vision, 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 4.7**.

- Implementation of environmental education and public awareness raising activities
- No environmental education and public awareness raising activities (status quo)

4.12.2 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 4.12.1** below will be evaluated in the next section.

Table 4.12.1 Master Plan Alternatives by Combination of the Optimum Options for Each Component

Master Plan (MP) Options	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)

4.13 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. Details of the environmental and social considerations are described in **Chapter 5**.
- 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 4.14**.
- Institutional and Organizational 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 4.13.1 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 organizational strengthening and institutional arrangements additionally, these inputs are also crucial to the other option and this is therefore not a serious disadvantage.

Table 4.13.1 Evaluation of the Master Plan Alternatives

Master Plan (MP) Options		**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) Options	**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 Organizational 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 organizational 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 organizational 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 fulfil 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 any improvement although new investment is not required.

4.14 Evaluation of the Optimum Master Plan

4.14.1 Technical Evaluation

Based on the detailed comparative study discussed in **Section 4.4**, 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 organize 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 to 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 the end of its 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.

4.14.2 Environmental and Social Impact Evaluation

Environmental and social considerations are carried out for Master Plan Option B. The detailed evaluation is presented in **Chapter 5**, and the result of the evaluation is summarised that Option B has a great combination of the processes involved in waste management and good features for natural and social environment through Separate Collection, Composting and RDF.

4.14.3 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 financial 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 August 2015.

(iii) Cut-off Rate

The cut-off rate for the economic evaluation is 7.0 per cent*, being equivalent to the reverse repo rate of the State Bank of Pakistan as of August 2015, which is also known as the policy rate or the discount rate of Pakistan (Note:* Web Site for the State Bank of Pakistan: http://www.sbp.org.pk).

(c) Identification of Financial Costs

(i) Investment Cost

The investment cost for the master plan on the financial price basis is estimated at Rs. 10,848 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 4.14.1**.

Table 4.14.1 Financial Investment Cost for the Master Plan

Year	Investment Cost (Rs. 1000)						Total
	Collection and Transport	Final Disposal	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	Institutional Strengthening	
2016	408,382	779,993	0	1,400	0	3,500	1,193,275
2017	247,600	592,741	0	0	0	3,500	843,841
2018	1.093,648	60,740	40,000	0	0	3,000	1,197,388
2019	129,800	0	402,000	0	0	1,000	532,800
2020	144,020	300,000	0	0	0	500	444,520
2021	284,640	541,455	0	0	0	500	826,595
2022	263,940	552,755	0	625	0	500	817,820
2023	236,900	127,458	0	0	0	0	364,358
2024	266,420	0	0	0	0	0	266,420
2025	540,650	541,455	0	0	0	0	1,082,105
2026	384,460	552,755	0	0	0	1,000	938,215
2027	392,464	57,333	0	0	0	0	449,797
2028	706,180	0	4,000	625	0	0	710,805
2029	481,344	105,000	70,000	0	0	0	656,344
2030	523,084	0	0	0	0	1,000	524,084
Total	6,103,532	4,211,685	516,000	2,650	0	14,500	10,848,367

(ii) Operation and Maintenance Cost

The operation and maintenance cost for the master plan on the financial price basis is estimated at Rs. 8,490 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 F.4.7** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***.

(iii) Replacement Cost

The replacement cost for the master plan on the financial price basis is estimated at Rs. 1,158 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 F.4.8** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***.

(iv) Total Project Cost

The total cost for the master plan on the financial price basis is estimated at Rs. 20,497 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 4.14.2.**

Table 4.14.2 Total Financial Project Cost for the Master Plan

Year	Total Cost (Rs. 1000)						Total
	Collection and Transport	Final Disposal	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	Institutional Strengthening	
2016	587,925	798,662	0	4,254	435	14,289	1,405,565
2017	458,447	614,600	0	2,479	870	14,518	1,090,914
2018	1,429,249	92,363	40,000	2,637	1,290	18,745	1,584,284
2019	486,983	32,831	402,000	3,803	1,290	29,496	956,403
2020	523,915	331,547	39,239	5,574	1,290	18,999	920,563
2021	707,357	574,008	42,415	4,414	1,725	19,701	1,349,620
2022	677,101	586,392	43,376	7,982	2,160	36,001	1,353,012
2023	700,576	181,983	44,799	7,209	1,290	23,109	958,966
2024	813,258	43,786	45,866	8,383	1,290	24,604	937,188
2025	1,113,864	586,234	45,866	10,573	1,725	41,891	1,800,154
2026	1,064,312	598,521	45,866	11,376	2,160	30,420	1,752,655
2027	1,134,195	106,587	45,866	10,403	1,290	30,848	1,329,189
2028	1,487,082	50,431	49,866	11,949	1,725	49,592	1,650,646
2029	1,372,386	225,906	115,866	13,630	2,160	34,034	1,763,982
2030	1,464,140	58,710	63,886	17,744	1,290	38,198	1,643,967
Total	14,020,790	4,882,562	1,024,911	122,410	21,990	424,447	20,497,110

(d) Identification of Financial Benefits

The financial project benefits of the master plan are calculated based on the market prices as of August 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. 24,225 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 financial benefits for the entire period of the master plan are as shown in **Table F.4.11** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***.

The following factors are taken into account when the benefits are calculated.

- The monetary-based benefit on the market price accrued from the total saved cost for the final disposal is based on the unit saved waste disposal cost as well as the related cost of Rs. 625.7 per ton.
- The above unit saved waste disposal cost as well as the related cost is estimated by the calculation based on the 5-percent increase of the unit cost of Rs. 595.9 with the master plan.
- The unit waste disposal cost of Rs. 595.9 in case of the implementation of the master plan is calculated based on the following formula:

  Unit Waste Disposal Cost in case of Implementation of Master Plan = Total Disposal and Related Cost for Entire Period of Master Plan (2016-2030) / Total Disposed Amount of Waste for Entire Period of Master Plan (2016-2030)

- The 5-percent increase of the unit waste disposal cost of Rs. 595.9 with the master plan is accrued from the inefficient waste disposal through frequent and ad-hoc bringing in of illegally-dumped wastes under the absence of the implementation of the master plan. The said 5-percent increase is estimated by the final disposal expert of the study team based on the inefficiency of the waste disposal under the absence of the implementation of the master plan.
- The monetary-based benefit on the market price accrued from the total saved cost for the collection and transport is based on the unit saved cost for the collection and transport of Rs. 1,354.7 per ton.
- The above unit saved waste collection and transport cost is estimated by the calculation based on the 5-percent increase of the unit cost of Rs. 1,290.2 with the master plan.
- The unit waste collection and transport cost of Rs. 1,290.2 in case of the implementation of the master plan is calculated based on the following formula:

  Unit Waste Collection and Transport Cost in case of Implementation of Master Plan = Total Collection and Transport Cost for Entire Period of Master Plan (2016-2030) / Total Collection and Transport Amount of Wastes for Entire Period of Master Plan (2016-2030)

- The 5-percent increase of the unit waste collection and transport cost of Rs. 1,290.2 with the master plan is accrued from the inefficient waste management through illegal dumping of uncollected wastes under the absence of the implementation of the master plan. This inefficient waste management is caused by the scattered collection points as well as the increase in the collection frequency in association with the ado-hoc collection of wastes due mainly to the said illegal dumping without the master plan. The said 5-percent increase is estimated by the collection and transport expert of the study team based on the collection inefficiency and the collection routes under the absence of the

implementation of the master plan.

