TECHNICAL FEASIBILITY REPORT

Assisting the State Government for Planning of Scientific Solid Waste Management through Cluster Approach and Bid Process Management for selection of Developers & Operators

Cluster 1

Submitted to

State Urban Development Agency (SUDA)
Urban Development & Municipal Affairs Department (UD&MA)
Government of West Bengal

December 2019

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24th December,2019

To,
Director
State Urban Development Agency
ILGUS Bhawan, HC block,
Sector III, Bidhannagar
Kolkata - 700106

Subject : Cover letter for Submission of TFR (Cluster 1)

Respected Madam,

As per the deliverables, we hereby submit the Technical feasibility report for cluster 1 in hard copy and soft copy has been shared through mail for your kind perusal.
Assuring you are best services.

Yours faithfully,

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Abbreviations

C&D	Construction and Demolition
C/N	Carbon/Nitrogen Ratio
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health & Environmental Engineering Organization
DPR	Detailed Project Report
EC	Environmental Clearance
EIA	Environmental Impact Assessment
FCO	Fertilizer (Control) Order, 1985
GCV/CV	Gross Calorific Value
Ha	Hectare
IEC	Information, Education & Communication
Kcal	Kilo Calories
MNRE	the union Ministry for Non-Conventional and renewable Energy
MOEF&CC	Ministry of Environment Forests and Climate Change
MOHUA	Ministry of Housing and Urban Affairs, Govt. of India
MOUD	Ministry of Urban Development (Govt. of India)
MRF	Material Recovery Facilities
MSW	Municipal Solid Waste
NABL	National Accreditation Board for Testing & Calibration Laboratories
NGOs	Non-Governmental Organizations
PPE	Personal Protective Equipment
PPP	Public Private Partnership
RDF	Refuse Derived Fuel
RFP	Request for Proposal
SBM	Swachh Bharat Mission
SPCB	State Pollution Control Board
SLB	Service Level Benchmark
SLF	Sanitary Landfill
SOP	Standard Operating Procedure
SWM	Solid Waste Management
TPD/TPA	Tons per Day / Tons per Annum
ULBs	Urban Local Bodies
BWG	Bulk Waste Generator

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Executive Summary

Solid Waste Management (SWM) is a vital service provided by Urban Local Bodies to its citizens to ensure a healthier environment, standard of living, health and sanitation facilities. Solid Waste Management Rules, 2016 issued by Government of India (GoI) and various directions given by National Green Tribunal (NGT) time to time have set the baseline for the modus operandi of SWM in the country. In line with these requirements, State Urban Development Agency (SUDA) of West Bengal has proposed to set up cluster based solid waste management projects in various municipalities of the state. SUDA has appointed Ernst and Young LLP, as the Transaction Advisor for project development of present cluster consisting of Dum Dum, North Dum Dum, South Dum Dum, Baranagar, New Barrackpore and Kamarhati municipalities.

Presently, the cluster generates about 635 TPD of waste which is estimated to reach 909 TPD by 2042. SUDA has initially proposed to set up a processing plant and Sanitary landfill for these 6 ULBs at Pramodnagar dumping Site. The area of the Pramodnagar site is about 22.69 acres and approximately 5.55 lakh cubic meter (4.995 lakh Tons) of legacy waste is already lying at the site and site needs to be reclaimed for developing the processing plant facility. Based on the field visits and waste quantification studies for all the cluster ULBs, it was observed that present site area cannot accommodate the proposed structure (i.e. Processing Plant + SLF) for the estimated waste quantity of 6 ULBs. Therefore, to reduce the processing of all waste burden at the Pramodnagar Site, another site for additional processing plant has been identified at Kamarhati during the field visits. This site measures an area of about 8 acres and around 1.22 lakhs cubic meter (1.098 lakh Tons) of waste is lying at this site. It is proposed to set up the processing plant for Kamarhati and New Barrackpore municipalities at this 8-acre site after biomining of legacy waste and reclaiming the land at Kamarhati site. The Processing plant at Pramodnagar site will cater the waste from Dum Dum, North Dum Dum, South Dum Dum and Baranagar municipalities which shall reduce the waste burden at Pramod Nagar site.

In addition to the above stated issue, the location of the Pramodnagar site brings concern to the present scheme. The site is in vicinity of a large water body, residential areas, belghoria expressway and also lies in the buffer zone of Dum Dum Airport. So, obtaining environmental clearance (EC) for constructing Sanitary Landfill Facility (SLF) at this site would be difficult, which may affect the project sustainability. Even considering relaxation in the EC criteria and support from the state govt., the estimated area required for SLF (around 33 acres) is more than the total available area (22.69 acres) at Pramod Nagar site. Due to this, SLF has been proposed to be developed at another site, which will accommodate processing rejects from both Promdnagar and Kamarhati sites. Hence after due consultation with SUDA, the initial scheme has been revised to set up two processing plants, one at Pramod Nagar (450 TPD compost & RDF facility and 100 TPD Bio-methanation plant), second at Kamarhati (180 TPD compost & RDF facility) and a common SLF at another site (to be finalized by SUDA). Also, to setup new plants at Pramod Nagar and Kamarhati, dumpsite reclamation activities need to be taken up which also requires low-lying area (preferably) for disposal of rejects. Therefore, in consultation with SUDA and KMDA, a low-lying land parcel has been identified at Panihati for this purpose. Site at Panihati has been proposed by KMDA, however, formal approval is required.

Based on the revised scheme, the present report describes a possible design for solid waste management system in present cluster and identifies feasible technologies for processing and disposal of MSW. From the analysis and the field studies, it is suggested that the processing of MSW into compost, RDF and biogas will be the most feasible option based on quantity of waste generation, land availability, waste characteristics of Cluster ULBs.

The project structure has been conceptualized for private sector participation in secondary collection and transportation, processing and disposal of fresh waste. The municipalities are expected to carry out the source segregation, primary collection and transportation of waste to the secondary collection points. Hence, this structure will be slightly different from Integrated Solid Waste Management scheme, where private developer is responsible for carrying out the entire waste management from door to door collection till processing & disposal. Present project structure has been proposed keeping in mind operational cost on C&T, existing infrastructure and resource utilization, optimization, operational dynamics of municipalities in West Bengal and reducing financial burden on the Government. However detailed Gap analysis is presented in the report in term of available infrastructure and for existing infrastructure upgradation. A few suggestions are also given with respect to compliance and monitoring part.

The overall project is designed considering the year 2027 and provisions of expansion have been taken in to consideration to cater the future waste generation till year 2042. The concession period accounts for the time envisaged in contract signing, biomining of legacy waste, construction & commissioning of the processing plant, SLF and operations for 20 years. The entire project is divided in to 3 components: (i) Primary Collection & Transportation; (ii) Secondary transportation & Processing and Disposal and (iii) Removal of Legacy waste. As mentioned, the first component will be expected to be ULBs responsibility which requires **INR 29.99 crores** for upgradation of existing infrastructure. The second component will be bid out to private player which requires an investment of **INR 113.14 Crores**. The third component will be funded by Govt. and executed by Private Player which requires an investment of **INR 54.91 Crores**.

To expedite the above work, it is suggested that Govt. should make necessary arrangement for funding ULBs for infrastructure upgradation. For second and third component, a combined bid process should be done to avoid the conflict in parallel operations. However, the latter will also bring the challenge in bidding process as dumpsite reclamation projects are usually civil works contract and do not involve PPP structuring. Hence, it is suggested to fix the cost bracket of legacy waste removal on per ton basis which shall be paid by government. The cost of revenue deficit (i.e. Tipping fee) for Collection and Transportation of waste to processing site, setting up processing & disposal facility and 20 years operation shall be used as a bidding variable in bid process for invitation of a private party. Considering the capital and operational cost of secondary collection and Transportation of waste to processing site, processing & disposal units, associated revenues and to maintain a healthy IRR of 16%, a tipping fee of **INR 1250** with a 3% year on year increase is estimated.

1 Introduction

Solid Waste Management (SWM) is a vital service provided by Urban Local Bodies (ULBs) to its citizens to ensure a healthier environment, standard of living, health and sanitation facilities. Waste generation encompasses activities in which materials are identified as no longer being of value (being in the present form) and are either thrown away or gathered together for disposal. Solid Waste Management Rules, 2016 (SWM Rules 2016) define Municipal Solid Waste (MSW) as commercial and residential wastes generated in a municipal or notified area in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes.

1.1 SWM Value Chain

Conventionally, there are four broad aspects in the MSW value chain, namely, collection, transportation, processing and disposal of waste. A holistic approach to waste management includes these four aspects to extract the maximum value from waste. Municipal solid waste is mainly generated from households, commercial establishments, and institutions. The collection system includes door-to-door collection of segregated waste from households. This waste from several households is then transported in small vehicles (primary transportation) to a common point where it is either stored temporarily and/or transferred to larger covered vehicles (secondary transportation). These vehicles transport large quantities of collected waste to a processing or disposal site. The processing of waste involves the application of appropriate technologies depending upon the quantity and quality of wastes to scientifically dispose them. Lastly, the rejects left over after processing are collected and disposed in scientifically engineered landfills. In an ideal system, the service levels of the entire process from collection to final disposal will be 100%. However, in India, the state of MSW deviates from the prescribed process. Government has taken several attempts to make the SWM value chain ideal.

Figure 1: SWM Value Chain

The key players across the solid waste management value chain primarily comprise:

a) **Waste Generators** - Individual households or bulk waste generators (apartment complexes, malls, shops, office buildings, hospitals, hotels & restaurants, schools, universities etc.). Waste segregation is the responsibility of each waste generator in the state/country.
b) **Urban Local Bodies (ULBs)** - Municipal corporations, municipal councils/city councils and municipal committees that collect and transport solid waste from doorsteps within their jurisdiction. In some cases, private players are also engaged by urban local bodies to carry out collection and transportation activities on their behalf.
c) **Urban Development Departments** - State urban development departments disburse funds for solid waste management activities to ULBs. They also issue policy directives and monitor the activities of ULBs from time to time.
d) **Project Developers** - Private developers that set up waste management projects on public private partnership (PPP) basis with the Urban Local Bodies. In integrated solid waste management projects, all four elements of the value chain i.e. collection, transportation, processing and disposal are managed by a single project developer. In other cases, collection

& transportation activities may be managed by the ULB and processing & disposal will be managed by a private agency.

e) **Technology Providers** - Companies that specialize in manufacturing and supplying, MRF/RDF plant, waste segregation machinery, waste-to-energy boilers, grates, air pollution control equipment etc.

f) **Bilateral and Multilateral Agencies** - International donor agencies provide loans or grants for solid waste management projects.

g) **Banks & Non-Banking Financial Corporations** (NBFCs) - NBFCs provide end-to-end infrastructure financing and project implementation services. Their business can be broadly classified into corporate investment banking (project finance, investment banking) and alternative asset management (private & project equity). These companies provide financial intermediation for infrastructure projects and services, adding value through innovative products to the value chain & asset maintenance of existing infrastructure projects. Banks understand that waste management projects are capital intensive and have long concession periods. These institutions usually have a highly evolved project level assessment framework. This enables them to conduct a credit assessment and establish bankability, after which long term debt is sanctioned and syndicated across a spectrum of commercial banks as senior debt.

Government of West Bengal has taken several steps/initiatives for making the cities Clean, Green and Beautiful with special emphasis on management of Solid Wastes in Municipal Towns of the State. One of the obligatory functions of the Municipal Bodies is to remove solid waste from the cities under Sections 63, 95B, 260, 273 of the West Bengal Municipal Act 1993 and corresponding Sections in the Municipal Corporations' Acts. Although an obligatory function, SWM service has been an area of concern for urban centers of all sizes especially with changing patterns of lifestyle and behaviour of population. With increasing population and urbanization, SWM in India has emerged as a priority not only because of the environmental and aesthetic concerns but also because of the quantities of waste generated every day. Next section is in detail about the regulatory arrangements that were mentioned here in the introduction.

1.2 Regulatory Landscape

The Indian government recognizes the urgent need for solid waste management in the country. They acknowledge that the existing state of services are raising serious public health concerns that require immediate attention.
Solid waste is a State subject and a municipal function. The responsibility for its management lies with the Urban Local Bodies (ULBs), which consist of municipal corporations (Nagar Nigam), municipalities (Nagar Palika) and City Councils (Nagar Panchayat) or Notified Area Council (Nagar Palika Parishad). As far as Solid Waste Management is concerned, following is the road map of the regulations by government.

Regulatory Roadmap of SWM:

GOVT. OF INDIA

- Solid Waste Management Rules, 2016

1.3 Hazardous Waste Management Rules, 2016

- Biomedical Waste Management Rules, 2016.
- E- waste (Management and Handling) Rules, 2016
- Plastic waste (Management and Handling) Rules, 2016
- Construction & Demolition Waste Management Rules, 2016
- Guideline of Ministry of Housing & Urban Affairs, GoI on Implementation of SWM
- Swachh Bharat Mission, GoI

Important Regulatory Guidelines:

Solid Waste Management Rules, 2016

In 2016, the Ministry of Environment, Forests and Climate Change (MoEFCC) notified the 'Solid Waste Management Rules, 2016 to replace the old and outdated SWM Rules, 2000. In these rules, distinct duties and responsibilities were allocated to waste generators, ministries, state governments, pollution control boards, local authorities & village panchayats as well as brand owners and industrial units for various aspects of waste management. SWM rules 2016 was aimed at standardization and enforcement of SWM practices in the ULBs. The rules mandated every municipal authority to, within the territorial area of the municipality, be responsible for the implementation of the provisions of these rules and infrastructure development for collection, storage, segregation, transportation, processing and disposal of municipal solid wastes. The Ministry of Agriculture required to provide flexibility in Fertilizer Control Order for manufacturing & sale of compost, propagating use of compost on farmland, setting up laboratories to test quality of compost by local authorities or authorized agencies.

1. **Segregation at source:**
   a. Waste generators required to segregate waste into 3 streams: biodegradables, dry (paper, plastic, metal, wood), and Domestic Hazardous Waste (diapers, napkins, cleaning agents)
   b. Institutional generators, hotels, restaurants made responsible for segregation, sorting, and managing in partnership with local bodies
   c. All resident welfare, market associations & gated communities above 5000 sqm. area mandated to segregate waste at source & hand over recyclables to authorized waste pickers & recyclers or the urban local body
2. **Collection and disposal of sanitary waste**
   Manufacturers or brand owners of sanitary napkins and diapers responsible for spreading awareness of proper disposal to generators. Also required to provide a pouch or wrapper for disposal of each diaper within the packet
3. **Collect back scheme for packaging waste**
   Brand owners required to put in place a system to collect back non-biodegradable packaging waste generated due to their production
4. **User fee for collection**
   a. Municipal authorities to levy user fee for collection, disposal & processing from bulk generators
   b. Generators required to pay "user fee" to waste collector and "spot fines" for littering & non-segregation
   c. Rag pickers, waste pickers and kabadiwalas to be integrated from informal to formal sector by state government
   d. Zero tolerance for throwing, burning or burying solid waste on streets, open public spaces, in drains or water bodies
5. **Scientific waste processing and treatment**
   a) Biodegradable waste to be processed, treated and disposed through composting or bio-methanation within the premises; residual waste to be given to waste collectors
   b) Developers of SEZs, industrial estates, industrial parks to earmark min. 5% of total area or min. 5 plots/sheds for recovery & recycling facility
   c) For census towns or local bodies with:
      - ✓ > 1 million population: waste processing facility to be set up in 2 yrs.
      - ✓ 0.5 million - 1 million population: common or stand-alone sanitary landfill to be set up in 3 yrs.
      - ✓ < 0.5 million population: common or regional sanitary landfills to be set up in 3 yrs.

   a. Bio-remediation or capping of old & abandoned dumpsites within 5 yrs.
6. **Promotion of waste-to-energy**
   a. All industrial units using fuel & located within 100 km of solid waste based RDF plant mandated to replace 5% of fuel requirement by RDF

b. Non-recyclable waste having calorific value of 1500 Kcal/kg or more to be utilized for generating energy through RDF. High calorific waste to be used for co-processing in cement or thermal power plants
c. MNRE to facilitate infrastructure creation for WtE plants & provide incentives or subsidy for them
d. Ministry of Power to fix tariff or charges for power generated from WtE plants based on solid waste & ensure compulsory purchase of power by discoms

7. **Parameters and standards for incineration, landfills, compost**
   a. New parameters & standards devised for incineration, landfills and compost
   b. Landfill site to be away from water bodies, highways, habitations, public parks, water supply wells and airports
   c. Emission standards for incineration completely revised, includes parameters for dioxins, furans, reduced limit for PM
   d. Compost standards amended to align with Fertilizer Control Order
8. **Management of waste in hilly areas**
   a. Construction of landfills on hills to be avoided
   b. land for construction of scientific landfills in hilly areas to be placed in plain areas within 25 km
   c. Transfer stations and processing facilities can be operational in hilly areas
9. **Constitution of a Central Monitoring Committee**
   a. A central monitoring committee comprising of stakeholders from central & state governments to be constituted under Secretary, MoEFCC for monitoring of overall implementation of Rules
10. **Other Changes**
    a. The term "municipal solid waste" has been replaced by solid waste; solid waste encompasses domestic waste including sanitary waste, commercial waste, institutional waste, catering and market waste and other non-residential wastes, street sweepings, silt removed or collected from the surface drains, horticulture waste, construction and demolition waste and treated bio-medical waste excluding industrial hazardous waste, bio-medical waste and e-waste
    b. Inclusion of a separate chapter on construction & demolition waste management with roles and responsibilities of various stakeholders defined including Bureau of Indian Standards
    c. Separate standards for organic compost and phosphate rich organic manure; stringent standards for incineration
    d. Removal of term 'municipal authority'; new stakeholders have been identified. The functions of MoEFCC, MoHUA/MoUD, Ministry of Chemicals and Fertilizers, CPCB, SPCB, Pollution Control Committees for Union Territories, municipal administration, state governments and urban local bodies
    e. Provision for incentives to decentralized waste treatment facilities
    f. The rules have enlisted duties of various stakeholders:
    g. The waste generators are mandated to segregate, and store waste generated by them in three separate streams namely bio-degradable, non-bio-degradable and domestic hazardous waste in suitable bins and handover these segregated wastes to authorized waste collectors. Further, construction and demolition waste shall be disposed of as per the Construction & Demolition Waste Management Rules, 2016.
    h. Ministry of Environment, Forest and Climate Change shall be responsible for overall monitoring and implementation of these rules in the country. A Central Monitoring Committee shall be setup to monitor and review implementation of these rules. Ministry of Urban Development formulated the national policy and strategy on solid waste management including a policy on waste-to-energy in consultation with stakeholders, promote research and development in the sector and undertake training and capacity building of local bodies and other stakeholders.

i. Department of Fertilizers, Ministry of Chemicals and Fertilizers shall provide market development assistance on city compost.
j. Ministry of Agriculture, Government of India shall endeavor to provide flexibility in Fertilizer Control Order for manufacturing and sale of compost.
k. Ministry of Power shall decide tariff for power generated from waste-to-energy plants and compulsorily purchase power generated from such waste-to-energy plants.
l. Ministry of New and Renewable Energy shall facilitate infrastructure creation and provide subsidy or incentives for waste-to-energy plants.
m. District Magistrate/ District Collector/ Deputy Commissioner shall facilitate identification and allocation of suitable land for setting up solid waste management facilities.

Swachh Bharat Mission

Launched in 2014 under the flagship programme namely Swachh Bharat Mission aims to provide the sanitation facilities with respect to scientific municipal solid waste management and liquid waste management to every citizen. SBM stipulates to build the capacities of urban local bodies strong to design, execute and operate all systems related to service provision. This requires close linkage between planning, operationalizing and sensitizing of the sanitation and waste management services within the departments as well as the citizens for achieving the overall goal of SBM. The initiative has also encouraged the participation of private sector by providing the suitable environment for their active and reliable participation in the sector.
SBM Model Municipal Solid Waste (Management & Handling), Cleanliness and Sanitation rules has few guidelines:

- Every generator of Municipal Solid Waste shall separate the waste at source of generation into the following categories as applicable and shall store separately, without mixing it for segregated storage in authorized storage bins, private/public receptacles for handing over or delivering to authorized waste pickers or waste collectors as directed by the local authority/body from time to time.
- It shall be the duty of every generator of municipal solid waste, either owner or occupier of every land and building to collect or cause to be collected from their respective land, premises and building, to segregate waste and to store and deliver the same to the municipal worker/vehicle/waste picker/waste collector deployed by the Municipal Corporation/Council/Municipality/Urban Local Body.
- Municipal Corporation/Council/Municipality/Urban Local Body shall release publicly, the monthly data about the quantity of waste going to the different landfills and waste processing sites. Such information shall be available at the Office and on Municipal Corporation/Council/Municipality/Urban Local Body website.
- To regulate and facilitate the sorting of the recyclable and non-recyclable waste, the Municipal Corporation/Council/Municipality/Urban Local Body shall provide for as many dry waste sorting centers as possible and required.
- The urban local body shall ensure arrangements for cleaning daily or at set intervals and all the year through at all the public roads, places, colonies, slums, Local Body, markets and tourism places, parks of the urban body, cremation grounds etc. and the urban local body shall be committed to collect and carry the garbage from these places door to door or from the nearest garbage bin/container/facility and transport it from there to the final disposal place in closed vehicles.

CPCB (Central Pollution Control Board)

CPCB had published technical guidelines with respect to solid waste management which are as follows:

- Guidelines for Environmentally Sound Facilities for Handling, Processing and Recycling of End-of- Life Vehicles (ELV)
- Revised Guidelines for Pre-Processing and Co-Processing of Hazardous and Other Wastes in Cement Plant as per H&OW (M & TBM) Rules, 2016

- Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty
- Guidelines for Common Hazardous Waste Incineration
- Criteria for Hazardous Waste Landfills
- Guidelines for Management, Handling, Utilisation and Disposal of Phosphogypsum Generated from Phosphoric Acid Plants
- Protocol for performance Evaluation and Monitoring of the Common Hazardous Waste Treatment Storage and Disposal Facilities including Common Hazardous Waste Incinerators
- Guidelines for Setting up of Operating Facility: Hazardous Waste Management
- Guidelines for Proper Functioning and Upkeep of Disposal Sites
- Guidelines for Environmental Sound Recycling of Hazardous Waste as per Schedule-V of Hazardous Waste (Management Handling and Transboundary Movement) Rules, 2008
- Guidelines for the Selection of Site for Landfilling
- Guidelines for Transportation of Hazardous Wastes
- Guidelines for Storage of Incinerable Hazardous Wastes by the Operators of Common Hazardous Waste Treatment, Storage and Disposal Facilities and Captive HW Incinerators
- Guidelines for Conducting Environmental Impact Assessment: Site Selection for Common Hazardous Waste Management Facility
- Manual for 'Sampling, Analysis and Characterization of Hazardous Wastes'.

National Green Tribunal Guidelines

As per the direction of Honorable NGT order dated 16th January 2019, CPCB had submitted draft "Guidelines on Disposal of Legacy Waste" to NGT on 18th February 2019. Following has been suggested in the guidelines:

- Solid waste dumps which have reached their full capacity or those which will not receive additional waste after setting up of new and properly designed landfills should be closed and rehabilitated.
- The treatment & disposal of Legacy MSW can be done by Bio-remediation and Bio-mining.
- A total station survey or drone mapping of any landfill/dumping site must be done prior to start of the project.
- Procedure of Bio-remediation and Bio Mining has been explained in the guidelines
- Local Body (LB) shall make a time bound plan to execute the bio-mining process to clear the old waste.
- An initial baseline survey of surface and subsurface soils and waters and also leachate present shall be performed. Samples should be drawn by an NABL or MOEFCC certified lab, also at the final stage.
- The recyclables recovered from the bio-mining process should be sent for recycling as per the quality of the material, which should also be randomly sampled by an NABL lab and tested for heavy metals, salinity/electrical conductivity and leachability to ensure no environmental harm during use.
- The recovered land from the bio-mining process shall be utilized for any purpose deemed appropriate. Ideally reclaimed space should be reused for waste processing, otherwise for alternate non-habitation uses
- It is important to do the risk assessment and an onsite emergency plan should be kept handy prior to commencement of dumpsite bio-remediation & bio-mining.
- Capping should only be considered for the maximum 10% residual rejects after bio-mining (screening) of stabilized waste.
- ULB also needs to ensure that fresh waste generated in city is handled, collected and processed separately as per the norms and guidelines issued by MoEF&CC.
- For Dry Waste a Material Recovery Facility should be installed to recover maximum material for ensuring that our cities are Zero Waste to Landfill cities.

GOVT. OF WEST BENGAL

- Policy and Strategy on Solid Waste Management for Urban Areas of West Bengal 2017
- Policy and Strategy on Plastics Waste Management for Urban Areas of West Bengal 2017

- Amendment of the West Bengal Municipal Act for banning using plastic bags below 50 microns.
- State Government Order to all the ULBs to regularly remove Solid Wastes from all area under its jurisdiction
- Hospitals in their jurisdiction and accordingly make special arrangement for Hospital Solid Waste removal.
- State Government declaration of Green Zone from Airport to NABANNA area.

Mandates on Solid Waste Management suggested by Hon'ble NGT to Govt. of West Bengal on 10.04.2019

1) Door to Door Collection [Rule 15 (b) SWM Rule]
Door to door collection of segregated solid waste from all households including slums and informal settlements, commercial, institutional and other non-residential premises. Transportation in covered vehicles to processing or disposal facilities

2) Source Segregation [Rule 15 (g) SWM Rule]
Segregation of waste by households into Biodegradable (green bins), non-biodegradable (blue bins) and domestic hazardous (black pouch of thickness more than 50 micron). As per directions of State level committee on SWM Rule 2016 vide no Z-16025/6/2018 dated 21.01.2019, all the reginal monitoring committee and State/UT/ULBs is to follow the two-bin system for storage of waste and separate storage for domestic hazardous waste.

3) Provision for Litter Bins & Waste Storage Bins [Rule 15 (h) SWM Rule]

- Installation of Twin-bin/ Segregated litter bins in commercial, public areas and strategic locations at every 50-100 meters
- Assisting West Bengal State government for Planning of Scientific SWM through Cluster Approach and Bid Process Management for Selection of Developers & Operators
- Avoid indiscriminate dumping in important location like river bank, roadside, near institutions, health care centers etc.

4) Transfer Stations
Installation of Transfer Stations instead of secondary storage bins in cities (mandatory for population above 5 lakhs)

5) Separate Transportation [Rule 15 (q and r) SWM Rule]

- Compartmentalization of Vehicles (for biodegradable and non-biodegradable) for the collection of different fractions of waste
- Use of GPS in collection and transportation vehicles to be made mandatory at least in cities with population above 5 lakhs along with the publication of route map.

6) Public Sweeping [Rule 15 (n) SWM Rule]
All public and commercial areas to have twice daily sweeping, including night sweeping and residential areas to have daily sweeping

7) Waste Processing (Wet Waste, Dry Waste, MRF Facility) [Rule 15 (h and v) SWM Rule]

- Separate space for segregation, storage, decentralized processing of solid waste to be demarcated Establishing systems for home/decentralized and centralized composting/ generation of bio gas
- Arrangements for Material Recovery Facilities (separation of recyclable material like PET bottle, soft drink can etc.)
- Establishment of Refuse-derived fuel (RDF) plants/ waste to energy plants

8) Scientific Landfill [Rule 15 (w) of SWM Rule]
Setting up common or regional sanitary landfills by all local bodies for the disposal of permitted waste under the rules

9) Systems for the treatment of legacy waste to be established. Bulk Waste Generators (BWGs) [Rule 4 (6 and 7) of SWM Rule]
Bulk waste generators (having an average waste generation rate exceeding 100kg per day) to set up decentralized waste processing facilities as per SWM Rules, 2016

10) Preventing Solid Waste from entering into Water Bodies [Rule 4 (2) of SWM Rule]
Installation of suitable mechanisms such as screen mesh, grill, nets, etc. in water bodies such as nallahs, drains, to arrest solid waste from entering water bodies.

11) User Fee [Rule 4 (3) of SWM Rule]
All Waste Generators shall pay user fee for solid waste management, as will be determined by the bye-laws of the local bodies
12) Penalty Provision [Rule 15 (zf) of SWM Rule]
Impose / levy of spot fine for persons who litters or fails to comply with the provisions of these rules/ relevant act
13) Notification of Bye Laws [Rule 15 (e) of SWM Rule]
Frame bye-laws incorporating the provisions of SWM Rules, 2016 and ensuring timely implementation
14) C&D Waste (Rule 6(4) & 6(5) of C&D WM Rules)
Ensure separate storage, collection and transportation of construction and demolition wastes
15) Plastic Waste (Rule 4(c) PWM Rules)
Implementation of ban on plastics below less than 50 microns thickness and single use plastic
16) Citizen Grievance Redressal
Establish an effective grievance redressal mechanism for this purpose
17) Monitoring Mechanism

- ULBs to update month wise targets/action plans on the online format to the UD&MA dept. The monthly progress report format to be communicated soon
- The local body shall submit annual report on solid waste management in Form-IV as specified in Solid Waste Management Rule, 2016 to WBPCB and UD&MA department before 15 April each year.

West Bengal Pollution Control Board

The SWM rules have laid down comprehensive guidelines for solid waste storage, treatment and disposal and have designated the Urban Affairs Department of the State Govt. as the nodal authority for development of treatment and disposal facilities. Local authorities are primarily responsible for collecting, transporting and disposing these wastes and they are required to obtain Authorisation from the Board for MSW management. Operators appointed/ selected by municipal authorities to carry out MSW management on their behalf are also required to obtain authorization. In addition to obtaining authorisation, the local bodies are required to submit Annual Report in Form-IV of SWM 2016 rule to State Pollution Control Board and the Secretary-in-Charge of the state Department of Urban Development in case of metropolitan city and to the Director of Municipal Administration or Commissioner of Municipal Administration or Officer in -Charge of Urban local bodies in the state in case of all other local bodies of state.
The Board issues authorization for the establishment of Solid Waste management facilities after obtaining approval from a Committee comprising representatives of Kolkata Metropolitan Development Agency, Municipal Engineering Directorate, State Water Investigation Directorate, etc. The Board has also been entrusted with the duty of monitoring the compliance of MSW management facilities w.r.t. groundwater, ambient air, leachate quality and compost quality including incineration standards as specified in the Rules.
Under provisions of the EIA notification, 2006 and its amendments, **Environmental Clearance** is required to be obtained for setting up of Common MSW Management Facilities as these are considered as category 'B' projects. Both facilities to be set up by an individual municipal authority or facilities to be set up and shared by two or more municipal authorities are required to obtain EC with some minor exceptions. The EC is to be obtained prior to application for authorization under the SWM (Management & Handling) Rules, 2016. EC applications are to be submitted to the Department of Environment, Govt. of West Bengal.

State Policy and Strategy on Solid Waste Management for Urban Areas of West Bengal

This policy and strategy paper was prepared to help ULB and other service providers for discharging their functions in a more effective, efficient and sustainable manner with respect to Municipal Solid Waste Management. This shall help in being successful on the effort of creating the cities Zero Waste discharging and vat free through recycling of waste and deriving Energy/Compost from the waste. Few of the important features of this policy are as follows:

- The action plan proposes the minimum land requirement for Processing and dumping for every district in the state
- Changes in public behavior through electronic forms of communication as opposed to paper, reducing plastic waste significantly
- Promotion of recycled paper bags as an alternative to polyethylene bags
- Using state government's inhouse departments like I&CA Department, IT department for advertising and visual publicity to develop semi-customised software
- Existing municipal staff will not be removed till retirement whereas contractual staff will be phased out I favour of a new arrangement. As per this, self-help groups active in a ward or a group of wards may federate into a cooperative society which may enter into a hybrid contract with municipality.
- Waste treatment options for every waste type is given in the policy
- Policy suggests that the state would decide the option of technologies for treatment of wastes i.e. Waste to Energy or Waste to Compost. Government of India is providing Rs.1500 per ton as subsidy for encouraging its adoption
- The union Ministry for Non-Conventional and renewable Energy (MNRE) has given a directive that waste to energy tariffs are fixed for up to 2022 for a price of Rs. 6.12 per unit for the state of West Bengal
- All industrial units using fuel and located within one hundred km from a solid waste based refused derived fuel plant shall make arrangements within six months from the date of the notification of these rules to replace at least 5% of their fuel requirement by refused fuel so produced.
- Duties of every stakeholder have been mentioned in the policy document.
- All the hotels and restaurants shall ensure segregation of waste at source

Directions on non-compliance of Municipal Solid Waste Management Rules in the State of West Bengal by The National Green Tribunal Principal Bench, New Delhi on 02.04.2019

1. To submit compliance report on sanitation and public health.

2. The State should enforce and implement the Solid Waste Management Rules, 2016 in all respects and without any further delay.

3. The authorities (The Chief Secretaries/Advisers of States/UTs by the Registry of the Tribunal) are directed to take immediate steps to comply with all the directions contained in this judgment and submit a report of compliance to the Tribunal.

4. Preparation of State Action Plan in terms of SWM Rule, 2016 with timelines and budgetary support/ provision

5. The States should have Monitoring Committees headed by the Secretary, Urban Development Department with the Secretary of Environment Department as Members and CPCB and State Pollution Control Boards (SPCBs) assisting the Committees.

6. Regular interaction and reporting with State level Monitoring Committee (SLMC)

7. Preparation for Performance Audit by MoHUA, CPHEEO to be conducted for 500 ULBs with population of 1 lakh and above initially.

8. Best Practice Compliance:
   a) Setting up of Control Room where citizen upload photos of garbage (Both at ULB and State level)
   b) Installation of CCTV Camera at Compost center, Garbage clinic, Waste processing site/ Dump site
   c) GPS enabled monitoring system in Garbage collection Van
   d) Waste management information should be available on Public domain (Website) of ULBs

9. To prepare time bound action plans and execute the same so as to restore water and air quality

10. The Collectors were to have monthly meetings, as per Rule 12 and submit reports to State Urban Development Departments, with a copy to State Level Committees.

11. At least three major cities and as many major towns as possible in the State and at least three Panchayats in every District may be notified on the website within two weeks from today as model cities/towns/villages which will be made fully compliant within next six months.

12. The remaining cities, towns and Village Panchayats of the State may be made fully compliant in respect of environmental norms within one year.

Institutional Arrangement for MSW Arrangement

To make sure that all the stakeholders adhere to all the mentioned regulatory rules, it is necessary to have a strong and robust institutional arrangement. In India the institutional arrangement comprises of various state and central government bodies. The structure and coordination between all the departments is described below:

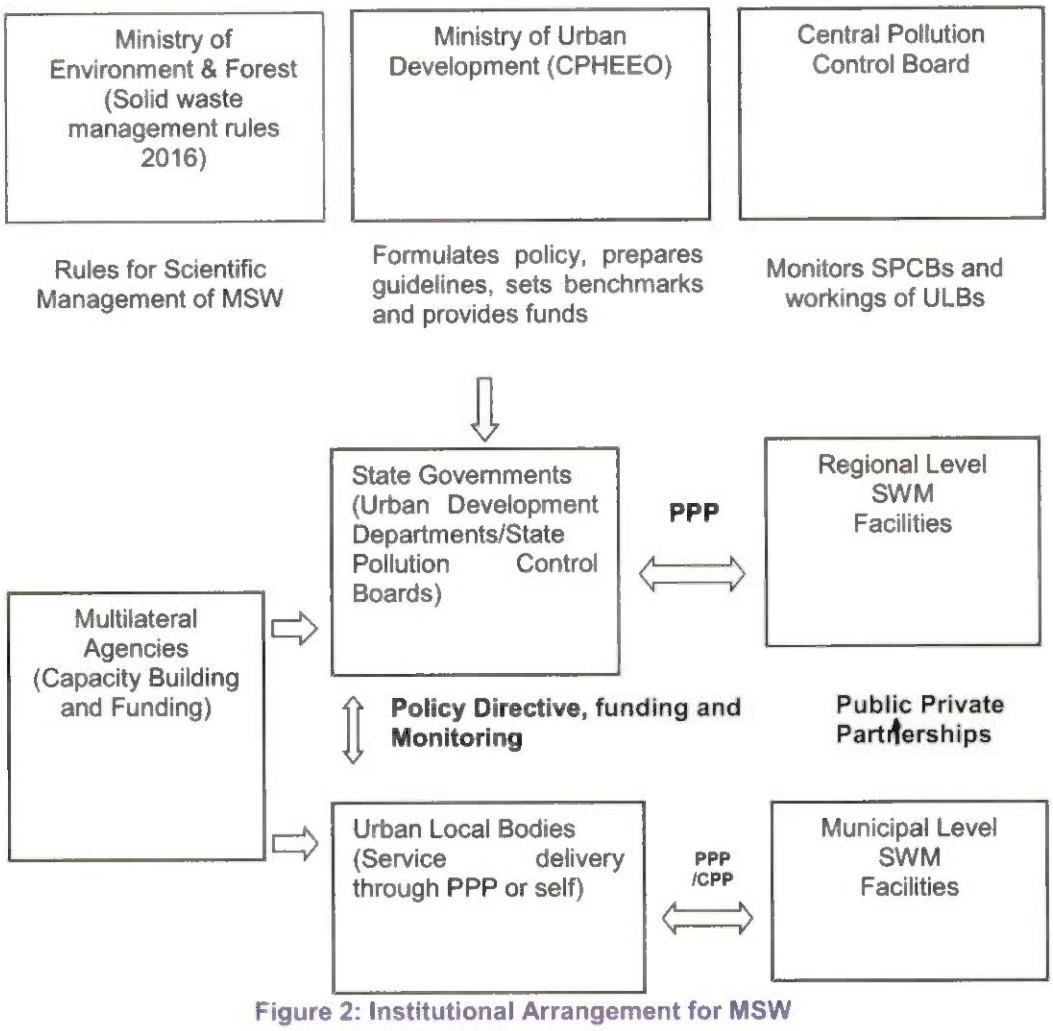


Figure 2: Institutional Arrangement for MSW

Roles and Responsibilities of Stakeholders

SWM 2016 has listed the duties and responsibilities of all the stakeholders:

Government:
Duties of the Secretary-in-charge, Urban Development in the States and Union territories. The Secretary, Urban Development and Municipal Affairs Department in the State through the commissioner or Executive Officers of Municipal Corporations/ Municipalities are as follows:

- Prepare a state policy and solid waste management strategy for the state or the union territory in consultation with stakeholders including representative of waste pickers, self-help group and similar groups working in the field of waste management consistent with these rules, national policy on solid waste management and national urban sanitation policy of the ministry of urban development, in a period not later than one year from the date of notification of these rules
- State policies and strategies should acknowledge the primary role played by the informal sector of waste pickers, waste collectors and recycling industry in reducing waste and

provide broad guidelines regarding integration of waste picker or informal waste collectors in the waste management system.

- Direct the town planning department of the State to ensure that master plan of every city in the State for setting up of solid waste processing and disposal facilities except for the cities who are members of common waste processing facility or regional sanitary landfill for a group of cities
- Ensure identification and allocation of suitable land to the local bodies within one year for setting up of processing and disposal facilities for solid wastes and incorporate them in the master plans (land use plan) of the State or, cities through metropolitan and district planning committees or town and country planning department
- Direct the town planning department of the State and local bodies to ensure that a separate space for segregation, storage, decentralized processing of solid waste is demarcated in the development plan for group housing or commercial, institutional or any other non-residential complex exceeding 200 dwelling or having a plot area exceeding 5,000 square meters
- Direct the developers of Special Economic Zone, industrial Estate, Industrial Park to earmark at least five percent of the total area of the plot or minimum five plots or sheds for recovery and recycling facility
- Facilitate establishment of common regional sanitary land fill for a group of cities and towns falling within a distance of 50 km (or more) from the regional facility on a cost sharing basis and ensure professional management of such sanitary landfills
- Notify buffer zone for the solid waste processing and disposal facilities of more than five tons per day in consultation with the State Pollution Control Board
- Start a scheme on registration of waste pickers and waste dealers.