- The monetary-based benefit accrued from the recycling is based on the condition that the unit cost per recovered material, the unit cost per compost product, and the unit cost per combustible waste is Rs. 13.00 per kg, Rs. 5.00 per kg, and Rs. 52.50 per ton, respectively.
- The unit cost of Rs. 13.00 per kg per recovered material is estimated by the latest weighted average of market prices of various recovered materials in Gujranwala, which is tabulated in **Table 4.14.3**.

Table 4.14.3 Estimated Weighted Average of Selling Prices of Various Recyclables

Recyclables	Average Unit Selling Prices (Rs./kg)	Percentage of Each Recyclable (%)	Weighted Average of Selling Prices of Recyclables (Rs./Kg)
Cardboard	8.0	26.0	2.08
Paper (Others)	8.0	8.0	0.64
Plastic	23.0	13.0	2.99
Plastic (Others)	12.0	15.0	1.80
Metal (Others)	62.0	6.0	3.72
Metal (Steel)	30.0	3.0	0.90
Glass	3.0	29.0	0.87
Total	-	100.0	13.00

Source: Field Survey in Gujranwala, August 2015

- The unit cost of Rs. 5.00 per kg per compost product is estimated by the latest market price in August 2015, which is based on the information collected from the compost plant in Lahore.
- The unit cost of Rs. 52.50 per ton per RDF product is estimated by the latest market price in August 2015, which is based on the information collected from the RDF plant in Lahore.
- The social benefit accrued from the willingness to pay is based on the condition that the willingness to pay for SWM services in low-income areas, middle-income areas, and high-income areas is Rs. 25 per month per household, Rs. 50 per month per household, and Rs. 100 per month per household, respectively.

(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 2025 based on the basic organizational 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 F.4.12** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***, 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 F.4.13** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***.

- For Case A, the base case of the master plan, in which the full-scale tariff system will be introduced in all areas from 2025 and the outsourcing to the private sector will not be carried out, the FIRR and the NPV are estimated at 7.42 per cent and Rs. 429 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 8.19 per cent and Rs. 663 million, respectively.
- For Case C in which the full-scale tariff system will be introduced in all areas from 2025 and the outsourcing to the private sector will be carried out from 2025, the FIRR and the NPV are estimated at 8.45 per cent and Rs. 794 million, respectively.

(ii) Sensitivity Analysis

Table 4.14.4 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 to the negative figures which are all below the cut-off rate.

Table 4.14.4 Results of Financial Evaluation and Sensitivity Analysis

Case	Case No.	Scenario	FIRR (Per cent)
Base Case	A-1	No Risk Factor	7.42
	A-2	Cost 10 % increase	2.86
	A-3	Benefit 10% decrease	2.35
	A-4	Cost 10% increase and benefit 10% decrease	-2.84
Introduction of Full-scale Tariff System from 2019	B-1	No Risk Factor	8.19
	B-2	Cost 10 % increase	3.35
	B-3	Benefit 10% decrease	2.81
	B-4	Cost 10% increase and benefit 10% decrease	-2.77
Private Sector Involvement from 2025	C-1	No Risk Factor	8.45
	C-2	Cost 10 % increase	4.25
	C-3	Benefit 10% decrease	3.79
	C-4	Cost 10% increase and benefit 10% decrease	-0.79

(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 **Table 4.14.5** with the following descriptions.

Table 4.14.5 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	2022	2025
Case 1	25	50	100	50.0	60.0	70.0		×
Case 2	25	50	100	60.0	70.0	80.0		×
Case 3	25	50	100	50.0	60.0	70.0	×	
Case 4	25	50	100	60.0	70.0	80.0	×	

(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 F.4.16** to **Table F.4.19** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***, and the major findings are as follows:

- For Case 1, in which the collection efficiency of the tariff is relatively lower and the full-scale introduction of the tariff system in all areas will start from 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 32.4 per cent.
- For Case 2, in which the collection efficiency of the tariff is relatively higher and the full-scale introduction of the tariff system in all areas will start from 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 37.9 per cent.
- For Case 3, in which the collection efficiency of the tariff is relatively lower and the full-scale introduction of the tariff system in all areas will start from 2022 in the fourth year of the mid-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 35.8 per cent.
- For Case 4, in which the collection efficiency of the tariff is relatively higher and the full-scale introduction of the tariff system in all areas will start from 2022 in the fourth year of the mid-term period, the cost recovery rate against the full recovery of the operation and maintenance cost is estimated at 42.0 per cent.

(ii) Required Tariff Level for Full Cost Recovery

Since it is obvious that the cost recovery rate is 32.4 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 4.14.6** 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.

Taking an example of Case 1, the required monthly tariff level for the full recovery of the operation and maintenance cost is estimated at Rs. 77.2 per month per household in low-income areas, Rs. 154.4 per month per household in middle-income areas, Rs. 308.8 per month per household in high-income areas, respectively. The said tariff level in case of low-income areas is 3.09 times as much as the assumed level of the tariff of Rs. 25.0 based on the social study.

Table 4.14.6 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	179,211	77.2
	Middle	110,383	340,860	154.4
	High	36,431	112,499	308.8
	Total	204,849	632,569	Not Applicable (n.a.)
Case 2	Low	69,642	183,512	58.9
	Middle	128,780	339,345	117.8
	High	41,636	109,713	235.7
	Total	240,058	632,569	n.a.
Case 3	Low	51,906	144,903	62.4
	Middle	98,727	275,607	124.8
	High	32,584	90,962	249.7
	Total	183,217	511,472	n.a.
Case 4	Low	77,864	148,380	47.6
	Middle	143,984	274,382	95.3
	High	46,551	88,710	190.6
	Total	268,399	511,472	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 August 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 7.0 per cent, being equivalent to the reverse repo rate of the State Bank of Pakistan as of August 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 and facilities.

(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. 8,417 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 (HQ) of GWMC. The detailed investment cost for the entire period of the master plan is as shown in **Table 4.14.7**.

Table 4.14.7 Economic Investment Cost for the Master Plan

Year	Investment Cost (Rs. 1000)						Total
	Collection and Transport	Final Disposal	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	Institutional Strengthening	
2016	313,229	605,245	0	1,109	0	2,685	922,267
2017	189,909	463,253	0	0	0	2,685	655,847
2018	838,828	46,588	30,680	0	0	2,301	918,397
2019	99,557	0	340,954	0	0	767	441,278
2020	110,463	230,100	0	0	0	384	340,947
2021	218,319	415,296	0	0	0	384	633,998
2022	202,442	423,963	0	479	0	384	627,268
2023	181,702	113,139	0	0	0	0	294,841
2024	204,344	0	0	0	0	0	204,344
2025	414,679	415,296	0	0	0	0	829,974
2026	294,881	423,963	0	0	0	767	719,611
2027	301,020	43,975	0	0	0	0	344,995
2028	541,640	0	3,068	479	0	0	545,187
2029	369,191	103,835	63,476	0	0	0	536,502
2030	401,205	0	0	0	0	767	401,972
Total	4,681,409	3,284,651	438,178	2,068	0	11,122	8,417,427

(ii) Operation and Maintenance Cost

The operation and maintenance cost for the master plan on the economic price basis is estimated at Rs. 6,588 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 F.4.22** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***.

(iii) Replacement Cost

The replacement cost for the master plan on the economic price basis is estimated at Rs. 908 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 F.4.23** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***.

(iv) Total Project Cost

The total cost for the master plan on the economic price basis is estimated at Rs. 15,913 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 4.14.8**.

Table 4.14.8 Total Economic Project Cost for the Master Plan

Year	Total Cost (Rs. 1000)						Total
	Collection and Transport	Final Disposal	Intermediate Treatment and 3R	Environmental Education	Environmental Monitoring	Institutional Strengthening	
2016	449,761	620,561	0	3,508	334	12,050	1,086,213
2017	350,238	481,017	0	2,130	667	13,403	847,455
2018	1,093,913	72,340	30,680	2,269	989	17,743	1,217,934
2019	370,841	26,679	340,954	3,181	989	26,349	768,992
2020	399,021	255,794	30,814	4,557	989	18,610	479,685
2021	539,483	441,762	33,434	3,691	1,323	19,495	1,039,188
2022	516,350	451,260	34,192	6,763	1,657	32,375	1,042,598
2023	534,180	160,301	35,335	6,219	989	22,837	759,861
2024	620,410	265,573	36,216	7,168	989	24,337	954,693
2025	850,764	451,531	36,216	8,896	1,323	37,950	1,386,680
2026	812,555	460,954	36,216	9,605	1,657	29,778	1,350,765
2027	865,915	83,641	36,216	8,890	989	30,573	1,026,225
2028	1,136,324	40,570	39,284	10,198	1,323	45,456	1,273,154
2029	1,048,048	213,837	99,692	11,867	1,657	34,034	1,409,135
2030	1,118,103	47,506	50,378	15,426	989	37,965	1,270,368
Total	10,705,905	3,843,226	839,626	104,368	16,866	402,955	15,912,947

(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. 625.7 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. 1,354.7 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. 13.00 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 2022. 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. The unit economic value of methane gas reduction per ton is estimated at Rs. 7,565.3 based on the recent record-low unit carbon price of €2.75 per ton, which was traded in April 2013 in the international market.

The calculation formula for estimating the unit economic value of methane gas reduction per ton is as follows:

Unit Economic Value of Methane Gas Reduction Rs. 7,565.3 =
Applied Unit Carbon Price of €2.75 x× Exchange Rate 110.04 of Euro to Pakistan Rupee in August 2015 × Global Warming Potential of 25.0

Methane generation amount in anaerobic landfill waste is estimated as shown in ***Section 4.6.3 (4) (c)*** and **Table F.4.25** in ***Volume 3, Supporting Report, Section F: Economic and***

Financial Aspect. The sanitary landfill site planned in the master plan will significantly reduce the methane generation amount of 38.1 kg CH4 per ton-waste by 50 per cent, which leads to the sizable environmental benefit.

(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
- Indirect Benefits Related to Health Improvement
- Increase in Land Value

(v) Total Benefits

The total benefit for the master plan on the economic price basis is estimated at Rs. 19,712 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 F.4.26** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***.

(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 2025 based on the basic organizational 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 F.4.27** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***, 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 F.4.28** in ***Volume 3, Supporting Report, Section F: Economic and Financial Aspect***.

- For Case A, the base case of the master plan, in which the full-scale tariff system will be introduced in all areas from 2025 and the outsourcing to the private sector will not

be carried out, the EIRR and the NPV are estimated at 9.62 per cent and Rs. 916 million, respectively.

- For Case B in which the full-scale tariff system will be introduced in all areas 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 10.01 per cent and Rs. 970 million, respectively.
- For Case C in which the full-scale tariff system will be introduced in all areas from 2025 and the outsourcing to the private sector will be carried out from 2025, the EIRR and the NPV are estimated at 10.60 per cent and Rs. 1,221 million, respectively.

(ii) Sensitivity Analysis

Table 4.14.9 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 4.14.9 Results of Economic Evaluation and Sensitivity Analysis

Case	Case No.	Scenario	EIRR (Per cent)
Base Case	A-1	Base Case	9.62
	A-2	Cost 10 % increase	5.21
	A-3	Benefit 10% decrease	4.72
	A-4	Cost 10% increase and benefit 10% decrease	-0.17
Introduction of Full-scale Tariff System from 2019	B-1	Base Case	10.01
	B-2	Cost 10 % increase	5.30
	B-3	Benefit 10% decrease	4.78
	B-4	Cost 10% increase and benefit 10% decrease	-0.51
Private Sector Involvement from 2025	C-1	Base Case	10.60
	C-2	Cost 10 % increase	6.49
	C-3	Benefit 10% decrease	6.05
	C-4	Cost 10% increase and benefit 10% decrease	1.65

(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. 3,533 million. While the EIRR for Case A-1 is calculated at 9.62 per cent which is significantly over the cut-off rate of 7.0 per cent, the NPV for Case A-1 is estimated at Rs. 916 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. 3,426

million. While the FIRR for Case B-1 is calculated at 10.01 per cent which is significantly over the cut-off rate of 7.0 per cent, the NPV for Case B-1 is estimated at Rs. 970 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. 4,116 million. While the FIRR for Case C-1 is calculated at 10.60 per cent which is significantly over the cut-off rate of 7.0 per cent, the NPV for Case C-1 is estimated at Rs. 1,221 million. The result proved that the implementation of the master plan, if the private sector involvement would be started from 2025, the economic feasibility would be more 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 might be economically feasible and financially viable on the condition that the following recommendations will be taken into account for the implementation of the master plan. 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, the selected option of the master plan might be 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 subsidies from the provincial government and/or a sort of concessional loan whose interest rate is relatively lower than those of commercial banks.
- 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 headquarters 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 cost recovery rate is 32.4 percent out of the total operation and maintenance cost*** in 2025 even after the full-scale introduction of the tariff system in all areas which is in line with the current willingness to pay, and ***the remaining 67.6 percent of the total operation and maintenance cost should be replenished by other stable financial sources and/or subsidies from the provincial government***.
- In order to fully cover the total operation and maintenance cost in 2025 which is the first year of the full-scale introduction of the tariff system in all areas, ***the required tariff level per month per household is estimated at approximately 3 times as much as the current level of the users' willingness to pay***.
- The introduction of the revenue generation through the provincial property tax as the stable financial source 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 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.