ULB:

- Prepare a solid waste management plan as per state policy and strategy on solid waste management and abiding by the Solid Waste Management Rules 2016, Plastic Waste Management Rules 2016, e-waste (Management) Rules, 2016, Bio-Medical Waste Management Rules,2016, Construction and Demolition Waste Management Rules, 2016 and Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 within six months from the date of notification of state policy and strategy and submit a copy to respective departments
- Arrange for door to door collection of segregated solid waste from all households including slums and informal settlements, commercial, institutional and other non-residential premises. From multi-storage buildings, large commercial complexes, malls, housing complexes, etc., this may be collected from the entry gate or any other designated location of State Government
- Establish a system to recognize organizations of waste pickers or informal waste collectors and promote and establish a system for integration of these authorized waste-pickers and waste collectors to facilitate their participation in solid waste management including door to door collection of waste
- Facilitate formation of Self Help Groups, provide identity cards and thereafter encourage integration in solid waste management including door to door collection of waste
- Setup material recovery facilities or secondary storage facilities with sufficient space for sorting of recyclable materials to enable informal or authorised waste pickers and waste collectors to separate recyclables from the waste and provide easy access to waste pickers and recyclers for collection of
- Segregated recyclable waste such as paper, plastic, metal, glass, textile from the source of generation or from material recovery facilities; Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be printed white and those for storage of other wastes shall be printed black
- Establish waste deposition centres for domestic hazardous waste and give direction for waste generators to deposit domestic hazardous wastes at this centre for its safe disposal. Such facility shall be established in a city or town in a manner that one centre is set up for the area of twenty square kilometers or part thereof and notify the timings of receiving domestic hazardous waste at such centres

- Ensure safe storage and transportation of the domestic hazardous waste to the hazardous waste disposal facility or as may be directed by the State Pollution Control Board or the Pollution Control Committee
- Direct street sweepers not to burn tree leaves collected from street sweeping and store them separately and handover to the waste collectors or agency authorised by local body
- Phase out the use of chemical fertilizer in two years and use compost in all parks, gardens maintained by the local body and wherever possible in other places under its jurisdiction. Incentives may be provided to recycling initiatives by informal waste recycling sector
- Ensure that the operator of a facility provides personal protection equipment including uniform, fluorescent jacket, hand gloves, raincoats, appropriate foot wear and masks to all workers handling solid waste and the same are used by the workforce
- Frame bye-laws and prescribe criteria for levying of spot fine for persons who litters or fails to comply with the provisions of this strategy
- Develop ICT enabled services for the citizen and create public awareness through information, education and communication campaign and educate the waste generators.

Consumer:

- Every waste generator shall, – segregate and store the waste generated by them in three separate streams namely bio- degradable, non-biodegradable and domestic hazardous wastes in suitable bins and handover segregated wastes to authorized waste pickers or waste collectors as per the direction or notification by the local authorities from time to time
- wrap securely the used sanitary waste like diapers, sanitary pads etc., in the pouches provided by the manufacturers or brand owners of these products or in a suitable wrapping material as instructed by the local authorities and shall place the same in the bin meant for dry waste or non-bio- degradable waste
- store separately construction and demolition waste, as and when generated, in his own premises and shall dispose of as per the Construction and Demolition Waste Management Rules, 2016
- store horticulture waste and garden waste generated from his premises separately in his own premises and dispose of as per the directions from the local body time to time
- No person shall organise an event or gathering of more than one hundred persons at any unlicensed place without intimating the local body, at least three working days in advance and such person or the organiser of such event shall ensure segregation of waste at source and handing over of segregated waste to waste collector or agency as specified by the local body.
- All resident welfare and market associations shall, within one year from the date of notification of these rules and in partnership with the local body ensure segregation of waste at source by the generators as prescribed in these rules, facilitate collection of segregated waste in separate streams, handover recyclable material to either the authorised waste pickers or the authorized recyclers. The bio-degradable waste shall be processed, treated and disposed off through composting or bio-methanation within the premises as far as possible. The residual waste shall be given to the waste collectors or agency as directed by the local body.

Cluster formation

The quantity and composition of MSW generated in the ULB is essential for determining collection, processing and disposal options that could be adopted. They are dependent on the population, demographic details, principal activities in the city/ town, income levels and lifestyle of the community.

To assess the sufficiency of the existing and potential MSW treatment, the following three parameters has been considered by SUDA for clustering as per the policy mentioned in 1.2.5:

- Distance between cities
- Waste generated by cities
- Per capita waste generated

1.4 Administrative structure of ULBs in West Bengal

The purpose of municipal governance and strategic urban planning in a country is to create effective, responsive, democratic, transparent, accountable local governance framework organized according to a rational structure that promotes responsiveness and accountability; to provide responsive policy guidance and assistance to sub-national entities; to strengthen the legal, fiscal, economic and service delivery functions of municipalities; and to foster greater citizen participation in the governance of local bodies.

Municipality

Background

Municipal Bodies have been accorded constitutional status in the 74th Constitutional Amendment Act of 1992 and raised to the status of 'Government' at the local level. Article 243W of the Constitution of India envisages that the State Government may, by law, endow the municipalities with such powers and authority as may be necessary to enable them to function as institutions of self-government and such law may contain provisions for the devolution of powers and responsibilities upon municipalities, subject to such conditions as may be specified therein, with respect to (i) preparation of plans for economic development and social justice and (ii) performance of functions and the implementation of schemes

Organizational Structure

Department of Municipal Affairs is entrusted with the responsibility of providing legal and administrative support to the ULBs of the State and to implement some of the development program through the municipal bodies. Urban development planning and infrastructural development are looked into by the Urban Development Department through various autonomous authorities/ agencies created under relevant Acts. Currently, one Minister-in-Charge looks after the affairs of the department. The Secretariat supervises the various functions of the Directorate and other organizations which are related to the department.

Chairman / Mayor, elected by the majority of the Board of Councilors (BOC), is the executive head of the ULB and presides over the meetings of the Chairman-in- Council / Mayor-in-Council responsible for governance of the body. The executive power of a ULB is exercised by the Council. The Chairman-in-Council / Mayor-in-Council, enjoys such power as is delegated by the Board. Every ULB, having a population of three lakh or more, groups the wards into five (up to 15 in respect of a municipal corporation) boroughs. The boroughs are constituted with not less than six contiguous wards and a Borough Committee is constituted for each borough. The Councilors of the respective wards are the members of such Borough Committee and elect the Chairman (not being a member of Chairman-in- Council / Mayor-in-Council) from among themselves.

Establishment of ULB is headed by an Executive Officer / a Commissioner. Other officers are also appointed to discharge specific functions of respective area / nature. Executive Officer / Commissioner, subject to the supervision and control of the Chairman / Mayor, functions as the principal executive of the ULB. The Executive Officer / Commissioner and the Finance Officer exercise such powers and perform such functions as are notified by the State Government from time to time.

Previously the Municipal Affairs of this State was administered by the Bengal Municipal Act, 1932. Later, in the end of '80s it was felt necessary to replace the said Act with an updated legislation. Accordingly the West Bengal Municipal Act, 1993 has been enacted on the 13th day of July, 1994 and the said new Act has replaced the Bengal Municipal Act, 1932.

1.5 Aims and Objectives

The proposed project aims to improve the existing waste management system of cluster 1: Dum Dum, North Dum Dum, South Dum Dum, Baranagar, Kamarhati and New Barrackpore by

understanding the gaps in the infrastructure, technical capability, financial muscle and managerial competence of the cluster-1 and each ULB's. The proposed project will identify key intervention areas along the solid waste management value chain. The outcome of the project is to propose a sustainable solid waste management by leveraging the current system followed by municipal bodies involved. This project has an aim to develop a financially feasible structure for private sector participation for the project to make an efficient solid waste management system. To maintain the above mentioned qualitative objectives, current waste management system should become effective at every point in solid waste management value chain. Following are the service level benchmarks for the same:

Service Level Benchmarks

To set minimum performance standards for public services, a Service Level Benchmarks (SLBs) programme has been undertaken by the Ministry of Housing and Urban Affairs (MoHUA)/MoUD since 2009 emphasizing on an increased focus on delivery of service outcomes. The programme covers vital services offered by the ULBs that include water supply, wastewater and solid waste management. The minimum set performance parameters for SWM services include:

1. Household Level Coverage - 100%
2. Efficiency in Collection of Solid Waste - 100%
3. Extent of Segregation of MSW - 100%
4. Extent of MSW Recovered - 80%
5. Extent of Scientific Disposal of MSW - 100%
6. Extent of Cost Recovery - 100%
7. Efficiency in Collection of SWM Charges - 90%
8. Efficiency in addressing of Customer Complaints - 80%

Performance-related funds were earmarked under the 13th Finance Commission for improvements in SLBs including SWM. The focus is to achieve 100% source segregation, efficient door-to-door collection, minimize manual handling of waste and increase efficacy of covered transportation. Waste management is a mammoth task which stands complicated with the increase in urbanization, changing lifestyles, and increase in consumer behaviour. Though the issue of recycling of solid waste has received attention to the authorities of ULBs yet it is not being implemented up to the mark due to lack of proper guidance and technology. Apart from commonly faced issues by government, an increasing pressure from NGT and various other boards made this project a necessity.

Primary and most important aim of the government is to reach the service level benchmarks listed above. Few of the unlisted goals include increase in awareness of every individual with respect to solid waste management, awareness of the ULBs, making system efficient which shall help in achieving the said aims and objectives of the project.
NGT had issued guidelines regarding management of legacy waste at both the dumpsites (Pramod Nagar & Kamarhati). An objective of this assignment is to follow those guidelines and clear the present dump of waste to construct processing facilities.

Solid waste management processes should be adhered to CPCB guidelines with respect to handling and processing of waste. These guidelines form an important part of the institutional structure for the solid waste management.

As cluster 1 represents ULBs in the important and denser part of the Kolkata, the available land is the most we can have for processing of the waste. An optimization of this land is another major objective of this assignment. Removing current waste from the land and adding processing plant simultaneously is the most forward way to do so.

Once processing of waste starts, huge environmental burden will be taken off with respect to land, air, water, noise and land pollution. To do so in long run is also an important objective of this project. A holistic approach to waste management to extract maximum value from waste and dispose it in a safe manner.

2 Project Development

2.1 Project background

As mentioned in the introduction, Government of West Bengal has taken several steps/ initiatives for making all the cities Clean, Green and Beautiful with special emphasis on management of Solid Wastes in Municipal Towns of the State. One of the obligatory functions of the Municipal Bodies is to remove solid waste from the cities under Sections 63, 95B, 260, 273 of the West Bengal Municipal Act, 1993 and corresponding provisions of the statute governing Municipal Corporations in West Bengal.

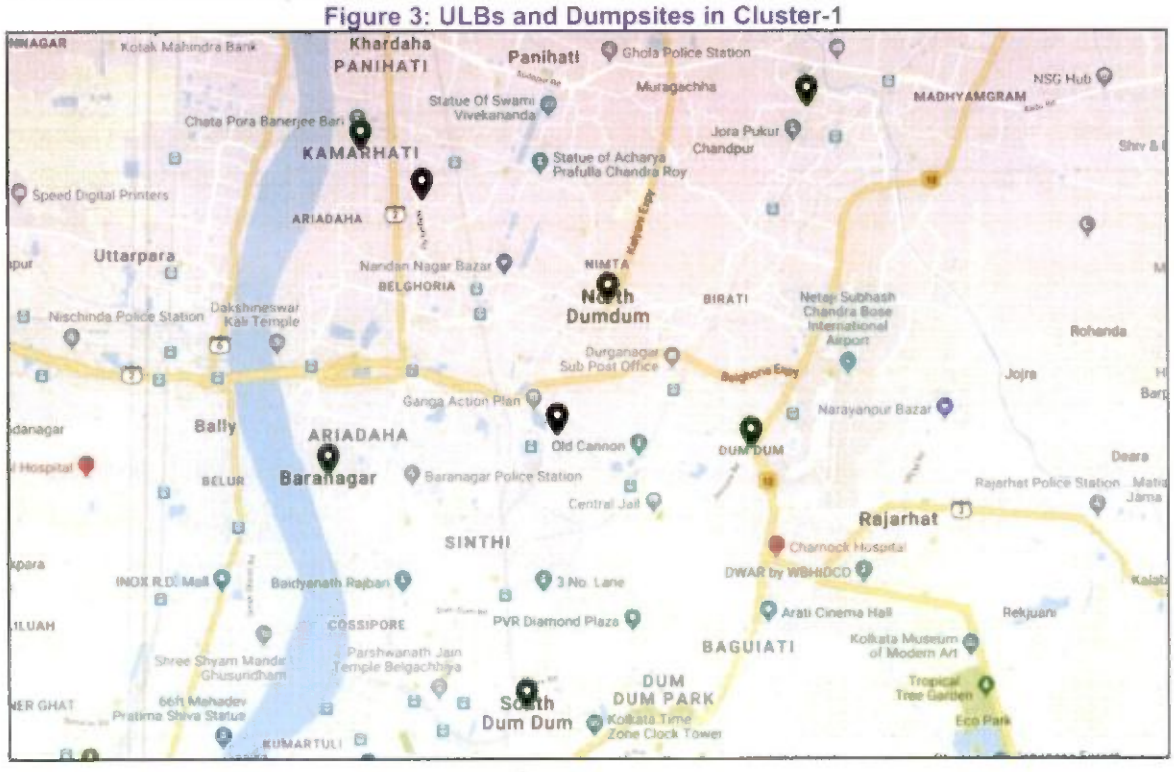
Under Mission Nirmal Bangla, number of equipment's such as garbage bins, compactors, hydraulic tippers and other vehicles, community bins were granted to Municipal Bodies to assist them in systematic collection of garbage from individual holdings, their transportation and stacking before disposal. Land has also been provided through inter departmental transfer to municipal bodies to set up dumping ground and solid waste processing plants. In some cases, these bodies have been permitted to purchase private land for setting up these facilities. The municipal bodies are required to collect waste from individual holdings systematically and transport them regularly to the solid waste disposal facility and get them recycled/processed scientifically. There are some sporadic efforts by some municipalities to collect waste and process them to the best of their abilities. It is, however, a fact that most municipal bodies need additional support in the technical capability, financial muscle and managerial competence aspects to handle solid waste in a scientific manner. Hence SUDA (State Urban Development Authority) formulated this project to identify gaps in existing technical, financial, infrastructure of respective municipalities and to improve the current situation of solid waste management substantially.

Proposed scheme as per RFP/Contract

Cluster-1 consists of 6 ULB's - Dum Dum Municipality, North Dum Dum Municipality, South Dum Dum Municipality, Baranagar Municipality, Kamarhati Municipality, and New Barrackpore Municipality.. As per scope, PramodNagar site (adjacent to Belgharia Expressway) was identified for setting up the processing plant and a Sanitary Landfill Site (SLF) for these 6 municipalities.

The details of ULBs are given below:

Figure 3: ULBs and Dumpsites in Cluster-1



1. Dum Dum

Dum Dum is located at 22.62°N 88.42°E. It has an average elevation of 11 meters. It is a city and a municipality of North 24 Parganas district in the Indian state of West Bengal and a part of the area covered by Kolkata Metropolitan Development Authority (KMDA).It is bounded by North Dumdum (municipality) on the north and a part of the west, Rajarhat CD Block on the east, and South Dumdum (municipality) on the south and a part of the west. As per the 2011 Census of India, Dum Dum had a total population of 114,786, of which 58,566 (51%) were males and 56,220 (49%) were females. Population below 6 years was 8,259. The total number of literates in Dum Dum was 97,997 (91.99% of the population over 6 years). Dumdum has an average literacy rate of 82%, higher than the national average of 59.5%: male literacy is 85% and, female literacy is 78%. In Dumdum, 8% of the population is under 6 years of age. Its brief profile is as follows:

Area	9.37 sq kms
Total population (as per Census 2011)	114786
Female population	56220
Male population	58566
Total number of wards	22

2. North Dum Dum

North Dum Dum is located at 22.6520800°N 88.4190700°E. It is a city and a municipality of North 24 Parganas district in the Indian state of West Bengal. It is bounded by Panihati (municipality), Teghari, Muragachha, Chandpur (all three census towns in Barrackpore II CD Block) and New Barrackpore (municipality) on the north, Barasat II CD Block and Rajarhat CD Block on the east, Dum Dum (municipality) and South Dumdum (municipality) on the south, and Panihati (municipality) on the west. As per the 2011 Census of India, North Dum Dum had a total population of 249,142, of which 126,279 (51%) were males and 122,863 (49%) were females. Population below 6 years was 18,411. The total number of literates in North Dum Dum was 209,964 (91.00% of the population over 6 years). It had a population of 220,032. Males constitute 51% of the population and females 49%. North Dumdum has an average literacy rate of 82%, higher than the national average of 59.5%: male literacy is 86%, and female literacy is 79%. In North Dumdum, 9% of the population is under 6 years of age. Its brief profile is as follows:

Area	20 sq kms
Total population (as per Census 2011)	249142
Female population	126279
Male population	122863
Total number of wards	34

3. South Dum Dum

South Dumdum is located at 22.61°N 88.40°E. South Dumdum is a city and a municipality of North 24 Parganas district in the Indian state of West Bengal and a part of the area covered by Kolkata Metropolitan Development Authority (KMDA). South Dumdum is bounded by North Dumdum (municipality) and Dum Dum (municipality) on the north, Baguiati on the east, Bidhannagar on the south, and Belgachia and Sinthee in Kolkata district and Baranagar (municipality) on the west. As per the 2011 Census of India, South Dum Dum had a total population of 403,316, of which 202,214 (50%) were males and 201,102 (50%) were females. Population below 6 years was 28,703. The total number of literates in South Dum Dum was 344,971 (92.09% of the population over 6 years). South Dumdum had a population of 392,150. Males constitute 51% of the population and females 49%. South Dumdum has an average literacy rate of 83%, higher than the national average of 59.5%: male literacy is 87%, and female literacy is 80%. In South Dumdum, 8% of the population is under 6 years of age. Its brief profile is as follows:

Area	17.25 sq kms
Total population (as per Census 2011)	403316
Female population	201102
Male population	202214
Total number of wards	35

4. Baranagar

Baranagar is located at 22.64°N 88.37°E. It has an average elevation of 12 meters (39 feet). It is a neighbourhood in Kolkata and a municipality of North 24 Parganas district in the Indian state of West Bengal. It is situated in the region of Greater Kolkata and therefore is a part of the area covered by Kolkata Metropolitan Development Authority (KMDA). More particularly to say, the boundary of Baranagar is - in the east, the Rail line from Sealdah towards Krishnanagar; in the west - the holy river Ganga, in the north - PWD Road and in the south - Baranagar Bazaar. It is connected by the holy Ganges to Dakshineshwar temple which lies just a quarter of a mile from this place. As per the 2011 Census of India, Baranagar had a total population of 245,213, of which 126,187 (51%) were males and 119,026 (49%) were females. Population below 6 years was 16,825. The total number of literates in Baranagar was 208,779 (91.41% of the population over 6 years). Baranagar had a population of 250,615. Males constitute 53% of the population and females 47%. Baranagar has an average literacy rate of 82%, higher than the national average of 59.5%; with 55% of the males and 45% of females' literate. 8% of the population is under 6 years of age. Its brief profile is as follows:

Area	7.12 sq kms
Total population (as per Census 2011)	245123
Female population	119026
Male population	126187
Total number of wards	34

5. Kamarhati

Kamarhati is located at 22.67°N 88.37°E. Kamarhati is a city and a municipality of North 24 Parganas district in the Indian state of West Bengal and a part of the area is covered by Kolkata Metropolitan Development Authority (KMDA). The sacred temple at Dakshineshwar is situated in Kamarhati municipal area. Neighbourhoods such as Belgharia and Ariadaha are part of this municipality. The Kamarhati Municipality is located in Rathtala on BT Road. Kamarhati is bounded by Khardaha and Panihati on the north, North Dumdum on the east, Baranagar on the south, and the Hooghly on the west. As per the 2011 Census of India, Kamarhati had a total population of 331163, of which 170,293 (52%) were males and 159,918 (48%) were females. Population below 6 years was 25,350. The total number of literates in Kamarhati was 267,267 (87.67% of the population over 6 years). Kamarhati had a population of 314,334. Males constitute 54% of the population and females 46%. Kamarhati has an average literacy rate of 77%, higher than the national average of 59.5%: male literacy is 81%, and female literacy is 72%. In Kamarhati, 9% of the population is under 6 years of age. Its brief profile is as follows:

Area	10.9 sq kms
Total population (as per Census 2011)	331163
Female population	159918
Male population	170293
Total number of wards	35

6. New Barrackpore

New Barrackpore is located at 22.7°N 88.45°E. New Barrackpore is a city and a municipality in Kolkata of North 24 Parganas district in the Indian state of West Bengal. It is a part of the area covered by Kolkata Metropolitan Development Authority (KMDA).

As per the 2011 Census of India, New Barrackpore had a total population of 76,879, of which 38,239 (50%) were males and 38,607 (50%) were females. Population below 6 years was 5,157. The total number of literates in New Barrackpore was 67,384 (93.99% of the population over 6 years). New Barrackpore had a population of 83,183. Males constitute 50% of the population and females 50%. In New Barrackpore, 7% of the population is under 6 years of age.The literacy rate is 95.19% where the male literacy rate is 97.66% and female literacy rate is 92.72%. Its brief profile is as follows:

Area	8.69 sq kms
Total population (as per Census 2011)	76879
Female population	38607
Male population	38239
Total number of wards	20

Table 1: Population & waste generation details of Cluster - 1

S. No	ULB	Population projection for 2019	Current Waste generation in 2019 (Tons per day)	Solid Waste Generated (Shared by ULB's) in TPD	Population projection for 2027	Estimated waste generation in 2027 (Tons per day)	Population projection for 2042	Estimated waste generation in 2042 (Tons per day)
1	Dum Dum	127281	59.35	62.1	189306	75.72	294399	117.76
2	North Dum Dum	276263	102.93	150	345079	120.78	461216	161.43
3	South Dum Dum	446869	204.07	698	506459	227.91	614345	276.46
4	Baranagar	271906	110.03	145	309441	123.78	388725	155.49
5	Kamarhati	367212	124.25	100	380981	133.34	433299	151.65
6	New Barrackpore	85237	34.62	29	108831	38.09	132080	46.23

2.2 Existing scenario of MSW management

To understand and analyze the current situation of solid waste management, the Transaction Advisor Team of EY LLP has carried out visits to all the ULBs, Pramodnagar Dumpsite and Kamarhati Dumpsite and initial meetings with the stakeholder's viz. municipalities, KMDA, WBPCB and SUDA.

Stakeholder Meetings

S.No	Date	Department	Purpose	Attendees
1	9 April 2019	SUDA	Initial meeting between ULB's, SUDA and Transaction Advisor - EY LLP	Mr. Abhaya Agarwal Mr. Puneet Babbar Mr. Saurabh Awatade Ms. Akhila Nunna Mrs. Chaitali Mondal

2	24 April 2019	SUDA	Brief discussion with municipality officials and sharing the detailed questionnaire formats required for TFR preparation with ULBs	Smt. Debarati Dutta Gupta, Director Sh. Amitava Das, Deputy Director Dr. Sujay Mitra, Chief Engineer Sh. B.K Pal, Executive Engineer Officials from all municipalities
3	26 April 2019	KMDA	Discussion regarding PramodNagar dumpsite challenges and gathering technical & design details of existing facilities	Sh. S.K Baidya, Chief Engineer Sh. Utpal Mandal, Supt. Engineer Sh. T. Bhowmik, Ex. Engineer Sh. T. N Banerjee, Ex. Engineer
4	26 April 2019	WBPCB	Deliberation on expected Environmental and compliance issues in the project and its remediation strategies	Dr. T.K Gupta, Chief Engineer Sh. Shishir Mondal, Env. Engineer

Field Visits to Cluster ULBs

S.No	Date	Location Visited	Purpose	Team Members
1	11 April 2019	Pramodnagar Dumpsite, South Dum Dum, Kamarhati, Kamarhati Dumpsite, New Barrackpore	To assess the current situation, interaction with ULB's	Mr. Puneet Babbar Mr. Saurabh Awatade Ms. Akhila Nunna Mrs. Chaitali Mondal
2	12 April 2019	North Dum Dum, Baranagar, Dum Dum	To assess the current situation, interaction with ULB's	Mr. Puneet Babbar Mr. Saurabh Awatade Ms. Akhila Nunna Mrs. Chaitali Mondal
3	28 May 2019	Panihati Land area	To assess the current situation of low-lying areas identified for disposing legacy waste processing rejects	Mr. Puneet Babbar Mrs. Chaitali Mondal

The following are the observations made on solid waste management current situation from the field visits and meetings with the stakeholders:

- The municipalities are responsible for the primary collection, transportation and disposal of solid waste in Cluster-1. Even though the household coverage of solid waste collection stands at 100% in all municipalities, the source segregation at household level is not performed by public. Because of this, the problem is further compounded to rest of the collection and transportation mechanism.
- In addition to the segregation problem, the all vehicles used for primary collection are not partitioned. In case of few municipalities, despite the efforts made the waste is not collected separately due to no partition in primary collection vehicles.

Picture of Primary Collection Vehicles from Site visit

- The ULB's have a very limited area available to set up intermediate transfer stations. Hence, they have mobile compactor station stations majorly and very few stationary compactor stations and there is a very less possibility of setting up new transfer stations in the ULBs.
- The inefficient waste transfer system is also minimizing the possibility of implementing a secondary segregation at these transfer points. The waste collected in the primary vehicles are dumped openly at a small temporary transfer land which is mostly beside a road and the waste is then fed into mobile compactors. Delay in the collection of waste from the temporary points can evolve a mini dumpsite. The secondary segregation is only done by informal private parties at stationary compact stations which is not adequate.

Pictures of Secondary Collection from Site Visits

Mobile Intermediate Transfer Station

Loading waste into Mobile Compactors

Stationary Intermediate Transfer Station

- The secondary segregation by informal private players at stationary intermediate transfer stations and compaction is the only waste processing that happens before dumping waste in Pramodnagar dumpsite. It is the only operational dumpsite for all the municipalities in cluster-1.
- PramodNagar site comes under the jurisdiction of South Dum Dum municipality, having a land area of approximately 22 acres. The site is surrounded by a few residential settlements, water body and Belghoria Expressway. It also comes under the Buffer zone of Dum Dum Airport. The height of waste dump has reached to 15-16 meters at some places causing serious concerns to Air, Land and Water ecosystems. To dispose waste scientifically, KMDA has undertaken constructing of a 50 TPD (Tons per Day) Compost plant along with a sanitary landfill cell in Pramodnagar Dumpsite. The site also has three huge mounds of Legacy waste which is also a major challenge.
- Another dumpsite of around 8 acres land area is located within the jurisdiction of Kamarhati Municipality, which is used for dumping waste from nearby areas. Currently there is no more land area available for dumping of solid waste in cluster ULB's. At present all the waste from cluster ULB's has been diverted to PramodNagar site for disposal. This dumpsite is also surrounded by residential areas.

Picture of Pramodnagar Dumpsite

Picture of Kamarhati Dumpsite

2.3 Issues in the proposed scheme by SUDA

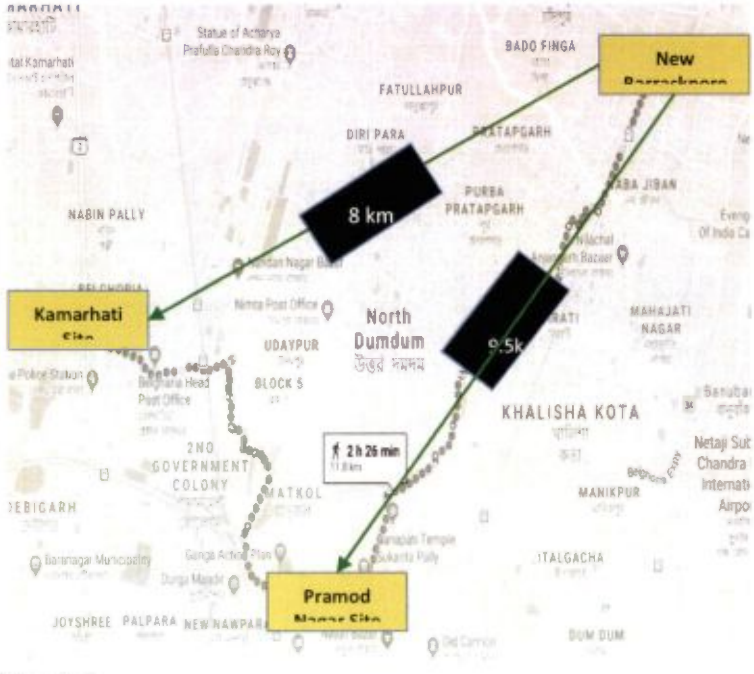
1) The PramodNagar site was already filled with legacy waste which stacked up to an average height of around 15-16 meters and measures approximately 22 acres. As per the KMDA's estimation, approximately 10 lakh metric tons solid waste is lying at Pramod Nagar site. Therefore, it is very difficult to perform any kind of construction activity without disposing the existing waste from the dumpsite. However about 6 Lakh tonnes of legacy waste has been estimated based on the topographical survey.
2) In addition to the legacy waste, the 50 TPD composting plant cannot treat total waste generated in Cluster-1, which is estimated to be at least 600 TPD to 700 TPD. Approximately, a land area of 30 acres is needed to set up a processing plant of 500 TPD capacity (approx.) and SLF considering 20% processing rejects, (100 TPD). So, constructing processing plant of 500 TPD and setting up the SLF with a design period of 20-25 years at the same place for disposal of rejects is not a feasible option due to less available area. The design period of SLF or capacity of processing plant has to be compromised to set up both at same land area, which will evolve new problem in the site.
3) Around 60 - 70% fraction out of 6 lakh metric tonnes of waste lying in Pramodnagar will be rejects or inerts. This should be disposed preferably in Low lying areas or by conducting landscaping activities a per "NGT guidelines on Legacy Waste". Therefore, liability on the bidder for disposal of around 3.6-4.2 lakh tonnes rejects can be a major bottleneck in the success of the project owing to cost of disposal and non-availability of disposal land.
4) As mentioned in the Schedule-I of SWM Rules 2016, the site is not suitable for setting up an SLF because it does not fulfil the land selection criteria. This aspect primarily includes vicinity to residential settlement, highway and water bodies and its location into the buffer zone area of Dum Dum Airport. Due to this, permission of getting EC (Environmental Clearance) may

become a major issue in future, which will affect the project sustainability. The issue was also discussed with the WBPCB officials during initial visits and they also have the same view regarding EC.

2.4 Suggested scheme revision

1) As mentioned in the observations of site visits, the Kamarhati municipality has its own dumpsite. The site measures an area of approximately 8 acres and it is full of legacy waste. It is suggested that a processing plant for Kamarhati municipality should be proposed on the existing closed dumpsite at Kamarhati after land reclamation. The land reclamation for the site needs to be carried out, in parallel to the processing plant construction. KMDA has already started carrying out initial surveys namely demarcation of boundary and Topographical survey of this site.
2) If possible, New Barrackpore Municipality may also be integrated with Kamarhati Municipality for waste processing at Kamarhati site. A new plant at Kamarhati site for processing waste from Kamarhati and New Barrack pore municipalities will reduce the stress on PramodNagar site by decreasing waste input by 100-120 TPD.
3) PramodNagar Site should cater to the waste from Dum Dum, North Dum Dum, South Dum Dum and Baranagar only. Accordingly, a plant of at least 500 - 600 TPD capacity should be planned at PramodNagar site with provision of future waste generation assessment and expansion. Again, the land reclamation activities need to be carried out in parallel to the plant construction.
4) Legacy Waste Processing rejects from both the sites (PramodNagar & Kamarhati) needs to be disposed in appropriate manner. Following options has been explored for the same:
   a) KMDA has identified a low-lying area near Panihati for disposal of legacy waste rejects. They are also carrying out basic surveys at this site to assess its suitability in terms of volume for legacy waste disposal.
   b) Agencies like WBIDC (West Bengal Industrial Development Corporation), WBSIDC (West Bengal Small Industries Development Corporation) and HIDCO (West Bengal Housing and Infrastructure Development Corporation) can be approached, if anyone of them can channelize this fraction into their city development projects as landscaping component.
   c) Alternatively, a part of legacy waste rejects from Cluster-1 sites can be taken to Cluster-4 RWMC site for disposal, in addition to the above two options.
5) The distance between New Barrackpore and Kamarhati site is less compared to distance between New Barrackpore and Pramodnagar Site.

Figure 3: Distance comparison for Kamarhati and Pramodnagar Site



6) The common SLF for fresh waste processing rejects from both the sites (Pramod Nagar & Kamarhati) should be planned at a different site. This will be helpful in following aspects:
   a) It will help in setting up the processing plant of adequate capacity (say initially 700-800 TPD capacity) and leaves land available for future expansion.
   b) It will also provide flexibility to the developer to plan or try additional components, like Biogas plant or Plastic to fuel, etc., in addition to the Compost + RDF facility.
   c) Shifting of SLF from Pramod Nagar, would also facilitate the developer during initial operations at site. Because it will spare enough land for mobilizing the civil machinery and other equipment to carry out multiple activities viz; remediating legacy waste, handling fresh waste and carry out new plant construction at the same time.
7) Options for setting up new SLF elsewhere than Pramod Nagar are:
   a) It was informed during the meetings that KMDA is looking for new land area. In fact, KMDA is looking for suitable lands and analyzing the options as per the area requirement given by TA.
   b) Existing SLF of RWMC for Cluster-4, can be used for disposing fresh waste processing rejects or inerts from Cluster-1 also. Although it will affect the design life of SLF at RWMC and it may be reduced to 10-12 years from 20 years as expected, but department can have a readymade solution. Later, the department will need to identify another site for SLF after 10-12 years for the rejects from Cluster 1 & 4.
8) Until a new contract is awarded to successful developer for Pramod Nagar site, the existing work of 50 TPD compost plant and SLF Cell should be put on hold because of following reasons:
   a) The existing assets for the 50 TPD compost plant and SLF will need to be transferred to the new developer after successful bidding. For compost plant, the civil construction is almost complete, but electro-mechanical equipment still needs to be ordered. Whereas for SLF, only embankments have been designed as of now and no liner material has put in place. When any new developer will come into picture, he may have its own design of processing line or different specification of liner material. This aspect may hinder the smooth handing over and taking over process at later stage. Therefore, it is suggested that any further progress should be avoided, and the present assets should be handed over to new developer on as it is basis.
   b) Considering the site layout, nearby geographical features and space constraint, it is strictly recommended that SLF should not be designed as an integral part of the processing plant at Pramod Nagar. This may have future Environmental constraint.
   c) The waste dumping profile at Pramod Nagar site at least 2-3 meter below the Ground level, as informed by KMDA officials. However, present SLF is being constructed by KMDA through compacting the waste approx. 1 meter above GL. This is technically incorrect and does not reflect scientific approach.
   d) Lastly, construction of 50 TPD Compost plant and SLF cell has disturbed over the entire layout of the site. There is hardly any space left for setting up new machinery or for movement of construction equipment.

3 Project Studies

3.1 Data Collection

As part of the study conducted to understand technical, economical and operational viability of Solid Waste Management, EY team has prepared a primary and detailed self-completion questionnaire to collect information from the ULB's. This information will be analysed to get a snapshot of SWM status in terms of the following aspects:

- Household coverage
- Extent of segregation
- Infrastructure gap in terms of Manpower, vehicles, processing plants for:
  - Primary collection & transportation
  - Transfer Stations
  - Secondary collection & transportation
  - Processing plant
  - Disposal facilities
- Standard of compliance with state and central norms on SWM.

EY team has also visited each of the ULBs and conducted a workshop to explain the nature of data required and the importance of the same. Format of the primary and secondary questionnaire has been attached in annexure II.

3.2 Waste Characterization of Fresh Waste

Solid waste is very heterogeneous in nature and its composition varies with place and time. Even samples obtained from the same place (sampling point) on the same day, but at different times may show totally different characteristics. Waste characterization has been done in all the ULBs to find out the physical and chemical components of MSW in Cluster-1.

The following parameters are analysed based on the waste sample collected for the **fresh waste** from each of the ULBs:

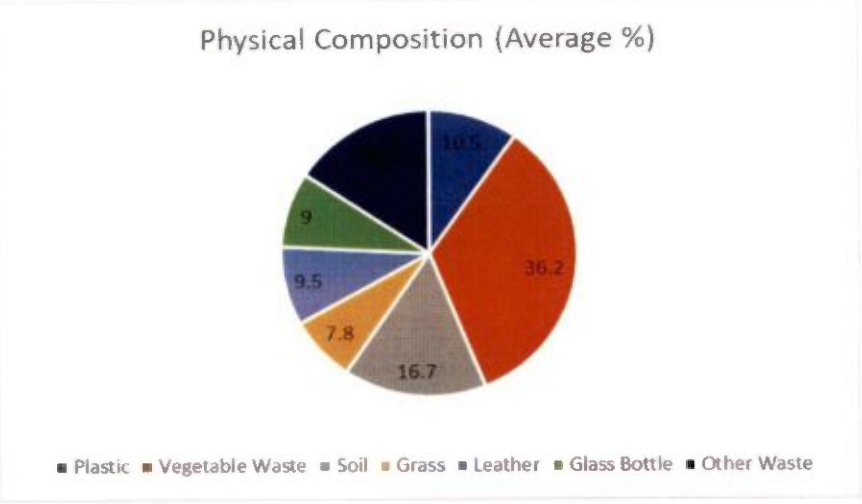
(a) Parameters tested:

i. Physical composition includes percentage fractions of different components in mixed waste & Sieve analysis results.

Table 1: Test Results

S.No	Test Parameters	Unit	Dum Dum	North Dum Dum	South Dum Dum	Kamarhati	New Barrackpore	Baranagar	Average
1.	Texture	--	Solid	Solid	Solid	Solid	Solid	Solid	Solid
2.	Smell	--	Rotten Odour	Rotten Odour	Rotten Odour	Rotten Odour	Rotten Odour	Rotten Odour	Rotten Odour
3.	Solids Constituent								
	a) Plastic	%	10	12	09	14	10	08	10.5
	b) Vegetable Waste	%	12	50	15	50	50	40	36.2
	c) Soil	%	30	15	25	12	08	10	16.7
	d) Grass	%	07	--	05	10	12	05	7.8
	e) Leather	%	08	10	08	--	--	12	9.5
	f) Glass	%	05	05	05	--	10	20	9

	Bottle								
	g) Other Waste	%	28	08	33	16	10	05	16.7
4.	Probe Moisture		29	30	27.5	31	31	26	29.1



ii. Chemical composition will include Moisture Content, Ash Content, Gross CV Value, Bulk Density.

Table 2: Chemical Composition

S.No	Test Parameters	Unit	Dum Dum	North Dum Dum	South Dum Dum	Kamarhati	New Barrackpore	Baranagar	Average
1.	Bulk Density	gm/cc	0.53	0.62	0.59	0.49	0.48	0.55	0.54
2.	Total Organic Content	%	10.40	8.95	12.81	6.85	7.30	8.40	9.12
3.	Moisture Content	%	63.51	66.85	75.91	45.55	70.71	64.67	64.5
4.	Ash Content (Dry Basis)	%	33.69	15.99	56.32	34.80	9.53	28.50	29.8
5.	Nitrogen	%	0.36	0.31	0.27	0.28	0.33	0.39	0.32
6.	C:N ratio	--	28.9	28.87	47.4	24.5	22.12	21.5	28.88
7.	Gross Calorific Value (Dry Basis)	Kcal/kg	2343	5489	2154	2715	3891	3403	3332

The original test reports have been attached in the Annexure IV

3.3 Waste Composition of Legacy Waste and its TCLP test (For dumpsite waste)

Legacy waste has always been a major concern with exhausted dumpsites. Legacy waste is a result of dumping of waste and leaving untreated garbage at dumpsites for decades. Toxicity characteristic leaching procedure (TCLP) is a soil sample extraction method for chemical analysis employed as an analytical method to simulate leaching through a landfill. There is a need to bio mine the legacy waste and dispose off the inert in a low-lying area before initiating any construction

work in the dumpsites at Prmodnagar and Kamarahati. When this dumped legacy waste is exposed to any kind of moisture, it tends to release heavy amounts of toxic chemicals along with the leachate. TCLP is conducted to understand the potential of the leachate in releasing toxic chemical. EY team hired a laboratory partner (Mars Consultants) to perform these tests. The testing methodology is used to determine if a waste is characteristically hazardous or not.

i. Waste Composition: This composition required 2 or 3 samples, based on the dump area, preferably taken from some depth to reflect actual results. No testing of top layer. Only Physical composition, Sieve analysis and Bulk density were calculated.
ii. TCLP: For legacy waste, it is required to assess the leachability potential 'or' the potential to bleed heavy metals and other toxic elements, when tested with zero water (solvent).