4.14.4 Institutional and Organizational Evaluation

(1) Evaluation of Option B

From the perspective of institutional and organizational 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 and 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 organization 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) Organizational Restructure of GWMC

Implementation of Option B requires the following organizational restructuring activities:

- 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 for Consideration

- Implementation and enforcement of the by-law depends on understanding and awareness of residents.
- Organizational structure and capacity should be periodically monitored and evaluated.

4.14.5 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.

4.15 Future Waste Stream of the ISWM Master Pan

In 2030, 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 from 2018 to 2030 are shown in **Table 4.15.1** and **Figure 4.15.1** to **Figure 4.15.3**.

Table 4.15.1 Waste Amount for Major Elements in Waste Management Stream from 2018 to 2030

Item	2018	2020	2024	2030
Total Waste Generation Amount in 98 UCs (t/d)	1,600	1,800	2,304	3,346
Uncollected Waste Amount in 98UCs (t/d)	391	340	206	0
Waste Collection Ratio in 64 Urban UCs (%)	100	100	100	100
Waste Collection Ratio in 34 Peri-urban UCs (%)	0	20	64	100
Waste Discharge Amount for Collection (t/d)	1,209	1,460	2,098	3,346
Waste Generation Prevention Amount (t/d)	0	0	0	201
Recovery Amount of Resource Materials (t/d)	163	208	330	602
Intermediate Treatment Amount (Composting/RDF) (t/d)	0	250	252	510
Waste Collection Amount (t/d)	1,046	1,252	1,515	2,033
Recovery of Resource Materials at Disposal Site (t/d)	10	10	15	20
Waste Disposal Amount (t/d)	1,036	1,242	1,500	2,013
Total Waste Diversion Amount (t/d)	174	468	598	1,334
Waste Diversion Rate (%)	14	32	28	40