Table 3: Results of Physical Properties of Legacy Waste

S.No	Test Parameters	Unit	Pramodnagar Dumpsite	Kamarhati Dumpsite
1.	Texture	--	Solid Dust	Solid
2.	Smell	--	Pungent Odour	Slight Foul Smell
3.	Solids Constituent			
	a) Plastic	%	15	20
	b) Vegetable Waste	%	--	--
	c) Soil	%	55	50
	d) Grass	%	--	--
	e) Leather	%	12	10
	f) Glass Bottle	%	10	05
	g) Other Waste	%	08	15
4.	Probe Moisture	%	15	14
5	Moisture Content	%	6.87	NA

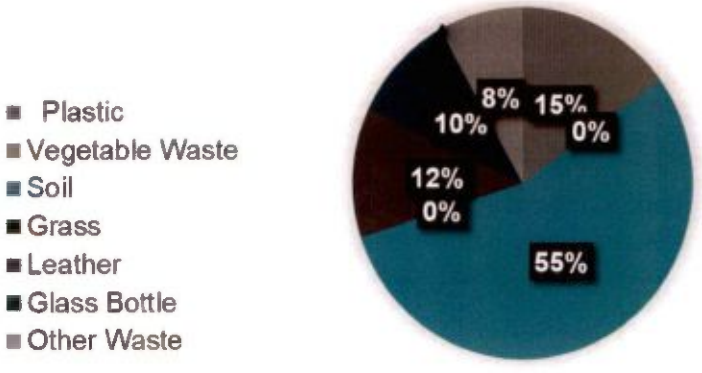


Figure 4: Physical Composition of Legacy Waste: Pramod Nagar

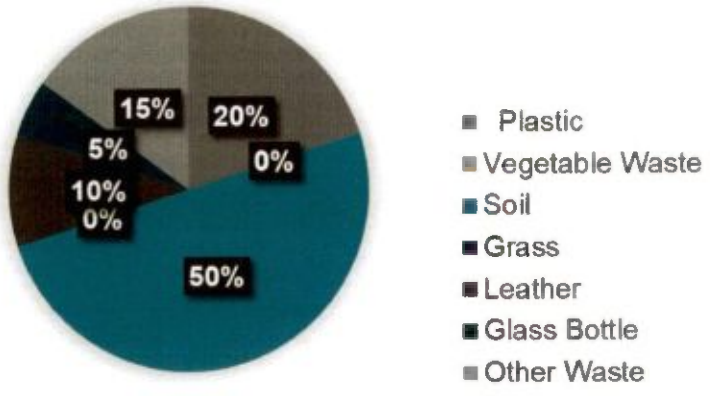


Figure 5: Physical Composition of Legacy Waste: Kamarhati

Table 4: Results of TCLP test of Legacy Waste

S.No	Test Parameters	Unit	Pramodnagar Dumpsite	Kamarhati Dumpsite
1.	Lead as Pb	--	<0.1	<0.1
2.	Cadmium as Cd	--	<0.01	<0.01
3.	Iron as Fe	%	3.750	0.109
4.	Zinc as Zn	%	0.928	0.05
5.	Nickel as Ni	%	0.160	0.188
6.	Copper as Cu	%	0.105	<0.05
7.	Chromium as Cr	%	0.10	<0.1
8.	Sulphide as S	%	<0.1	<0.1
9.	Cyanide as CN	%	<0.1	<0.1
Note: Minimum Detection Limit of Pb, Cr, S & CN .. 0.1 mg/lt., Cd .. 0.01 mg/lt., Cu .. 0.05 mg/lt				

The original test reports have been attached in the Annexure IV.
From the test reports of TCLP conducted on Pramodnagar Dumpsite and Kamarhati Dumpsite legacy waste, it is safe to dispose it in low lying area after appropriate processing.

3.4 Topographical Survey and Geo Technical Studies

The topographical survey will be carried out to prepare site plan and contouring of the site, to get the dimensions of the site & to analyze the general surface drainage slope. Topographical study is conducted to gather data about the waste elevation points of the landfills. 10% variation in topographic area was allowed to get exact contour. Waste quantification of dumpsite would also need to be done based on topographical details. This shall also include details about the infrastructure facilities available near the site.

Results of Pramodnagar Dumpsite topographical survey:
Total area of the site as per our survey is 22.69 Acres. There are 4 landfill zones in the area. The area and volume of each are given below.
Area Statement:

1. LANDFILL ZONE - A :- 3569.70 SQM
2. LANDFILL ZONE - B :- 40748.15 SQM
3. LANDFILL ZONE - C :- 27095.32 SQM
4. LANDFILL ZONE D : 26505.12 SQM

TOTAL LANDFILL AREA : 97918.29 SQM

Volume Statement

1. LANDFILL ZONE - A :- 12850.94 CUM
2. LANDFILL ZONE - B :- 264659.8 CUM
3. LANDFILL ZONE - C :- 166455.9 CUM
4. LANDFILL ZONE - D :- 111630.4 CUM

TOTAL LANDFILL VOLUME: 555597 CUM.

Zone B is the Most utilized Landfill amongst all.

Existing water bodies in the vicinity: Canals on North and South side, Pond on East side.There is a processing shed and Proposed Site for SLF cell/ Leachate Tank in Zone D.

Figure 6: Detailed topographical survey of the Pramodnagar Dumpsite

ALL DIMENSION AREIN M OR OTHERWISE MENTIONED

Results of Kamarhati Dumpsite topographical survey:

Total area of the site as per our survey is 8.003 Acres. There are 1 landfill zone in the area. The area and volume is given below.

Area Statement:
LANDFILL ZONE - A:- 28784.23 SQM ; TOTAL LANDFILL AREA : 28784.23 SQM

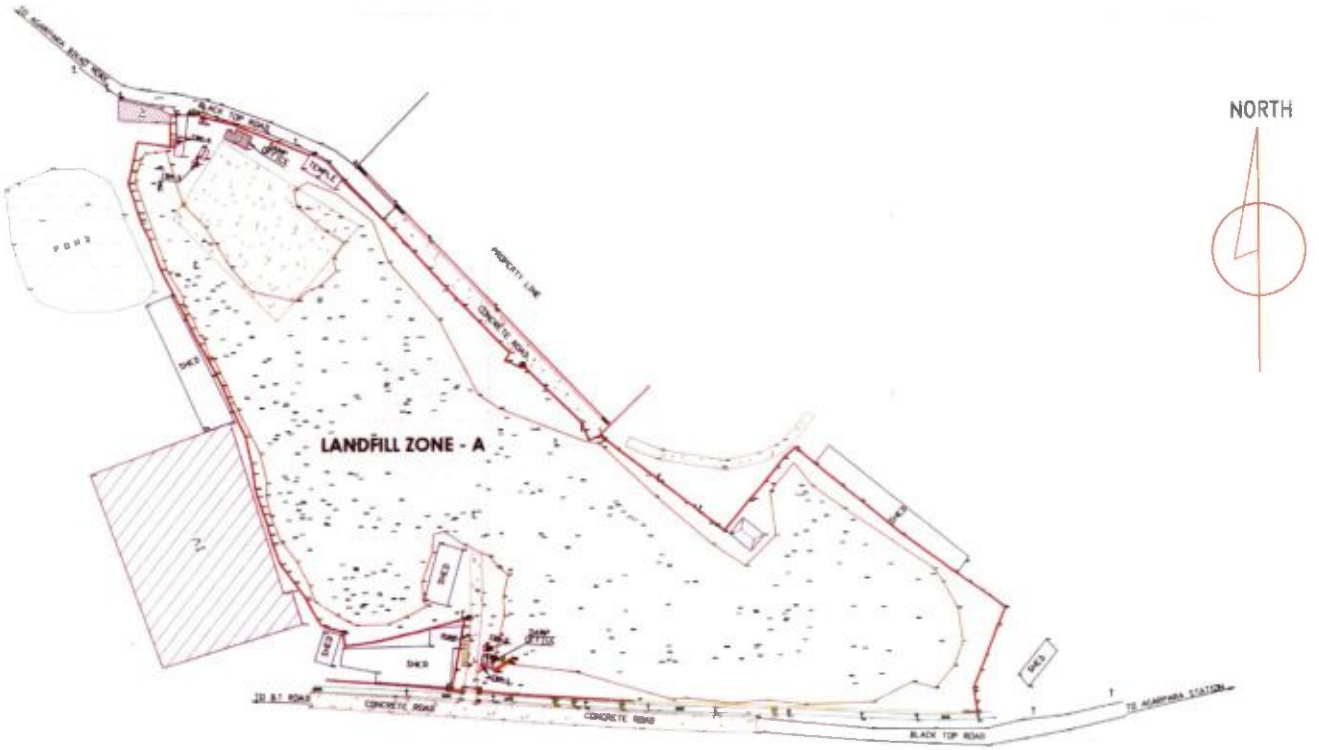
Volume Statement
LANDFILL ZONE - A:- 122333 CUM ; TOTAL LANDFILL VOLUME :- 122333 CUM

Existing water bodies in the vicinity: Water body on East side
There is no processing shed and Leachate Tank.

Figure 7: Detailed topographical survey of the Kamarhati Dumpsite

LEGEND

SL.NO	DESCRIPTION	SYMBOL
1	BUILDING	
2	RTS	
3	BOUNDARY WALL	
4	BLACK TOP ROAD	
5	CONCRETE ROAD	
6	DRAIN	
7	GUARD WALL	
8	HURTMEN	
9	GATE	
10	POND	
11	TREE	
12	ELCETRIC POST	
13	LIGHT POST	
14	TUBE WELL	
15	TELEPHONE POST	
16	WATER TAP	
17	ELECTRIC JOIN BOX	
18	TRANSFORMER	
19	HIGHMARK	
20	TBM	
21	VALVE	
22	LANDFILL AREA	



ALL DIMENSION AREIN M OR OTHERWISE MENTIONED

Geo-technical studies are conducted to analyses the strength and other characteristics of soil by making boreholes in the proposed site. Apart from a few on-site physical strength tests, the following parameters analysed in the laboratory:

The soil investigation covered the following procedures: -

- Laboratory team conducted Standard Penetration Test (SPT) / Dynamic Cone Penetration Test (DCPT) at 2 -3 Nos. of locations up to a depth of 10.0 m or refusal whichever is earlier.
- Laboratory team collected soil samples at various depths as per requirement of the Client from the bore holes as feasible, for laboratory tests.
- Laboratory team collected disturbed & undisturbed soils samples.
- Laboratory team analyzed the field and laboratory observations and have put up a report

The report contains the details of field investigations, laboratory tests and the recommendation based on the results. The various results are produced in two following heads, i.e.
(i) The field tests
(ii) The laboratory tests

The field tests comprised of:

- Laboratory team bored at the proposed site to obtain soil samples from every stratum encountered by the boring tools. Depending upon the type of soil, both disturbed & undisturbed samples were collected.
- A standard penetration test is meant for measuring the penetration resistance of the soil, which is measure of its bearing capacity in-situ.

The laboratory tests included:

- Bulk Density Test - Bulk density determinations were carried out on undisturbed soil samples collected from the boreholes.
- Moisture Content- Moisture Content of undisturbed soil samples were determined by oven drying method for knowing Dry Density of soil.
- Particle Size Analysis of Soil (as per IS: 2720 (Part-IV) – 1985)
- Atterberg Limit (as per IS: 2720 Part-V - 1985. "Determination of Liquid and Plastic Limits".)
- Shear strength test and Permeability Tests.
- Analysis of water samples where water table occurs within the depth of geotechnical exploration such as pH value, Chlorides etc.

FIELD WORK: A brief description of method of boring, field tests, collection of samples etc. and type of equipment used are given below:

1. BORING

Boring through the soil was carried out using 150 mm auger upto a depth of about 1.00 M and thereafter is followed by bentonite to advance the bore holes upto termination depths. Casing was used upto about 3.00 m below ground level. Bentonite solution of adequate density was used for stabilization of boreholes.

2. COLLECTION OF REPRESENTATIVE SAMPLES

Representative soil samples were collected where possible from auger split spoon samples of standard penetrometer and outing shoe of undisturbed sampling of strata encountered. All the samples were labeled and placed in air-tight polythene bag and shifted to the laboratory for identification and testing.

3. STANDARD PENETRATION TESTS

Standard Penetration Tests were conducted at the boring points at suitable interval. The number of blows required for niddle 30 cm penetration of split spoon samples out of a total penetration of 60 cm driven by 63.5 kg. Hammer falling freely from a height of 75 cm. was recorded as N-value. The samples from split were collected after each test and were properly labelled and placed in air-tight polythene bags before sending it to the laboratory for identification and testing purpose. The test procedure was conformed to IS 2131-1981.

4. COLLECTION OF UNDISTURBED SAMPLES

Undisturbed samples were collected by means of a two tier 100 mm. I.D. open drive sampling assembly having area ration of about 14%. Before sampling, the boreholes were thoroughly cleaned. The sampling assembly was driven to the required depth manually with the help of a jarring link. Samples collected in the lower tube were obtained, labeled and waxed at both ends before sending to the laboratory.

5. GROUND WATER TABLE

Water levels in the boreholes were observed during and after completion of boring operation. The final water readings were recorded in the field and are shown in the individual boring logs and test boring summary.

Representative soil samples were tested in the laboratory for identification purpose and to determine their strength and other physical characteristics. Based on the findings of the sub-soil condition, their strength and settlement characteristics, reasonable and appropriate soil parameters were obtained and recommended here in this report.

Results of Pramodnagar Dumpsite Geo-technical studies:

SUMMARY OF BORING DATA

Table 5: Summary of Boring Data

Borehole No.	Termination Depth. (M)	Depth of Ground Water below G.L. (M)
1	10.45	(-) 1.20
2	10.45	(-)1.30

LABORATORY TESTS

SUB-SOIL PROFILE AND PROPERTIES

Depending on color, constituents etc. as revealed from borehole it is observed that the sub-soil profile is sum of different deposits of silty clay followed by decomposed wood & vegetation. The sub-soil profile as revealed from borehole is divided into three major strata and are shown in "Bore Log Data Sheets" & also described as below,

FILL- Filling with soft brownish gray silty clay, plastic, brick bats, surki, rubbish, etc. constitute this stratum. Max. thickness of this stratum is 1.50 m.

STRATUM - I

Soft blackish gray silty clay.

Constitute this stratum: Thickness of this stratum is 2.70 m from BH 2.

SPT value varies from 3 to 4.

STRATUM - II

This stratum consists of Soft yellowish gray silty clay.

This layer has a maximum thickness of 3.00 m as obtained from borehole 01.

SPT value varies between 4 and 5

The engineering properties are as below,

Table 6: Engineering Properties

Natural water content	35.0 %
Liquid Limit	51.0 %
Plastic Limit	33.0 %
Bulk	1.72 t/m3
C_u	2.50 t/m2
φ	0
Cc	0.175

STRATUM - III

Soft blackish gray silty clay with decomposed wood & vegetation.

Constitute this stratum. Thickness of this stratum is obtained 4.95 m from Bore no. 02.

SPT values varies between 2 to 3.

The engineering properties are as below

Table 7: Engineering Properties

Natural water content	37.0 %
Liquid Limit	55.0 %
Plastic Limit	31.0 %
Bulk Density	1.69 t/m3
C_u	2.30 t/m2
φ	0
Cc	0.190

Results of Kamarhati Dumpsite Geo-technical studies:

SUMMARY OF BORING DATA

Table 8: Boring Data-Kamarhati Dumpsite

Borehole No.	Termination Depth. (M)	Depth of Ground Water below G.L. (M)
1	10.45	(-) 1.30
2	10.45	(-)1.40

LABORATORY TESTS

SUB-SOIL PROFILE AND PROPERTIES

Depending on color, constituents etc. as revealed from borehole it is observed that the sub-soil profile is sum of different deposits of silty clay followed by decomposed wood & vegetation. The sub-soil profile as revealed from borehole is divided into three major strata and are shown in "Bore Log Data Sheets" & also described as below,

FILL- Filling with soft brownish gray silty clay, plastic, brick bats, surki, rubbish, etc. constitute this stratum. Max. thickness of this stratum is 1.80 m.

STRATUM - I

Soft blackish gray silty clay. Constitute this stratum:
Thickness of this stratum is 2.20 m from BH 2.
SPT value varies from 2 to 4.

Table 9: Engineering Properties

Natural water content	35.0 %
Liquid Limit	51.0 %
Plastic Limit	33.0 %
Bulk	1.68t/m3
C_u	2.60 t/m2
φ	0
Cc	0.168

STRATUM - II

This stratum consists of Soft yellowish gray silty clay.
This layer has a maximum thickness of 3.30 m
SPT value varies between 3 to 4
The engineering properties are as below,

Table 10: Engineering Properties

Natural water content	36.0 %
Liquid Limit	52.0 %
Plastic Limit	32.0 %

Bulk	1.65 t/m3
C_u	2.30 t/m2
φ	0
Cc	0.170

STRATUM - III

Soft blackish gray silty clay with decomposed wood & vegetation.
Constitute this stratum. Thickness of this stratum is obtained 3.95 m.
SPT values varies between 2 to 3.
The engineering properties are as below

Table 11: Engineering Properties

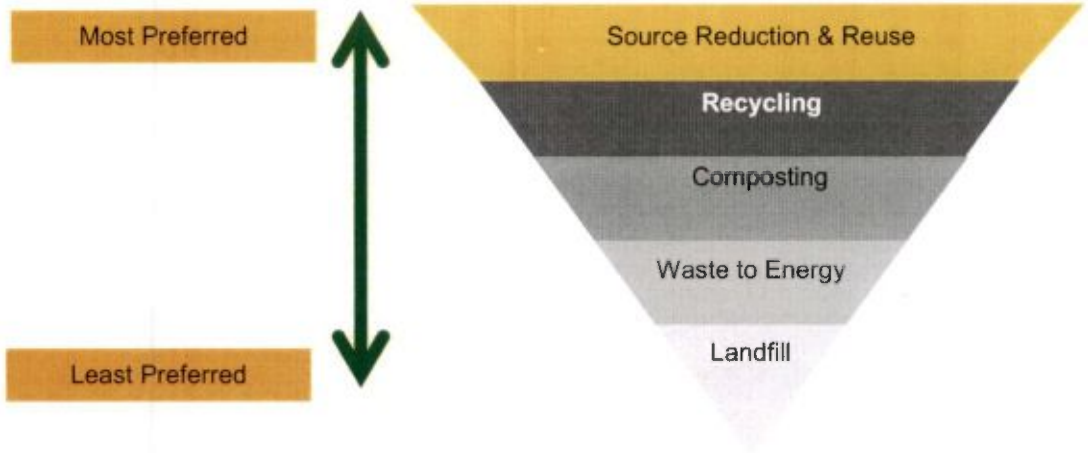
Natural water content	38.0 %
Liquid Limit	51.0 %
Plastic Limit	31.0 %
Bulk Density	1.65 t/m3
C_u	2.20 t/m2
φ	0
Cc	0.190

Detailed discussions, calculations original test reports have been attached in the Annexure -III

4 Municipal Solid Waste Management

Solid Waste Management (SWM) proposes a waste management hierarchy with the aim to reduce the amount of waste being disposed, while maximizing resource conservation and resource efficiency. The SWM hierarchy ranks waste management operations according to their environmental, economic and energy impacts. Source reduction or waste prevention, which includes reuse, is considered the best approach (tier 1) followed by recycling (tier 2) and composting of organic matter of waste, resulting in recovery of material (tier 3). The components of waste that cannot be prevented or recycled can be processed for energy recovery (tier 4). Tier 5 is disposal of waste in sanitary landfill, which is the least preferred option. Moreover, solid waste management system shall be compliant with Solid Waste Management Rules, 2016 (and to amendments thereto).

Figure 8: Municipal solid waste management hierarchy

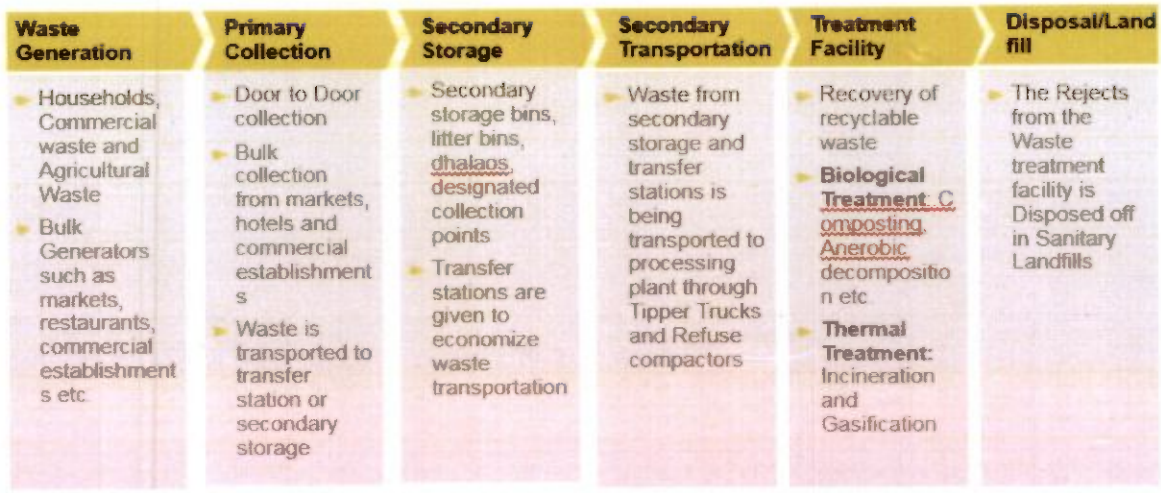


The quantity and composition of MSW generated in the ULB is essential for determining collection, processing and disposal options that could be adopted. They are dependent on the population, demographic details, and principal activities in the city/town, income levels and lifestyle of the community. Waste generation encompasses activities in which materials are identified as no longer being of value (being in the present form) and are either thrown away or gathered together for disposal. Figure 16 depicts various sources of solid waste. The primary generators of solid waste are local households, commercial establishments, industries, markets, hotels, restaurants, and hospitals. Apart from MSW, a lot of e-waste as well as bio-medical waste (hospital sector) is generated.

Figure 9: Sources of MSW generation

The broad scope of work for integrated solid waste management is depicted in the following figure:

Figure 10: Scope of work for integrated solid waste management



4.1 Source Segregation

Waste should be segregated by waste generators into two fractions - wet fraction (green container) and dry fraction (blue container). The list of different waste bins is provided below:

Table 12: Waste bins for source segregation of waste

Wet Waste (Green Bin)	Dry Waste (Blue bin) With further sub-segregation			
Food wastes of all kinds, cooked and uncooked, including eggshells and bones, flower and fruit wastes including juice peels and house plant wastes, soiled tissues, food wrappers, paper towels	Paper, cardboard and cartons	Containers and packaging of all kinds, excluding those containing hazardous material, compound packaging of all kind	Rags, rubber, wood, discarded clothing, furniture	Metals, glass (all kinds), Inert, house sweeping,

Collection of wet and dry waste separately enhances the potential of cost-effective treatment of such wastes cost effectively and ensure optimum advantage from the recyclable material fed into the system. Segregated waste must be stored on-site in separate containers for further collection and should be kept separate during all steps of waste collection, transportation and processing.

Municipalities are advised not to mix construction and demolition waste with household waste in primary or secondary collection. Drain desilting and road sweeping waste should be directly transferred to sanitary landfill.

4.2 Collection & Transportation

In the PPP structure proposed, the municipalities are responsible for collection and transportation of solid waste management in cluster-1. As observed during site visits, there is a need for

substantial improvement in the primary and secondary vehicles of municipalities to achieve the standards set by Solid waste management rules and NGT guidelines

4.3 Primary Collection

Primary collection refers to the process of collecting waste from households, markets, institutions and other commercial establishments and taking the waste to a storage depot/ transfer station. Primary collection may be accomplished through the use of containerized push carts/tri-cycles, small mechanized vehicles, compactors and/or tipping vehicles.

4.3.1 Secondary storage

Secondary collection includes picking up waste from community bins, waste storage depots or transfer stations and transporting it to waste processing sites or to the final disposal site. It comprises of both activities - secondary storage and secondary transportation.

4.3.2 Transfer station

Transfer stations have been proposed in this cluster so that the MSW being transported in smaller vehicles is collected at a common location from nearby ULBs. The waste will then be transferred to a larger vehicle for transportation to a processing facility (in refuse compactors/larger transportation vehicles). MSW from the nearby locations are either to be delivered to the transfer stations or directly to the Processing Plant site depending, whichever is nearer. This method of transporting waste in bulk would help in reduction of the overall transportation cost and also substantially reduce the traffic and environmental nuisance associated with a large number of small refuse collection vehicles moving on the road.

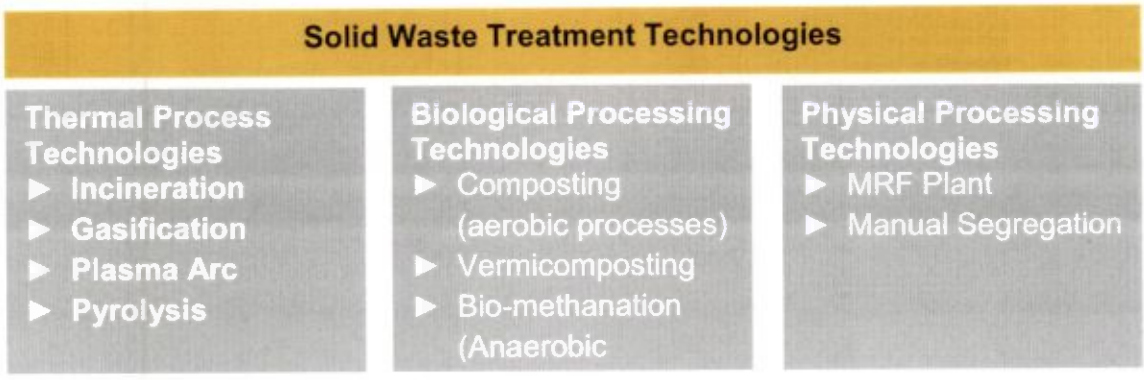
4.3.3 Secondary transportation

Larger capacity vehicles are proposed to transport waste from the secondary or tertiary collection point (depot/transfer station) to the processing facility. The vehicles shall synchronize well with containers placed at depots/transfer stations to prevent multiple handling of waste. The current waste management system employs a combination of dumper placers, tractor trolleys and refuse collectors.

4.4 Technologies and Trends for MSW treatment

A judicious choice of technological options is mandatory to address treatment of municipal solid waste. A choice of more than one technology or combination of technologies (according to SWM) has many-a-times proved beneficial. The available technologies to treat MSW can be broadly categorized into 3 broad sections.

Figure 11: MSW Treatment Technologies



Thermal processing technologies

The thermal processing technologies involve thermal decomposition of waste into gaseous, liquid and solid conversion products with release of heat energy. These technologies operate at temperatures greater than 200°C and have higher reaction rates. They typically operate in a temperature range of 375°C to 5,500°C. Thermal technologies include advanced thermal recycling (a state-of-the-art form of waste to-energy facilities) and thermal conversion (a process that converts the organic carbon-based portion of the MSW waste stream into a synthetic gas which is subsequently used to produce products such as electricity, chemicals, or green fuels).
The main thermal processing technologies adopted internationally for the treatment of municipal waste are:

- **Incineration**
  Mass-burn systems are the predominant form of the MSW incineration. Mass-burn systems generally consist of either two or three incineration units ranging in capacity from 50 to 1,000 tons per day; thus, facility capacity ranges from about 100 to 3,000 tons per day. It involves combustion of unprocessed or minimally processed refuse. The major components of a mass burn facility include: (1) Refuse receiving, handling, and storage systems; (2) Combustion and steam generation system (a boiler); (3) Flue gas cleaning system; (4) Power generation equipment (steam turbine and generator); (5) Condenser cooling water system; and (6) Residue hauling and storage system.

- **Pyrolysis**
  In pyrolysis, at high temperatures of 700°C to 1200°C, thermal degradation of organic carbon-based materials is achieved using an indirect, external source of heat, in the absence or almost complete absence of free oxygen. This thermally decomposes and drives off the volatile portions of the organic materials, resulting in a syngas composed primarily of hydrogen (H_2), carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4). Some of the volatile components form tar and oil, which can be removed and reused as a fuel. Most pyrolysis systems are closed systems and there are no waste gases or air emission sources (if the syngas is combusted to produce electricity, the power system will have air emissions through a stack and air emission control system). After cooling and cleaning in emission control systems, the syngas can be utilized in boilers, gas turbines, or internal combustion engines to generate electricity or used as raw stock in chemical industries. The balance of the organic materials that are non-volatile or liquid that is left as a char material, can be further processed or used for its adsorption properties (activated carbon). Inorganic materials form a bottom ash that requires disposal, although some pyrolysis ash can be used for manufacturing brick materials.

- **Gasification**
  In the gasification process, thermal conversion of organic carbon based materials is achieved in the presence of internally produced heat, typically at temperatures of 660°C to 1800°C, and in a limited supply of air/oxygen (less than stoichio-metric, or less than what is needed for complete combustion) to produce a syngas composed primarily of H_2 and CO. Inorganic materials are converted either to bottom ash (low-temperature gasification) or to a solid, vitreous slag (high temperature gasification that operates above the melting temperature of inorganic components). Some of the oxygen injected into the system is used in reactions that produce heat, so that Pyrolysis (endothermic) gasification reactions can initiate; after which, the exothermic reactions control and cause the gasification process to be self-sustaining. Most gasification systems, like Pyrolysis, are closed systems and do not generate waste gases or air emission sources during the gasification phase. After cooling and cleaning in emission control systems, the syngas can be utilized in boilers, gas turbines, or internal combustion engines to generate electricity, or to make chemicals.

Biological processing technologies

Biological treatment involves using microorganisms to decompose the biodegradable components of waste. Biological processing technologies operate at lower temperatures and lower reaction rates. Biological processing technologies are focused on the conversion of organics in the MSW. MSW consists of dry matter and moisture. The dry matter further consists of organics (i.e., whose molecules are carbon-based), and minerals, also referred to as the ash fraction. The organics can be further subdivided into biodegradables or refractory organics, such as food waste, and non--biodegradables, such as plastic. Biological technologies can only convert biodegradables component of the MSW. By-products can vary, which include: electricity, compost and chemicals. Biological process can be aerobic and anaerobic. Biological technologies adopted for treatment of solid waste include:

- **Composting**

  Composting is a natural micro-biological process, where bacteria break down the organic fractions of the MSW stream under controlled conditions to produce a pathogen-free material called "Compost" that can be used for potting soil, soil amendments (for example, to lighten and improve the soil structure of clay soils), and mulch. The microbes, fungi, and macro-organisms that contribute to this biological decomposition are generally aerobic. A mixture of organic materials is placed into one or more piles (windrows), and the natural microbial action will cause the pile to heat up to 60 - 70°C, killing most pathogens and weed seeds. A properly designed compost heap will reach 70°C within 6 to 10 days, and slowly cool off back to ambient temperatures as the biological decomposition is completed. Systematic turning of the material, which mixes the different components and aerates the mixture, generally accelerates the process of breaking down the organic fraction, and a proper carbon/nitrogen balance (carbon to nitrogen or C/N ratio of 20:1) in the feedstock ensures complete and rapid composting. The composting process takes from 30 to 90 days.

  There are two fundamental types of composting techniques: a) open or windrow composting, which is done out of doors with simple equipment and is a slower process, and b) enclosed system composting, where the composting is performed in some enclosure (e.g., a tank, a box, a container or a vessel).

- **Anaerobic digestion**

  In anaerobic digestion, biodegradable material is converted by a series of decomposition processes by different bacterial groups into methane and CO2. A first group breaks down large organic molecules into small units like sugar. This step is referred to as hydrolysis. Another group of bacteria converts the resulting smaller molecules into volatile fatty acids, mainly acetate, but also hydrogen (H2) and CO2. This process is called acidification. The last group of bacteria, the methane producers or methanogens, produce biogas (methane and CO2) from the acetate and hydrogen and CO2. This biogas can be used to fuel boilers or reciprocating engines with minimal pre-treatment. In addition to biogas, anaerobic bioconversion generates a residue consisting of inorganics, non-degradable organics, and bacterial biomass. If the feedstock entering the process is sufficiently free of objectionable materials like colourful plastic, this residue can have market value as compost. Anaerobic digestion process is also referred to as the Bio-methanation process.

- **Bioreactor landfill**

  A bioreactor landfill is a wet landfill designed and operated with the objective of converting and stabilizing biodegradable organic components of the waste within a reasonable time frame, by enhancing the microbiological decomposition processes. The technology significantly increases the extent of waste decomposition, conversion rates and process effectiveness over what would otherwise occur in a conventional wet landfill. Stabilization in this context means that landfill gas and leachate emissions are managed within one generation (twenty to thirty years) and that any failure of the containment system after

this time would not result in environmental pollution. There is better energy recovery including increased total gas available for energy use and increased greenhouse reduction from reduced emissions and increase in fossil fuel offsets. These factors lead to increased community acceptance of this waste technology. Management of a bioreactor landfill requires a different operating protocol to conventional landfills. Liquid addition and recirculation is the single most important operational variable to enhance the microbiological decomposition processes. Other strategies can also be used, to optimise the stabilization process, including waste shredding, pH adjustment, nutrient addition and temperature management.

Physical processing technologies

Physical technologies involve altering the physical characteristics of the MSW feedstock. The MSW is subjected to various physical processes that reduce the quantity of total feedstock, increase its heating value, and provide a feedstock. It may be densified or pelletized into homogeneous fuel pellets and transported and combusted as a supplementary fuel in utility boilers. These technologies are briefly described below.

- **Refused Derived Fuel (RDF)**
  The RDF process typically includes thorough pre-separation of recyclables, shredding, drying, and densification to make a product that is easily handled. Glass and plastics are removed through manual picking and by commercially available separation devices. This is followed by shredding to reduce the size of the remaining feedstock to about eight inches or less, for further processing and handling. Magnetic separators are used to remove ferrous metals. Eddy-current separators are used for aluminium and other non-ferrous metals. The resulting material contains mostly food waste, non-separated paper, some plastics (recyclable and non-recyclable), green waste, wood, and other materials. Drying to less than 12% moisture is typically accomplished through the use of forced-draft air. Additional sieving and classification equipment may be utilized to increase the removal of contaminants. After drying, the material often undergoes densification processing such as pelletizing to produce a pellet that can be handled with typical conveying equipment and fed through bunkers and feeders. The RDF can be immediately combusted on-site or transported to another facility for burning, alone or with other fuels. The densification is even more important when RDF is transported off-site to another facility, in order to reduce volume being transported. RDF is often used in waste to energy plants as the primary or supplemental feedstock or co-fired with coal or other fuels in power plants, in kilns of cement plants, and with other fuels for industrial steam production.

- **Mechanical separation**
  Mechanical separation is utilized for removing specific materials or contaminants from the inlet MSW stream as a part of the pre-treatment process. Contaminants may include construction and demolition (C&D) debris, tires, dirt, wet paper, coarse materials, and fine materials. Generally, MSW reaching the dumping sites is unsegregated and mixed, containing C&D debris and other contaminants. Therefore, it is essential to remove these contaminants from the incoming MSW by mechanical separation before processing the waste further by either biological, physical and thermal technologies (except Plasma Arc Technology).

- **Size reduction**
  Size reduction is often required to allow for more efficient and easier handling of materials, particularly when the feed stream is to be used in further processes. Sizing processes include vibrating screens and trommels. In order to reduce the size of the entire stream, or

portions of it, mechanical equipment, such as shredders, is utilized. This allows for other physical processes, such as dryers, magnetic and eddy current separators, and densification equipment to work more efficiently. Magnetic and eddy current separators may be installed both up and downstream of shredders to increase the recovery of metals.

The above technologies can be summarized as follows:

Table 13: Summary of MSW processing technologies

		Pros	Cons
Thermal processing technologies			
Incineration	Waste incineration is a treatment process that involves the combustion of organic fraction of MSW to convert the same into ash, flue gases and heat.	✓ Reduction in volume of waste going to landfill ✓ Production of energy which could be used for various purposes ✓ Reduction in toxicity of waste and pathogens	✓ Release of harmful emissions in the air ✓ Treatment of the by-products is imperative ✓ Skilled operators are required ✓ NIMBY syndrome
Gasification	Gasification also involves the partial oxidation of carbon-based feedstock to generate syngas, which can be used as a fuel or for the production of chemicals.	✓ Limited air requirement which leads to less volume of flue gas for treatment	✓ Larger land requirement ✓ Requirement of pre-treatment of waste
Pyrolysis	Pyrolysis is a thermal process that uses high temperatures to break down any waste containing carbon.	✓ Less quantity of waste going to landfill	✓ Limited success stories
Biological processing technologies			
Composting	Controlled decomposition of organic matter by micro-organisms into stable humus. It can be done by either open/windrow composting or enclosed/in vessel composting.	✓ Relatively cost effective	✓ Discharge of leachate and phenols leading to water contamination ✓ Possible odour ✓ NIMBY syndrome
Biomethanation	Biodegradable material is broken down by bacteria into methane and CO_2 in the absence of oxygen.	✓ Treatment at source ✓ Gas/ power generation	✓ Only applicable to organic fraction of MSW
Physical processing technologies			
Refuse Derived Fuel Technology	MSW may be separated, shredded and/or dried in a processing facility. The resulting material is referred to as Refuse Derived Fuel (RDF).	✓ Higher calorific value from for power generation ✓ Suitable for low input capacity	✓ Stringent air pollution monitoring is required for burning

4.5 Assessment of technologies/ Technology selection criteria

The selection of best available technology (BAT) for any waste processing facility depends upon a number of factors such as:

- Indian experience
- Nature of waste
  - Quantity of waste
  - Quality of waste

- Cost considerations
  - Capital investments required
  - Recurring expenditure
  - Economy of operation
  - Cost of end products
- Manpower Requirement
- Level of skill required
- The capability of the ULBs to manage such facility departmentally or through private sector participation
- Scale of operation
- Environmental impact of such technology
- Process aesthetics
- Compatibility of cycle of nature

The following criteria are to be considered in order to assess the suitability of technology in Indian context as per MSW CPEEHO Manual:

- Technology reliability
- Waste suitability
- Waste supply chain approach

Technology Reliability: The table below presents MSW treatment technologies with respect to potential reliability of operations.

Table 14: MSW treatment technology reliability

S.No.	Technology Category	Comments
a.	Composting	▸ A number of installations have been satisfactorily working in India . The technology is simple and easy to scale up. This is one of the best suited technology due to techno-economical feature and composite climate of Indian cities.
b.	RDF	▸ With large scale operations in the US, the technology is well proven. A number of medium scale plants are in operation in India. Although initial RDF plant experience has been discouraging, the integrated approach is fast catching up in the country. Some of the recent examples of RDF technology installed via the integrated approach in the country includes Kanpur, Agra and Surat.
c.	Biomethanation	▸ Large scale projects are operational in the Europe. Pilot projects are been taken up in India. Some projects include Melvishram Project taken up in Tamil Nadu. Accelerated R&D is taking place to use this method to treat segregated waste.
d.	Vermicomposting	▸ The technology is suitable for small scale plants as it requires high control of temperature and humidity. In India small scale plants are being taken up. Some plants worth mentioning are 100TPD plants at Mangalore and Eluru.

Table 15: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies

CRITERIA	Technical Criteria								
	Land Requirement for 500 TPD	Indicative Capital Investment for 500 TPD	Natural environment	Minimum Waste Quantity required for making single facility viable	Waste quantity which can be managed by a single facility	Requirement for Segregation prior to technology	Rejects	Potential for Direct Energy Recovery	Technology Maturity
WINDROW COMPOSTING	For segregated/pre-sorted MSW: 8.33 ha (including buffer zone)	Typically, 15-20 Cr for 500 TPD plant	Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation.	500 TPD	NA	High	About 30% including inerts if only composting is done[1]. 15%[2] rejects with RDF, if located in the same plant	No	Windrow composting technique is well established
VERMICULTURE	For segregated/pre-sorted: 31.25 ha.	25 Cr. per 500 TPD	Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation.	1 TPD	20 TPD (Higher capacities can also be planned if adequate land is available along with other necessary arrangements)	Very High	About 30% including inerts[2]	No	Community scale projects are successful
BIOMETHANAT-ION	For segregated/pre-sorted MSW: 4.17 ha	Typically, 75-80 Cr for 500 TPD plant	NA	1 TPD at small scale	500 TPD at larger scale	Very High	About 30% from mixed waste[2]	Yes	Feasibility for biodegradable waste is proven. In case of mixed waste, appropriate pre-sorting has to be carried out.
RDF	For segregated/ pre-sorted MSW: 3.33 ha	Typically, 17-20 Cr for 500 TPD plant	NA	100 TPD of segregated waste	500 TPD (in India)	High	Around 30% from mixed waste[3]	No (feed stock for energy recovery)	Quality of RDF should be based on end use, no clear consensus on quality requirements. Burning of RDF below 850°C for less than 2 seconds residence time can pose serious problems of health and environment. Rules regulating characteristics of RDF and guidelines for appropriate use not prescribed by concerned authority.
INCINERATION[4]	For mixed waste: 2.5 ha (including buffer zone)	Very high capital, operating and maintenance costs. 62 -188 Cr for 500 TPD depending on the efficiency of the plant. (15 Cr. per MW power production)	NA	1000 TPD (smaller plants are not techno-economically viable, given the cost of required environmental control equipment and boiler technology	2400 TPD of mixed waste (in India)	High – Feed stock should be free from inerts and low on moisture content	Around 15%[3]	Yes	Technology is available. However constraints of low calorific value, high moisture content and high proportion of inert waste should be considered while undertaking the project commercially.

[1] In cases of an integrated facility of composting and RDF, 15% rejects from mixed waste stream is expected
[2] Rejects from mixed waste fundamentally depends on the presence of non- biodegradable material which are taken out during pre-sorting stage
[3] For incoming mixed waste for RDF & Incineration Non-combustible material is taken out during the sorting stage
[4] The Indicative capital cost is estimated by using data from Table - 9

CRITERIA	Technical Criteria								
	Land Requirement for 500 TPD	Indicative Capital Investment for 500 TPD	Natural environment	Minimum Waste Quantity required for making single facility viable	Waste quantity which can be managed by a single facility	Requirement for Segregation prior to technology	Rejects	Potential for Direct Energy Recovery	Technology Maturity
INTEGRATED SYSTEM (COMPOSTING + RDF)	For segregated/pre-sorted MSW: 10 ha	Typically, 25-30 Cr for 500 TPD plant) without a mechanical Hot Air Generator (HAG) for drying. However, moisture can be reduced by bio drying with much less cost but slightly reduced efficiency.		500 TPD (economically sustainable above 500 TPD plant size)	NA	Moderate because both dry and wet fractions are utilized	Approximately 15-20%[5]	Yes	Composting and RDF combined facility is an upcoming phenomenon. Utilization of rejects from compost plants as input material for RDF production and sale. Rejects from integrated system are 15- 20% as opposed to 30-40% from individual system.
SANITARY LANDFILL[6]	60 ha (assuming the height of landfill is 10m) is required for 15 years.	73Cr (Construction, Operation & Maintenance Cost) for 15 years	Should be avoided in marshy land and in conditions where the ground water table is 2 m from the base of the liner. In marshy land, apart from ground and surface water contamination potential, there could be huge risks due to structural safety of the landfill (slippage and complete breakdown).	100 TPD inert Smaller landfills are not techno - economically viable	NA	Only inert waste may be placed in landfills as per SWM Rules	No rejects	Not as per SWM rules	Sanitary landfill is a proven method for safe disposal of waste, practiced world over. However it has environmental implications and efforts have to be made to minimize waste going to landfills. MSW Rules only permit inert wastes to be landfilled.

CRITERIA	Financial Criteria	Managerial Criteria		Environmental Criteria	
	Market for product/ By – Product	Labour Requirement	Predominant skills for Operation and Management	Concerns for toxicity of product	Leachate Pollution
WINDROW COMPOSTING	Quality compost compliant with FCO 2013 has a good market. IPNM Task Force (vetted by Supreme Court, 1 Sep 2006) has recommended co-marketing of 3-4 bags of compost with 6-7 bags of inorganic fertilizer.	Labour intensive	Technically qualified and experienced, and semi-skilled staff.	The final product is generally applied to soil and used as manure. Can contaminate the food chain if compost is not meeting FCO norms.	Potential exists. Varies with the climate of area and seasonal variation. In relatively dry seasons, leachate can be recirculated into the windrow to contain loss of nutrients and also pollution potential. In high rainfall areas, the windrows need to be covered either temporarily or permanently to control leachate generation. However, the design of the shed should be such that good natural ventilation is maintained.
VERMICULTURE	Good market potential in urban and rural areas. However, it is not adequately explored for bulk marketing.	Labour intensive	Technically qualified, experienced and semi-skilled staff (On-site training is required for unskilled labour, as a minimum requirement for efficient operation)	The product is generally safe as worms cannot endure significant contamination of raw materials. FCO Standards are to be met with.	Insignificant quantities at low waste volumes per vermi-pit.

[5] Process rejects from segregated waste should be less than 10%

[6] The Land requirement and Indicative capital cost are estimated by taking Gorai dumpsite in Mumbai as base case

CRITERIA	Financial Criteria	Managerial Criteria		Environmental Criteria	
BIOMETHANATION	So far, there is no appropriate system for pricing biogas. The system of pricing according to kerosene equivalent puts biogas at a disadvantage. At present, there is lot of interest in conversion of biogas into automotive fuel by stripping CO2. In this case, equivalent pricing with power/CNG again puts biogas at a disadvantage because of scale of economy	Less labour intensive	Technically qualified and experienced staff.	The final product is generally applied to soil as a soil conditioner. Can contaminate the food chain if compost is not meeting FCO norms.	High if not treated appropriately
RDF	Good market potential for RDF. In small cities, RDF plants only become feeders of RDF to large RDF based power plants and cement plants.	Labour intensive (based on current practice)	Technically qualified and experienced staff.		Low
INCINERATION	Good potential of energy generation if power purchase agreements are made reflecting true cost of production including O&M costs	Non labour intensive but requires considerable technical capacity	Technically qualified and experienced staff		High potential of leachate at the receiving pit.
INTEGRATED SYSTEM (COMPOSTING + RDF)	Quality compost compliant with FCO 2009 has a good market. Good market potential for RDF. In small cities, RDF plants only become feeders of RDF to large RDF based power plants and cement plants.	Labour intensive but requires considerable technical capacity	Technically qualified and experienced and semi-skilled staff	The final product is generally applied to soil and used as manure. Can contaminate the food chain if compost is not meeting FCO norms	Potential exists for compost Varies with the climate of area and seasonal variation. In relatively dry seasons, leachate can be recirculated into the windrow to contain loss of nutrients and also pollution potential. In high rainfall areas, the windrows need to be covered either temporarily or permanently to control leachate generation. However, the design of the shed should be such that good natural ventilation is maintained.
SANITARY LANDFILL	No potential, since it is stipulated by the SWM Rules that only inert wastes are to be disposed in landfills	Only inert wastes are to be deposited in sanitary landfills. Labour intensive but requires considerable technical expertise as well.	Technically qualified and experienced and semi-skilled staff		Polluted surface runoff during wet weather, groundwater contamination due to leachate infiltration Moderate to high depending upon the leachate recycling and control systems. Leachate management during monsoons requires special attention

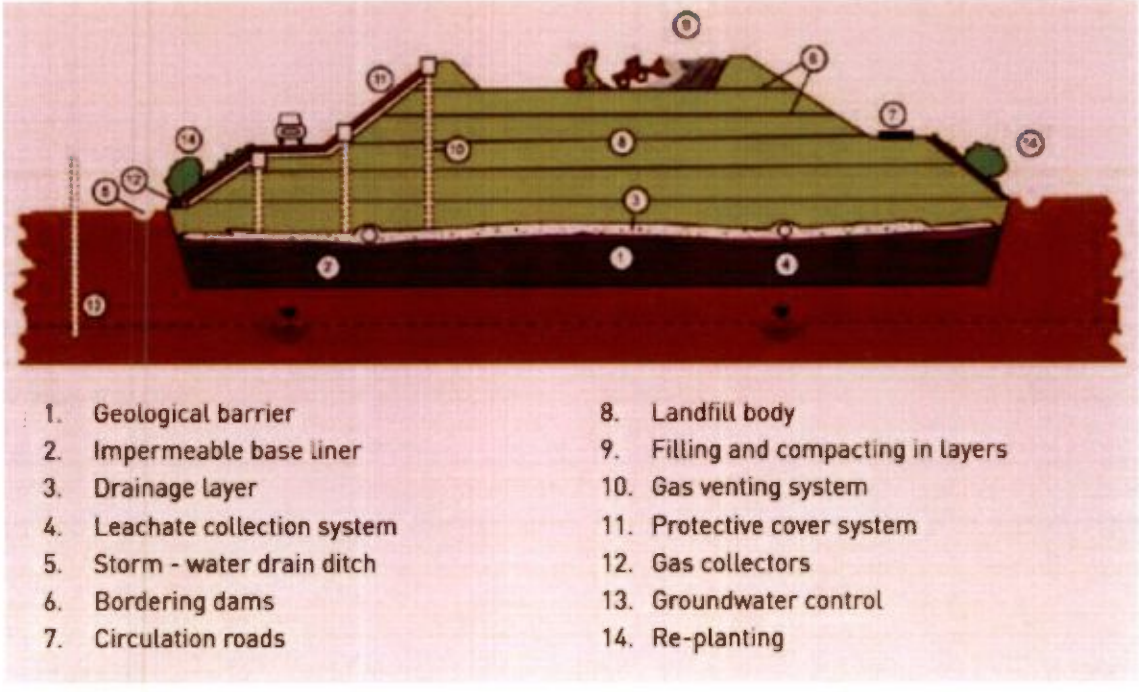
Table 16: Suitability of waste for processing methods

Waste processing method	Important waste parameters	Desirable range
Thermal processing technologies	Moisture content	<45%
	Volatile Matter	>40%
	Inert Material	<35%
	Fixed Carbon	<15%
	Net Calorific Value	>1200Kcal/ kg
Biological processing Technologies	Moisture Content	>50%
	Organic Matter	>40%
	C/N Ratio	25-30

4.6 Sanitary Landfill

The term sanitary landfill is used herein to describe a unit operation for final disposal of 'Municipal Solid Waste' on land, designed and constructed with the objective of minimizing impact to the environment and according to the SWM Rules.

Figure 12: Illustration of essential components of Sanitary Landfill



1. Geological barrier
2. Impermeable base liner
3. Drainage layer
4. Leachate collection system
5. Storm - water drain ditch
6. Bordering dams
7. Circulation roads
8. Landfill body
9. Filling and compacting in layers
10. Gas venting system
11. Protective cover system
12. Gas collectors
13. Groundwater control
14. Re-planting

The essential components of an MSW sanitary landfill which include:

1. A liner system at the base and sides of the sanitary landfill which prevents migration of leachate or gas to the surrounding soil
2. A leachate collection and control facility which collects and extracts leachate from within and from the base of the sanitary landfill and then treats the leachate
3. A gas collection and control facility (optional for small sanitary landfills) which collects and extracts gas from within and from the top of the sanitary landfill and then treats it or uses it for energy recovery;
4. A final cover system at the top of the sanitary landfill which enhances surface drainage, prevents infiltrating water, and supports surface vegetation;
5. A surface water drainage system which collects and removes all surface runoff from the sanitary landfill site

6. An environmental monitoring system which periodically collects and analyses air, surface water, soil, gas, and groundwater samples around the sanitary landfill site; and
7. A closure and post-closure plan which lists the steps that must be taken to close and secure a sanitary landfill site once the filling operation has been completed and the activities for long-term monitoring and operation and maintenance (O&M) of the completed sanitary landfill are functional.

4.7 Legacy Waste Reclamation

4.7.1 Introduction

It is estimated that more than 10000 hectares of urban land is locked in the dumpsites in India. In the absence of exposure to air, the high-rises of rotting mixed waste on these sites generate methane (a greenhouse gas) and other landfill gases, which contribute to global warming. Many municipal authorities across the country are opting for "capping" as a solution to the legacy of mixed waste, which is not the first option in the order of priority for environmentally save legacy waste management as per Clause 'J' of Schedule-I of the SWM Rules, 2016.
The methane produced at solid waste disposal sites contributes approximately 3 to 4 percent to the annual global anthropogenic greenhouse gas emissions (IPCC, 2001). Clearing these mounds of years-old waste, called legacy waste, is the easiest and fastest way to reduce our national emissions, and save surrounding villages from polluted water sources, smoke, flies and stench.
Over the years, generation of dry waste, especially plastic waste and packaging, has increased at a tremendous rate. This is because of

i. Rapid increase in e-commerce industry from shopping to ordering food.
ii. Many brand owners have shifted from larger SKU (Stock Keeping Unit) size to smaller SKU size due to changing market scenario.
iii. Shifting of public consumer preferences to daily use plastic products like bottles, food containers, etc.
iv. GST on recyclables making it uneconomical for waste-pickers and kabadiwalas to collect low-value waste.

These reasons have contributed to ever-growing dumping grounds. Some waste materials may or may not be recyclable and others might be too small to recover.

4.7.2 SWM Rules 2016

The Government of India has notified the Solid Waste Management Rules (SWM) Rules, 2016 for proper and effective management of municipal solid waste (MSW). Under the SWM Rules, 2016, following provisions have been made to manage old dumps of MSW. 3.1 Rule 15 - Duties and responsibilities of local authorities and village Panchayats of census towns and urban agglomerations. - The local authorities and Panchayats shall investigate and analyze all old open dumpsites and existing operational dumpsites for their potential of bio-mining and bio-remediation and wheresoever feasible, take necessary actions to bio-mine or bio-remediate the sites
Further, provisions under Schedule I (j) are given below:

3.2 Schedule-I (j) - Closure and Rehabilitation of Old Dumps- Solid waste dumps which have reached their full capacity or those which will not receive additional waste after setting up of new and properly designed landfills should be closed and rehabilitated by examining the following options:

(i) Reduction of waste by bio-mining and waste processing followed by placement residues in new landfills or capping as in (ii) below.
(ii) Capping with solid waste cover or solid waste cover enhanced with geomembrane enable collection and flaring / utilization of greenhouse gases.
(iii) Capping as in (ii) above with additional measures (in alluvial and other coarse-grained soils) such as cut-off walls and extraction wells for pumping and treating contaminated ground water.
(iv) Any other method suitable for reducing environmental impact to acceptable level.

4.7.3 Methodology

The treatment & disposal of Legacy MSW can be done by Bio-remediation and Bio-mining. A total station survey or drone mapping of any landfill/dumping site must be done prior to start of the project. Hence, it is suggested to ensure precursor study with history of the site, compositional analysis of waste. Site environment parameters such as baseline study of heavy metals in surface and subsurface soils and water, rainfall, soil type, surface hydrology, topography, wind direction etc. shall be studied before and after bio-mining. Periodic study should also to be carried out after completion of bio mining to check for any adverse effects in the surrounding area.

A. Bio-remediation & Bio-mining of Old Municipal Dumpsites

It refers to the excavation of old dumped waste and make windrow of legacy waste thereafter stabilization of the waste through bio-remediation i.e. exposure of all the waste to air along with use of composting bio-cultures, i.e. screening of the stabilized waste to recover all valuable resources (like organic fines, bricks, stones, plastics, metals, clothes, rags etc.) followed by its sustainable management through recycling, co-processing, road making etc.

The first step is to excavate legacy waste, loosen it and make windrows so as the leachate can be dried of through solar exposure and all the entrapped methane is removed from the heap. All biodegradable waste, like discarded food, fruit, flower and garden waste, needs air to decompose it in an odorless way without producing leachate. So, the first step in stabilizing and bringing down airless legacy waste is to expose as much of it as possible to air.

Addition of composting bio-cultures speeds up decomposition and rapidly creates biological heat within the waste that helps to dry it out and reduce its volume by 35-40%. This happens through loss of moisture and by decomposition of some of the aerated waste to carbon dioxide and water vapor. This is called bio-remediation and makes the waste dry enough for screening. Waste is called stabilized when there is no more generation of heat or landfill gas or leachate, and seeds can germinate in it.

It means the screening of such stabilized waste into different size fractions that can be usefully used off-site or disposed of without affecting the environment. Screen sizes commonly used are one or more of the following: 150 mm. 80 to 100 mm, 24 to 50mm, 12- 16 mm and 4-6. The finest fraction is called bio-earth or good earth. It contains a mixture of humus-rich organics which improve soil fertility along with a high proportion of soil or sand, which is why it cannot meet FCO standards for compost. The coarsest fraction contains bricks, stones, coconut shells, footwear, cloth and larger plastics. Density separation helps recover combustibles which can be used (usually up to 5-10%) as fuel replacement after supplying it to customer requirements. The lighter mid-fractions are mostly plastics and can be shredded as per industry requirement for use in bitumen hot- mix plants to make so- called Plastic Roads or as refuse derived fuel for co-processing in cement kilns. Fractions up to 50mm do not require shredding for use as RDF. The heavier mid-fractions are mostly stony inert which can be used in the lowest layers of road-making or plinth-filling or in low-lying areas, but should not contain more than 3–5% plastics by weight. Less than 10% of the original waste remains as totally unusable residual rejects and may remain onsite, either in a small heap or spread to raise the ground level by a couple of meters.

The land which was hosting waste dumps is now fully recovered for alternate uses. Bio- mining and Bio-remediation processes should be adopted as early as possible to ensure holistic solid waste management.

B. Process of Bio-remediation and Bio-mining

Exposing the legacy waste to air to stabilize it has been done since 1998 in many ways. Almost all of them involve forming the waste into long low heaps of about 2-meter height called wind-rows, to get maximum surface area to volume. Repeated turning is necessary to ensure that the innermost waste in wind–rows also gets exposed to air. Usually 3-4 turnings of legacy waste are necessary to stabilize it.

1. Use a tractor–tiller to repeatedly loosen the topmost 150 mm layer of legacy waste. Mist-spray the waste lightly with bio-cultures to control odour and get the decomposing microbes dispersed into the waste. Hand-pick out large objects like rocks or coconut-shells or long pieces of cloth. Form the waste into wind-rows using a Bob-cat or JCB or similar

earth-moving equipment. Turn these wind-rows every 5 days. After 2-3 weeks when the heaps are free-flowing enough for screening, move the material to multi-deck vibrating screens or to trommels (rotating cylinders with different size perforations) to get fractions of different size and weight.

2. Use a JCB to dig 2-2.5-meter-deep trenches downwards from the top of a legacy waste heap at 1.5 to 2 meter intervals. This is a rapid and cost-effective way to slice the uppermost layer into in-situ wind-rows. Mist-spray the sides of the trenches to get microbes to reach exposed waste surfaces. Bring down these slices to form terraces and turn one aerated windrow onto another weekly before repeating the process until almost ground level is reached. Start screening when waste moisture is low enough.
3. Use a JCB to lift legacy waste off the top of a heap and drop it from a height to aerate and loosen the waste and form 2-3-meter-high cones. Mist-spray bio culture on the cones. Every day or 2-3 days use the JCB to lift waste from the cones and drop it back to the same or a nearby location, to aerate the waste. This is rather fuel-intensive.
4. Where space permits, move the waste to form several long parallel windrows. Turn these weekly with a JCB. Often at the second or third turning, one heap can be combined with a second one as their volumes decrease. Windrows can be aerated either by moving all the waste to form a new parallel windrow, with the innermost waste on the outside for aeration, or by moving all the waste forward in small steps while dropping it from a height for aeration.
5. If waste needs to be moved from one location to another part of the same site, usually the perimeter, place it in thin 150 mm layers and mist-spray bio cultures. Allow 5 days to aerate one layer before adding the next one and mist-spraying bio cultures on that also. Turning may not be necessary when waste is spread thin like this, to decompose like leaves on a forest floor.
6. This is a constantly-evolving field. Hence other cost effective and space effective methods can also be applied.

C. Treatment Process

Processing of accumulated legacy waste shall be done in following manner as given below:

1. Local Body (LB) shall make a time bound plan to execute the bio-mining process to clear the old waste.
2. Volume of waste to be determined through contour survey (Total Station Survey) and site measurements. Drone mapping of heap volumes at different stages is most cost-effective and fast. Weighment of heaps is difficult and problematic as payment would be collected for heavy fractions, leaving behind the more pollution-prone lighter fractions.
3. Initial Contour level survey of the site shall be done on start of work and Final Contour level survey shall be done on completion of the work.
2. Do an initial baseline survey of surface and subsurface soils and waters and leachate present, to check for heavy metals and toxics if any. Samples should be drawn by a NABL or MOEFCC certified lab, also at the final stage. During operations, the operator should collect and keep daily samples of the finest fractions, to be pooled and analysed monthly or at random by an NABL lab. This is to ensure that unsterilized rotted waste is not simply moved from one location to another by mining without bioremediation.
1. Sprinkle the newly exposed surfaces with a composting bio culture solution or a dilute solution of 5% fresh cow dung in water. This will control smell and speed up decomposition. With the help of Back Hoe loader, the waste in the demarcated area should be loosened up.
2. Usually the top layer has several materials in the active biological state. This layer shall be stabilised through composting bio-cultures, as well as herbal/biological sanitizers if found necessary for odour control.
3. Raking of garbage layers by a long spike harrow operating in cross directions may be done as needed to pull out large rags, plastic, rubber, textiles etc.
4. Waste pickers or labour should manually pick out bulky waste like coconut shells, banana stems, tyres and rocks prior to screening for bio-mining. Store in separate heaps for sale or use.

5. Turn these windrow heaps once a week until no more volume reduction is observed in the heaps and no more heat is generated. If the garbage is stabilized, there will be no smell or leachate formation and the material will be dry enough for sieving.
6. LB or its agency may deploy Trommels and/or Horizontal Screens or other types of screens for screening. Screen the stabilized waste in a rotary screen or gravity screens of different size openings, preferably 35mm and 8mm. A fan can blow out the plastic fraction for use by recyclers. Compost
7. Appropriate numbers of excavators, back hoe loaders and workers will be required to execute the work.
8. The recyclables recovered from the bio-mining process should be sent for recycling as per the quality of the material, which should also be randomly sampled by an NABL lab and tested for heavy metals, salinity/electrical conductivity and leachability to ensure no environmental harm during use. FCO standards for pH and contaminants could be provisionally used as a benchmark. Non-Recyclable plastic material shall be sent for road making or to RDF units or cement plants. Initial cleaning of recyclable waste shall be done before it is transported for sale or disposal.
9. The recovered earthy fines shall preferably be used for landscaping or gardening or road medians within the Local Body or the site. The recovered soil can also be used as "Soil enricher" to develop green areas or by farmers.
10. The recyclables like plastic, glass, metals, rags and cloth recovered from the waste during screening shall be sorted out and preferably cleaned before sending to recycling industries or as RDF.
11. The heavy fractions may be sand and gravel usable for road shoulders or for plinth filling. Stones and concrete if any can be used for road sub-grade, or for crushing. recycling and reuse in the construction industry. The recovered construction and demolition waste recovered from the bio-mining process may be sent to a C&D processing facility if suitable for production of building materials.
12. In very old garbage layers with high debris content, most of the organic matter may have already been decomposed. Do a seed germination test to ensure it is stabilised. Add bio cultures to fully stabilise it if heat is still generated in windrow heaps or volume reduction is observed. After 7-10 days of stabilization the waste can be taken up for screening.
13. Usually the finest fraction will be organic matter plus fine soil, called 'bio-earth', which can be used as soil improver, especially for restoring alkaline or saline soils to fertility, or to grow some vegetation for erosion control. It is also useful as a lawn subgrade cum drainage layer, or it can be used as organic manure in tree pits. The next coarser fraction will be gravel and coarse organics, which can be used for road and railway embankments the coarsest fraction may have a lot of combustibles (cloth etc.) which can be baled and supplied as Alternate Fuel Resources in cement kilns or boilers.
14. There may be some (maximum 5–10% of total) left over waste including lumps of heterogeneous nature. The waste may be soaked with leachate or hard and difficult to disintegrate. This waste can be sent to scientific landfill for disposal (near zero residues).
15. The recovered land from the bio-mining process shall be utilized for any purpose deemed appropriate. Ideally reclaimed space should be reused for waste processing, otherwise for alternate non-habitation uses.

D. Use of Screened Fractions:

When planning for bio-remediation and bio-mining, it is important at the same time to identify where the screened fractions will go, in order to bring down the heap of mixed waste to fractions that would each have been usable if unmixed. None of these fractions will bring in income. In fact, their transport offsite is a cost to be budgeted for. Look for the nearest industries using solid fuel. Look for the nearest bitumen hot-mix plants and also specify Plastic Roads in road tenders to ensure offtake of the thin-film plastic fractions. Start a dialogue with all kabadiwalas within the local body to see who will be willing to pick up or accept which items. Plan for offsite aggregation space for different fractions and types of waste that will result from screening. Identify aggregation and storage sheds for use by waste-picker groups or kabadiwalas. Identify transporters who can transport different fractions out on their return trips.

For the bio-earth or good earth finest fraction, test periodically for heavy metals, then look for farmers willing to accept it. It is excellent for reclaiming salt-affected soils and for restoration of mining overburden areas if any are nearby. There is a cess for restoration of mined areas, which is

normally unspent as forest departments are supposed to revegetate them. But this is unviable in barren rocky soil by planting and watering saplings. Revegetation is instead possible and effective by mixing grass seed with the good earth fraction and spreading it on the overburden to start a natural succession of grasses, herbs and shrubs.

4.4 Process Management:

There are several factors that must be kept in mind during implementation of the project.

4.4.1 Space Management:

For all waste-stabilising methods, management of space is the biggest challenge, as aeration, stabilizing and screening mostly needs to be done within the boundaries of an already overloaded dumpsite. This is achieved mainly by experience and creative common-sense. Onsite earth-mover operators often come up with the best solutions, so seek their opinions. Every dumpsite poses a case-by-case challenge, but there is no above-ground dump that cannot be successfully bio-remediated and bio-mined.

Keep safety in mind. Always try to work downward from the top surface. Do not think of slicing waste from the top down along one side of the heap unless you can ensure leaving a stable wall of waste with a safe slope of 25 - 30 degrees while you work. Leaving a vertical wall of waste during operations can cause a dangerous landslide of disturbed waste.

4.4.2 Leachate Management:

Most high heaps of legacy waste are water-logged with leachate even near the topmost layers and all the way to the bottom. This is not just from rainwater entering the heap but is produced by airless rotting within the entire waste heap. So, when legacy waste heaps are opened up, some leachate almost always trickles out. This is not produced by the formation of wind-rows or cones, which in fact help to dry out the waste by aerated decomposition.
Channels must be created to lead the oozing leachate rivulets to a lined depression or pond for treatment or for leachate recirculation onto wind-rows as a type of bioculture. (test to see if heaps generate enough heat with its use). Leachate can also be treated in collection ponds by underwater composting. Bio-cultures that have been proved successful at other locations can be sprinkled onto the leachate pools. But intermittent aeration is a must, using small compressor pumps or aerators or airlift aeration or even simple manual or mechanical agitation. Aeration is necessary for the added microbes to do their work of digesting the polluting solids suspended in the dark and turbid leachate. Success is noticed by a progressive change in colour from dark to light, by reduction or absence of odour and by fine bubbles rising to the surface from digested solids.

E. Fire Control and Safety

Most large dumpsites are smouldering from hidden fires. Methane itself is flammable with a blue flame and supports the yellow-flame burning of combustible plastics, cloth and oily rags. Sometimes flammable industrial waste find its way onto dumpsites, aggravating the problem. It is difficult to begin bio-remediation work on a smoking dump. Sometimes digging into the dump awakens hidden fires. So fire control is important. Adding water increases the generation of both methane and leachate and is counter-productive, not a long-term solution, adding soil cover to smother the flames adds more material to a heap that one is trying to bring down.
There is a better way, again requiring creative common-sense and experience and training of earth-mover drivers. Most fires within heaps have a point source – a bag of textile discards or plastic waste or a ball of oily rags. Earthmover drivers must learn to dig in and pluck out these burning balls of fire. These should be laid nearby on the surface of the dump and then rubbed out with the back of the excavator shovel to extinguish the flames and smoke. Wet soil should be kept handy to immediately plug the excavated hole. Adding composting bio- cultures can be tried, to counter the anaerobic conditions around the burning spots. Smoking points must be tackled patiently and systematically, one by one, till the dump is smoke-free to begin stabilizing operations by bio-remediation.

It is important to do the risk assessment and an onsite emergency plan should be kept handy prior to commencement of dumpsite bio-remediation & bio-mining.

F. Use of Recovered Space

The benefit of bio-mining lies in abatement of ongoing and future pollution and ill health and in the recovery and re-use of valuable space. This is ideally for continued long-term waste management since public consent for new waste sites is increasingly difficult because of earlier visible mis-management of a Virgin site. Ensure advance demarcation and declaration of a buffer zone of no new habitation for upto 500 meters around the cleared site to prevent real-estate activity from encroaching the buffer as soon as the dump is removed. If a dump is engulfed within a growing city and its continued use for waste management is unsuitable, identify in advance the planned future use of that site and put up a signboard indicating that use, to ensure public acceptance of the biomining operations which will be temporarily noisy and dusty. This will also protect the site from land-grabbers. leared dumps are not permitted for habitation for at least 15 years (SWM Rules Schedule I, H (2)). This is because of unhealthy leachate below the site and formation of flammable and offensive landfill gases from waste pockets that may remain unexcavated. Permissible options are reuse for SWM, open stadia, sports grounds, parks and gardens, parking lots, container yards, warehouses of non-flammables and similar facilities where people are not living or working all day and night.

4.7.4 Costs

Operation & Maintenance Cost for Bio-remediation and Bio-mining:

Operational Expenditure of the project would depend on the size of dumpsite. The onsite bioremediation cum bio mining cost ranges between Rs 400 to 700 per cubic meter, irrespective of capital cost. The case by case cost of moving screened fractions offsite will be extra and variable, depending on distance to farmers, cement plants etc. For this cluster case, this rate shall increase as the developer coming in should include capital expenditure, profitability and contingencies. Being through practical examples of reclamation, we have arrived at the cost of per ton of legacy waste removed to be fixed at Rs. 750. This has been finalized in discussion with SUDA

4.7.5 Pramodnagar & Kamarhati Dumpsite Details

As per the survey, total volume of waste estimated to be present in Pramod Nagar is 5.5 Lakhs cubic meter. Similarly, Kamarhati dumpsite has a volume of 1.22 Lakh cubic meter present. Waste samples have been collected from both the dumpsites and TCLP test reports have been summarized in chapter 3 of this report.

5 Gap Analysis for Collection & Transportation

In the proposed PPP structure, the cluster ULBs shall be responsible for Primary collection and transportation of solid waste management to secondary collection points in cluster-1. The developer shall be responsible for improvement, deployment of secondary waste collection infrastructure for secondary collection & transportation of the waste to the processing sites and further disposal of processing rejects to the sanitary landfill site to be developed by the Developer. As observed during site visits to cluster ULBs, there is a need for substantial improvement in the primary and secondary vehicles of municipalities to achieve the standards set by Solid waste management rules and NGT guidelines.

EY team has collected data form ULBs through visits and questionnaire format to analyze the infrastructure gap in the primary and secondary collection of waste. The methodology followed for the estimation of waste generation for year 2019, in the year 2027 and 2042 is as follows:

Population Projection: Three different methods have been used for population projection. Population data from census website has been collected.

ULB	2011	2001	1991
Kamarhati	330211	314507	266889
New Barrackpore	76846	83183	NA
Baranagar	245213	250615	224821
Dumdum	114786	101319	40961
South dumdum	403316	392150	232811
North dumdum	249142	220032	149965

1) Arithmetic Increase Method:
Average increase per decade = Total increase in population/ Number of decades

Location	Growth rate (1991-2001)	Growth rate (2001-2011)	Average Growth	Projected Population 2019	Projected Population 2027	Projected Population 2042
Kamarhati	4761.8	1570.4	3166.1	355540	380869	428360
New Barackpore	Not available due to unavailability of 1991 data	-633.7	5085.36	117529	117529	117529
Baranagar	2579.4	-540.2	1019.61	253370	261527	276821
Dumdum	6035.8	1346.7	3691.25	144316	173846	229215
South dumdum	15933.9	1116.6	8525.25	471518	539720	667599
North dumdum	7006.7	2911	4958.85	288813	328484	402866

2) Geometric Increase Method:
The geometric mean of the growth rate (r) = $(n-1)^{th}$ root of the multiplication of all 'r's

Location	Growth rate (1991-2001)	Growth rate (2001-2011)	Average Growth	2019	2027	2042
Kamarhati	0.01655285	0.004884441	0.008991743	354726	381060	435820
New Barackpore	Not available due to unavailabilit y of 1991 data	-0.007892646	0.019466439	89661	104614	139695
Baranagar	0.01092053	-0.002176695	0.019466439	286106	333819	445763
Dumdum	0.09479305	0.012557752	0.034501995	150570	197511	328519
South dumdum	0.05352506	0.00281154	0.01226735	444639	490195	588569
North dumdum	0.03908145	0.012502514	0.022104669	296763	353487	490686

3) Exponential Increase method:
$P(t+n) = P(t) \times e^{rn}$ where r is the constant annual growth rate
$r = \log_e(P(t+n)/P(t))/n$

Location	Growth rate (1991-2001)	Growth rate (2001-2011)	Average Growth	2019	2027	2042
Kamarhati	0.01641734	0.004872551	0.008943957	354704	381014	435718
New Barackpore	Not available due to unavailabilit y of 1991 data	-0.007923958	0.019121778	89548	104350	139015
Baranagar	0.01086133	-0.002179068	0.019121778	285745	332978	443591
Dumdum	0.09056535	0.012479557	0.033618678	150208	196560	325463
South dumdum	0.05214174	0.002807595	0.012099294	444307	489463	586867
North dumdum	0.03833710	0.012425002	0.021825183	296671	353268	490097

Average population from all three methods is considered for final calculation

Location	Population 2011	Avg population 2019	Avg population 2027	Avg population 2042	Avg population 2022
Kamarhati	330211	354990	380981	433299	364590
New Barackpore	76846	98913	108831	132080	107540
Baranagar	245213	275074	309441	388725	287396

Dumdum	114786	148365	189306	294399	162745
South dumdum	403316	453488	506459	614345	473009
North dumdum	249142	294082	345079	461216	312439

Waste Estimation: The waste generated per capita in each ULB has been assumed from CPHEEO manual and in discussions with Technical Committee SUDA. Following are the considered values for waste quantity estimation and finalizing plant capacity after the discussion with the technical committee SUDA.

S. No	ULB Name	Waste generation per capita per day (in grams)
1	Dum Dum	400
2	North Dum Dum	350
3	South Dum Dum	450
4	Baranagar	400
5	Kamarhati	350
6	New Barrackpore	350

As per the population projections and per capita waste generation, following are the waste projections.

S. No	ULB	Population projection for 2019	Current Waste generation in 2019 (Tons per day)	Solid Waste Generated (Shared by ULB's) in TPD	Population projection for 2027	Estimated waste generation in 2027 (Tons per day)	Population projection for 2042	Estimated waste generation in 2042 (Tons per day)
1	Dum Dum	127281	59.35	62.1	189306	75.72	294399	117.76
2	North Dum Dum	276263	102.93	150	345079	120.78	461216	161.43
3	South Dum Dum	446869	204.07	698	506459	227.91	614345	276.46
4	Baranagar	271906	110.03	145	309441	123.78	388725	155.49
5	Kamarhati	367212	124.25	100	380981	133.34	433299	151.65
6	New Barrackpore	85237	34.62	29	108831	38.09	132080	46.23

5.1 Primary Collection

According to the provided data from ULBs in cluster-1, there are combination of tricycles and light commercial vehicles being deployed for primary collection purpose. The ULBs data have been analyzed to estimate the number of additional vehicles required to sustain 100% collection of waste generated by households for the year 2027. To ensure a seamless procurement, EY team has proposed the additional vehicles which may be referred from the Government e- Marketplace website (https://gem.gov.in/).

Present Scenario:

As per the data collected through detailed questionnaire from ULBs, we have analysed the current waste collection efficiency of each cluster ULBs from the vehicle deployment, capacity and number of trips per day to the disposal site. The waste generation quantity has also been projected for the future years and Gap between the current infrastructure and required infrastructure has been proposed. This has been listed below.

The gap analysis for the infrastructure requirement with respect to primary and secondary collection and transportation of waste is given in the table below:

As per CPHEEO manual, for a ULB with a population in the range of 1 lakh to 5 Lakh, 70% of the primary collection needs to be performed by deploying Light commercial vehicles (LCV's) and the rest needs to done using Tricycles. In the gap analysis, considering the family size of a household to be 5, it has been assumed using past references that 1 LCV can covers 600 households and 1 tricycle covers 200 households per day. Hence the total number of LCV's and tricycles required for primary collection and transportation in all participating cluster ULBs are 479 and 613 respectively. The waste collected in primary collection should be segregated and it should have a twin bin system each for dry and wet waste.

According to the data collected from the ULB's, it is observed that the vehicles used for primary collection do not comply with the CPHEEO manual i.e. tractors and handcarts which are being used presently shall not be used for primary collection. As a result of which, a gap analysis has been performed for the existing vehicles as given in the table below. The existing vehicles are well partitioned and equipped to perform collection of waste in a segregated manner, however segregated waste collection is not being implemented presently. As per the gap analysis, it can be concluded that all the 6 ULB's, requires a definite upgradation of primary collection vehicles. The ULB's are required to deploy 479 LCV's for efficient collection and transportation in compliance to the SWM rules,2016. From the analysis, it can be inferred that Kamarhati Municipality is required to upgrade their collection vehicles and replace the existing vehicles with LCV'S and Tricycles i.e. 98 and 127 respectively.

Assumptions on which we have based our calculation:

Assumptions	
Family size	5
LCV (70% coverage)	0.7
Tricycle (30% coverage)	0.3
Percentage of spare vehicles	10%

Table 17: Gap Analysis for All municipality for Collection & Transportation

Municipality	Population (2027)	No. of Wards	Total Waste generation 2027	Primary Collection Infrastructure										
				No. of Households	No. of LCV's	Spare LCV's	Total No of LCVs	Existing LCV's	Gap (LCV)	No. of Tricycle	Spares Tricycles	Total No of Tricycles	Existing Tricycles	Gap (Tricycles)
Dum Dum	189306	22	75.72	37862	45	5	50	0	50	57	6	63	42	21
Kamarhati	380981	35	133.34	76197	89	9	98	0	98	115	12	127	0	127
New Barrackpore	108831	20	38.09	21767	26	3	29	0	29	33	4	37	33	4
Baranagar	309441	34	123.78	61889	73	8	81	0	81	93	10	103	80	23
South Dum Dum	506459	35	227.91	101292	119	12	131	0	131	152	16	168	490	-322
North Dum Dum	345079	34	120.78	69016	81	9	90	0	90	104	11	115	170	-55
Total		**180**	**720**				**479**	**0**	**479**	**554**		**613**	**815**	**-202**

Vehicles and equipment

Tricycle with Hydraulic Tipping Containers: MSW tricycles should have mild steel epoxy painted and tipping containers. The tipping containers should be mounted on a standard tricycle. These tricycles are suitable for door-to-door collection from houses in small/narrow lanes and small waste generators. As per manual, a tricycle can cover approximately 200 households. Available options for Tricycle in Government e Marketplace are presented in this Link (https://gem.gov.in/).

Figure 13: Indicative picture of Tricycle

Light Commercial Vehicles (Mini Trucks) with Hydraulic Tipping Containers:
These vehicles are suitable for door-to-door collection of segregated waste for lanes with less than 5m width. They have a total payload capacity of nearly 600-900 kg per trip. The load height is approximately 1,500 mm from the ground level. They should have a leak-proof MS load body with drainage tube and plug. The small tipper should be built on a suitable chassis. These vehicles should have four openings, two on each side to facilitate direct transfer of waste from a domestic bin to the vehicle. They can also have a central removable partition to facilitate storage of segregated waste. It is desirable to use up to 3m3 capacity vehicle for door-to-door collection to cater to a large number of houses in a single trip. As per manual, a LCV can cover approximately 600 households. Available options for LCV (tippers) in Government e Marketplace are present in this Link (https://gem.gov.in/).

Figure 14: Indicative picture of Light Commercial Vehicle

The Summary of proposed requirement is as follows:

Manpower
The manpower requirement for primary collection is as follows:

Table 18: Manpower requirement for primary collection in Cluster – 1 for 2027

Particulars	Details	Requirement
Tricycles	One worker per vehicle	613
	Supervisors (One for 15 workers)	41
Light Commercial Vehicles	One driver per vehicle	479
	One worker per vehicle	479
	Supervisors (One for 20 workers)	48

The PPE requirements for all the above manpower handling MSW are gloves, shoes and uniforms covering the entire body. It is proposed that domestic waste shall be collected in the morning hours before 12 noon. Waste from the commercial areas shall be collected between 10.00 am and 2 pm. Vegetable market waste shall be collected in non-peak hours either early morning or late in the afternoon or at night.