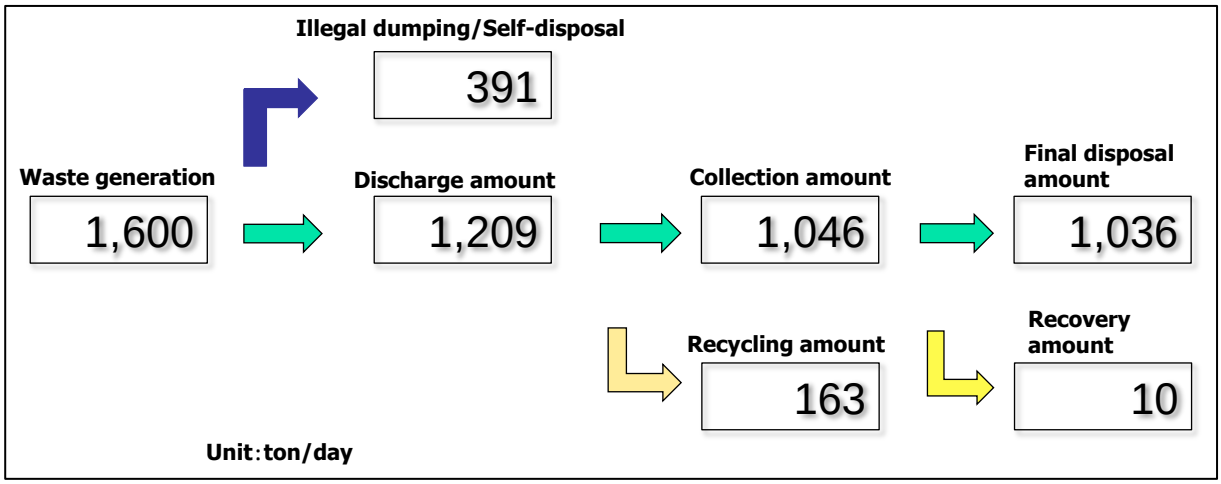


Figure 4.15.1 Waste Management Flow and Estimated Waste Amount in 2018

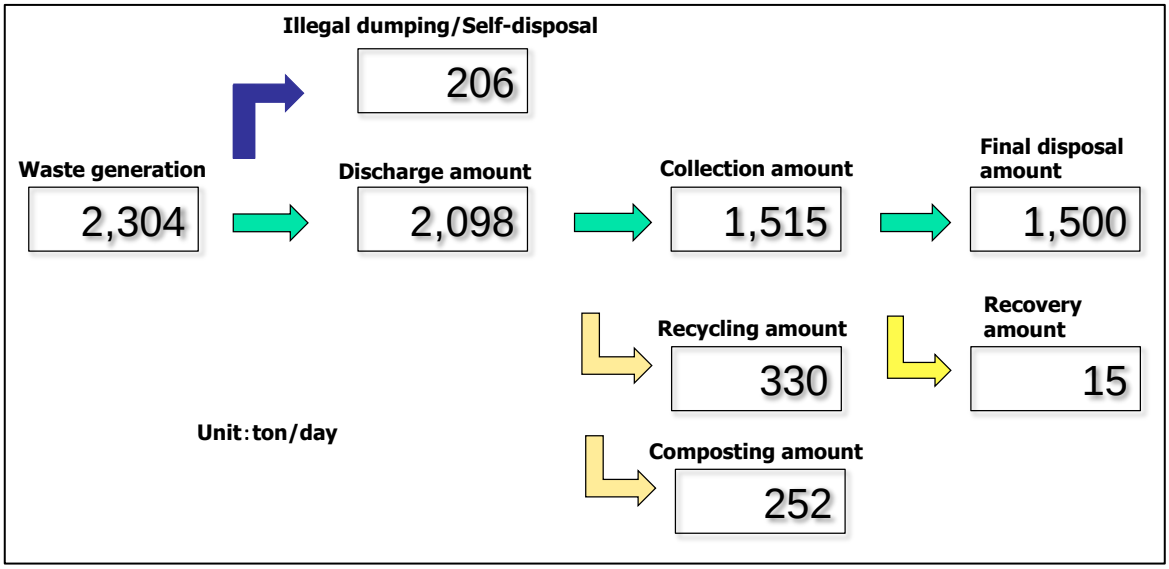


Figure 4.15.2 Waste Management Flow and Estimated Waste Amount in 2024

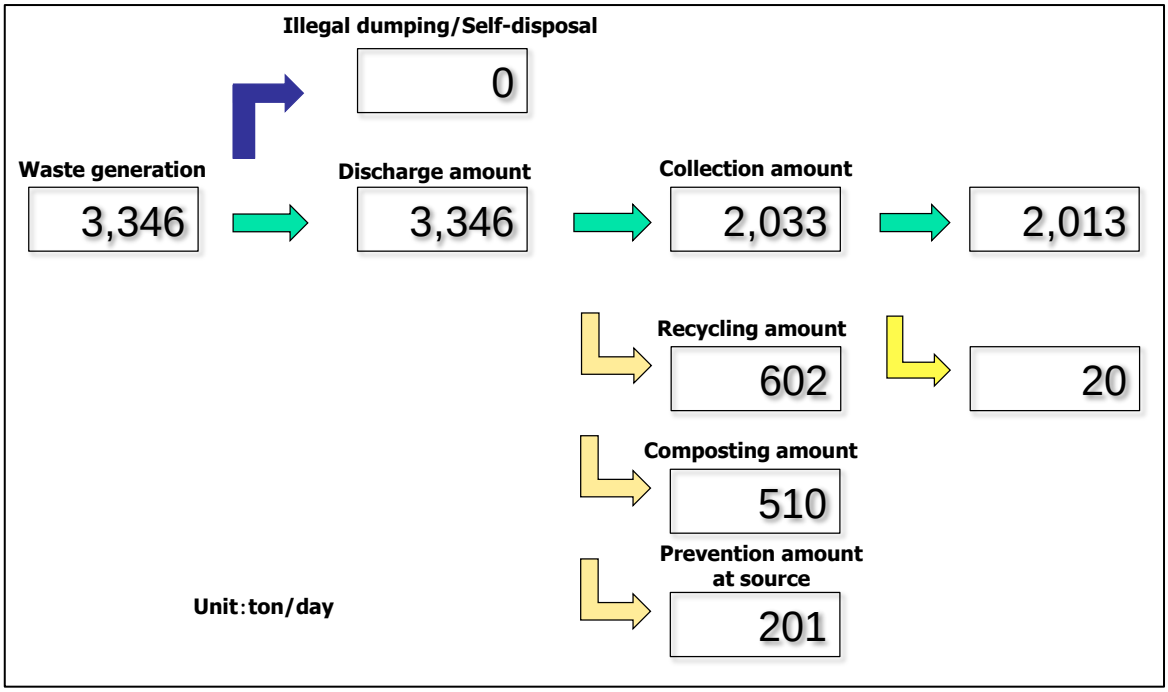


Figure 4.15.3 Waste Management Flow and Estimated Waste Amount in 2030

Based on the proposed future waste stream of this master plan illustrated above, the target levels are set out as shown in **Table 4.15.2**.

Table 4.15.2 Present and Future Waste Reduction, Material Recovery and Waste Diversion Rate

3R Activities/Year	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%

4.16 Operation and Effect Indicators for Project Evaluation

Monitorable operation and effect indicators of the Project or activities formulated in the ISWM Master Plan were determined through consultations with the Pakistani side. The following subsection proposes the operation and effect indicators for the activities in each programme as well as the current (2014/2015), 2020 and 2030 values for monitoring.

4.16.1 Proposed Operation and Effect Indicators for Monitoring and Evaluation of the Projects

The operation and effect indicators proposed for monitoring and evaluation of the activities for each programme are as presented in **Table 4.16.1** below.

Table 4.16.1 Method for Calculation and Evaluation of Operation and Effect Indicators

Programme/Operation and Effect Indicator	Calculation/Evaluation Method
Programme 1: Waste Collection and Transportation Plan	
Waste Collection and Transportation Amount (t/day)	1. Analyse the truck scale records to calculate the daily average value. 2. Calculate the waste collection achievement rate (%) by taking the planned value as the denominator. 3. Evaluate by the achievement rate. The higher achievement rate shows that the collection and transportation activity has been carried out in accordance with the plan.
Waste Collection Service Rate (%)	1. Analyse the truck scale records to calculate the daily average value. 2. Calculate the waste collection rate (%) by taking the planned waste generation amount value as the denominator. 3. The higher waste collection rate shows that the collection and transportation activity has been carried out in accordance with the plan.
Status of Illegal Dumping (Collection amount of waste from the illegal dump sites) (t/day)	1. Analyse the truck scale records to calculate the average value of the discarded waste by the OTC (One Time Cleaning) activity. 2. Calculate the achievement rate (%) by taking the current collection amount as the denominator. 3. The higher achievement rate shows that the OTC activity has been promoted.
Rate of Remaining Number of Illegal Dump Site (%) (Alternative)	1. Carry out the field reconnaissance and record the status of all the remaining illegal dump sites. 2. Calculate the remaining rate of illegal dump sites by taking the current number of illegal dump sites (799 lots) as the denominator. 3. The lower remaining rate shows that the OTC activity has been promoted.
Programme 2: **Final Disposal Plan**	
Final Waste Disposal Amount (t/day)	1. Analyse the truck scale data to calculate the average incoming waste amount per day. 2. Calculate the achievement rate by taking the planned waste disposal amount as the denominator. 3. The higher achievement rate shows that the waste disposal plan including 3R and waste collection plan has been carried out in accordance with the ISWM plan.
Waste Diversion Rate (%)	1. Carry out the interview survey to the recyclers/junk shops/waste pickers to estimate the resource material recovery amount. 2. Estimate the waste discharge amount by adding the waste collection amount and the resource recovery amount. 3. Calculate the waste diversion rate by dividing the resource recovery amount with the waste discharge amount. 4. Calculate the achievement rate by taking the planned waste diversion rate as the denominator 5. The higher achievement level shows that the waste reduction has been carried out as intended.
Programme 3: Intermediate Treatment and 3R Promotion Plan	
Per Capita Waste Generation Amount (g/c/day)	1. Carry out the Waste Amount and Composition Survey (WACS) to estimate the per capita domestic waste generation amount. 2. Calculate the achievement rate by taking the planned per capita waste generation amount by the denominator. 3. The results of achievement rate close at 100% shows that the estimation in the plan was appropriate. 4. The higher achievement rate shows that the waste reduction at source has not yet promoted.
Resource Material Recovery Amount (t/day)	1. Carry out the interview survey to the recyclers/junk shops/waste pickers to obtain the resource material recovery amount.