5.2 Secondary Collection

As per the field survey conducted by EY team, some of the secondary collection points in the cluster ULBs have static compactors to improve collection and transportation of waste to disposal site. Whereas contrary to that some secondary collection points are informal points, wherein through open and roadside dumping, the waste is further transferred from smaller vehicle to larger vehicle. EY suggests upgradation of Secondary collection points in compliance with SWM rules,2016 and in accordance CPHEEO manual and hence proposed the deployment of bins of appropriate size as listed in the table below.

Indicative Bin Image:

Figure 15: Bins for Secondary Collection

Table 19: Secondary Collection Calculations

ULB	No. of SCP's	Calculated number of SCPS as per CPHEEO manual	Waste Qty. (Ton/day)	Waste Qty. (Cum/day)	200% waste Qty./day considered for planning (as per CPHEEO manual)	Total waste at each SCP (Cum)	Wet Waste (50%)	Dry waste (50%)	No. of Bins (Total)	Cost
Dum Dum	31	38	75.72	95	190	7	4	4	2	5270000
Kamarhati	53	77	133.34	167	334	7	4	4	2	9010000
New Barrackpore	13	22	38.09	48	96	8	4	4	2	2210000
Barranagar	7	62	123.78	155	310	45	23	23	7	4165000
South Dum Dum	71	102	227.91	285	570	9	5	5	3	18105000
North Dum Dum	29	70	120.78	151	302	11	6	6	3	7395000
								TOTAL		**46155000**
								TOTAL in Cr		**4.62**

5.3 Secondary Transportation

According to the data obtained from ULBs in cluster-1, there are a combination of tractors, lorries, dumper, compactors are being used for secondary waste transportation purpose as attached in annexure 5.The ULBs data have been analysed to estimate the number of additional vehicles required to sustain 100% collection and transportation of waste in year 2027. To ensure a seamless procurement, EY team has proposed additional vehicles which can be refereed readily in Government e Marketplace website (https://gem.gov.in/). To ensure uniformity in vehicles of secondary transportation, dumper placers and compactors are proposed for secondary transportation of waste. Small and medium sized compactors are proposed to allow for efficient transportation of waste. It is proposed that dumper placers of 6 tonnes waste/ trip and RCs of 1 tonnes waste /trip would cater to all the ULBs in this cluster. Each vehicle can undertake a maximum of 2 trips per day. Further, remaining waste shall be transported by 16 cu.m compactors with a payload capacity of 10 tonnes/ trip. These compactors can undertake a maximum of 2 trips per day. Manpower calculated as one driver and one helper per vehicle. Cost estimates have been provided in the chapter 7

The number of SCP in table 20 has been calculated as per population in compliance with CPHEEO guidelines. Due to less availability of space in this cluster and high land costs, EY suggests ensuring maximum use of the existing SCPs for secondary collection & transportation. The details of existing secondary collection points have been attached in annexure VII.

Vehicle and Equipment

To ensure uniformity in vehicles of secondary collection, compactors are proposed for secondary transportation of waste. Small and medium sized compactors are proposed to allow for efficient transportation of waste. It is proposed that dumper placers of 6 cum and 16 cum waste/ trip would cater to the waste in Cluster-1. Available options for Compactors in Government e Marketplace are present in this Link

Figure 16: Indicative picture of medium size compactor truck

Assumptions for Secondary Transportation:

Assumptions	
Family size	5
1 SCP/Population	5000
Percentage of spare vehicle	10%
No. of trips of RC's/DP's	2
Capacity of RC's (cum)	16[7]
Capacity of DP's (cum)	6[8]

[7] The actual capacity shall be 14cum
[8] The actual capacity shall be 5cum

Table 20: Requirement of vehicles for secondary transportation of waste for 2027

Municipality	Population (2027)	No. of Wards	Total Waste generation (TPD)	Secondary collection		
				No. of Households	No. of refuse compactors	No. of Dumper placers
Dum Dum	189306	22	75.72	37862	2	2
Kamarhati	380981	35	133.34	76197	4	3
New Barrackpore	108831	20	38.09	21767	1	2
Barranagar	309441	34	123.78	61889	3	3
South Dum Dum	506459	35	227.91	101292	8	1
North Dum Dum	345079	34	120.78	69016	4	1
Total		**180**	**720**	**368023**	**22**	**12**

Manpower requirement

Table 21: Manpower requirement for secondary collection of waste in cluster-1

Particulars	Details	Requirement
6 cum Dumper Placers	Drivers	12
	Helper /Worker (One for each)	12
	Supervisors for dumper placers	2
16 cum compactors (RC)	Drivers	22
	Helper /Worker (One for each)	22
	Supervisors for compactors	3

Further, it is proposed to incorporate advanced information management system such as GPS, MIS for management of information in such vehicles.

6 Processing and Disposal

6.1 Land details of proposed processing plant

Pramodnagar Site

The vast area of Pramodnagar site is under the jurisdiction of South Dum Dum municipality. Over the past two decades the location has been turned into a dumping yard. The site is approximately a 22 acres land which stacked up to 15 meters with waste. It is located in a sensitive zone surrounded by Pramodnagar Jheel, Adarsh Nagar residential area, Mathkol School and Belghoria Expressway which is a four-lane, 8 kilometer (5.0 mi) long access controlled tolled expressway in the northern suburbs of Kolkata, West Bengal. It is a key arterial road, linking the terminal junction points of NH 19 and NH 16 near Dankuni to Dakshineswar, across Nivedita Setu, and NH 12 (Jessore Road), near Dum Dum Airport.

Figure 17: Bird's eye view of the Pramod Nagar dumpsite

The site was previously used by 6 ULBs - Dum Dum, South Dum Dum, North Dum Dum, Baranagar, Kamarhati and New Barrakpur. Due to heavy inflow of 500 - 600 tonnes solid waste per day, the site is in the verge of exhaustion. The authority has controlled the waste inflow and now allows only 4 ULBs - Dum Dum, South Dum Dum, North Dum Dum, Baranagar to dump waste at Pramodnagar site.

During the site visit, it was observed that there is likely release of methane and carbon dioxide gases from the fresh waste. The leachate released from the site has choked the adjacent water body (Pramodnagar Jheel) and made the water non-potable. The site is also filled with a significant amount of legacy waste which does not have any alternative processing plant or site to process and dispose it. The gases and odour released from the site contaminates the air in the surrounding areas. The people living in the adjacent residential areas use the contaminated water from

Pramodnagar Jheel for domestic purposes. The pig breeding is also observed in the vicinity of the site.

Under Mission Nirmal Bangla (Urban) and Swach Bharat Mission (Urban) on turnkey basis, the Kolkata Municipal Development Authority have initiated few projects with an aim of managing solid waste in scientific manner.

As demonstrated in the figure above, the Pramodnagar dumpsite area can be broadly divided into:

- Platform area - It is located at the entrance point of Dum Dum and South Dum Dum municipalities and is a major area for waste unloading
- Waste Mount A, B & C - These waste mounts divide the contours of waste dumped in 3 major sections. However, apart from these 3 mounts, the waste is also spread across entire site up to a height of 5 mts. or so.
- SLF Cell - KMDA had also initiated the work for constructing a SLF Cell
- 50 TPD compost plant - KMDA has initiated the work for setting up a 50 TPD compost plant

Figure 18: Pramodnagar site pictures from Visit Conducted on 11 April 2019

Platform Area

Legacy waste

SLF Cell – Under Construction

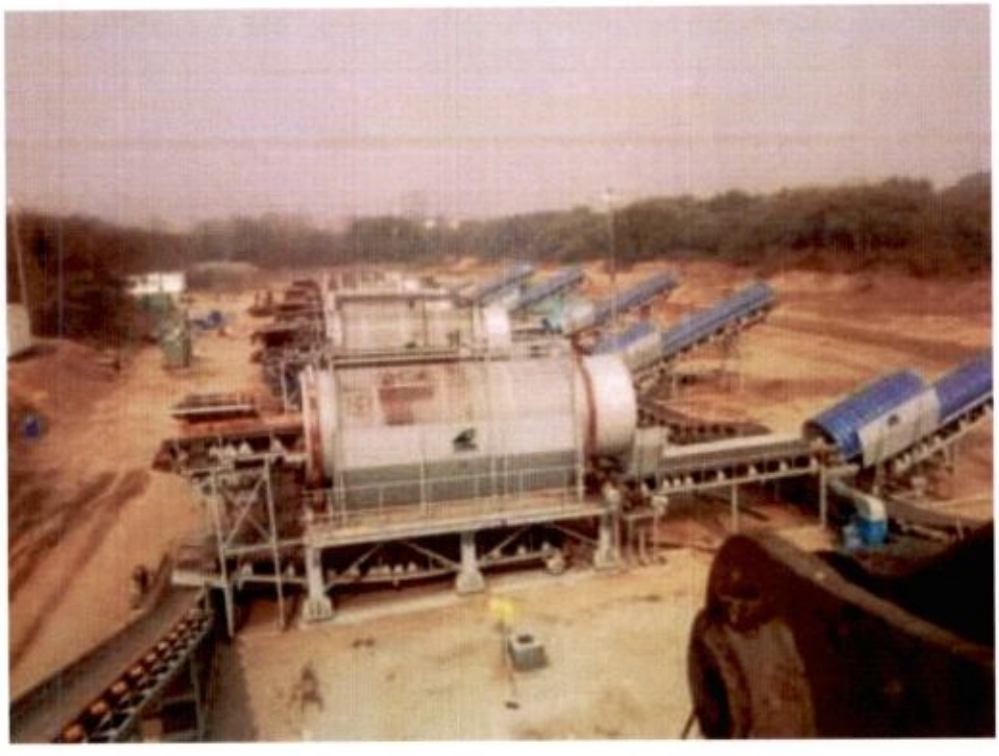
50 TPD Compost Plant

Temporary Septage Plant

According to the proposed modifications in project structure, the Pramodnagar Site should cater waste from Dum Dum, North Dum Dum, South DumDum and Baranagar only. Accordingly, a RDF plant and windrow composting of 450 TPD capacity should be planned at Pramod Nagar site with provision for future waste generation assessment and expansion. Addition to this, the land reclamation activities should be carried out in parallel to the plant construction.

The possible scheme can be first to remove Mount A and Mount C to get an extra space for the expansion of current 50 TPD compost plant into windrow composting + RDF plant. It is assumed that this activity will take around 2 years. Until then the fresh waste can be dumped at Mount B side, where Baranagar municipality is dumping their waste. After installation of the new plant, processing of fresh waste can be initiated. Therefore, removal of waste from Mount B and other remaining waste scattered at the site can be done. The free space at Mount B may be used for future expansion of processing plant. The SLF space, after the entire land reclamation process, can also be used for setting up some Bio-Methanation plant.
As discussed earlier, for initiating any new construction activity, the land should first be reclaimed by processing the legacy waste. The disposal of legacy waste and new construction should be done in parallel to achieve synergies in project. Usually process of removal of legacy waste is called landfill reclamation. In this, the waste is subjected to mining and segregation activities using conveyors and trommels. A typical layout of such plant working in Noida (U.P) is given at Figure below. Usually these are mobile equipment, which are removed from the site after completion of landfill reclamation activities.

Figure 19: Typical layout of Bio-remediation plant



Kamarhati site

The Kamarhati site is enclosed in an area of approximately 8 acres under the jurisdiction of Kamarhati municipality. This area was utilized by Kamarhati and New Barrackpore for dumping waste. The site is filled with legacy waste which staked up to 6 meters and has leachate flowing out of it and is completely exhausted now. This site is also located in a very sensitive residential zone with a school beside it. Since this dumpsite is completely exhausted. An immediate action should be taken on this site by processing the waste accumulated.

Figure 20: Kamarhati site pictures from Site Visit Conducted on 11 April 2019

The processing plant for Kamarhati municipality should be proposed on the existing closed site at Kamarhati. The land reclamation for the site should be carried out in parallel to the processing plant construction. If possible, New Barrackpore Municipality may also be integrated with Kamarhati Municipality for waste processing at Kamarhati site only. Processing waste from Kamarhati and New Barrack pore municipalities in Kamarhati site will reduce the stress on PramodNagar site by about 100-120 TPD.
The possible scheme can be to remove the legacy waste completely. The empty area can be used to construct new windrow composting and RDF plant of capacity 180 TPD while transporting the waste from Kamarhati and New Barrackpore simultaneously.

6.2 Recommended technologies

The limitations of the individual conventional technologies can be mitigated by bringing together a mix of technologies by integrating them together to provide a holistic solution for the treatment of urban waste. An integration of technology so carried out would have the following benefits:

a. It treats various components of urban waste in an efficient manner so as to provide optimum utilization of waste to produce compost, biogas, power and building materials.
b. It leads to optimization of cost by treating larger quantities at the same place, sharing infrastructure and variable costs.
c. It is environmentally desirable, as the rejects of one process becomes inputs for the other process.

Considering the cluster-1 ULBs scenario, an economically and environmentally sustainable solid waste management system will only be effective if it follows an integrated approach i.e. refining of mixed waste in a series of mechanical sorting, shredding and drying stages followed by density separation to separate the combustibles, organic and inerts out of mixed waste and giving treatment to each fraction that would be most suitable and efficient for it. The combustible material thus separated out from the MSW is known as Refuse Derived Fuel (RDF). These stages may be referred to as the fundamental stages in the preparation of RDF. There should be different technologies that can treat the mixed and green waste separately and specific wastes should be dealt with in such a system but in separate streams.
The waste produced in the ULBs is not completely seggregated into organic and inorganic componets before transferring it to the dumpsite. Eventhough the municipalities are putting in their best efforts to transfer segregated waste to the dumpsites, due to the issues like gap in

infrastructure & man power availability, lack of awareness in the people makes it challenging. Out of the available options,Composting and RDF plant is the most suitable option which can take in the unsegregated waste as input and reduce the waste to approximately 15-20%. In addition to mix waste, Cluster-1 also generates huge amounts of segregated bio-degradable waste from bulk waste generators (vegetable and fish markets, Hotels, restaurents etc.) which can be chanelized and utilised in Bio-Methanation plant. In future, if the municipalities manage to transport the segregated waste to processing plant, that could also act as an input to this Bio-Methanation plant. Since the Cluster-1 ULBs also falls in a high rainfall zone, the windorw composting option is the best option under composting part of the processing plant.

Table 22: Choosing best available processing plant option for Dumpsites

Criteria	Pramodnagar Dumpsite Vs Windrow Composting + RDF facility		Kamarhati Dumpsite Vs Windrow Composting + RDF facility	
	Required	Available	Required	Available
Land area	15 - 20 acre	22.69 acre	4.59 to 6.125 acre	8.003 acres
Natural environment	Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation.	High rainfall	Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation.	High rainfall
Minimum Waste Quantity required for making single facility viable	500TPD (economically sustainable above 500 TPD plant size)	Recieves 548 TPD waste by the year 2027	500TPD (economically sustainable above 500 TPD plant size)	Recieves 171 TPD waste by the year 2027
Requirement for Segregation prior to technology	Moderate because both dry and wet fractions are utilized	Currently the waste input from the ULB's is not completely seperated	Moderate because both dry and wet fractions are utilized	Currently the waste input from the ULB's is not completely seperated

From the analysis performed on data collected from ULBs, the estimated waste input from Dum Dum, South Dum Dum, North Dum Dum, Baranagar is 548 TPD (including waste from BWG) in year 2027. Hence the land available in Pramodnagar dumpsite can accommodate only processing plant and not sanitary landfill. From above table, we can conclude that out of the avaialble options, taking the land available, natural environment, extent of segregation of waste in ULBs and minimum waste required for making single facility feasible, the best available processing plant option for Pramodnagar Dumpsite is the Windrow Composting + RDF plant of 450 TPD capacity (estimated waste input in 2027) which would 15-20 acres. It is also suggested that for the segregated Bio-degradable waste input from BWG, a Bio-Methanation plant of capacity 100 TPD which would require 2.06 acres should be added in the land available at pramodnagar after completion of the windrow compost + RDF plant. Furthur, there is a scope for expanding these plants by increasing the capacity of both the Compost+RDF plant and Bio-Methanation plant.

The area available in Pramodnagar dumpsite can accommodate waste input from all the ULBs in cluster-1 but there will not be any scope for further expansion of that plant interms of capacity. Hence in the revised scheme, it is proposed to develop a separate processing plant at existing dumpsite in kamarhati for the waste input from New Barrackpore and Kamarhati.

From the analysis performed on data provided by ULBs, the estimated waste input from New Barrackpore and Kamarhati is 171 TPD of mixed waste in 2027. From the above table, we can conclude that out of the avaialble options, taking the land available, natural environment, extent of segregation of waste in ULBs and minimum waste required for making single facility feasible, the

best available processing plant option for Kamarhati Dumpsite is Windrow Composting + RDF plant of 180 TPD capacity which would require about5-6 acres.

Unsegregated waste mixed with biodegradable and non-biodegradable material is collected and sent to the processing facility. At the processing facility, the mixed waste stream may be segregated manually or mechanically to separate recyclable material from compostable and inert waste. Compostable matter and recyclable materials may then be processed separately, and residual inert wastes should be sent to the landfill.

Compost Plant

a. Yard Management System
The <100 mm fraction of MSW screened in the trommel of pre- processing section is conveyed to the designated areas of compost pad for windrow preparation. In windrow type aerobic composting system, the fresh MSW is stacked in the form of trapezoidal heaps called 'windrows' *Sufficient quantity of decomposing microbial cultures (inoculum & sanitizer*) will be inoculated at this point with sprayer to reduce odour and repel vectors. Moisture will also be supplemented at required levels before windrow preparation. The thoroughly mixed waste is then made to windrows of convenient dimensions and kept for the biologic decomposition.
The windrows are periodically turned (normally once a week) using hydraulic excavators to provide proper aeration and temperature control. The composting heap is stabilized in about 6 weeks, when it is shifter to the screening plant for removal of the inert and non-composted matter.
In some of the plants, particularly, in high rain-fall areas, a shed is provided called 'rain shed' or 'monsoon sheed'. In this case the material is shifted to the rain-shed after about 4 weeks and kept there for a further period of 2 weeks.
    1) After windrowing, water is added to windrow using water tanker to maintain requisite moisture level.
    2) Just after windrowing, bacterial activity starts within 2-3 days. Inside temperature of the windrow may go up to 65 °C.

b. Coarse segregation system
Stabilized material from monsoon shed is then fed to the 'coarse segregation section' using a Skid Steer Loader for intermediate screening. Two stage screening system is adopted to achieve maximum screening efficiency using trommel of different hole sizes. Cascading action inside the trommel ensures better screening of the lumpy and highly heterogeneous municipal solid waste. These days equipment in this section are hydraulically driven to ensure greater safety against breakdowns and to lower power consumption. Hydraulic drive also introduces features like on-load starting, centralized control etc. PLC based controls allows automatic shutdown in case of any emergency.
Screened material coming out of this section is uniform in texture and contains semi-stabilized organic compost. This material needs further stabilization, so it is transferred to the curing section.

c. Curing system
Material coming out of the coarse segregation section is stored in curing section for 15 days for further stabilization and moisture control. Some additives, such as, as rock phosphate may be added at this stage to improve quality of final product. Curing area can hold up to 20 days of material coming to the curing section on daily basis.

d. Refinement system
As per compost quality norms nationally (FCO) and internationally, the compost should be below 4 mm average particle size and it should not contain impurities such as glass, plastic, other inert material etc. which spoils the overall appearance and creates suspicion in the mind of the end user about quality of the final product. To achieve this, a refinement section is incorporated in the machine line.
Cured material from the curing section is fed to this section using a skid steer loader. First equipment of the refinement section is a drag feeder conveyor. Once this equipment is filled up with cured material, it gradually feeds the same to the consecutive equipment at a controlled rate. This section consists of a trommel screen 4 mm. which contains the hole size of 4mm. The screened material coming out of the trommel screen is sent to the gravity separator which

removes heavy impurities such as glass, metals, sand, silica etc. from the organic manure. The magnetic separator in the production line will take care of all kinds of ferrous impurities in the compost. Organic Manure free from major impurities is passed through a liquid add mixer where quality enhancer in powder or liquid form is added.
High quality organic manure is then passed through the packing spout and final packing of the product takes place.

e. Packing and storage system
The mechanized packing section can do the bagging, weighment and stitching of 50 kg bags and finally stacked in the finished product store by using a stacking conveyor.

f. Leachate, litter and odour management system
During composting some dark coloured thick fluid may get generated. This fluid is known as 'leachate'. It should not get percolated in the soil or else it will pollute the ground water. To avoid this, proper concreting of the 'compost pad' is done and a peripheral drain is provided to collect the leachate generated during the process. The leachate so collected has to be suitably treated or recycled over the windrows. The air-borne litter is controlled by providing a high wire mesh. A green belt is provided around the plant.

ii. Process monitoring & control systems

a. Yard management

Yard management process needs to be monitored in order to achieve proper digestion and obtaining right quality finished product. For aerobic composting, proper temperature, moisture and aeration is required in the windrows. Temperature in the core of the windrow should reach up to 65-750 C and a moisture level of 35 - 40 % should be maintained in the windrows. These will ensure proper growth of the bacteria and thus proper stabilization. An operator will take temperature readings of the windrows and also check the moisture level. C: N ratio of the waste must also be checked by sampling, so that corrective measures can be taken at the initial stage if the ratio is found not in-line with the requirement. If heavy metals are found in the waste with the values exceeding the stated ones, the waste material should be removed from the windrows and not used for food crops.

b. Segregation plant

Segregation plant is centrally controlled by a control panel. Control panel shuts down the plant automatically in case temperature, pressure and current reading exceeds the stated value. An Inspector will take these three readings of the control panel periodically and see if all the readings are within limit.

c. Removal of recyclables & processing rejects

Recyclables will be sold to authorized recyclers and combustibles fraction will be balled and sold to industries. Rejects from the compost plant must be regularly removed. These would be loaded in dumpers or tractor trolleys and directed to designated landfill site.

RDF processing plant

The RDF processing unit would receive MSW of >100 mm size and produce RDF through following process:

a. Walking Floor Feeder
The walking floor feeder provides constant material feed to the pre-shredder. The feeder also works as a buffer. The feeder is all steel, very wear and impact resistant and almost maintenance free. The walking floor automatically feeds a sufficient amount of waste to the shredder. A sensor above the shredder meters the amount of material in the shredder and thus controls the automatic feeding of material. Once the walking floor is filled, the plant will work automatically for some time.

b. Trommel screen
The MSW is conveyed to a trommel screen with 100 mm screen size. The below 100 mm size will be taken for composting and above 100 mm size will be further conveyed to the main shredder for size reduction.

c. Shredder
The shredder cuts the material to a size of approx. 30 - 50 mm, (can be adjusted by means of changeable bottom screens). In case the un-shreddable material is detected, the shredder is

stopped automatically. The foreign object is also automatically discharged to a dedicated container by means of reversible belt conveyor after the following conveyor. The MIPS (Massive Impact Protection System) protects the knives of the shredder in case of un-shreddable material enters the shredder. The shredded material is discharged from the shredder by means of chain/belt conveyor. The shredder qualities described above are from one of the working shredders in MSW processing facility in India.

d. Ballistic Separator
   The ballistic separator is used to segregate the heavy inert, glass and metal pieces.

e. RDF Specifications
   It is reported that, after drying and separation of non-combustible fraction and a part of biodegradables, MSW on conversion to RDF, possesses an average calorific value of 2500 kcal/ kg (i.e. 11.7 MJ/Kg) with less than 50 mm size.

   The specifications are as follows:

Ultimate analysis			
Moisture	: 15% - 25%	20%	17.68
Mineral matter	: 15% - 25%	20%	17.68
Carbon	: 35% - 40%	37.5%	33.16
Hydrogen	: 5% - 8%	6.5%	5.75
Nitrogen	: 1% - 1.5%	1.25%	1.11
Sulphur	: 0.2% - 0.5%	0.35%	0.31
Oxygen	: 25% - 30%	27.5%	24.31

Proximate analysis:

Moisture	:	15% - 25%
Ash content	:	15% - 25%
Volatile matter:		40% - 60%
Fixed carbon	:	10% - 20%

Figure 21: Process flow at the Material Recovery processing facility

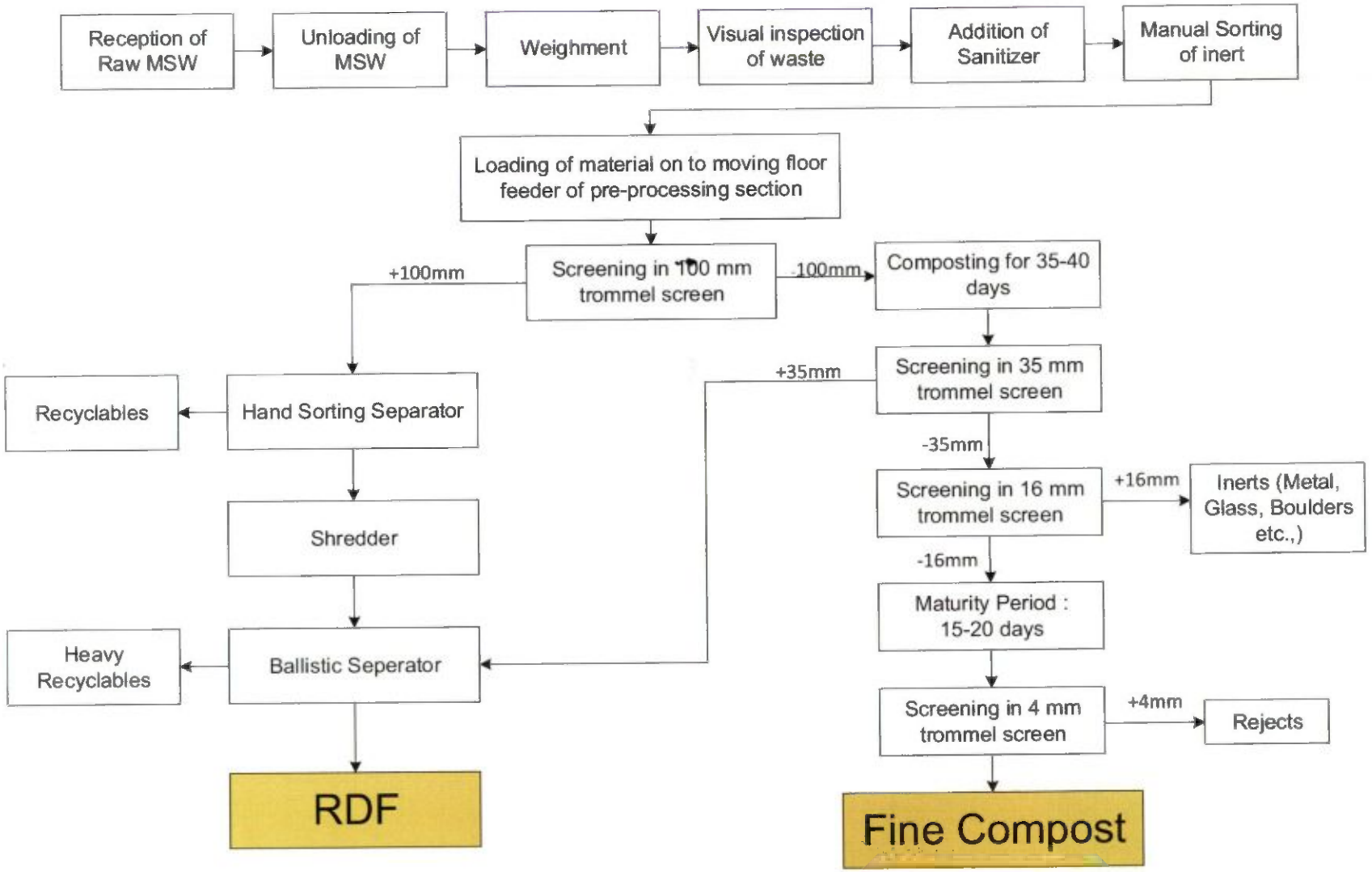
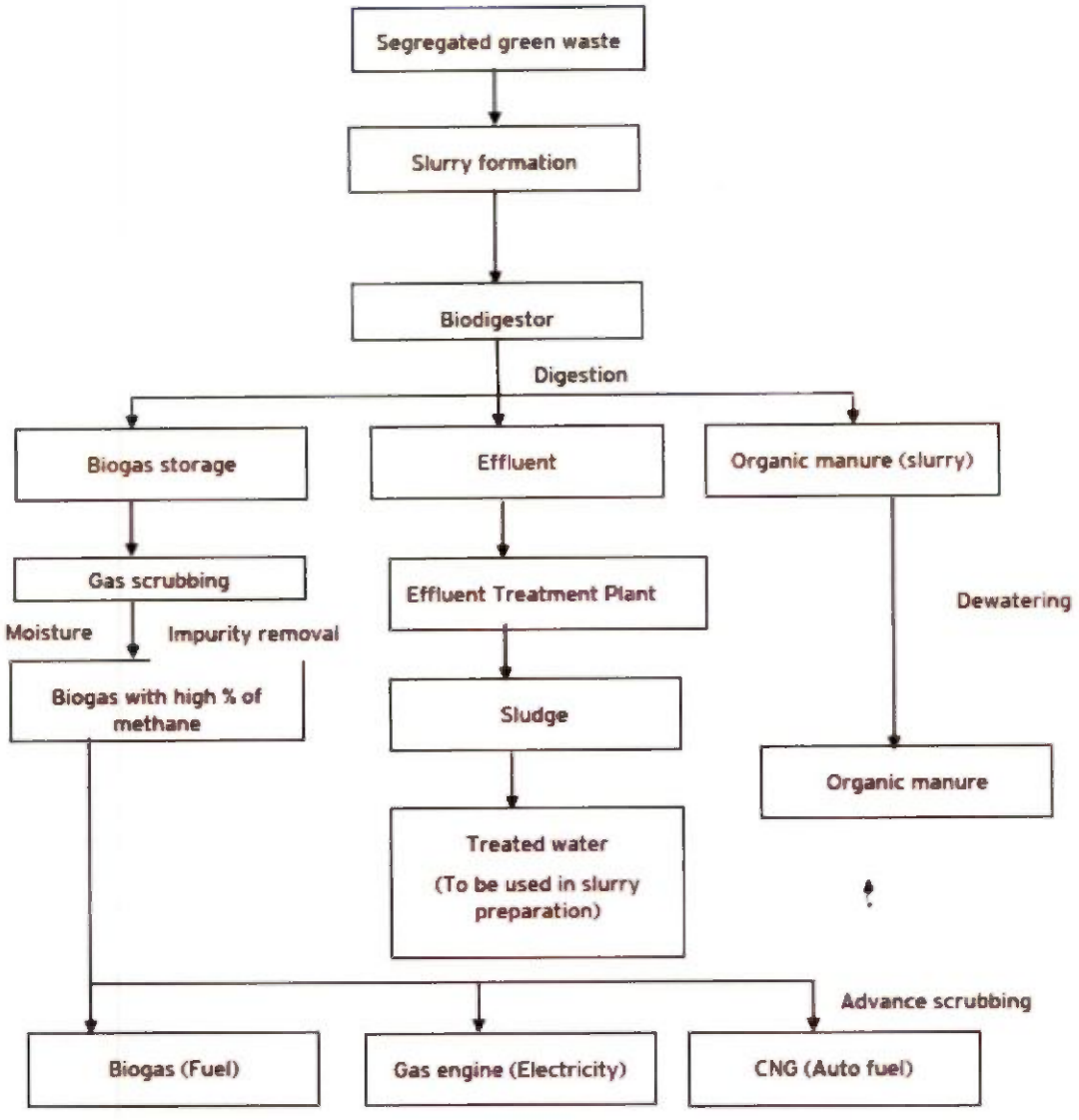


Figure 22: Flow chart for Bio-methanation



6.3 Mass Balance

Mass Balance for Legacy Waste is as follows:

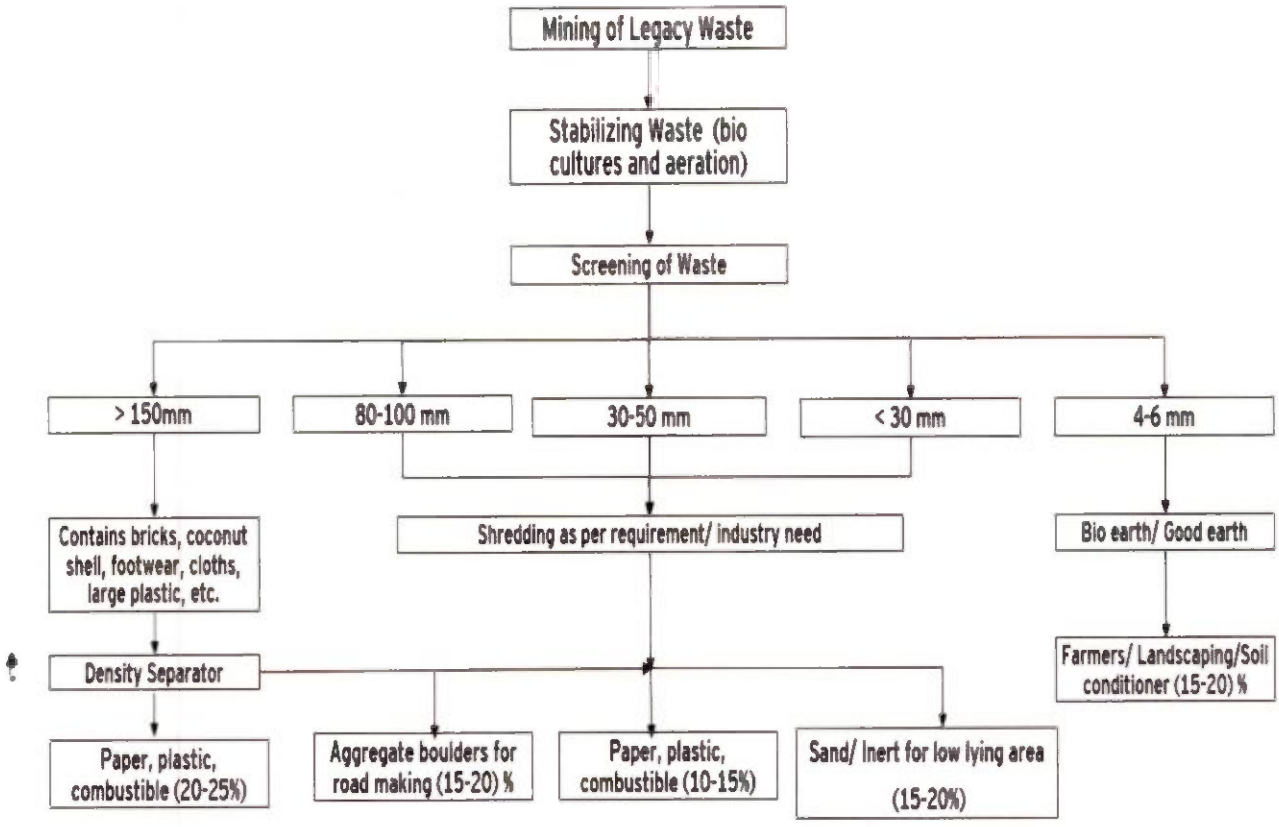
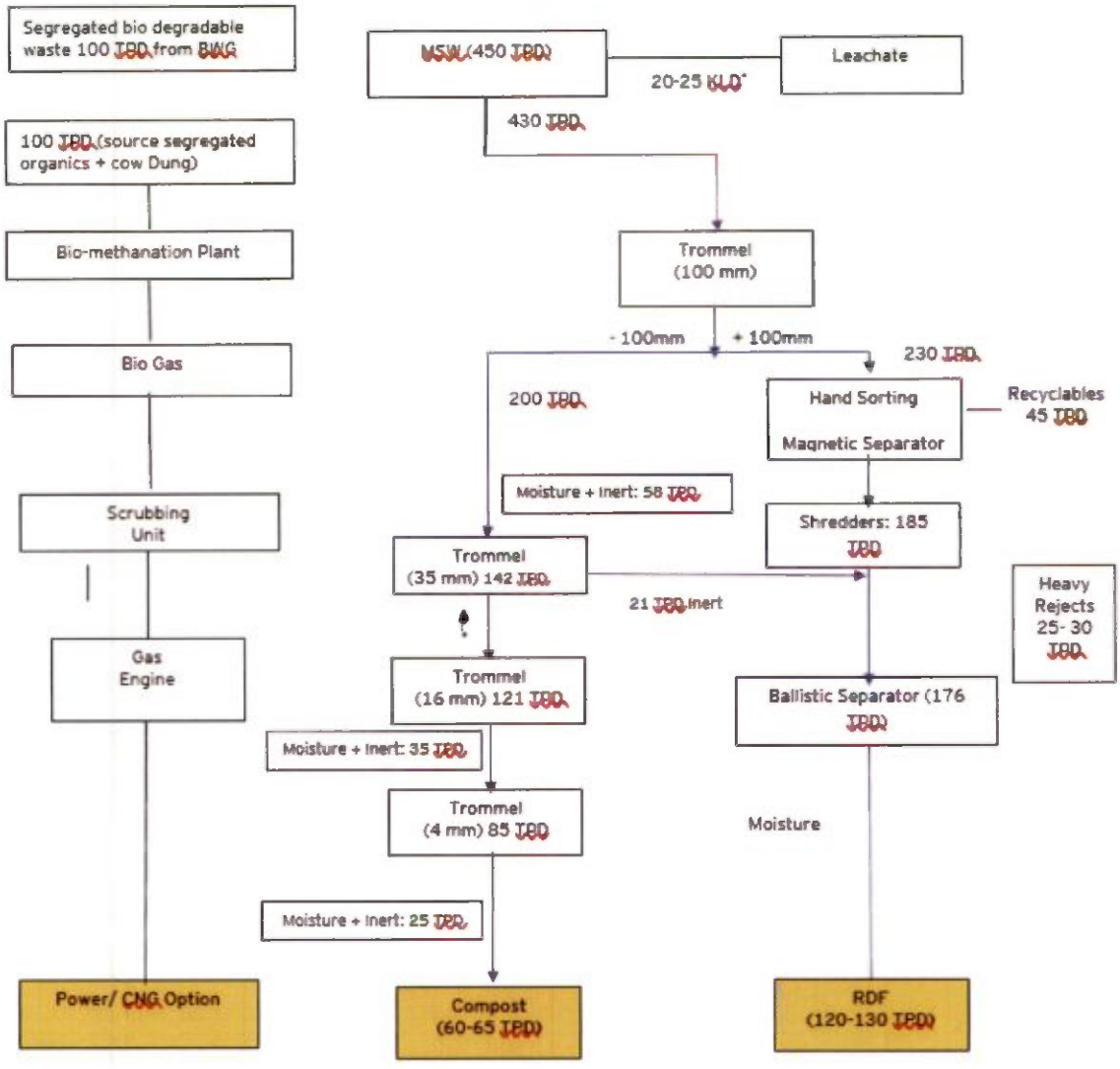


Figure 23: Mass Balance for Legacy Waste

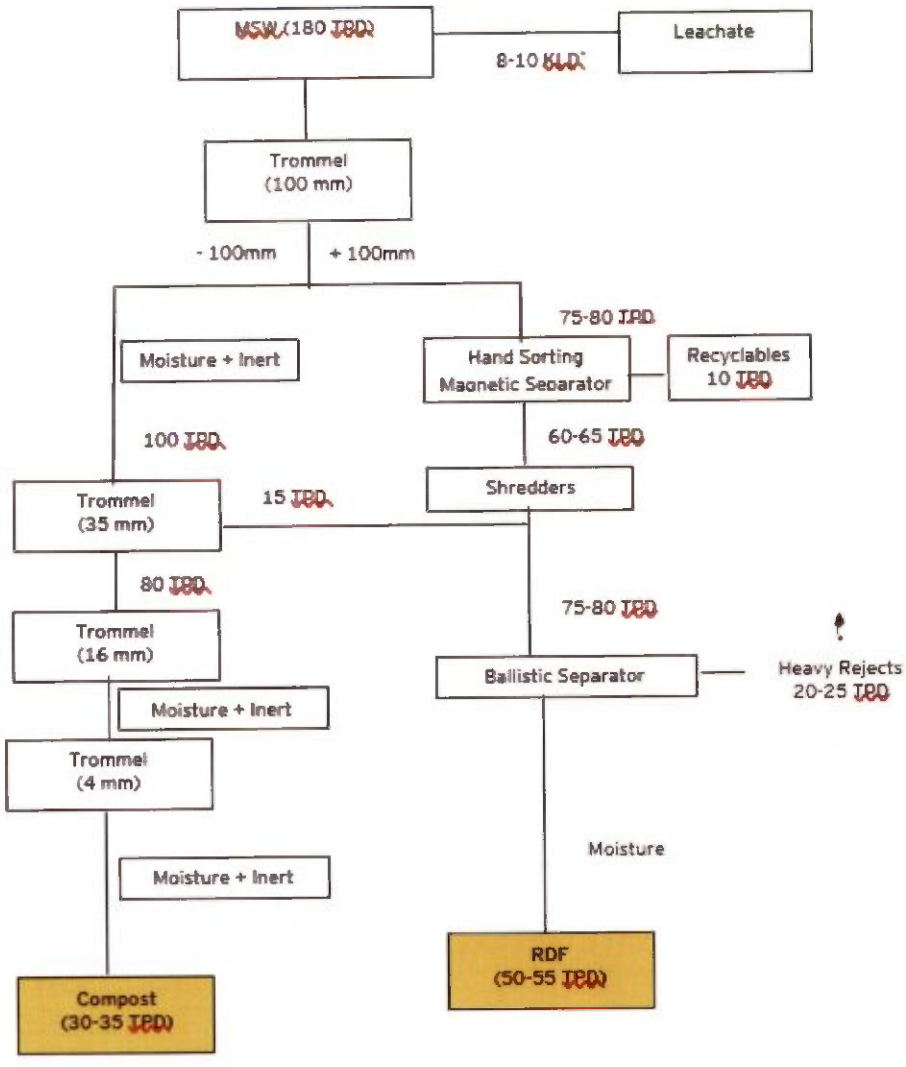
The MSW processing facility for Dum Dum, South Dum Dum, North Dum Dum, Baranagar at Pramodnagar can be summarized in the following mass balance flow chart:

Figure 24: Flow Chart – Material Balance of 450 TPD Pramod nagar processing Plant



The MSW processing facility for Kamarhati and New Barrackpore at Kamarhati Dumpsite can be summarized in the following mass balance flow chart:

Figure 25: Flow Chart – Material Balance of 180 TPD Kamarhati processing Plant



6.4 Sanitary Landfill

Currently, the total waste generated by ULBs in Cluster-1 is being transported to the Pramodnagar site where waste is being dumped crudely or indiscriminately. In the light of the above, as the part of development of MSW management project for the Cluster-1, it is proposed to develop a common sanitary landfill site. Common sanitary waste disposal facility would be planned for the safe disposal of processing rejects and non-biodegradable components of solid waste and it is envisaged that common sanitary landfill site would receive/accommodate about 20% of processing rejects and inert per day from the total MSW processed at processing plant.