Programme/Operation and Effect Indicator	Calculation/Evaluation Method
	2. Estimate the total resource material recovery amount by the survey results. 3. Calculate the achievement rate by taking the planned recovery amount as the denominator. 4. The higher achievement rate shows that the recovery of resource material has been promoted as planned.
Compost Plant Input Waste Amount (t/day)	1. Analyse the truck scale record to calculate the average incoming raw material amount to the plant. 2. Calculate the achievement rate by taking the planned input amount as the denominator. 3. The results of achievement rate close at 100% shows that the plant operation has been carried out as planned.
Status of Compost Production – Production Amount (t/day)	1. Analyse the truck scale record to calculate the average amount of final compost product. 2. Calculate the achievement rate by taking the planned production amount as the denominator. 3. The results of achievement rate close at 100% shows that the production of compost has been carried out as planned.
Status of Compost Production – Sold Amount (t/day) (Alternative)	1. Analyse the truck scale record to calculate the average shipping amount of compost product. 2. Calculate the achievement rate by taking the planned shipping amount as the denominator. 3. The results of achievement rate close at 100% shows that the sale of compost has been carried out as planned.
Programme 4: Environmental Education and Public Awareness Raising Plan	
No. of School Classes for Environmental Education (class/year)	1. Record the number of classes that carried out the environmental education programme. 2. Calculate the achievement rate by taking the planned number of classes as the denominator. 3. The result of achievement rate close to 100% shows that the school education programme has been carried out as planned.
No. of Education Programmes for General Public (times/year)	1. Record the number of environmental education programmes carried out for the general public. 2. Calculate the achievement rate by taking the planned number of public education programme as the denominator. 3. The result of achievement rate close to 100% shows that the environmental education for the general public has been carried out as planned.
Raising Public Awareness (%)	1. Carry out the public awareness survey and analyse the awareness of the residents for the SWM services. 2. Calculate the achievement rate by taking the planned rate of public awareness as the denominator. 3. The higher achievement rate of public awareness shows that the public awareness programme has been effective for raising awareness of the residents.
Programme 5: Economic and Financial Plan	
FIRR (Financial Rate of Return) (%)	1. Collect the actual annual cost and income up to the previous evaluation year. 2. Input the actual annual cost and income into the FIRR Calculation Sheet to recalculate the FIRR. 3. The higher FIRR estimated shows that the proposed plan financially viable.
EIRR (Economical Rate of Return) (%)	1. Collect the economic annual cost and gross benefits up to the previous evaluation year. 2. Input the economic annual cost and income into the EIRR Calculation Sheet to recalculate the EIRR. 3. The higher EIRR estimated shows that the proposed plan economically feasible.
Required Amount of Subsidy for O&M Cost (1000 Rs.)	1. Collect the actual annual cost and income up to the previous year. 2. Input the actual cost and income into the Cost Recovery Rate Calculation Sheet to recalculate the rate. 3. Calculate the achievement rate by taking the planned cost recovery rate as the denominator. 4. The result of achievement close to 100% shows that the cost recovery has been carried out as planned.
Level of Waste Fee for Recovering 100% O&M Cost (Low-income Area) (Rs./month/household)	Since the collection of waste fee starts in 2025, recalculate the level of waste fee required in 2020 based on the actual cost and income up to 2019.
Level of Waste Fee for Recovering 100% O&M Cost (Middle-income Area) (Rs./month/household)	Since the collection of waste fee starts in 2022, recalculate the level of waste fee required in 2020 based on the actual cost and income up to 2019.
Level of Waste Fee for Recovering 100% O&M Cost (High-income Area) (Rs./month/household)	Since the collection of waste fee starts in 2022, recalculate the level of waste fee required in 2020 based on the actual cost and income up to 2019.

Programme/Operation and Effect Indicator	Calculation/Evaluation Method
Programme 6: Environmental Monitoring Plan	
Number of Environmental Monitoring at Bhakhraywali (times/year)	1. Record the number of environmental monitoring surveys implemented per year. 2. Calculate the achievement rate by taking the planned number of times as the denominator. 3. Achievement rate at 100% shows that the environmental monitoring has been carried out as planned.
Number of Monitoring at Gondlanwala (times/year)	1. Record the number of environmental monitoring surveys implemented per year. 2. Calculate the achievement rate by taking the planned number of times as the denominator. 3. Achievement rate at 100% shows that the environmental monitoring has been carried out as planned.
Number of Monitoring at Chianwali (times/year)	1. Record the number of monitoring surveys implemented per year. 2. Calculate the achievement rate by taking the planned number of times as the denominator. 3. Achievement rate at 100% shows that the environmental monitoring has been carried out as planned.
Programme 7: Institutional Strengthening and Organization Plan	
Number of Capacity Development Programmes (Unit: cumulative number of trainings)	1. Record the number of respective training courses implemented and obtain the cumulative number of times. 2. Calculate the achievement rate by taking the planned cumulated number of times as the denominator. 3. Achievement rate at 100% shows that the training programmes have been carried out as planned.
Number of Management Staff of the Organization (Unit: person)	1. Count and record the total number of management staff of the organization. 2. Calculate the sufficiency rate by taking the planned number of the management staff as the denominator, 3. The sufficiency rate at 100 % shows that the number of management staff has been deployed as planned,

4.16.2 Current Value and Planned Value of Operation and Effect Indicator

Table 4.16.2 shows the values of operation and effect indicators in the current year (2014/2015) and the planned values for the years 2020 and 2030. The values in 2020 and 2030 shown in the table are the base values for comparison with the values in the evaluation year to be calculated by the method mentioned above.

Table 4.16.2 Current and Planned Value of Operation and Effect Indicator

Planned Project/ Operation and Effect Indicator	Current Value (2014/2015)	Planned Value in 2020	Planned Value in 2030	Reference (Table No. and/or Section No. showing the value)
Programme 1: Waste Collection and Transportation Plan				
Waste Collection and Transportation Amount (t/day)	410	1,459	3,346	Table 4.4.23 – Table 4.4.26
Waste Collection Service Rate (%)	Urban UC: 43 Peri Urban: 0 98UC Avg.: 34	Urban UC: 100 Peri-Urban: 20 98UC Avg.: 81	Urban UC: 100 Peri-Urban: 100 98UC Avg.: 100	Table 4.4.12 - Table 4.4.13 or Table 4.4.23 - Table 4.4.26
Status of Illegal Dumping (Collection amount of waste from the illegal dump sites) (t/day)	60	0	0	Table 2.3.9
Rate of Remaining Number of Illegal Dump Sites (%) (Alternative)	100	0	0	Table 2.3.10
Programme 2: Final Disposal Plan				
Final Waste Disposal Amount (t/day)	406	991	2,013	Table 4.5.1
Waste Diversion Rate (%)	15	32	40	Table 4.15.1
Programme 3: Intermediate Treatment and 3R Promotion Plan				
Per Capita Waste Generation Amount (g/c/day)	Urban UC:400 Peri-Urban:350	Urban UC:424 Peri-Urban:374	Urban UC:467 Peri-Urban:414	Table 4.3.5
Resource Material Recovery Amount (t/day)	70	218	622	Table 4.15.1
Compost Plant Input Waste Amount	0	250	250	Table D.4.5, Figure D.4.4

Planned Project/ Operation and Effect Indicator	Current Value (2014/2015)	Planned Value in 2020	Planned Value in 2030	Reference (Table No. and/or Section No. showing the value)
(t/day)				
Status of Compost Production - Production Amount (t/day)	0	125	125	Table D.4.5, Figure D.4.4
Programme 4: Environmental Education and Public Awareness Raising Plan				
No. of School Classes for Environmental Education (class/year)	0	200	710	Table 4.7.5
No. of Education Programmes for General Public (times/year)	1	3	4	Table 4.7.7
Raising Public Awareness (%)	38	60	80	Figure 2.6.4, Average of the whole project area
Programme 5: Economic and Financial Plan				
FIRR (Financial Rate of Return) (%)	9.18	9.18	9.18	Table 4.14.3
EIRR (Economic Rate of Return) (%)	10.88	10.88	10.88	Table 4.14.8
Required Amount of Subsidy for O&M Cost (1000 Rs.)	212,290	475,063	629,544	Table F.4.13
Level of Waste Fee for Recovering 100% O&M Cost (Low-income Area）(Rs./month/household)	77.2	77.2	77.2	Table 4.14.5
Level of Waste Fee for Recovering 100% O&M Cost (Middle-income Area）(Rs./month/household)	154.4	154.4	154.4	Table 4.14.5
Level of Waste Fee for Recovering 100% O&M Cost (High-income Area）(Rs./month/household)	308.8	308.8	308.8	Table 4.14.5
Programme 6: Environmental Monitoring Plan				
Number of Environmental Monitoring at Bhakhraywali (times/year)	0	4	4	Table G.5.1
Number of Monitoring at Gondlanwala (times/year)	0	1	1	Table G.5.2
Number of Monitoring at Chianwali (times/year)	0	1	1	Table G.5.2
Programme 7: Institutional Strengthening and Organization Plan				
Number of Capacity Development Programs (Unit: cumulative number of training)	0	11	27	Figure H.4.4
Number of Management Staff of the Organization (Unit: person)	46	70	76	Figure 2.8.3, Figure 4.10.1 Figure 4.10.2, Figure 4.10.3, or Table H.5.1