6.4.1 Institutional and legal framework

The Ministry of Environment and Forest & Climate Change (MoEFCC) as per the directives of "The Supreme Court of India" has formulated "The Solid Waste Management Rules, 2016" to supersede "The Municipal Solid Wastes (Management and Handling) Rules, 2000". As per these guidelines every municipal authority shall set up waste processing and disposal facility. These guidelines also specify,

- Criteria for the selection of the site, responsibility of the authorities, environmental considerations, design period (life of landfill site), etc.
- Infrastructure such as approach and internal roads, weigh bridge, fencing, monitoring of vehicles, etc. required at the disposal site
- Design specification such as liners, daily cover type of covering material, barriers, etc.
- Pollution prevention measures like storm water drains, non - permeable lining, leachate management, air and water quality monitoring, plantation, etc.
- Post closure specifications

6.4.2 Design of Sanitary Landfill

The landfill design comprises of an active period and a closure and post closure period. For the site the active period is designed as 20 years with a height of 10 meters.

Table 23: Landfill Site setting criteria

S.No	Criteria	CPHEEO Mandates
1.	Lake/Pond	200m away from the Lake/Pond
2.	River/streams	100m away from the river/stream
3.	Flood plain	No landfill within a 100-year flood plain
4.	Highway	Away from 200m NHAI/State
5.	Public parks	300m away from public parks
6.	Wetlands	No landfill within wet lands
7.	Habitation	500m away from the notified habitation area
8.	Ground water table	Ground water table > 2m
9.	Critical habitat area, reserve forest, protected area, ecologically sensitive area	No landfill within the critical habitat area. It is defined as the area in which 1 or more endangered species live.
10.	Airports	No landfill within 20 Km
11.	Water Supply schemes/ wells	Minimum 500m away

6.4.3 Site details

The MSW Regulations pertain to the design and construction of the conventional lined sanitary landfill (containment landfill). These regulations do not address alternate landfill designs like the natural attenuation or bioreactor landfills. Hence, to adhere to the Solid Waste Management

Rules, 2016 and land availability in the region, it was decided to construct a common municipal sanitary landfill, for the entire cluster. It was informed during the meetings that KMDA is looking for new land area for sanitary landfill development as per the area requirement given by TA. The land shall be finalized within nine months period from award of work to private developer within the distance of 35 km. The site would be provided for the project throughout the concession period, on a nominal lease. Preliminary site development activities and detailed design would be required to carry out, prior to landfill development by the Concessionaire.

6.4.4 Assessment of landfill volume and life

Assessment of volume of the waste to be land filled is the preliminary design requirement in terms of area and landfill life estimation. The volume of waste to be placed in the landfill is computed for the active period of the landfill considering (a) the current generation of waste per annum and (b) the anticipated increase in rate of waste generation and waste diversion rates that cluster-1 intends to achieve. Table below provides a summary of estimates of waste generation and diversion rates and the waste quantities to be landfilled. It is envisaged that in Processing Plants at Pramodnagar and Kamarhati site, about 550-650 TPD of waste would be processed and about 20% of processing rejects would be landfilled as final disposal to SLF site i.e. about inert rejects of 130-150 TPD plus top liners would be land filled per day. By assuming the height of landfill would be 10m the following table presents landfill volume requirements for a duration 20 years:

Table 24: Landfill area requirement for compost & RDF processing rejects

Year	Projected MSW Generation (TPD)	Rejects/inerts per day @ 20% (TPD)	Density of rejects (kg/m^3)	Area required/year (m^2)	Area required /year (acre)
2022	568	113.50	800	5178.52	1.28
2023	578	115.59	800	5273.61	1.30
2024	588	117.67	800	5368.69	1.33
2025	599	119.75	800	5463.77	1.35
2026	609	121.84	800	5558.85	1.37
2027	620	123.92	800	5654.01	1.40
2028	632	126.45	800	5769.22	1.43
2029	645	128.97	800	5884.44	1.45
2030	657	131.50	800	5999.65	1.48
2031	670	134.02	800	6114.87	1.51
2032	683	136.55	800	6230.09	1.54
2033	695	139.08	800	6345.30	1.57
2034	708	141.60	800	6460.52	1.60
2035	721	144.13	800	6575.73	1.62
2036	733	146.65	800	6690.95	1.65
2037	746	149.18	800	6806.17	1.68
2038	759	151.70	800	6921.38	1.71
2039	771	154.23	800	7036.60	1.74
2040	784	156.75	800	7151.81	1.77
2041	796	159.28	800	7267.03	1.80
2042	809	161.80	800	7382.25	1.82
Total Land Required for Landfill				**131133.46 sq. m**	**32.40 acre**

6.4.5 Disposal: Landfill

As per the requirements of the Solid Waste (Management & Handling) Rules 2016, land filling should be restricted to non-biodegradable, inert waste and other waste that are not suitable for further recycling or biological processing. Land filling, amounts ranging from 15-20% shall also be carried out as residues of waste processing facilities . Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. The process of land filling must be performed by adhering to proper norms and landfill sites should meet the specifications as given in these rules.

As per solid waste management rules, 2016, it is mandatory to design, construct and operate Sanitary landfill in addition to waste processing facilities. Provision for adequate land availability which can last for 20 years and 15 years post closure maintenance are required. After installation and commissioning of MSW processing facility the quantity of remnants going to sanitary land fill will be greatly minimized.

7 Cost Estimates

7.1 Primary Collection and Transportation Cost

As per the data collected from ULBs, present primary collection capacity of ULB has been calculated. For the remaining uncollected primary waste, 3 types of vehicles have been proposed. Similar procedure is also followed for secondary waste collection. Cost for each vehicle is used from the reference from Gem Portal (https://gem.gov.in/).

Table 25: Capital cost of Primary Collection and Transportation Vehicles

Cluster 1 Primary Collection and Transportation Cost

Description	Quantity	Unit Cost (INR)	Total Cost (INR Crore)
Primary Collection			
Dum Dum			
Tricycles	21	25,000	525000.00
Light commercial vehicles with hydraulic tipping containers	50	6,17,000	30850000.00
Baranagar			
Tricycles	23	25,000	575000.00
Light commercial vehicles with hydraulic tipping containers	81	6,17,000	49977000.00
New Barrackpore			
Tricycles	4	25,000	100000.00
Light commercial vehicles with hydraulic tipping containers	29	6,17,000	17893000.00
South Dum Dum			
Tricycles	0	25,000	0.00
Light commercial vehicles with hydraulic tipping containers	131	6,17,000	80827000.00
North Dum Dum			
Tricycles	0	25,000	0.00
Light commercial vehicles with hydraulic tipping containers	90	6,17,000	55530000.00
Kamarahati			
Tricycles	127	25,000	3175000.00
Light commercial vehicles with hydraulic tipping containers	98	6,17,000	60466000.00
Total Cost			**299918000.00**
Total Cost in Crores			**29.99**

Total Cost to Government = Cost of collection and transportation

Total Cost to Government= 29.99 Crores[9]

7.2 Secondary Transportation Cost

Secondary Transportation						
ULB	**Waste Generation (2027) in TPD**	**No. of RCs**	**No. of DPs**	**Cost of RC**	**Cost of DP**	**Total Cost**
Dum Dum	75.72	2	2	7200000	3000000	10200000
Kamarhati	133.34	4	3	14400000	4500000	18900000
New Barrackpore	38.09	1	2	3600000	3000000	6600000
Baranagar	123.78	3	3	10800000	4500000	15300000
South Dum Dum	227.91	8	1	28800000	1500000	30300000
North Dum Dum	120.78	4	1	14400000	1500000	15900000
TOTAL		22	12	7,92,00,000	18000000	**97200000**

Cost of Each DP = Rs. 1500000
Cost of Each RC = Rs. 3600000
Total Cost for Secondary Transportation= Rs. 9.72 Crores
Total Cost of Secondary Collection Points = Rs. 4.62 Crores (as calculated in table 19)
Total Cost of Secondary Collection & Transportation = Rs. 14.34 Crores

7.3 Approach for sustainable Financing for MSWM (processing cost)

The core methodology for assessing the financial viability of the project is the Discounted Cash Flow (DCF) method for calculating the Internal Rate of Return (IRR). IRR is the annualized effective compounded return rate which can be earned on the invested capital, i.e., the yield on the investment. Simply put, If IRR is higher than the benchmark rate, then project is financially viable and if the IRR is lower than the benchmark rate then the project is not financially viable. In our analysis, apart from the other benchmarks and ratios, the key viability parameters which are used for analysis and project structuring are:

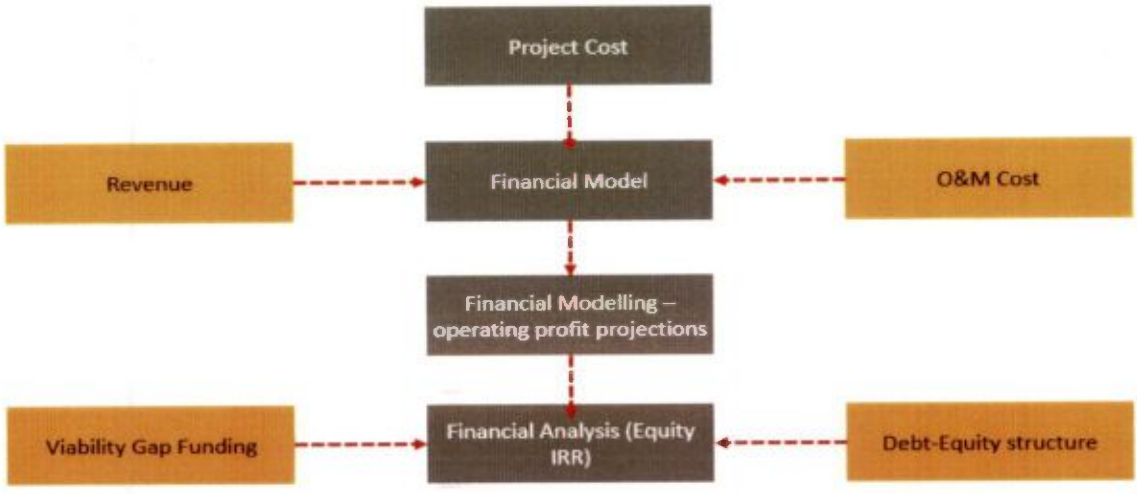
Project IRR: Project IRR is the annualized return from the project, irrespective of its funding structure. For example, if Project Authority was to fund the project from its own resources then Project IRR (pretax), is the ideal benchmark to evaluate the intrinsic viability of the project. If the Project IRR is below say 10% (assumed authority's benchmark return expectation), then project is not financially viable, and if it is higher than 10%, then project is financially viable.

Equity IRR: Equity IRR is the annualized return from the project to the private sector investor in the PPP project, assuming an ideal funding scenario. Equity IRR assumes, funding of the project through commercial debt, any soft loan or other measures.

[9] The cost incurred for bins and road sweeping is excluded from the total cost to government mentioned here

The private sector expectations of the return from the project are higher than the government's and depending upon the risk profile of the project, private sector Equity IRR expectations can hover in the range of 15-18%.

Our approach to financial analysis is depicted in the following figure:



7.4 Capital Cost for Processing and Disposal

The project cost contains the following components:

Details of these costs are as follows: *(the below given cost is indicative and is calculated by analysing the market rates of the equipment/machines through telephonic conversations with equipment manufacturers and by referring to past projects established by the firm. This is also with the reference of the CPHEEO manual part 2, page number 109*[10]*)*

7.4.1 Cost of 450 TPD compost and RDF plant plus 100 TPD Bio methanation Plant for processing at Pramodnagar site

The indicative capital expenditure for the plant includes construction of a compost plant plus RDF plant for the processing of waste, construction of bio methanation plant construction of a sanitary landfill site for disposal of inert waste. The construction of compost plant would further include building a concrete yard, leachate tank, office building, investment in machinery and equipment etc.

[10] Toolkit for Solid Waste Management (2012), Jawaharlal Nehru National Urban Renewal Mission, Ministry of Urban Development, Government of India. http://jnnurm.nic.in/wp-content/uploads/2012/11/SWM-toolkit.pdf

Table 26: Capital Cost for Processing Plants at Pramod Nagar

450 TPD Capacity Plant at Pramod Nagar

Description	Quantity	Unit Cost (INR)	Total Cost (INR Crore)
Processing			
Bio methanation (100TPD)	1	18,00,00,000	18
Pre-processing including composting (450 TPD)	1	27,00,00,000	27
EMP (Effluent & leachate treatment, greenbelt, ventilation system)	1	2,20,00,000	2.2
Other			
Base Project Cost			**47.20**
Contingency (including weighing bridge)	5%		2.36
Total Project Cost			**49.56**

7.4.2 Cost of 180 TPD compost and RDF plant for processing (compost and RDF) in Kamarhati

Table 27: Capital Cost for Processing Plant at Kamarhati

180 TPD Capacity Plant at Kamarhati

Description	Quantity	Unit Cost (INR)	Total Cost (INR Crore)
Processing			
Pre-processing including composting	1	12,00,00,000	12
EMP (Effluent & leachate treatment, greenbelt, ventilation system)	1	1,50,00,000	1.5
Base Project Cost			**13.5**
Contingency	5%		0.68
Total Project Cost			**14.18**

7.4.3 Cost of Landfill (33 Acres)

This capital cost does not include the cost of covering the landfill once it reached full capacity. This is because the covering cost shall incur after 20 years. This task can later be done through a separate tendering process at that particular time as there is no need to include that cost in current estimation.

Table 28: Capital cost for 33 Acre Sanitary Landfill

Sanitary Landfill (33 Acres) Capital Cost

Description	Quantity Acre	Unit Cost	Total Cost (Crores)
Landfill	33	10121457	33.40
Contingency	0.05	33.40	1.67
Total Disposal cost			**35.07**

Total Capital Cost for Processing and Disposal of fresh waste = 98.81*

7.4.4 Cost of Reclamation (To be paid by Government)

According to the surveys done on both the dumpsites, following volume of legacy waste has been estimated. Assuming 20% more waste under the ground and density of 0.9 gm/cum, weight of the waste is calculated. As per the NGT guidelines on legacy waste and few practical cases of reclamation of legacy waste, unit cost of Rs. 750/ton is assumed. **This cost includes the infrastructure development cost for the development of land at Panihati Site and transportation cost of Inert material of Legacy waste to Panihati site. The topographical maps of Panihati site have also been attached in the annexure VIII.**

Table 29: Capital Cost for Reclamation

Reclamation Cost both Pramodnagar and Kamarhati				
Description	**Quantity (cum)**	**Weight (Tons)**	**Unit Cost (INR)**	**Total Cost (INR Crore)**
Reclamation Pramod Nagar				
Total (Pramod Nagar)	6,66,716[11]	600044	750	**45.00**
Reclamation Kamarhati				
Total (Kamarhati)	1,46,800[12]	132120	750	**9.91**
Total Cost				**54.91**

Total Capital Cost for Processing and Disposal of legacy waste = 54.91*

7.5 Phase wise construction details

Table 30: Construction Details (Phase wise) (tentative)

Parameter / Year	2020	2021	2022	2023	2024
Construction Schedule for compost and RDF Plant in Kamarhati	-	100%			
Construction Schedule for compost and RDF in Pramod Nagar	-	100%		-	
Construction Schedule for Bio methanation in Pramod Nagar	-	70%	30%	-	
Legacy Waste removal (Expenses Given by Government) *	100%			-	
Construction of Sanitary Landfill	-	25%	25%	25%	25%

*above construction plan has been prepared considering developer is selected by March 2020

[11] This quantity includes (555597 cum calculated from topographical survey plus 20% assumed extra below ground)

[12] This quantity includes (122333 cum calculated from topographical survey plus 20% assumed extra below ground)

7.6 Indicative Operational and Maintenance Costs

SWM services involves significant maintenance, wherein regular working of the waste collection vehicles and operation of the processing plant and SLF site demand high operating cost. Other than the equipment and vehicles, human resource component forms a major part of the operating cost. The indicative operating expenditure for the project is given below. The operation and maintenance expenditure have been assumed component wise for the estimation of manpower required, fuel and lubricant requirement, depreciation, taxation and general maintenance expenses. Looking at the nature of these expenses these have been escalated on a 5% year or year basis inflation.

7.6.1 O&M for compost and RDF Plant

The O&M on processing has been assumed to be INR 2500 per ton of compost yield (including the manpower expense) as per the 34th report of standing committee of chemicals and fertilizers 2016-2017. The waste to compost conversion ratio has been taken as 15%. A yearly inflation of 5% has been assumed on the processing cost.

7.6.2 O&M for 100 TPD Bio-Methanation Plant

Table 31: O&M for Bio-Methanation

O&M for Bio Methanation	
Plant Capacity (TPD)	100.00
Biogas produced (cum)	4400.00
Electricity required per hour (kw)	55
Per Year Units	481800
Per Unit Rate in Kolkata (Rs.)	7
Cost of electricity for the year	3372600
Repair and Maintenance as % of capital cost	5%
Repair and Maintenance cost	9450000
Other costs as % of capital Cost	0.50%
Other costs	945000
Labour cost	
Supervisor Salary (rs)	20000
Helpers salary (Rs)	12000
Number of Supervisors Required	1
Number of Helpers Required	4
Labour cost (Rs) per year	816000
Total O&M Costs in Crore	1.46

7.6.3 O&M for Landfill Management

Here is the Operation and Maintenance cost for landfill management.

Table 32: O&M for Landfill Management

O&M Landfill	Pramod Nagar	Kamarhati
Total Capacity of the plant (TPD)	450.00	180.00
Distance between Plant and Landfill(km)	35	35
Waste to be transported daily (%)	20.00%	20%
Waste to be transported daily TPD	90	36.00
Capacity of a transportation truck (ton)	10	10
Number of trucks required daily	9	4
Distance travelled totally in km	630	280
Cost of fuel per km	18	18
Total cost per day for fuel	11340	5040
Total cost for year	4139100	1839600
Salaries per month	150000	50000
Salaries per year	1800000	600000
Miscellaneous	1000000	500000
SLF Management cost	4927500	1971000
Total Cost in crore	**1.68**	

O&M for Secondary Transportation

Table 33: O&M for Secondary Transportation

ULB	Average Running/ Trip (km)[13]	trips per day	Number of Secondary Vehicles (Total)	Total Kms per day	Fuel Consumption (lit)	Cost of Fuel (Rs/Litre)	Per day fuel cost Rs	Monthly Exp	Yearly Exp	Manpower	Salary per month (average of driver and helper)[14]	total Salary per month total	Salary per year	Maintenance per year (5%)
Dum Dum	14	2	4	112	28	2016	60480	725760	596160	9	9446	85010	1020114	510000
Kamarhati	8	2	7	112	28	2016	60480	725760	596160	16	9446	151128	1813536	945000
New Barrackpore	28	2	3	168	42	3024	90720	1088640	881280	7	9446	66119	793422	330000
Baranagar	14	2	6	168	42	3024	90720	1088640	881280	14	9446	132237	1586844	765000
South Dum Dum	24	2	9	432	108	7776	233280	2799360	2255040	20	9446	188910	2266920	1515000
North Dum Dum	18	2	5	180	45	3240	97200	1166400	933120	11	9446	103901	1246806	795000
Total							**21096**	**632880**	**7594560**	**77**			**8727642**	**4860000**
													Total	2,11,82,202
													Total in Cr per year	**2.12**

[13] Detailed Calculation of this distance is given in annexure VI

[14] As per the circular No 218/703/Stat/2RW/29/2016/LCS/JLC by office of Labour commissioner, Statistics Section, Government of WB

7.7 Project Revenue Details

7.7.1 Tipping Fee

SWM in India is an entirely new concept. Major importance is being given to this sector because of government's initiatives like "Swachh Bharat Abhiyan". However, it is not viable for the project to self-sustain itself based on above stated revenue streams. Therefore, it is recommended that the concerned authorities provide support to the developer in the form of tipping fees. Since the solid waste management practices and industries are still at an infant stage given the Indian context. People are not well verse with the habit of proper disposal of the waste generated, therefore it is proposed that the developer should be given financial support by the government in the form of tipping fee for making the project financially viable. A tipping fee based upon the efficiency of the developer to process the waste. This is one way to incentivize the developer for bringing in more efficiency into the composting process rather than an easier way of disposing the waste into the sanitary landfill.

7.7.2 Sale of recyclables

After processing the waste, the developer could sell the recyclable waste. Recycling of waste would help reduce the pollution levels in the environment and help providing an incentive to the private player for effectively processing the waste.
We have assumed 4% of the waste to be recyclable. The rates for recyclables are Rs. 2500 per ton with 3% increase in the rates yearly.

7.7.3 Sale of compost

The sale of compost in the market would be one of the major sources of revenue for the developer. With an increasing demand of compost in the market, this source of revenue provides immense potential for any private player. As per the market interactions with current key players for similar projects in the country, it emerged that compost could be sold at INR 1500-2500 per tonne in the market. It was also observed that the buyers of the compost typically comprise of various government landscaping departments. A practice of buying compost directly from the producer is prevalent in departments like horticulture, forest, agriculture etc. An inflation of 3% year on year has been assumed on the compost price.

It is proposed to provide certainly of revenue streams to the private operator, The West Bengal Government may as part of the PPP contract provide 100% assured offtake of the compost produced. This serves as a win-win strategy for both the parties. Such structure provides surety to the private developer of a secured market and government authorities would also get an assured quantity and quality of compost for its operations at an affordable rate. Efficiency of conversion of waste into compost also forms a major component. Since all the bio degradable waste cannot be converted into compost, therefore it is assumed that only 15% of the waste generated could be converted into compost.

7.7.4 Sale of RDF

The SWM Rules, 2016 suggest the possible usage of RDF in various industries. The usage of RDF may translate into potential cost savings and reduce fossil fuel consumption. The use of RDF as an alternate fuel has been established primarily because of its calorific value which can be extracted to generate energy. RDF can be used in cement plants, thermal power plants and iron & steel manufacturing plants and other industries using boiler as co-generation and brick kilns. RDF can be transported to 200-250 kms after compaction. The sale of RDF within/outside the city shall be in the preview of private player. 30% of the total waste has been assumed as the RDF produced. Rs. 1000 per ton has been assumed as selling cost of RDF (RDF III of CV 2500Kcal/kg is considered @ 0.4 Rs. Per 1000Kcal/kg) A yearly inflation of 3% has been assumed on the sale price.

7.7.5 Sale of Gas

Gas produced from the bio-methanation plant can be used as a fuel and hence can be sold. Methane percentage has been assumed as 40%. 4400 m^3 gas is produced everyday with 80 % of the plant utilization, 55 m^3/ton of gas production. 1376 Rs/cylinder is the cost of commercial gas in the state of west Bengal. Excluding 20% marketing cost and 15% distribution cost and 15% discount Rs.36.21/kg has been assumed as the cost of gas. A yearly inflation of 3% has been assumed on the sale price.

7.8 Financial Implementation Structure

7.8.1 Project Structure

A Debt/Equity ratio of 70:30 has been assumed for this project. The rate of interest on the term loan has been assumed to be 11.5% with tenure of 20 years after the construction is completed and moratorium period of 3 years on repayments. A repayment has been assumed after the initial 3-year moratorium.

Table 34: Financial Assumptions

Name of the Parameter	Value	Unit
Debt	70%	
Equity	30%	
Rate of Interest for Loan	11.5%	Per Annum
Moratorium	3.00	Years
Tenure	20.00(from construction of plants)	Years
Inflation in revenue	3.00%	Per Annum
Inflation in O&M expenses	5.00%	Per Annum
General Inflation	5.00%	Per Annum

7.8.2 Financial Viability

The objective if this analysis was to evaluate the financial performance of the project, its ability to source financing and meet "return" expectations of capital providers. Based on the same, to suggest a transaction structure with good returns on investment to make the project commercially viable for a concessionaire.
The scenario has been taken with required project cost and revenue structure and operational cost per year considering that no capital grant support is available.

Table 35: Important Parameters

Name of the Parameter	Unit	Value
Project Cost (total)	Crores	113.14
Operation & Maintenance in 2027	Crores	19.70
Revenue in 2027		54.08
Tipping Fees	Rs. Per Ton	1250
IRR	Percentage	16.00

8 Environmental & Social Management Plan

Environmental & Social Management Plan (ESMP) is aimed at mitigating the possible adverse impact of a project during Construction Phase and for ensuring to maintain the existing environmental quality. The CEMP comprise of all aspects of planning and construction of the project, which are related to environment and social factors associated with it. It is essential to incorporate ESMP into the project from the initial phase of Planning. Hence, it can be considered as a tool to identify Adverse Impact which a project can cause and what are the possible solutions to mitigate it.
The Environment and social Management Plan should also adhere to the guidelines stipulated in the "SWM (Handling & Management) Rules, 2016" of the Ministry of Environment & Forest, Govt. of India and also relevant norms stipulated by CPCB and SPCB.
The specific measures that shall be put to practice to minimize the impact on the environment are discussed below:

8.1 Air Pollution

Provision shall be made for sprinkling of water on loose soil to avoid dust generation. The debris and unutilized construction material and earth from the construction site shall be removed immediately to recycle within the project so that no nuisance dust is generated due to wind. The vehicles employed by the developers shall be checked for vehicular emissions.

The mitigation measures shall include regular monitoring, maintenance of machinery and provision of personnel protective equipment to workers where needed. The steps shall be taken to reduce the impact of noise by carrying out plantation or noise barricades from the very beginning. A Leachate Treatment Plant with tertiary level of treatment shall be provided to avoid any odour pollution from the Leachate generated from the Plant. Extensive plantation to mitigate the impact of noise and to improve the ambient air quality shall be provided.

8.2 Water Pollution

Construction work requires large quantities of water to be used in various processing plants for material preparation; wastewater will be generated in various forms in the processing plants and workshops. As the construction period is long impacts such as runoff or leachate being washed to nearby water body or ground water can permanently deteriorate the water quality in the area; Hence adequate mitigation strategies should be adopted.
The run-off during development shall be controlled by removing construction related solid waste as construction debris, loose soil etc. A septic tank shall be provided with toilet facilities to meet the daily needs of labor during working hours. Workers shall be discouraged from Open Defecation. Both roof top rainwater harvesting, and storm water run-off shall be tapped for recharging the aquifers and storage.

8.3 Noise Pollution

The sound will be generated during almost all the construction activities such as movement of vehicles, operation of construction machines and equipment, repair and maintenance work, operation of DG sets, etc. Continuous exposure of workers to high sound levels may result in annoyance, fatigue, and may cause temporary shift of threshold limit of hearing and even permanent loss of hearing.
Sound reduces with the distance and even if all the reduction factors are removed, direct sound levels reduce by 6 dB(A) with every doubling of distance. Further, the sound level reduces considerably when the wave passes through a barricade. Therefore, if location of construction equipment is planned to keep in view the safe distance from habitation, impact can be greatly

reduced on large section of population. Workers who are directly exposed need to use Personal Protective Equipment to reduce the impact.

8.4 Land Pollution

The activities that expose the soil shall be scheduled in such a way that some type of vegetative cover native or appropriate to the site shall be established prior to onset of monsoons. Natural waterways/drainage pattern shall be maintained by providing culverts. The solid waste generated from the construction activities shall be effectively recycled and minimized within the project.

8.5 Mitigations

The best way of impact mitigation is to prevent the event occurring. All efforts should be made to locate the developmental activities in an area free of agricultural lands, ecologically sensitive, erosion, forests, flooding, human settlements, landslides, natural scenic beauty, water logging. However, practically, this is not possible as project design criteria govern the location of various activities. Therefore, the next step is to look at the raw materials/technologies/ processes alternatives which produce least impact i.e. adopting or using processes or technologies which are efficient and produce recyclable wastes/ minimum waste/wastes that can be easily disposed, without seriously affecting the environment. However, if the developmental activities produce the adverse impact, action has to be taken to mitigate the same. Following are some of the recommendations on mitigation measures for various Environments and Noise Levels

8.5.1 Air Pollution Mitigation

- Locate stockpiles of sand in sheltered locations or provide wind breaks.
- Keep the stockpiles to the minimum practicable height and use gentle slopes.
- Ensure that all dust generating materials transported to and from site (i.e. in trucks) are covered by tarpaulin.
- Keep site vehicles and plant well maintained and regularly serviced. All vehicles must comply with the Traffic Licensing Directorate emission standards at all times.
- Do not burn waste materials on-site.
- Use covered containers for organic waste and empty frequently before decomposition.
- Take account of the wind conditions when arranging activities that are likely to emit aerosols, fumes, odors and smoke.
- Educate the personnel at site on the above issues through tool box meetings

8.5.2 Water Pollution Mitigation

- Segregation of different types of wastes at source and avoid their mixing up in the river.
- Accumulation of oil wastes in depressions should be minimized in order to avoid possible contamination of the ground water system.
- Surface runoff from oil handling areas/devices (workshops and DG operation areas) should be treated for oil separation before discharge into the environment.
- If oil wastes are combined with sanitary sewage, oil separation will be necessary at the wastewater treatment facility.
- The growth of aquatic weeds is to be monitored in the reservoir and excess weeds shall be removed.
- The proposed plant includes a RO system in the design.

8.5.3 Land Pollution Mitigation

- Proper and secure bunding.
- Minimize the amount of land disturbance, develop and implement stringent erosion and dust control practices.
- Consolidate infrastructure requirements (e.g., roads and rains) for efficient use of land.

8.5.4 Noise Pollution Mitigation

- Location of the construction equipment to be decided to keep in view the safe distance from habitation.
- Contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards.
- All the construction equipment will be required to use available noise suppression devices and properly maintained mufflers.
- Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided, whenever possible.
- Minimize the use of noise producing equipment during night hours to avoid the disturbance to locals and wild animals of surrounding area.
- Monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- Educate the personnel at site on the above issues through tool box meetings

8.6 Safety Measures

8.6.1 Occupational Health, Safety and associated risks

- The organization shall identify the occupational health and safety (OHS) hazards and the associated risk on ongoing basis, to facilitate setting of OHS objective and targets, control risk and to keep this information up to date.
- While identifying occupational health and safety (OH&S) hazards and risk during initial OH&S review the following criteria should be considered.
  - All activities where previous records of Incidents, Accident occurred.
  - Inputs from regular Plant visit and meetings.
  - All activities routine and non-routine, where substantial hazards and risks are involved including contracted & company own activities / facilities.
  - Evaluation of feedback from investigation of previous incidents/accidents
  - Examination of all existing OH&S procedure and practice.
- While identifying significant OH&S risks consideration shall also be given to
  - Chemical hazards.
  - Physical hazards, Biological hazards. Monotonous work.
  - Hazard Due to layout and design deficiency.
- Prepare a Register of OH&S hazards and associated risks, which shall include the departments &Facility layout chart.

8.6.2 EHS & Social Roles and Responsibility

Define and communicate role, responsibilities and authority for effective functioning of EHS & Social management systems:

- Organization shall comply with the relevant applicable policies such as environmental, quality and fund standard guidelines.
- Shall define roles, responsibilities and authorities w.r.t EHS and applicable social guidelines from statutory bodies.
- Monitoring of effective implementation, Compliance to rules/acts.
- Initial training needs to be addressed and provide awareness and competence.
- Calibration and Maintenance of EHS equipment.
- Maintenance of updated on - Site Emergency Plan.
- Handling and investigation of incidents/ accidents, non-conformities, acting to mitigate impacts and completing corrective and preventive actions.
- Conduct internal EHS & social compliance audits

8.6.3 Training & Awareness

To lay down the procedure for identification of training needs and providing appropriate training to all Employees and contract employees to ensure effective implementation of EHS & Social management systems at all levels and functions. The organization shall do the necessary training need identification at all level and functions.

The training shall in general address the following areas:

- General Awareness Training
  - General awareness and employees' roles and responsibilities in achieving conformance with policy, objective and targets.
  - Relevant EHS & Labour laws rules and regulations.
- EHS & Social induction training
- Policy goals and objectives.
  - Applicable legislative requirements.
  - Requirements that are conditions of employment. Benefits of improved personal performance.
  - The potential consequence of deviation from specified operating procedures.
  - Emergency Preparedness and Response.
- Job Specific Training
  - The potential consequence of deviation from specified operating procedures.
  - SOP/WIs for the work areas and occupational hazards of their activities.
  - Emergency Preparedness and Response.

8.6.4 Emergency Preparedness & Response Plan

To establish and maintain procedures to identify potential foreseeable accidents/ emergency situations and to prevent, control and mitigate the associated environmental impacts and Occupational Health & Safety risks and to test effectiveness of such procedure. If required review/revise such procedures periodically.

Some of the key measures include:

- Maintain all fire extinguishers in working condition. Provide
- training to employees on fire fighting.
- Explosion Prevention.
- Explosive Mitigation.
- Corrective and Preventive action.
- Avoidance of Major Spillage of any chemical.
- Prepare emergency response plan and disaster management plan as per applicable norms.

8.6.5 Non- Conformity, Corrective & Preventive Actions

The organization shall establish, maintain documented records of accidents, incidents, operating procedures defining the responsibilities and authority for identifying and investigating nonconformance and acting to improve the EHS & SMS Performance.

Nonconformance which may affect the EHS performance shall be identified through:

- Reporting incidents (including near misses).
- Carryout investigation to find out the root causes of accidents and incidents.
- Maintaining corrective & preventive action & maintaining records. o The SOPs shall be suitably amended to address the reason for change.
- Suggestions shall be drawn for mitigating the consequences of accidents and avoiding the reoccurrence of accidents/incidents.
- Establishing procedures for identification on nonconformance.
- Results of mock drill of onsite emergency plan.

8.6.6 General Measures

- Vehicle speed will be restricted to 15 km/hour at site to minimize potential for dust generated in the surroundings.
- Restrict the heavy vehicles from frequent entry in the site as high-tension line close to the G.L. will affect the humans as well as vehicles adversely.
- Appropriate measures will be employed to minimize windblown litter and dust during transportation by either covering trucks or transporting wastes in enclosed containers.

- Heavy Goods Vehicles holding areas to be provided for vehicles waiting to deliver loads at work sites to avoid queuing on other connecting roads.
- Fixed noise sources to be located away more than 50 m away from the site fencing.
- Site workers working near high noise equipment to use personal protective devices like ear muff/plugs to minimize their exposure to high noise levels. Maintain clearance between electric lines and work spaces / nearest service lines, ensure enough space for maintenance.
- Adequate precautions shall be taken to prevent the accidents and from the machineries. All machines used shall confirm to the relevant Indian standards.
- Protective footwear and protective goggles to all workers employed on mixing of materials like cement, concrete etc.
- Welder's protective eye shields shall be provided to workers who are engaged in welding works.
- Earplugs shall be provided to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation.
- The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, earplugs, mask etc to workers and staffs.
- For safety of people occupying the site, regulations concerning fire safety to be followed. Some of the requirements include:
    - Installation of fire extinguishers.
    - Provision of water sprinklers for unpaved roads. o Emergency exit.
    - Proper labeling of exit and place of fire protective system installation;
        - Trained personal to use fire control systems.
    - Display of phone numbers of the city/local fire services, nearest hospital, ambulance facility, etc.
    - A readily available first aid unit including an adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone.
    - Availability of suitable transport always to take injured or sick person(s) to the nearest hospital.

8.7 Project Clearance

S.No	Clearances	Remarks
STATUTORY CLEARANCES		
1	Environmental Clearance by SEIAA/ MoEF&CC under EIA Notification, 2006	SLF included in the project
2	Site Authorization under SWM Rules 2016	Mandatory for all facilities
3	Consent to Establish and Operate by SPCB	Mandatory for all facilities
5	NOC by Town & Country Planning	Mandatory for all facilities
6	Land use from the Revenue Authority	Mandatory for all facilities
7	NOC by Central Ground Water Authority (CGWA)	Mandatory for all facilities
9	PESO Clearance	For Bio-methanation Facility
10	Fertilizer Management System registration, Fertilizer Control Order Clearance	For Composting facility
11	Public Liability Insurance Act, 1991 and Rules, 1991	Mandatory for all facilities
12	Industries (Development and Regulation) Act, 1951	Mandatory for all facilities
13	Factories Act, 1948	Mandatory for all facilities
14	Motor Vehicles Act, 1938, amended in 1988 and Rules, 1989	Mandatory for all facilities
15	Petroleum Act, 1934	Mandatory for all facilities
16	Energy Conservation Act, 2001	Mandatory for all facilities
NON-STATUTORY CLEARANCES		
1	Proof of Possession of Site	Mandatory for all facilities
2	Bank Loan Sanction Letter and Agreement Bank Appraisal Note	Mandatory for all facilities

9 Information, Education & Communication (IEC) & Capacity Building

9.1 Introduction

The Ministry of Urban development, Government of India has launched Swacch Bharat Mission on 2nd October 2015 to make India clean up to 2nd Oct.2019 at the 150th Birth anniversary of Father of the nation Mahatma Gandhi. The mission has made provision for obtaining the support and services of empanelled agencies for carrying out capacity building training programme, awareness campaign and Information Education and Communication activities for facilitating the success of the mission. Keeping in view above provisions we submit our proposal for providing technical support and services for field investigation, preparation of project design, proposals of solid waste management, quality monitoring etc. for solid waste management, need based skill training, capacity building (individual & institutional),Generate public awareness, behavioural changes about sanitation, cleanliness and its linkages with public health, Information, Education & Communication, strategy of behavioral changes etc. under Swachh Bharat Mission.
Also, to improve cleanliness standards of the city on. all parameters as mentioned in Swachh Bharat Mission Guidelines by bringing behavioural changes in citizens through advocacy campaign by organizing activities and online campaigning, building capacity of sanitation workers and enabling municipal officials to use modern tools for handling waste. Our three-pronged approach will ensure that city improves its cleanliness as envisaged under Swachh Bharat Mission. One of our targeted outcome is to make behavioural changes in the citizens to behave properly and also participate in the mission activities to improve the unhygienic conditions of the city.

9.2 Swachh Bharat Mission (SBM)

The Swachh Bharat Mission (SBM) emanates from the vision of the government articulated in the address of The President of India to the joint session of the Parliament on 9th June 2014; "We must not tolerate the indignity of homes without toilets and public spaces littered with garbage. For ensuring hygiene, waste management and sanitation across the nation, a" Swacch Bharat Mission" will be launched. This will be our tribute to Mahatma Gandhi on his 150th birth anniversary to be celebrated in the year 2019"
The objective of the mission is to:

1) Elimination of open defecation.
2) Eradication of Manual Scavenging.
3) Modern and Scientific Municipal Solid Waste Management.
4) To effect behavioral change regarding healthy sanitation practices.
5) Generate Public Awareness about sanitation and its linkages with public health.
6) Capacity Augmentation of Urban Local Bodies.
7) To create an enabling environment for private sector participation in Capex (Capital Expenditure) and Opex (operation and Maintenance)
8) Information Education and Communication

Total 3% of central government allocation under the mission will be utilized for capacity building, administration and office expenses of Urban Local Bodies. Extensive capacity building activities and awareness programme needs to be implemented in a mission mode manner to enable the progressive achievements under SBM.

9.3 IEC

It is necessary to provide technical support and services in the following areas:
1) Capacity building training (individual & institutional),and Need based skill training.
2) Field investigation, preparation of project design, proposals, quality monitoring etc. for solid waste management.

3) Preparation of proposals, DPRs of Solid Waste Management.
4) Generate public awareness about sanitation, Solid Waste Management and its linkages with public health.
5) Behavioural change strategy for creating public opinion for meeting all the requirements of sanitation and solid waste management.
6) Information, Education & Communication programme etc.
7) Teach Basics of Health Sanitation to public residing in slums.
8) Community participation methodology and strategy for maintaining unhygienic conditions.
9) Public Private Participation strategy.
10) Excreta and Sewage Management.
11) Occupational Hazards and Health Management for Sanitary Staff.
12) Operation and Maintenance Equipments used in Sanitation Management. -.
13) Study tour and other topics as per requirements.
14) Other related issues not covered above.
It comprises of following components

a) Capacity Building Training

i) Capacity Building Training of ULB and related officials:

The capacity building training is one of the important components of Swachh Bharat Mission. It comprises of two types of capacity building the first one is institutional capacity building and another one is individual capacity building training of the officials of urban local bodies and concerned departments. The institutional capacity building will help in improving and strengthening the organizational strength, service delivery and supply capacity on the other hand the individual capacity building training will improve the functional knowledge, individual skill and attitude towards the public. This will improve the service delivery system and the functional skill.

ii) Capacity Building (Workshops and Seminars)

The Workshops and Seminars provides an opportunity to meet, deliberate, finalize new strategy and firm up policies and implementation strategy for the mission. Scheme and projects to accelerate the implementation, better methodology and to deliver the benefits in shortest period of time. It is mainly meant to inculcate professional training for ensuring better implementation of government programs and execute their work efficiently. Our institute has large experience of conducting such type of activities in urban development, health, sanitation and education sector too. The minimum cost of per workshop and seminars shall be around 10 .00 lakh. However, the actual estimate depends upon the actual status of the city and number of participants.

iii) *Capacity Building Training of citizens (school/college, teachers and students, market association, RWAs, Slum Dwellers, Residents of unauthorized colonies etc.)*

The community participation is one of the important tools for ensuring the success of the scheme mission/ programme. The Swachh Bharat Mission is directly related to the population of the area I Ward/district I state. Therefore, the active involvement of the citizens in the implementation of the mission is quite necessary for the success of the mission. The question arises is how their participation can be ensured? This is' a very simple question but for its answer we have to think very deep to evolve an effective -strategy and methodology to finalize the implementation process of sanitation. The people's participation is quit persuasive process and for that purpose scientific methodology along with awareness campaign has to be carried out to motivate the peoples. The students I teachers I RWAs I NGOs/ Market association/ other CBOs are very much strong pillars of the society and their involvement in the implementation of different activities of the mission will be guarantee in the success of the programme. Their involvement in the mission activities requires huge motivation and persuasion exercise to make aware the public about the programme and make positive changes to participate in the mission activities at their own and with full energy and vigor.

(iv) *Swachhta Pledge in schools/colleges/academic institutions*

Engage school and college going students to bring about behavioral changes among young generation. We will encourage students to take Swachhta Pledge as initiated by Prime Minister of India. Such activities will be planned on a regular interval in colleges, schools and neighborhood.

b) Awareness Campaign

The awareness campaign is one of the important activities that leads to the success of the programme. These type of campaign can be carried out through various types of activities like Hoarding on Unipole & on other places, Press Media, Jingles in FM Radio banners, leaf lets, painting compilation in schools rallies by school children, street play, workshop with Residents Welfare

Associations and Market Trading Associations, Consultations with NGO & Self-help groups (SHGs), use of social media, Face book, WhatsApp, bulk messages and twitter, display on transport Buses Shelter, city buses, Railway, Airport"13ooking Screens etc. The no of above mentioned activities and their financial estimates needs to be calculated keeping in view the area, population, dense areas, market areas and the most crowded areas etc. 'No Polythene Sunday' Campaign. Use of poly bags has become a regular practice in our day-to-day life. The campaign will target to reduce the usage of poly bags. Self Help Groups can be engaged in the campaign for distributing jute bags or any kind of environmental friendly bags. The efforts will also be made to encourage shopkeepers and individuals to go for such environment-friendly bags.

Swachhta Senani Award This award can be an annual feature of Municipal Corporation in which the city government would award an individual or a social group for their exemplary work in the field of sanitation and cleanliness. This will encourage people to register for Cleanliness Ambassadors.

Ward Level Competition On the lines of Swachhta Sarvekshan, city governments can rate individual wards for their works. The methodology of the competition can be in sync with Swachh Sarvekshan or can be formulated in coordination with Urban Local Body.

Encouraging societies/Resident Welfare Associations to become Zero Waste Societies by segregating waste at source and utilizing for composting and giving out recyclable waste to scrap dealers/rag pickers.

The activities wise physical and financial detail is given below:

A. Hoarding on Unipols

The campaign of the mission is needed to carry out in the whole urban area to promote the objective of the mission in order to understand and implement in mission mode.

B. Distribution of Leaflets

The distribution of leaflets shall be carried out in densely populated areas, Markets, ·Main roads, Near Bus stops/ stand, Railway stations etc. The leaf let will reflect the brief of the program, its advantages with the request to participate in to ensure the success of the program.

C. Press Media

The publicity of the mission I scheme through newspapers is very important for creating awareness amongst the public to ensure their participation and also contribution for the success of the mission/ scheme/ program.

D. Television Scroll

Now a day's television is one of the important tools for fast communication, creating awareness and behavioral changes. The use of television for spreading the theme of the scheme will be beneficial for creating awareness amongst the public particularly women and children. The women and children have a very important role in maintaining the unhygienic: and clean condition around the neighborhood.

E. FM Radios & Jingles

The information and communication through FM radio and Jingles are also very important. The major population of disadvantaged, weaker section of the society and peoples living below poverty line still rely and enjoy the FM Radio and Jingles. Therefore, the use of FM Radios will be most useful for communicating the massage in shortest periods of time.

Experts from the city would participate and suggest solutions to address the issue. Three documentaries (5 min., 10 min. and 20 minutes) on sanitation. The first two documentaries will be used for advocacy. The longer documentary, at the end of the project, would showcase the outcome of all the activities executed in the city...

Creating a Radio Jingle for promotion on radio. Making of an audio album with songs on cleanliness

F. Installation of Banners

The banners are one of the important medium for attracting the attention and also transferring the desired information to create awareness amongst the public and facilitate the behavioral changes. The behavioral changes of the public are most important for the implementation and success of the mission. The banners numbering - minimum five hundred may be installed in the important locations of the cities to transfer massage in most effective manner.

G. Painting Competition in School based on Swachh Bharat & Generate Sponsorship Based Programme. The children are the future of the nation their involvement in the awareness campaign and related activities will definitely effect the implementation of the scheme and behavioural changes in the society. The children posses' great imagination and grasping power to understand follow and implement. We will organize painting competitions in schools based on the theme of

Swachh Bharat Mission to obtained new concepts for generating awareness and ensuring public participants

H. Rallies by School Children

Rallies may also be organized to divert the attention of the public for proper behaviour of cleanliness and participations in maintaining cleanliness and hygienic conditions in the neighbourhood.

I. Street Play

The street play shall be organized at important locations of the cities to attract the crowed, entertain then and pass on the massage and theme of the scheme to accelerate the implementation of the scheme.

J. Consultation with NGO & SHG

The Non-Government Organization and self-help groups are very much important from their involvement or obtaining their views, making consultation with them for the speedy and effective implementation of the mission I scheme I projects. The above-mentioned organizations work in different sectors therefore their knowledge and experience quite important from the implementation and success of the scheme. We may initiate Swachhta Dialogue which would be a public engagement forum in which a technical expert in the domain along with local municipal officials would organize the event to interact with citizens and address their issues related to cleanliness, littering, and sanitation. These events will also be used for 'Target Influencers' or famous local personality for building up a positive mind-set amongst policy/decision makers.

K. Use of Social Media Facebook, WhatsApp, Bulk Messages & Twitter

Now days the social media is playing very important role in creating public opinion, spreading the news and obtaining the comments of the public. This medium is quite important for obtaining the facts about the success of the mission/scheme/projects. Should try to create public opinion for communication, information, participation and evaluation of the mission. Have to send Message, Screenshot, Bulk Message in social media awareness, musical jingles, still photo, message approx. through various means of social media for the effective implementation of Swachh Bharat Mission. Should create social media channels for public engagement to reach out citizens online.

L. Use of Print Media

The print media is one of the effective instruments for propaganda, creating awareness, diverting the views of the public, behavioural changes, changes in life style itself. We will try to send good articles to newspapers for making part of the publication. The people generally look after the newspaper in the morning and after going through good articles they will appreciate the concept and follow in their life.

M. Pamphlets (Flyer in A-4 size distribute in Newspaper)

Pamphlets shall also be distributed for informing the public about the objective of the mission, implementation methodology and its advantages. Through this way the people may be able to know more about the program and understand its importance so that the public participation will be increased.

N. Display on Public Bus Shelter

Public bus shelter is very important location in the city where in thousands of commuters waits for the arrival and departure of the bus. During this period any display, poster, banner and massage may be read properly and that will have deep impact in the mind of the person. This practice may also enhance the public participation and expedite implementation of the mission.

O. Display on Railway Booking Screens

The display on railway booking screens is also very important from the propaganda, publicity, Education, learning and changing the public opinion. Therefore, the display of the objective and advantages of the Swachh Bharat Mission shall be beneficial for the success of the scheme.

P. Radio (Theme Based)

The use of radio is still prevalent in the rural area, Juggi jhopri clusters, slums, unauthorized colony and Urban Extensions. The public living in above mentioned areas are poor, disadvantaged, living below poverty line and weaker section of the society. They use the radio during their work time and at the home. The number of search persons is very high in the country. The massage, slogan, quote will affect them positively arid motivate them for behavioural changes and participation in the scheme. Therefore, theme-based messages shall be passed through radio to cover a sizeable section of society.

9.4 Capacity Building

The subject of Solid Waste Management has remained neglected for the past several decades with the result that the level of service is highly inadequate and inefficient. For improving the Solid Waste Management (SWM) services it is essential to adopt modern methods of waste management methods with right choice of technologies, which can work in the given area successfully. Simultaneously, measures to be taken for institutional strengthening and internal capacity building so that the efforts made can be sustained over a period and the system put in place can be well managed. For sustainability of waste management practices in any given area, training and capacity building of the employees and everyone responsible for Solid Waste Management in the Urban Local Bodies is the most important aspect without which the effective waste management would be unattainable.

In Solid Waste Management (SWM) the people, partnerships, coalitions, resources and skills are essential to its successful implementation and hence all these are included under the large umbrella of the term "capacity".

9.4.1 Capacity Building Methods

There are many approaches to providing capacity building services, like:

- Providing access to repositories of information and resources (for example, databases, libraries and web sites)
- Trainings (public, customized or on-line)
- Consultation (for example, facilitating, expert advice and conducting research)
- Publications
- Web based forum for interaction among different players

9.4.2 Capacity Building in Solid Waste Management

The approach to capacity building in SWM should be not only about technology and economics but also about:

- Understanding the administration systems for waste management and related activities (multidisciplinary and cross-sectoral).
- Understanding the need for human resource development to achieve better results in SWM.
- Focus on building sound institutions and good governance for attaining improved SWM. Delineating strategies for sustenance of achievements.

9.4.3 Strategic Framework for Capacity Building

The following diagram illustrates the capacity building framework in general. The framework is premised on four core areas: (i) situation analysis (ii) creating the right vision and mission (iii) drawing up the correct strategy and corresponding action, and (iv) measures for sustainability.

9.4.4 Training Needs

The plan should invariably indicate the target group or agencies to be capacitated for effective implementation. The major key factor for any training is depend on identification of target groups, for effective waste management implementation there are various groups/levels of people in the community who are major target groups.

The following are major target groups:

- Senior level officers-Decision makers
- Middle level officers-Managers and technical staff
- Junior Level -Technical staff
- Unqualified ground-level staff
- Elected members
- Members of NGOs and private participants if any

Appropriate training programmes must be organized for staff on the concepts of SWM, health, environmental, legal implications and functional aspects depending on the knowledge levels and their organizational positions. Every person involved for the SWM in ULBs has to be well-versed with the process, methods of SWM implementation.

10 Assessment of PPP options

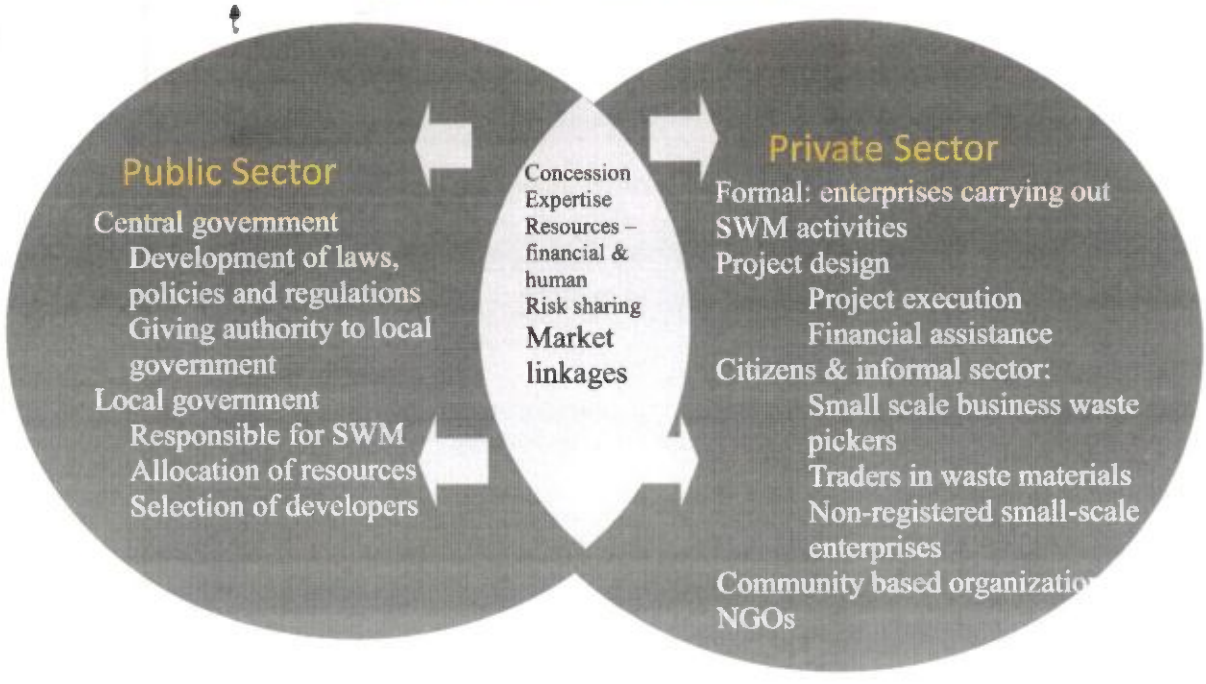
10.1 Different PPP Models

PPP is considered as an important model for urban development. The public and private sector together need to assume much more responsibility for waste generation and disposal, specifically product design and waste separation. There is considerable room for a wide array of public and private services in SWM. Many cities find that the mix of both public and private within their jurisdiction offers a good blend of competition and contestability, making both the public and private sector optimally efficient. The goal is to optimize cost-effectiveness however possible. In some cases, this may be done with public systems; other cases with private systems. The Solid waste sector (SWS) is not a "natural monopoly", so there is not required piping network or grid requiring a monopoly approach. Also, the SWS is not characterized by components with large economies-of-scale. Most cities can have multiple zones for collection and transfer, served by either the public or private sector. Only when looking at landfill and waste-to-energy to the economies-of-scale become appreciable and may even necessitate a clustering of municipalities to achieve.

Whether the system is done by public or private means, the issues of institutional capacity, cost recovery, emissions control, and by-product marketing need to be addressed.
Formalizing these responsibilities through well-structured PPPs can result in significant improvements in efficiency and quality of solid waste management. It has been found that privatization or partnership can be used as a good policy to improve economic growth. PPPs are also said to enhance social infrastructure in a sustainable way.

The following figure demonstrates the role of public private partnerships:

Figure 26: Public Private Partnerships



10.2 Risk Matrix

The parties involved in a project can affect the amount of risk by:

- The level of influence they have over events, and
- The level of information they have about the present and the future.

Influence relates to the power parties have to create action and determine outcomes. Influence can come from delegated authority, for example where a public authority has certain powers granted to it under law, from good management and organization, and from specific knowledge.

Information is directly related to risk. It is precisely because we usually don't have all the information that we can't predict future outcomes for certain. When we have better information, we are better able to foresee and reduce risk.

The public and private sectors are different in the types of influence and information that they have. This means they can control risks in different ways from each other and they are better at controlling some risks and not as good at controlling others. The risks which are usually applicable to a project are detailed below[15]:

Table 36: Major types of risk in PPP projects

Risk type	Description
Pre-operative task risks	
Delays in land acquisition	Refers to the risk that the project site will be unavailable or unable to be used within the required time, or in the manner or the cost anticipated, or the site will generate unanticipated liabilities due to existing encumbrances and native claims being made on the site.
External linkages	Refers to the risk that adequate and timely connectivity to the project site is not available, which may impact the commencement of construction and overall pace of development of the project.
Financing risks	Refers to the risk that sufficient finance will not be available for the project at reasonable cost (e.g., because of changes in market conditions or credit availability) resulting in delays in the financial closure for a project.
Planning risks	Refers to the risk that the pre-development studies (technical, legal, financial and others) conducted are inadequate or not robust enough resulting in possible deviations from the planned or expected outcomes in the PPP project development.
Approvals risk	Refers to the risk that necessary permits, authorisations and approvals required prior to the start of construction are not obtained in a timely fashion, resulting in delays to construction and the project.
Construction phase risks	
Design risk	Refers to the risk that the technology used will be unexpectedly superseded during the term of the project and will not be able to satisfy the requirements in the output specifications. It would result in increased costs of a replacement technology.

[15] Source: www.pppindia.com

Risk type	Description
Construction risk	Refers to the risk that the construction of the assets required for the project will not be completed on time, budget or to specification. It may lead to additional raw materials and labour costs, increase in the cost of maintaining existing infrastructure or providing a temporary alternative solution due to a delay in the provision of the service.
Approvals risk	Refers to the risk that delays in approvals to be obtained during the construction phase will result in a delay in the construction of the assets as per the construction schedule. Such delays in obtaining approvals may lead to cost overruns.
Operation phase risks	
Operations and maintenance risk	Refers to the risks associated with the need for increased maintenance of the assets over the term of the project to meet performance requirements.
Volume risk	Refers to the risk that demand for a service will vary from that initially projected, such that the total revenue derived from the project over the project term will vary from initial expectations. There is no risk in annuity contracts.
Payment risk	Refers to the risk that tolls are not collected in full or are not set at a level that allows recovery of costs. This is a risk for the public sector under shadow tolls and for the private sector under user tolls. There is no risk in annuity contracts.
Financial risk	Refers to the risk that the private sector over stresses a project by inappropriate financial structuring. It can result in additional funding costs for increased margins or unexpected refinancing costs.
Handover risks	
Handover risk	Refers to the risk that the concessionaire will default in the handover of the asset at the end of the project term or will deviate from the minimum quality / value of the asset that needs to be handed back to the public entity.
Terminal value risk	Refers to the risk relating to differences from the expected realisable value of the underlying assets at the end of the project.
Other risks	
Change in law	Refers to the risk that the current legal / regulatory regime will change, having a material adverse impact on the project.
Force Majeure	Refers to the risk that events beyond the control of either entity may occur, resulting in a material adverse impact on either party's ability to perform its obligations under the PPP contract.
Sponsor risk	Refers to the risk that sponsors will prove to be inappropriate or unsuitable for delivery of the project, for example due to failure of their company.
Concessionaire event of default	Refers to the risk that the private entity will not fulfil its contractual obligations and that the government will be unable to either enforce those obligations against the sponsors or recover some form of compensation or remedy from the sponsors for any loss sustained by it because of the breach or the sponsors will prove to be inappropriate or unsuitable for delivery of the project.

Risk type	Description
Government event of default	Refers to the risk that the government will not fulfil its contractual obligations and that the private entity will be unable to either enforce those obligations against the government or recover some form of compensation or remedy from the government for any loss sustained by it because of the breach.

Risks in PPPs for Solid Waste Management Project:

1) Funds: to establish and operate integrated MSW management facilities
2) Technical Expertise: to set up and operate MSW management facilities
3) Commercial competence: to engage the private partner transparently-e.g. Inviting - "Expression of Interest", "Request for Proposal' and evaluating the proposal technically and financially
4) Finding appropriate Land along with buffer zone for MSW management

With proper monitoring, PPP ensures innovation, efficiency and improved level of services, together with compliance to environment, Health and safety. PPP allows for involvement of user and other stakeholders and inculcates the habit of user charges through service delivery.

Private Sector issues in MSW PPP Project:

1) Ownership and clarity of the CA is not there on part of authority giving Concession
2) CAs needs to become 'Agreements' rather than Regulations
3) Onus on getting Government Permissions typically falls on the Private sector, which causes delays. Government should ensure Permissions being a partner
4) Both sides should respect Concession Agreement
5) Delay in Land possession and Land Lease; jeopardize debt financing and timely project completion
6) No guarantee for input waste: the private operator arrives at the Tipping fee by calculating revenue inflows from the waste generation estimates of the Government.
7) Timely inflow of grant should be inbuilt into project financing
8) Tipping fee /Revenues are not linked to increase in critical inputs like diesel, WPI etc
9) Timely and complete payment of periodic Revenues to the Concessionaire is not there
10) Successful bidder has to sign on the dotted lines of the Concession Agreement (CA) as there is no model concession agreement

Techno-commercial issues in MSW PPP Project:

The following are important while developing a PPP Projects in MSW:

1) Quantity and Quality of Waste: There is conspicuous lack of accuracy regarding estimation of Municipal Solid Waste.
2) Most of the technologies require high level of segregation. Moreover, Indian solid waste has low calorific value and the developer is forced to add other material (biomass).
3) RDF/Pallets have limited no of users unless the developer uses in his own plant furnaces (e.g. Grasim project in Jaipur).
4) Market has not developed for composting which has resulted in uncertainties in revenues. The burden of high operational cost falls on the developer and it becomes uncompetitive.
5) The combustion Technologies entail high dust and ash content in wastes this can pose a problem in effectively using the technology.
6) Bio-methanation Plants entail high capital cost and O&M costs and there is an additional problem of sale of power.

Governance Issues in MSW PPP Project:

1) Project Structure and Risk: Waste Quantification and characterization pose a serious problem in technology assessment and feasibility studies. Equitable risk sharing is far and few (MSW supply, payment, penalties and termination). And few developers in the sector further complicate the situation.

2) Land is the single most important factor in SWM sector. Availability and clearances are to be ensured for successful implementation.
3) The capacity/willingness of the contracting Agency is perceived to be the biggest stumbling block. Lengthy approval period and award period and the tendency not to honour the agreement once signed creates a lot of problem.
4) Most of the ULB's are unaware of tipping fee which is further complicated by promises of "royalty" by competing developer/agents.

Political and Operation Issues:

1) The collection and transportation (C&T) part of SWM in cluster-1 is currently handled by the ULB's themselves. So, bidding out the C&T part for a private player will raise a revolution from staff who are handling C&T currently.
2) In addition to this, the current infrastructure viz. collection vehicle's, compactors, transfer vehicles will remain unused if a private player is deployed for the collection and transportation part.
3) Legacy waste removal from Pramodnagar Dumpsite and Kamarhati Dumpsite can cause a significant delay in the initiation of the processing plant construction.

10.3 Case Studies

PPP services and types of PPP projects or models being implemented by the different cities for the treatment of municipal solid waste generated and management by Public Private Partnership.
At present, a handful of cities have ventured into public private participation in an attempt to overhaul their waste management systems. The partnerships range from engagements for collection & transportation, processing & disposal of waste and for construction and/or management of sanitary landfills. Some ULBs, depending upon their need, have partnered only for C&T segments, some for processing and disposal, and a few only for the disposal of waste. The concept of Integrated Solid Waste Management, being relatively new in the country, has been adopted only by a few cities. The concern for efficient and safe disposal of waste has been growing in recent times as citizens are more aware of the need for and the importance of good waste management systems PPP models and the projects in India with PPP models are defined in the Table below[16]:

Table 37: MSW management using PPP model

S.No	PPP Services	Projects in India with PPP Models
1	Door-door Collection	Bangalore, Ahmadabad, Nagpur, Dumdum Gandhinagar, Jaipur, North, Delhi
2	Sweeping Streets	Hyderabad, Surat
3	Storage and Transportation	Surat, Ahmadabad, Mumbai, Delhi
4	Integrated Treatment & Disposal	Delhi, Bangalore, Coimbatore, Kolkata, Chennai, Ahmadabad, Chennai
5	Integrated primary collection, street sweeping, storage and transportation	Chennai
6	Integrated MSWM (complete value chain)	Guwahati, Hyderabad, Haryana

Selection of PPP model for implantation of project shall depend on following 4 parameters:
1) Quantity of waste generated
2) Availability of central and state funds for solid waste management

[16] SOLID WASTE MANAGEMENT THROUGH PUBLIC-PRIVATE PARTNERSHIP MODEL by Sesha Sai Ratnamala Bommareddy

3) ULB's internal resource generation capacity
4) ULB's financial health

The first two parameters, namely, quantity of waste generated and availability of central and state funds for solid waste management, are largely dependent on the size of the city. Therefore, the other two parameters, ULB's internal resource generation capacity and its financial health, determine the appropriate source of funds for capital and operational expenditure. For large cities, with a population greater than a million inhabitants, the quantity of waste generated is generally high and the central and state grants cover only up to 50% of the cost of the project. For such large cities, if the financial health of the ULB is good, then all the capital expenditure can be met through the ULB's financial resources. In case of poor financial health, some portion of the capital expenditure might need to be financed by the private sector. Cost recovery of operating expenses would depend on the paying capacity of the users, as well as the ULB's ability to monitor generation, bill accurately and collect dues. If both the paying capacity of the users and the ULB's collection efficiency are high, full cost recovery through user charges should be attempted. In case either of the two is low or weak, partial cost recovery must be attempted, with the shortfall being financed through government grants or external grants. A model of cross subsidization, e.g., where water is supplied to industry that pays higher rates than domestic consumers, can also be implemented.
We conducted a research on the international and national best practices in the municipal solid waste space based on resources available in the public domain. This section provides an overview of selected practices implemented in various countries and their relevance to this project.

1) Timarpur Okhla Integrated Municipal Solid Waste Management Project

Project Description

Delhi generates 14,000 metric tonnes (MT) of Municipal Solid Waste (MSW) daily, which is expected to increase to 18,000 MT by 2021. The present landfill sites that are being utilized for disposing the garbage are approaching their full capacity and even with the envisaged capacity addition, the situation is unlikely to improve. The Municipal Corporation of Delhi (MCD) has thus embarked on a project to reduce the amount of MSW being disposed in the landfill sites and utilizing the waste for productive purposes such as generation of power from waste. MCD has identified two locations, namely Timarpur and Okhla, for implementing this project.

The following facilities are to be developed as a part of the integrated municipal waste handling project:
1. Plants for converting MSW to Refuse Derived Fuel (RDF), capable of processing 1300 TPD at Okhla and 650 TPD at Timarpur.
2. A bio-methanation plant capable of handling of 100 TPD of green waste at Okhla.
3. A water recovery plant capable of handling up to 6 MLD of treated sewage at the Okhla site for recycling into process water and cooling water.
4. A Power plant with a generation capacity of 16 MW at Okhla.
5. Transportation of RDF from Timarpur to Okhla for combustion in the boiler of the power plant mentioned above.
The project is registered with the United Nations Framework Convention on Climate Change (UNFCCC) for the Clean Development Mechanism (CDM) to earn 2.6 million Certified Emission Reductions (CERs) over a ten-year period.

PPP Structure of the project:

The project has been undertaken on Built, Own, Operate and Transfer (BOOT) basis. IL&FS IDC and the Andhra Pradesh Technology Development & Promotion Board established an SPV known as the Timarpur-Okhla Waste Management Company Private Limited (TOWMCL) prior to the bid itself.

The successful bidder M/s Jindal Urban Infrastructure Limited (JUIL) acquired 100% equity in the SPV - TOWMCL. The following were the agreements executed by the SPV for this project

1. The SPV signed the main concession agreement for the development, construction, operation and maintenance of an integrated municipal waste processing plant with NDMC.
2. The SPV signed a lease agreement with the Delhi Power Company Limited (DPCL) for the land at Timarpur. DPCL, the owner of the Timarpur site, is a holding company with shares in Indraprastha Power Generation Company Limited (the electricity generation company), Delhi Power Supply Company Limited (the electricity procurement, transmission and bulk supply company) and in the three power distribution companies (Central & East Delhi Electricity Distribution Co. Ltd., South and West Delhi Electricity Distribution Co. Ltd. and North and North est Delhi Electricity Distribution Co. Ltd.)
3. The SPV signed a lease agreement with New Delhi Municipal Council (NDMC) for the land at Okhla for 25 years. NDMC had taken this land on lease from the Delhi Development Authority.
4. The SPV entered into agreements with the MCD and NDMC for the supply of municipal waste.
5. It entered into an agreement with the Delhi Jal Board (DJB) for receiving sewage and disposing treated effluent.
6. The SPV entered into a Power Purchase Agreement with BSES Rajdhani Power Limited.

Financing Information

JUIL had estimated the project cost to be 200 crores, 25 crores more than the stated DPR cost of 175 crores. The increase in cost was principally due to the increase in the capacity of the power plant from 16 MW to 20 MW.
JUIL arranged finance through a mixture of equity and debt, with the debt being raised from financial institutions. Axis bank was the lead consortium bank for lending towards the project.

Key Learning and Observations

When this project was awarded in the year 2008, it was one of its kinds in the sector. Generally, MSW was not regarded as a sector for attracting private participation. The development of the project has outlined the following learning:

1. **Project Preparedness**

Observation
The extent of preparation prior to the launch of the bid process was considerable. This phase entailed detailed technical studies and reviews, financial evaluation, contractual clarity, risk evaluation and obtaining regulatory as well as statutory approvals. In fact the SPV to implement the project was also incorporated prior to the launch of the bid.

Learning
Good project preparation is critical to ensure project attractiveness and faster financial closure. Clarity on the contractual and regulatory framework reduces the extent of uncertainty faced by the private investors.

2. **Government Support:**

Observation
IL&FS and APTDC had the support and the backing of the Chief Minister of GoNCTD and the Principle Secretary (Power and Urban Development of GoNCTD). Despite this government support, it took three years to bid out the project. One of the reasons was the time taken to convince stakeholders, along with procuring clearances and no-objection certificates from various government departments.

Learning
It is quite essential the government establishes a single clearance window or an authority to resolves such issues. This process will assist in reducing the time lag between expected and the actual time for completing the project. It is also essential to have complete government support which helps in obtaining a buy in from the general public.

3. **Technology:**

Observation
The consortium chose RDF over the other proven technologies owing to the nature of Indian waste. The technology can efficiently convert majority of the waste into pellets to be utilized in the power plant. The technology was experimented at two different locations before being implemented in Delhi.

Learning
When there is a choice of technology or method to achieve the said output, the benefits and losses by adopting that particular method or technology should be thoroughly assessed by way of a comparative study.

4. **Consumer Education:**

Observations

- The project is in the vicinity of residential localities, resulting in protests about its development and pollution from burning waste.
- To address these concerns, five public hearings were organised; three in Timarpur, one in Okhla and one in the Delhi Electricity Regulatory Commission. The public hearings helped address substantial doubts regarding the project.

Learning
Implementation of a new technology requires consumer or end user education, so as to appreciate the benefits. Projects which have multiple stakeholders should have public hearings or stakeholder interactions to obtain a buy-in.

Waste processing and Sanitary Landfill: Coimbatore Municipal Corporation

City	Coimbatore, Tamil Nadu
Project	Waste Transportation, Processing & Sanitary Landfill
Month/Year of Issue of RfQ	July 2007
Month/Year of Project Award	November 2007
Bid process timeframe	5 months
Bid Variable/Winning offer	NPV of [Transportation - Rs 440 per ton, Processing - Rs 185 per ton, Landfill - Rs 171.5 per tons of inert to landfill, Closure of dumpsite - Rs 45 lakh per year]

Selected Private Operator	Consortium of M/s Bharuch Enviro Infrastructure Limited (BEIL) and United Phosphorous Ltd. (UPL)
Project Cost	Rs.69 Crore
Investment by Operator (% of project cost)	21 Crore (Rest 68 crores under JnNURM)
Project Scope and Operator Obligations	
• MSW Transportation from the existing & proposed transfer stations to Vellalore site; • Establish transfer stations at specified 4 (four) locations and O&M of the same; • Establish MSW processing using aerobic composting along with other suitable options and its O&M; • Closure of existing waste dumpsites at specified 3 (three) locations in the city; • Construction, Development and O&M of Sanitary Landfill in compliance with MSW Rules 2000	
ULB Obligations	
• Capital cost for SFL after phase I (5 yrs.) to the extent of Rs 4.0 crore per year with 5% annual increment • Collect & Transfer MSW to transfer station; except 50 TPD of organic waste for existing Vermi plant. • Assured minimum waste quantity of 360 TPD in Year 1. • Payment on monthly basis to concessionaire within 30 days of receipt of fee statement • Segregation of waste, non-mandatory (no penalties) target to achieve and maintain • Disburse grants in timely manner and approvals, permissions and authorisations to concessionaire • Landfill need within 12 months upon operator' request, in case available site falls short of need.	
Key Learnings	
• NPV concept - One of the very few projects in SWM in India where the bidding parameter was Net Present Value for different components and evaluation was successfully conducted based on weighted average for technical score (30 marks) and financial offer (70 marks). • JNNURM funding - the project utilised the JnNURM funding (70%) for part of the initial capital investment and balance (30%) funding by private player in the project. Prima facie this seems to provide comfort to private operator for investment and also helped in bringing down tipping fee	
Risk Allocation summary	
Investment risk	Private player (30%) and Government (70%)
Construction/development risk	Private player
Operating Risk	Quantity Risk by Government [360 tons per day] Waste quality Risk by Private Player

Integrated SWM: Hyderabad Municipal Corporation

City	Hyderabad, Andhra Pradesh
Project	Integrated SWM system - Entire value chain
Month/Year of Issue of RfQ	August 2008
Month/Year of Project Award	February 2009
Bid process timeframe	6 months
Bid Variable/Winning offer	Tipping Fee per ton of MSW received at the gate of the disposal

	facility - Rs 1431 per ton of MSW
Selected Private Operator	M/s Ramky Enviro Engineers Limited (REEL)
Project Cost	Rs.434.91 Crore
Investment by Operator (% of project cost)	50% by Private Player; Rs 217.46 crore [rest 35% under JnNURM scheme and 15% by Government of Andhra Pradesh]
Project Scope and Operator Obligations	
• Primary & secondary collection - entire GHMC area; all 5 zones • Up-gradation, operation & maintenance, and management of existing transfer stations • Development, operations and maintenance of additional transfer stations • Construction & Development of Sanitary Landfill and O&M of the same in line with MSW Rules 2000 • Reclamation/ reuse of dumpsites.	
ULB Obligations	
• In the event the grants are not obtained under the JnNURM scheme GHMC would be responsible for providing equivalent grants contributing to 50% (35% of JnNURM + 15% of GoAP) of the eligible project cost. • Provide power connections to the transfer stations and treatment & disposal facilities. However, usage charges and distribution arrangements, as well as back-up to be made by concessionaire. • Road connectivity to the transfer stations and treatment & disposal facilities by GHMC. • Handover all existing infrastructure like dumper bins, vehicles, transfer station to concessionaire.	
Key Learnings	
• Labour Unrest -The GHMC unions were opposing the handing over of collection & transportation to Ramky on the apprehension that once the private operator would start operations, the municipal workers will be diverted to activities like road sweeping and drain cleaning than the desired collection and transportation work. The strike by the unions forced the state government to keep the agreement on hold and the project implementation was kept in abeyance for 9 months due to objections/concerns raised by municipal worker' unions. • Information, communication and awareness programmes - there is a pressing need for running structured awareness programmes to involve all stakeholders with focus on sharing new technologies and procedures for handling the SWM activities.	
Risk Allocation summary	
Investment risk	Private player (50%) and rest 50% by Government of AP
Construction/development risk	Private player
Operating Risk	Both Quantity & Quality Risk by Private Player

Collection and Transportation: Delhi

City	Delhi
Project	Collection & Transportation of MSW - West Zone, Delhi
Month/Year of Issue of RfQ	August 2004
Month/Year of Project Award	January 2005
Bid process timeframe	6 months
Bid Variable/Winning offer	Tipping Fee of Rs 693 per tons of waste collected and transported to the disposal facility
Selected Private Operator	M/s Metro Waste Handling Pvt. Ltd. for the West Zone

Project Cost	NA
Investment by Operator (% of project cost)	100% by Private Operator
Project Scope and Operator Obligations	
• Secondary collection from waste storage depots (WSDs) and transportation to the disposal facility; • Waste segregation at WSDs/dhalaos - the ownership of recyclables waste with private players • Structured communication activities for awareness on segregation and storage of wet and dry waste. • Ensure that the dhalao/WSDs and its defined surroundings of 25 feet are clean and odourless.	
ULB Obligations	
• Give all assistance to the concessionaire to employ the existing informal Municipal Solid Waste collectors including rag pickers and assist the concessionaire in solving issues arising from the redeployment and employment of such waste collectors by the concessionaire. • Primary collection till the waste storage depots to be the responsibility of MCD. • Payment on monthly basis to concessionaire within 30 days of receipt of fee statement • Timely manner grants for approvals, permissions and authorizations to concessionaire	
Key Learnings	
• The design of the privatization system was different from other cities in a way that the contract did not start at the doorstep of the waste generator. Instead, this space was left open for informal players in the value chain. • The monthly payments are linked to the segregation efficiency achieved as per the pre-determined benchmarks specified for discrete yeas during the concession period leading to operational gains.	
Risk Allocation summary	
Investment risk	Private player (100%)
Construction/development risk	Private player
Operating Risk	Both Quantity & Quality Risk by Private Player

Collection and Transportation of MSW: Chennai Municipal Corporation

City	Chennai, Tamil Nadu
Project	Collection and Transportation of MSW
Month/Year of Issue of RfQ	May 2007
Month/Year of Project Award	July 2009
Bid process timeframe	4 months
Bid Variable/Winning offer	Tipping Fee per ton of MSW collected & transported - Rs 673 & Rs 642 per ton of MSW for two separate zones
Selected Private Operator	Consortium of Neel Metal Fanalca S.A
Project Cost	NA
Investment by Operator (% of project cost)	100% by Private Operator
Project Scope and Operator Obligations	
• Primary & secondary collection - 4 zones out of 12 zones in Chennai • Segregation of MSW at source • Road sweeping including collection, removal, transportation and disposal of road dust	

• Providing manpower and machinery (including but not limited to vehicles & bins) for collection, segregation and transportation. • If required, installation of transfer stations with permanent refuse compactors, along with manpower required for operations. • Providing required number of vehicles with operators/drivers for collection, segregation and transportation such as small/medium/large capacity compactors, and skip loading vehicles etc. • The operational management of the CoC' transfer stations will be the responsibility of the private operator but the ownership of the same will rest with CoC.
ULB Obligations
• Security against default in monthly payments - The CoC would provide an irrevocable standby letter of credit in favour of the concessionaire, which can be utilized against any unpaid invoice that was delivered to the CoC in accordance with the agreement. • Decide at the disposal area to weigh the MSW disposed by the concessionaire.
Key Learnings
• Political championing is necessary for PPPs in urban services: in this case, the Mayor steered clear the rationale for the privatization of MSWM services to the corporation council and passed a council resolution approving the privatization of MSW services. • Need for well-defined transition process/duration – it is imperative to initiate steps in developing service handover management competencies, else it can lead to complete failure of adequate service delivery as in the case of transition between CES Onyx to Neel Metal Fanalca.