4.16.3 Number of Direct and Indirect Beneficiaries of the Project

(1) Project Area Population - Waste Collection Target Area Population (Direct Beneficiaries)

The Project will impact directly on the Project Area, i.e., the waste collection target area, and its population of the current year (2014), 2020 and 2030 is estimated at 2,964 thousand, 3704 thousand and 5,373 thousand, respectively on the basis of the 1998 Census population. (Refer to **Table 4.2.3**)

(2) Gujranwala District Population (Indirect Beneficiaries)

The Project can be realised to contribute to the Gujranwala District indirectly since the increase of the waste collection rate up to 100% in the urban UCs by 2018 followed by the peri-urban UCs by 2030 will impact on the remaining areas of the District. The current population of Gujranwala District in 2014 based on the 1998 Population Census is estimated at 4,667 thousand (Source: page 287, Punjab Development Statistics 2014, http://www.bos.gop.pk/system/files/Dev-2014.pdf).

4.17 Implementation Schedule and Cost, and Plan of Operation

Actions and costs required for the implementation of each component of the Master Plan are summarised in **Figures 4.17.1 and 4.17.2**.

Implementation Programme (Programme 1 to 3)	Cost (thousand Rs.)		Short-Term Plan			Mid-Term Plan						Long-Term Plan					
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 1: Waste Collection & Transportation Plan																	
1-1 Itroduction of Separate Collection & Alternate-Day Collection through Implementation of Pilot Project		143,525															
1-2 Increase of Waste Collection Rate in 64 UCs up to 100% in 2018		1,649,399															
1-3 Planning/Implementing for the Method of Separate Collection in 98 UCs	GWMC																
1-4 Increase of Waste Collection Rate in 34 UCs from 0% to 60% in 2024	GWMC																
1-5 Sustaining Waste Collection Rate in 64 UCs from the Current with 100%	GWMC																
1-6 Increase of Waste Collection Rate in 34 UCs to 100% in 2030	GWMC																
1-7 Procurement of Waste Collection Vehicles and Containers in 98 UCs		10,555,881															
1-8 Monitoring on Improvement of Waste Collection and Transportation in 98 UCs	GWMC																
1-8 Outsourcing the Waste Collection and Transportation Service to a Private Company	GWMC																
1-9 Conducting Street Cleaning		316,400															
1-10 Collection of Bulky Waste		97,350															
1-11 Cleaning Up of Illegal Dumping Sites in 64 Ucs		23,773															
1-12 Collection of Construction and Demolition Waste		115,350															
1-13 Construction of Parking Area		1,119,112															
Sub-Total of Programme 1		**14,020,790**															
Programme 2: Final Disposal Plan																	
2-1 Procurement of Sanitary Landfill Site		450,000															
2-2 Engineering Service for Sanitary Landfill Facilities		294,495															
2-3 Construction of Sanitary Landfill Facilities in Bhakhraywali		2,990,400															
2-4 Procurement and Replacement of Landfill Machinery		332,100															
2-5 Operation and Maintenance of Landfill Facilities		698,915															
2-6 Improvement Work of the Existing Landfill in Gondlanwala		55,902															
2-7 Safe Closure of the Landfill Site in Gondlanwala		26,196															
2-8 Safe Closure of the Landfill Site in Chianwali		34,554															
2-9 Monitoring of Final Disposal in Bhakhraywali	GWMC																
2-10 Post-Closure Monitoring of Gondlanwala and Chianwali Landfill Sites	GWMC																
2-11 Site Selection of Sanitary Landfill Site (Stage 2 - Stage 3)	GWMC																
Sub-Total of Programme 2		**4,882,562**															
Programme 3: Intermediate Treatment and 3R Promotion Plan																	
3-1 Awareness & IEC Campaign on Resources Recovery		in Programme 4															
3-2 IEC Campaign for Resource Recovery at Source/Registration of Waste Pickers and Recycling Industries		in Programme 4															
3-3 Implementation of Simplified WACS	GWMC																
3-4 Preparation for PPP & Formation of a Committee of the BOD of GWMC	GWMC																
3-5 Implementation of Land Preparation by GWMC	GWMC																
3-6 Engineering Service for Detailed Design of the Compost (& RDF) Plant by SPV		44,000															
3-7 Purchase of Land for the Compost Plant		42,000															
3-8 Construction Work for the Gujranwala Compost Plant owned by SPV including Procurement of Equipment		430,000															
3-9 Operation and Maintenance of the Compost (& RDF) Plant		508,911															
3-10 Monitoring of Implementation of the Compost (& RDF) Plant	SPV																
3-11 Preparation and Enacting of Recycling Laws in Punjab, Pakistan	Gov..of the Punjab																
Sub-Total of Programme 3		**1,024,911**															
Total of Programme 1 to 3		**19,928,263**															

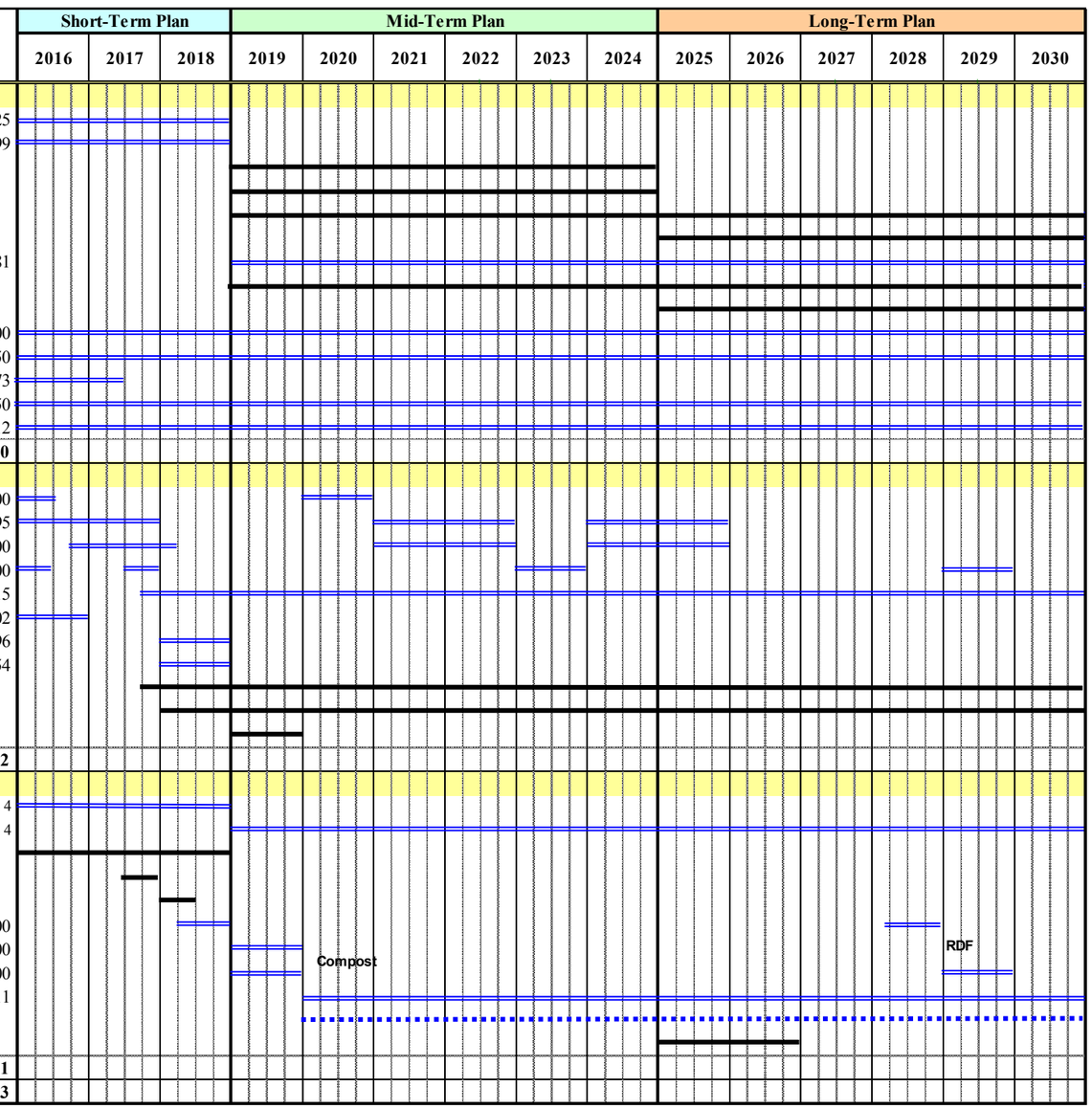


Figure 4.17.1 Summary of Implementation Schedule and Cost of the Master Plan (1)

Implementation Programme (Programme 4 to 7)	Cost (thousand KSh)		Short-Term Plan			Mid-Term Plan						Long-Term Plan					
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Programme 4: Environmental Education and Public Awareness Raising Plan																	
4-1 Capacity Development of Communication Unit to Strengthen the Coordination among Relevant Bodies		62,135															
4-2 Development and Implementation of Educational Programmes Targeting Primary School Teachers and Students		42,136															
4-3 Development and Implementation of Educational Programmes Targeting General Public		12,514															
4-4 Development and Implementation of Monitoring Plan		4,125															
4-5 Development of Environmental Education Facility and its Utilisation Plan		400															
4-6 Managment of Environmental Education Facility and its Utilisation		1,100															
Sub-Total of Programme 4		**122,410**															
Programme 5: Economic and Financial Plan																	
5-1 Establishment of Sustainable Cost Recovery	GWMC																
5-2 Implementation of Accurate Total Costing	GWMC																
5-3 Introduction of Proper Tariff Charging System		in Programme 7															
5-4 Implementation of Financially Efficient Private Sector Involvement	GWMC	in Programme 7															
Sub-Total of Programme 5																	
Programme 6: Environmental Monitoring Plan																	
6-1 Monitoring of Collection and Transport Work	GWMC																
6-2 Monitoring of Final Disposal Site in Bhakhraywali		20,170															
6-3 Monitoring of Post-Closure Final Disposal Sites in Gondlanwala and Chianwali		1,820															
6-4 Monitoring of Intermidiate Process (Compost Facility)	GWMC																
Sub-Total of Programme 7		**21,990**															
Programme 7: Institutional Strengthening and Organizational Plan																	
7-1 Improvement of Organisational Restructuring of GWMC		346,709															
7-2 Capacity Development of GWMC Staff		76,894															
7-3 Establishment of Gujuranwala Solid Waste Management By-Law		844															
Sub-Total of Programme 7	**0**	**424,447**															
Total of Programme 4 to 7	**0**	**568,847**															
Grand Total	**0**	**20,497,110**															

To be conducted by local fund
To be conducted by Special Purpose Vehicle (SPV)
To be conducted by the GWMC's own resources

Figure 4.17.2 Summary of Implementation Schedule and Cost of the Master Plan (2)

4.18 Selection of Priority Projects

The priority projects are defined as projects for the short-term period of the Master Plan which will be developed to the action plans in the next stage. Based on the detail discussions described in **Sections 4.4 to 4.10,** the following projects are thus selected as the priority projects:

1. Waste Collection and Transportation Plan

1-1 Introduction of Separate Collection and Alternate day Collection through Implementation of Pilot Project

1-2 Increase of Waste Collection Rate in 64 UCs up to 100% in 2018

1-3 Conducting Street Cleaning in 64 UCs

1-4 Collection of Bulky Waste

1-5 Cleaning up of Illegal Dumping sites in 64 UCs

1-6 Construction and Demolition Waste Collection

1-7 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 Machinery

2-5 Operation and Maintenance of Landfill Facilities

2-6 Improvement Work of the Existing Landfill in Gondlanwala

2-7 Safe Closure of the Landfill Site in Gondlanwala

2-8 Safe Closure of the Landfill Site in Chianwali

2-9 Monitoring of Final Disposal in Bhakhraywali

2-10 Post-Closure Monitoring of Gondlanwala and Chianwali Landfill Sites

3. Intermediate Treatment and 3R Promotion Plan

3-1 Awareness and IEC (Information, Education and Communication) Campaign on Resource Recovery

3-2 Implementation of Simplified WACS

3-3 Preparation for PPP and Formation of a Committee of the BOD of GWMC

3-4 Implementation of Land Preparation by GWMC

3-5 Engineering Service for Detailed Design of a Compost Plant by SPV

4. Environmental Education and Public Awareness Raising Plan

4-1 Capacity Development of Communication Unit to Strengthen 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 Establishment of Sustainable Cost Recovery

5-2 Implementation of Accurate Total Costing

5-3 Introduction of Proper Tariff Charging System

5-4 Implementation of Financially Efficient Private Sector Involvement

6. Environmental Monitoring Plan

6-1 Environmental Monitoring for the Collection and Transportation Work

6-2 Environmental Monitoring for the Final Disposal Site in Bhakhraywali

6-3 Environmental Monitoring for the Safe Post-Closure of Final Disposal Sites in Gondlanwala and Chianwali

7. Institutional Strengthening and Organizational Plan

7-1 Organizational Restructuring of GWMC

7-2 Capacity Development of GWMC Staff

7-3 Establishment of Gujranwala Solid Waste Management By-Law