Risk Allocation summary	
Investment risk	Private player (100%)
Construction/development risk	Private player
Operating Risk	Both Quantity & Quality Risk by Private Player

Integrated SWM: Guwahati

City	Guwahati, Assam
Project	Integrated SWM system - Entire value chain
Month/Year of Issue of RfQ	October 2007
Month/Year of Project Award	October 2008
Bid process timeframe	12 months
Bid Variable/Winning offer	Lowest Levelised Power Tariff - per unit price of electricity at Rs 4.00
Selected Private Operator	M/s Ramky Enviro Engineers Limited (REEL)
Project Cost	102 Crore
Investment by Operator (% of project cost)	Private player - Rs 65.66 crore [Grant under JnNURM scheme at Rs 36.24 crore]
Project Scope and Operator Obligations	
• Primary and secondary waste collection, transportation and segregation • Processing of MSW - RDF plant, compost plant, and power plant • Development and management of sanitary landfill	
ULB Obligations	
• Timely manner grants for approvals, permissions and authorizations to concessionaire • GMC shall pay tipping fee of Rs 130 per ton of waste for transportation with 4% annual escalation	
Key Learnings	

• Policy on primary waste collection system with community participation - the involvement of community and informal sectors was considered while structuring the project, though the overall responsibility lies with a SPV named Guwahati Waste Management Company Pvt Ltd (GWMCL), however, for smooth coordination and implementation, a society named Guwahati Waste Management Society (GWMS) was formulated with informal sectors given job opportunities.	
Risk Allocation summary	
Investment risk	Private player (100%)
Construction/development risk	Private player
Operating Risk	Both Quantity & Quality Risk by Private Player

Waste processing and Sanitary Landfill: Bangalore Mahanagar Palike[17]

City	Bangalore, Karnataka
Project	Waste Processing and Sanitary Landfill
Month/Year of Issue of RfQ	June 2003
Month/Year of Project Award	August 2004
Bid process timeframe	10 months
Bid Variable/Winning offer	Tipping Fee of Rs 198 per ton of MSW rejects to Landfill [max cap to landfill 50% of input MSW]
Selected Private Operator	M/s Ramky Enviro Engineers Limited
Project Cost	Rs.10 Crore
Investment by Operator (% of project cost)	100% by Private Operator
Project Scope and Operator Obligations	
• Segregation of MSW transported by BBMP at the processing facility. • Construction and O&M of MSW compost facility in line with DPR provided; • Construction and O&M of sanitary landfill in line with SWM Rules & DPR provided; and • Post closure maintenance of sanitary landfill for 15 years after the Term of concession	
ULB Obligations	
• Collect & Transfer MSW to the disposal facility. • Timely manner grants for approvals, permissions and authorizations to concessionaire • Provide 100 acres of land on nominal lease rentals of Rs 1 per sq. meter.	
Key Learnings	
• Land acquisition is critical for the success of PPP projects; as BBMP could provide only ~50 acres against contracted 100 acres for the project facilities, resulting in implementation delay and sub-capacity processing installation of 250 TPD against 600 TPD envisaged initially • Technology selection -need to provide flexibility to private operator in technology selection and focus on outcome based indicators rather than input based factors. Unlike in this case, where the need to follow DPR for project implementation significantly constrained the probable usage of innovative technologies with may have resulted in higher commercial benefit realization.	
Risk Allocation summary	

[17] Toolkit for Public Private Partnership frameworks in Municipal Solid Waste Management by ADB and MoUD

Investment risk	Private player (100%)
Construction/development risk	Private player
Operating Risk	Both Quantity & Quality Risk by Private Player

Waste processing: Jaipur Municipal Corporation

City	Jaipur, Rajasthan
Project	Only Waste Processing
Month/Year of Issue of RfQ	February 2005
Month/Year of Project Award	June 2005
Bid process timeframe	4.5 months
Bid Variable/Winning offer	Highest Royalty of Rs 1.01 per ton of input MSW to JMC
Selected Private Operator	M/s Grasim Limited
Project Cost	Rs.15 Crore
Investment by Operator (% of project cost)	100% by Private Operator
Project Scope and Operator Obligations	
• MSW segregation at the processing facility; and • Construction & Development of MSW processing facility at the prescribed site.	
ULB Obligations	
• JMC shall at its risk and expense, supply to the processing facility an aggregate quantity of MSW = 250 * D tones (Assured waste quantity), D = no. of days in such month; with no penalties. • Endeavour not to supply construction debris, biomedical/hazardous waste (no penalty clause) • Endeavour to assist the concessionaire in obtaining finances from the FIs for the project.	
Key Learnings	
• Failure in providing assured MSW - the JMC has failed at times in providing the minimum assured waste quantity to the processing facility due to workers unrest and related factor. This needs to be backed by stringent penalties /or private firm should be responsible for secondary transportation. • Risk pertaining to MSW quality -the JMC is providing mixed un-segregated waste after informal stakeholders like rag-pickers extracting most of the organic/recyclable waste, thereby significantly affecting the desired calorific value of the waste. .	
Risk Allocation summary	
Investment risk	Private player (100%)
Construction/development risk	Private player
Operating Risk	Both Quantity & Quality Risk by Private Player

Waste processing and Sanitary Landfill: Rajkot Municipal Corporation

City	Rajkot, Gujarat
Project	MSW Processing & Sanitary Landfill
Month/Year of Issue of RfQ	March 2001

Month/Year of Project Award	June 2003
Bid process timeframe	2 years 3 months
Bid Variable/Winning offer	Tipping Fee of Rs 220 per tons of MSW reject to Landfill [max cap of 20% of input MSW; or max 60 MT]
Selected Private Operator	M/s Hanjer Biotech Energies Pvt. Ltd.
Project Cost	NA
Investment by Operator (% of project cost)	100% by Private Operator
Project Scope and Operator Obligations	
• MSW segregation at the processing facility; and • Construction & Development, O&M of MSW processing facility at the prescribed site. • Transportation of inert/reject to landfill • Construction & development, O&M of Sanitary Landfill at the prescribed site	
ULB Obligations	
• RMC shall at its risk and expense, supply to the processing facility an aggregate quantity of MSW = 300 * D tones (Assured waste quantity), D = no. of days in such month; with no penalty clause. • To lease 12 hectares land for setting up of processing plant & warehouse facilities for 7 years. • To provide utilities like motor able access road up to entrance of premises, water requirement up to 2 lakh litres per day, electricity power line and user charges for such utilities to be borne by HBEPL	
Key Learnings	
• Better Customized Technologies for screening and segregating of MSW into Wet waste and Dry waste is the need of the hour for better quality output like compost, refuse derived fuel, pallets, electricity, eco-bricks etc. As in the case of Rajkot processing plant, initial experiments leading to establishment of the by-products and their quality in line with market requirements has led to sustainable operations with desired returns. • Authority' capacity & commitment to deliver minimum assured/guaranteed waste to the processing plant is decisive in success of similar waste processing projects.	
Risk Allocation summary	
Investment risk	Private player (100%)
Construction/development risk	Private player
Operating Risk	Both Quantity & Quality Risk by Private Player

INTERNATIONAL PPP Experience:

1. **MSWM in Singapore**

The total waste generation in Singapore is 5.02 million tons per annum out of which around 2.47 million tons (49%) is getting recycled and about 2.29 million tons (46%) is being incinerated, there by leaving only around 10% of the net waste to reach the landfills. Singapore aims to achieve 60% recycling.

To meet the goal of solid waste management, the National Environment Agency (NEA), Singapore has formulated strategies on five (5) focus areas; (i) volume reduction by incineration, (ii) waste recycling, (iii) reduce land filled waste, (iv) waste minimization, and (v) public awareness and 3P partnership.

PPPs have been adopted in all components of the MSWM value chain in Singapore.

- The waste collection conventionally done by NEA was corporatized in 1996 and then fully

privatized in September 2001.

- To ensure financial viability, every household pays an amount of Sing $ 4.5-7.5 per month and individual landed property owner pays Sing $ 17-24 per month. Thus, the waste collection is completely viable with no liability on NEA
- The 5th Incineration plant at Tuas was developed on DBOO format. However, the NEA took the risk of waste quantity and quality for successful implementation of the plant.

2. MSWM in Malaysia

- Daily waste generation in peninsular Malaysia today exceeds 19,000 tons and approximately 75% of this is collected and disposed in 130 landfills and dumps.
- The current recycling rate in Malaysia is around 5.5% and the target is achieving 22% by 2020.
- The Ministry of Housing and Local government enacted Solid Waste and Public Cleansing Management Act (SWPCM) in 2007 with an objective to regulate the management of MSW.
- Prior to the implementation of the SWPCM Act 2007, SWM was the responsibility of the Local Authorities (LAs), and were normally subcontracted to smaller waste management service providers which resulted in more efficient management in the early stages of implementation.
- However, with the increasing costs of waste management, the situation resulted in subcontractors not being paid promptly, leading to drastically reduced efficiency. With the passing of the Act, the authority governing solid waste and public cleansing was shifted from state governments/ LAs to the Federal Government - a Corporation named Solid Waste and Public Cleansing Management Corporation (the Corporation) was established.
- The SWPCM Act requires residents to pay for the waste collection and disposal service provided by the licensed concessionaire (private authority) under the Act.
- The Act provides for penalty provisions for consumers who refuse to pay waste disposal fees - a fine of up to RM5000 (US$1316) & RM50 (US$13) for each day of the continuation of the offence.

10.4 Proposed PPP Structure

EY LLP has visited and collected information from all the ULB's in cluster-1 for mapping the gap in infrastructure in all the ULBs and to develop a strong scientific plan for solid waste management. During the visits, it has become clear that KMDA, SUDA and municipalities has a very active role in the functions and clearances with regards to solid waste management.

To reduce the identified political, economic, financial, operational, techno-commercial risks the technical groups and authorities to be associated with implementation strategy is presented in below table:

Table 38: Scope of Work of Private Players and Government authorities

Component	Task appointed to	Main Scope of Work
Primary Collection and Transportation	ULBs	From the solid waste management data acquired from ULB through detailed questioner the equipment gap has been estimated by EY LLP team. The ULBs are responsible for procuring the equipment and vehicles by obtaining required funds with assistance of SUDA and KMDA. They are also responsible for primary collection, transportation, compaction, secondary transportation. The ULBs are also responsible for providing segregated wet waste generated from markets to Bio-Methanation plant at Pramodnagar Site.
Secondary Transportation	Private Player	The Private player should identify and develop secondary collection points in consultation with ULB and shall collect the waste from thereon. It shall take the responsibility to transport the waste from secondary collection points to the processing site
Identification of land	KMDA	As part TFR development, EY LLP team along with KMDA personnel has visited Pramodnagar & Kamarhati Dumpsite and Panihati site to assess their operational feasibility. KMDA holds the responsibility for assisting the private player in obtaining initial land permits.
Environmental Clearances	KMDA and WBPCB	KMDA and WBPCB should assist the private player deployed for processing plant and sanitary landfill development, in obtaining required Environmental clearances.
Legacy Waste disposal	Private Player on Output based pricing model	The Private player should scientifically process the legacy waste and dispose it in a low-lying area after processing. The KMDA and WBPCB should assist the private player in obtaining environmental clearances for the disposal of waste.
Processing Fresh waste	Private Player on Output based pricing model	The Private player should process and scientifically dispose the fresh waste generated from cluster-1 during the construction of processing plants at Pramodnagar and Kamarhati sites.
Compost and RDF plant and Biomethanation plant at Pramodnagar	Private player on DBFOT model	A suitable private player should be deployed on a concession agreement for designing, procurement, operation and maintenance of the processing facility at Pramodnagar and Kamarhati Dumpsite on tipping fee basis
Compost and RDF facility at Kamarhati	Private player on DBFOT model	A suitable private player should be deployed on a concession agreement for designing, procurement, operation and maintenance of the processing facility at Pramodnagar and Kamarhati Dumpsite on tipping fee basis

Sanitary landfill facilities	Private player on DBFOT model	A suitable private player should be deployed on a concession agreement for designing, procurement and third party supervision of the Sanitary landfill facility at a site to be identified within 6-9 months for reject from Cluster-1
Information Education and Communication	NGO and ULB	A suitable NGO can be appointed to conduct various IEC activities to create awareness in the public with regards to solid waste management along with necessary assistance from ULBs.

*The Green rows show the opportunity of involving private party in PPP model for the respective assignment

The basic model that was arrived at was, to give the responsibility of obtaining the equipment required for initial collection and transportation to ULB's. The municipalities are expected to carry out the source segregation, primary collection and transportation of waste to the secondary collection points, which is their prime responsibility as per SWM Rules 2016. Whereas private player shall be responsible for the waste transportation thereon. Hence, this structure will be slightly different from Integrated Solid Waste Management scheme, where private developer is supposed to carry entire waste management from door to door collection till processing. Present project structure has been proposed keeping in mind operational cost on C&T, existing resource optimization, operational dynamics of municipalities in West Bengal and reducing financial burden on the Government. The initial collection and transportation should be undertaken individually by each ULB.

Due to the lack of land available in each ULB, a common processing facility at Pramodnagar dumpsite after land reclamation for processing waste from Dum Dum, South Dum Dum, North Dum Dum, Baranagar and another processing plant at Kamarhati dumpsite for Kamarhati and New Barrackpore. Project is awarded to a private player through bidding process management for a given concession period. The private player shall be responsible for collection and transportation of waste from secondary collection points, biomining of legacy waste at Pramodnagar and Kamarahti site, processing plant development, waste processing, operation & maintenance and finally the transfer of processing rejects to sanitary landfill.

As suggested in the revised scheme, the Pramodnagar dumpsite is not suitable for developing both processing plant and sanitary landfill. SUDA is in process to finalize land at Naihati for sanitary landfill development. Private player can be given the responsibility based on selection through bidding process for developing, processing, operating and maintaining the sanitary landfill facility for 20 years from the construction of the landfill.

10.4.1 Bidding Strategy

The private party can be involved in the PPP model as shown in the table. Following are the projects identified for private player involvement.

Table 39: Identification of Projects

Component	Legacy Waste Removal	Secondary Collection & Processing of Fresh waste
Brief scope of the Private Party	Processing & Removal of legacy waste from Pramodnagar and Kamarhati dumpsite as per NGT Guidelines	1. Developing and maintaining of secondary collection points, Collection and transportation of waste from secondary collection points to processing site 2. Construction, operation & maintenance of Compost + RDF plant at Pramodnagar (450 TPD) 3. Construction, operation & maintenance of Biomethanation plant at Pramodnagar (100 TPD) 4. Construction, operation & maintenance of Compost + RDF plant at Kamarhati (180 TPD)

		5. Construction, operation & maintenance of sanitary landfill (33 acres)
Approximate capital cost involved	54.91 Crores	113.14 Crores
Bid variable	Cost of legacy waste per Tonne	Tipping Fee (As per financial model calculations)
Time Period	1-2 years	20 years
General Practice	Non-Revenue generation Project	Revenue Deficit Project
Common project model	Construction Work	PPP

Construction of processing plants logistically depends on removal of legacy waste. For an effective flow of activities, it is necessary to perform both the tasks in parallel to each other. If both the projects are allotted to separate developers, there is a high chance of coordination conflict between both the developers. Hence the proposed bidding strategy is to allot both the identified projects to a single private party (developer).

But both projects are different in nature. Based on previous case studies, both have different procurement models as mentioned in the table above. To solve this issue, one of the bidding variables has to be fixed and the second variable can be used for bid evaluation. For removal of legacy waste, the time required is less compared to the processing & disposal of fresh waste. Hence, we recommend fixing the cost of legacy waste removal per Tonne as per NGT guidelines of legacy waste removal and few legacy waste removal practical cases. The tipping fee for transportation of waste from secondary collection points, processing & disposal can be used as a bidding variable.

The responsibility of handling fresh waste generated in cluster-1 during the processing plant construction period shall also be on the private player. Since the exact construction period cannot be determined at this stage, this component is left as variable. The tipping fee used as bid variable does not includes this additional cost. Hence, this additional cost component should be borne by government.

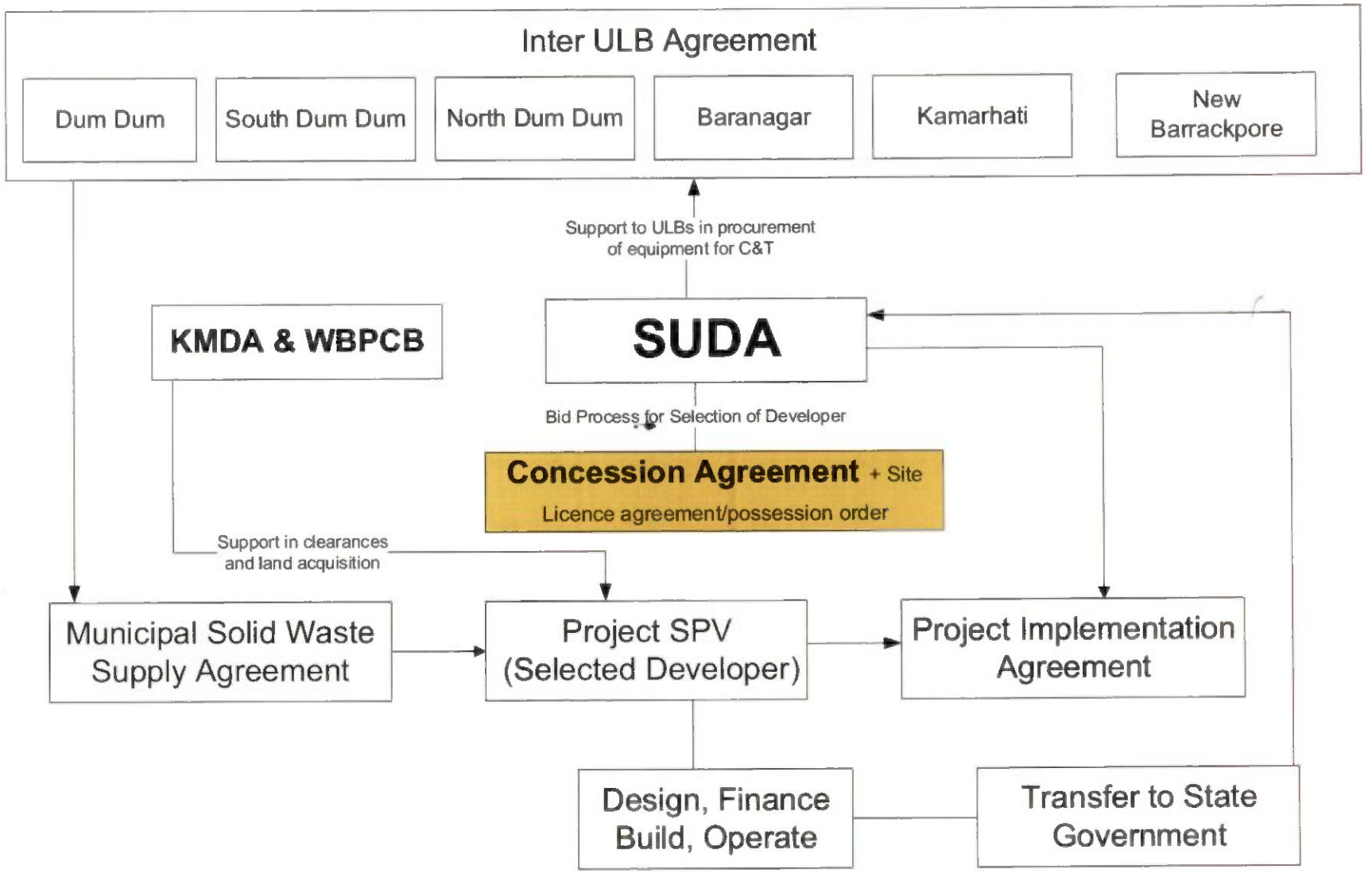
The responsibility of supervision of the performance of private player and assistance in land acquiring and environmental clearances is given to KMDA and SUDA to ensure the smooth transition of the project.

Table 40: Envisaged Allocation of Roles and Responsibilities

Activity	**ULB**	**Developer**	**KMDA/SUDA/ WBPCB**
Procurement of equipment for collection and transportation of MSW			Support to ULBs in deploying funds
Primary Collection and transportation of MSW			
Procurement of equipment for Collection & transportation of waste from secondary collection points: Secondary C&T			
Selection of developer for processing Facility			
Financing, development and O&M of treatment & disposal facilities			
Upfront capital support			Through fund earmarked for ULBs
MSW processing			
Transportation of inerts			
Sanitary Landfill			
Tipping fee Payment			

Monitoring of design, construction, O&M, quality and post-closure			
Contract monitoring and support			
Information Education and Communication	Assistance to NGO		

Figure 27: Concession Agreement Structure



10.5 Advantages and Challenges in Proposed Structure

Advantages:

1. The collection and transportation part have been assigned to municipalities to leverage the existing infrastructure and operations ownership. This avoids the handover risk involved in asset transfer to a private player and also the political risk which might raise due to loss of employment for the labour and staff who are currently operating the collection and transportation.
2. To reduce the financial risk, the investment for legacy waste removal, construction of compost + RDF plant, sanitary landfill is spread over the construction period to reduce the initial cost to the developer.
3. Since municipalities are not equipped enough to handle treatment and disposal of waste, it is necessary to assign this task to a private player for this purpose.
4. The compost + RDF plant does not demand segregated waste. This will reduce the volume risk of operator even if the municipalities were not able to supply the segregated waste. If the municipalities are managing to supply segregated waste, as an extension to existing plant a Bio-Methanation plant has also been suggested.
5. The PPP structure has clearly mentioned the roles and responsibilities of all the stakeholders to increase the sense of responsibility.
6. The scientific disposal of legacy waste has been proposed as an output-based pricing model to have a control over the performance and payment of private player.
7. The DBFOT model is adopted for construction and operation of processing plant and sanitary landfill to bring in best available operator in the market to perform the task and also to give a share of risk associated with finance to the private player as well.
8. In most of the developing countries the tipping fee model is found to be most sustainable way for revenue.
9. Bringing in more than one private party for legacy waste removal and processing & disposal plant development might raise a conflict between the developers. This issue is solved by fixing the legacy waste cost per ton which also make the bidding process very straightforward.

Challenges:

1. The urban sector investment involves third tier of governments, which increase the perceived political risks for private sector investments.
2. Delay in Land possession and Land Lease can jeopardize debt financing and timely project completion.
3. If the municipalities do not perform the collection and transportation well, there is no guarantee for input waste. The private operator arrives at the Tipping fee by calculating revenue flow inflows from the waste generation estimates.
4. There is a conspicuous lack of accuracy in the data provided by ULBs which might have reflected in the estimation of Municipal Solid Waste.
5. RDF/Pallets have limited no of users unless the developer uses in his own plant furnaces (e.g. Grasim project in Jaipur)
6. Bio-methanation Plants entail high capital cost and O&M costs and there is an additional problem of sale of power.

References

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- CPCB Guidelines and Check-list for evaluation of MSW Landfills proposals with information on existing landfills, 2008
- Solid Waste Management (Management and Handling) Rules, 2016
- Environment (Protection) Act, 1986
- Handbook of Service Level Benchmark (MoUD)
- CPCB- Guidelines and Check-list for evaluation of MSW Landfills proposals with information on existing landfills (2012)
- CPCB- Protocol for Performance Evaluation and Monitoring of the Common Hazardous Waste Treatment Storage and Disposal Facilities including Common Hazardous Waste Incinerators
- Report of the Task Force on Waste to Energy - Planning commission
- Guidelines on Usage of Refuse Derived Fuel in Various Industries by Expert Committee Constituted by Ministry of Housing and Urban Affairs (MoHUA), 2018
- Position Paper on The Solid Waste Management Sector in India 2009
- Draft Model Municipal Solid Waste (Management & Handling), Cleanliness and Sanitation RULES / BYE-LAWS by MINISTRY OF URBAN DEVELOPMENT
- State Policy and Strategy on Solid Waste Management for Urban Areas of West Bengal
- Guidelines for Disposal of Legacy Waste (Old Municipal Solid Waste)
- Transforming urban landscapes of India (Success Stories in Solid Waste Management)

Annexure – I

Basic questioner for solid waste management data collection:

Planning of Scientific Solid Waste Management through Cluster Approach and Bid Process Management for selection of Developers & Operators

Basic details of SWM status for Cluster ____

S.No.	Details	Reply
1	Name of ULB	
2	Area (appox.)	
3	No of Zones	
4	No of Wards	
5	No. of Households	
6	Population	
7	Solid Waste generated (Approx. quantity)	
	Domestic	
	Industial	
	Road side cleaning, bush cutting, drain cleaning	
	Total	
8	Waste composition (Approx. percentage)	
	Organic	
	Inorganic	
	Rejects	
	Total	
9	Any report on waste characterisation- Physical/ Chemical/ size analysis	
	If yes, please share available report	
10	Whether 100% households are covered for SWM	
11	Wheter waste segregation at household level is being practiced	
12	Estimated collection efficiency (in %age)	
13	Type of vehicles used for collection	
	Primary	
	Secondary	
14	Whether collection vehicles are partitioned or not	

15	Please describe waste transportation chain briefly	
16	Status of road sweeping in ULB (manual/mechanized)	
	Frequency of road sweeping	
17	Whether ULB has any processing facility	
	If yes, What is the type and capacity	
	If no, Is there any future plan for the same	
18	Whether any land has been identified for setting up waste processing plant	
	If yes, area and location of the site	
	Also provide near by eco-sensitive zones (if any)	
19	Please provide details of waste disposal (dumpsite)	
	Area, year of operation, approx. waste dumped	
	Whether it is engineered landfill or open dump	
	Please provide near by eco-sensitive zones (if any)	
20	Is any services viz. collection/tranportation/processing/ disposal outsourced	
	If yes, details of the contract	
	Concession period	
	Any dispute with the operator	
21	Safai Karamcharies/Sanitation staff number	
	Number of Safai Karamchari on roll	
	Number of Safai Karamchari on contract	
	Presentage utilization of Safai Karamcharies (%)	
22	Details of such places where segregated organic waste can be made available, such vegetable markets, etc.	
23	Whether ULB has carried out survey of BWG	
	If yes, please provide number	
24	Any issues faced by ULB related to SWM infrastructure	
25	Whether ULB has adequate manpower or not	

26	Please mention, issues related to capacity building	
27	Cost incurred by ULB on existing SWM system	
28	Whether user charges have been notified or not	
	If yes, please mention amount per household	
29	Any directions to ULB from NGT or State	
30	Public perception regarding waste management in ULB	
31	NIMBY syndrome	
32	Ranking of ULB in SS-2019	
33	Status of ODF/ODF+/ODF++	
34	Status of Star Ranking (GFC)	
35	Involvement of Informal Sector in ULB area	
36	Whether waste bye-laws are in place for municipal solid waste, plastic waste, C&D waste, etc.	
37	Whether any citizen grievance redressal and feedback system is in place or not. Please give details	
38	Whether ULB has prepared City Sanitation Plan. If yes, Please provide a copy	
39	Whether ULB is maintaining MIS for SWM. Provide detials.	
40	Methods of monitoring of SWM services in ULB area	
	Sign	
Nodal Person Details	Name	
	Designation	
	Contact details	

Annexure – II

Detailed Self completion questioner for solid waste management data collection

Ward-wise Population Data

Ward-wise Population Data

Name of the ULB:_____

S.No	Ward No.	Area	Population		Number of households	Number of non-residential premises	No. of Slums and approximate population*	
			As per Census 2011	Present expected			Numbers	Population
1								
2								
3								
4								
5								
6								
7								
8								
9								

**Slum population can be expressed as %age of ward population*

Officer in-charge (SWM):_____
Contact Number: _____
Email:_____
Sign:_____

Bulk Waste Generator

Bulk Waste Generator*

Name of the ULB:_____

S.No.	Ward No.	Please provide Ward-wise information on Type and Number of BWGs in the table below			
		Type 1:_____	Type 2:_____	Type 3:_____	Please add more types, if required.....
1		Number.....			
2		Number.....			
3					
4					
5					
6					
7					
8					
9					

** Bulk Waste Generators means such establishments, which generates more than 100 KG/day of waste "or" from where segregated organic waste can be obtained in large amounts. For example: Dairy complexes/vegetable markets/schools/colleges/ hostels/ hotels/ commercial establishments/ places of worship/Ceremonial Houses, etc.*

Officer in-charge (SWM):_____
Contact Number: _____
Email:_____
Sign:_____

Solid Waste Generation Data

Solid Waste Generation Data

Name of the ULB:_____

S.No.	Ward No.	House Hold residential waste (in TPD)				Bulk Waste Generation (in TPD)				Commercial / Industrial Waste (in TPD)			
		Bio-degradable*	Non-biodegradable	Inerts**	Total	Bio-degradable*	Non-biodegradable	Inerts**	Total	Bio-degradable*	Non-biodegradable	Inerts**	Total
1													
2													
3													
4													
5													
6													
7													
8													
9													

* Horticulture or Green waste will come under Bio-degradable component

**Inerts will include drain desilting and road sweeping also

All waste data in tonnes per day

Officer in-charge (SWM):_____
Contact Number: _____
Email:_____
Sign:_____

Ward-wise information on Source Segregation, Collection and Transportation

Ward-wise information on Source Segregation, Collection and Transportation

Name of the ULB: _____

S.No.	Ward No.	Green & Blue bins in each household (Y/N)	Source Segregation (Y/N)	PRIMARY COLLECITON					INTERMDIATE STORAGE					SECONDARY COLLECITON			Remarks, If any
				Door to Door Collection (including households, educational places, commercial places, etc.)			Primary Collection End point (Processing plant/ Community or Litter Bins/Transfer Station/Compactor Station)	Type of primary collection vehicle	No. of Community/ Litter Bins	No. of Transfer Station / Compactor Stations	No. of Roadside collection points	Any Other, Please specify	Availabilitity Land for setting additional Transfer Stations (Y/N)	Time of collection	Secondary Collection End point (Processing plant/dumping Site/SLF)	Type of secondary collection vehicle	
				Y/N	If No, specify primary collection points	Time of collection											
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	

Officer in-charge (SWM): _____
Contact Number: _____
Email: _____
Sign: _____

Road Sweeping and Area Cleaning

Road Sweeping and Area Cleaning

Name of the ULB:_____

S.No.	Ward No.	Major Road			Minor Road			Covered Drain			Open Drain			Park			Bus Stand			Any Other		
		No.	Lenth in Km.	Frequency	No.	Lenth in Km.	Frequency	No.	Lenth in Km.	Frequency	No.	Lenth in Km.	Frequency	No.	Area in sqm.	Frequency	No.	Area in sqm.	Frequency	No.	Area in sqm.	Frequency
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						

Officer in-charge (SWM):_____

Contact Number:_____

Email:_____

Sign:_____

Types of Vehicles/Equipment Used

Types of Vehicles/Equipment Used

Name of the ULB:_____

A. Primary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitoned (Y/N)	Outsourced (Y/N)
	Vehicle	Equipment							
1									
2									
3									

**Add more serial number if required*

B. Secondary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitoned (Y/N)	Outsourced (Y/N)
	Vehicle	Equipment							
1									
2									
3									

**Add more serial number if required*

C. Drain De-silting, Road Sweeping, Septage Carrying, etc.

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitoned (Y/N)	Outsourced (Y/N)
	Vehicle	Equipment							
1									
2									
3									

**Add more serial number if required*

Officer in-charge (SWM):_____
Contact Number: _____
Email:_____
Sign:_____

Detailed Information on Sanitation Workers

Detailed Information on Sanitation Workers

Name of the ULB:_____

S.No.	Ward No.	No. of Permanent Staff	No. of Casual Staff				No. of Ragpickers			
			On Monthly Remunration	Under West Bengal Urban Wage Employment Generation Scheme or Other	Hired through Private Agency	Social Security Scheme*	Whether Survey Done (Y/N)	If Yes, No. of Ragpickers	Whether registered (Y/N)	Social Security Scheme*
1										
2										
3										
4										
5										
6										
7										
8										
9										

*EPF/ESI/Housing/Healthcare/WPS/Disability Pension/Any Others

Officer in-charge (SWM):_____
Contact Number: _____
Email:_____
Sign:_____

Details of Waste Processing Plant

Details of Waste Processing Plant

Name of the ULB:_____

S.No	Details	Reply
1	Name of the Facility	
2	Daily waste amount received (in TPD)	
3	Technology/Process Used (Please attach additional sheet for the technical details of the plant)	
4	Type of output product and amount (compost, RDF, etc.)	
5	Daily waste amount sent to dumpsite/SLF after processing (in TPD)	
6	Land area of facility	
7	Distance of the facility from City	
8	Distance of dumpsite/landfill Site from processing facility	
9	Whether the land is in posession of ULB or not	
10	Location of Facility	
	Distance from nearest habitation	
	Distance from nearest water body	
	Distance from nearest national/state highway	
	Distance from nearest airport	
11	Type of Land (Flood prone/Marshy/Low-lying/Abandoned mining/other, please specify)	
12	Whether infrastucre facilities are available (boundary wall, Lighting arrangement, Weighbridge, etc.). Please specify what facilities exists.	
13	Whether Testing laboratory is available	
14	Whether Leachate Staorage arrangement is available	
15	Whether Leachate Treatment Plant is available	
16	Pls attach the map of the site (if available)	
17	Contour sheet or geotechnical survey for the site, pls attach, if not avaiable	
18	Whether Authorizaiton is obtained from WBPCB	
19	Whether NOC obtained from WBPCB (CTE/CTO)	
20	EIA done or not	
21	If ULB doesn't have its processing site, whether they have identified any land or approached to collector for allocation of required quantum of land	

Dumpsite Details

Dumpsite Details		
Name of the ULB:_____		
S.No	**Details**	**Reply**
1	**Existing Dumpsite (Open Dump/Sanitary)**	
a	Area of existing dump site (In sq.m or acres)	
b	Nature of Dumpsite (Permanent / Temporary)	
c	Whether the land is in posession of ULB or not	
d	Whether NOC obtained from WBPCB (CTE/CTO)	
e	Location of Dumpsite	
	Distance from nearest habitation	
	Distance from nearest water body	
	Distance from nearest national/state highway	
	Distance from nearest airport	
f	Type of Land (Flood prone/Marshy/Low-lying/Abandoned mining/other, please specify)	
g	Whether infrastucre facilities are available (boundary wall, Lighting arrangement, Weighbridge, etc.). Please specify what facilities exists	
h	Height of dump site (in m)	
i	Depth of dumpsite (in m)	
j	Daily waste being dumped (in TPD)	
k	Waste Quantity dumped till date (in TPD)	
l	Area of the dumpsite covered under legacy waste (In sq.m or acres)	
m	Whether any Treatment options available at dumpsite area or not. If yes, provide details	
n	Pls attach the map of the site (if available)	
o	Contour sheet or geotechnical survey for the site, pls attach, if not avaiable	
p	Distance of Existing dumpsite from the city	
q	EIA done or not	
r	If ULB doesn't have its own land, whether they have approached to collector for allocation of required quantum of land	
2	**Old Dumpsites**	
a	Area of old dumpsite (in sq.m.or acre)	
b	Height of dump site (in m)	
c	Depth of dumpsite (In m)	
d	Waste Quantity Dumped (Approx. in TPD)	
e	Pls attach the map of the site	
f	Contour sheet or Geotechnical survey for the site, pls attach, if not available	
g	Distance of dumpsite from the city	
h	Location of Dumpsite	
	Distance from nearest habitation	
	Distance from nearest water body	
	Distance from nearest national/state highway	
	Distance from nearest airport	
i	Type of Land (Flood prone/Marshy/Low-lying/Abandoned mining/other, please specify)	
4	**Please mention, if you have a common dumping site with any other ULB**	
5	**Kindly mention, how the waste is being handled in dumpsite**	

Officer in-charge (SWM):_____
Contact Number: _____
Email:_____
Sign:_____

Expenditure and Cost recovery

Expenditure & Cost Recovery (In Rs.)											
Name of the ULB:_____											
Monthly Recurring Expenditure (In Rs.)								Monthly Revenue (In Rs.)			TOTAL
Remuneraiton of Conservancy Staff	Waste Transportaiton/ Fuel Consumption	Vehicle/Equipment Maintenance	Cleaning Material Procurement	Waste Processing Plants Operations	Waste Disposal Site Operations	Cost of IEC/other activities on Waste Management	Any Other Cost Input, Please specify	User Fee Collection	Revenue form Sale of Compost/RDF	Any Other Revenue	
(+ve)	(+ve)	(+ve)	(+ve)	(+ve)	(+ve)	(+ve)	(+ve)	(-ve)	(-ve)	(-ve)	

Officer in-charge (SWM):_____
Contact Number:_____
Email:_____
Sign:_____

Compliance & Monitoring System

Complaince & Monitoring System

Name of the ULB:_____

S.No	Details	Reply
1	Whether ULB has drafted guidelines/policy and framed bye-laws for Solid Waste Management. If yes, please enclosed a copy.	
2	Whether ULB has drafted guidelines/policy and framed bye-laws for Plastic Waste Management. If yes, please enclosed a copy.	
3	Whether ULB has drafted guidelines/policy and framed bye-laws for Bulk Waste Generators. If yes, please enclosed a copy.	
4	Whether ULB has drafted guidelines/policy and framed bye-laws for C&D Waste. If yes, please enclosed a copy.	
5	Whether ULB has notify mandatory source segregation of houdse hold waste. If yes, please enclosed a copy.	
6	Whether ULB has notify User fee charges for SWM. If yes, please enclosed a copy.	
7	Whether ULB has issued notification for banning Open defecation/Open urination/ littering and provision of fine imposing. If yes, please enclosed a copy.	
8	Whether ULB is maintaining logbooks for C&T, P&D, C&D, Bulk Waste, CT/PT, Faecal Sludge, Garden composting, etc.	
9	Whether ULB has system in place for online monitoring of the collection vehicles.	
10	Whether CCTV or ICT based monitoring n place for prcessing facilities or not.	
11	Whether all the sanitation staff has been provided with PPEs or not.	
12	Whether ULB has a collection system for the collection of Animal dung.	
13	Whether ULB has Faecal sludge collection system and treatment provisions. Please provide details.	
14	Whether payroll system of the ULB has linked with bio-metric attendance. (For department as well as outsourced staff)	
15	Whether suitable grievance redressal system is in place or not.	
16	If Yes, What is the average time-period of complaint redressal	

Officer in-charge (SWM):_____
Contact Number: _____
Email:_____
Sign:_____

Annexure – IV

Original Copies of Lab Reports

R. V. BRIGGS & CO. PRIVATE LTD.
ANALYTICAL CONSULTING & TECHNICAL CHEMISTS
TAHER MANSION, 1ST FLOOR
9, BENTINCK STREET, KOLKATA - 700 001
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E-mail : rvbriggs.kolkata@gmail.com, Website : www.rvbriggs.com
CIN : U51109WB1931PTC007007

TEST REPORT

NO. G(D)/19-20/117B **Date: 11 June 2019** **Page 1 of 1**

Issued to	:	M/s. MARSS CONSULTANCY Kolkata
Your Ref. No.	:	E mail dtd. 13.05.2019
Description of sample	:	Municipal Waste (Legacy)
Collection Source	:	Legacy waste from Promodnagar Dump site
Sample Drawn by us on	:	30.05.2019
Analysis completed on	:	10.06.2019

A. PHYSICAL PROPERTIES

Sl. No.	Test Parameters	Unit	Results
01.	Texture	-	Solid Dust
02.	Smell	-	Pungent Odour
03.	Solids Constituent :		
	a) Plastic	%	15
	b) Vegitable Waste	%	--
	c) Soil	%	55
	d) Grass	%	--
	e) Leather	%	12
	f) Glass Bottle	%	10
	g) Other Waste	%	08
4.	Probe Moisture	%	15

B.GENERAL PARAMETERS:

Sl. No.	Test Parameters	Unit	Results
01.	Moisture Content	%	6.87

(T. NANDI)
Authorised Signatory

R. V. BRIGGS & CO. PRIVATE LTD.

ANALYTICAL CONSULTING & TECHNICAL CHEMISTS

TAHER MANSION, 1ST FLOOR
9, BENTINCK STREET, KOLKATA - 700 001
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E-mail : rvbriggs.kolkata@gmail.com, Website : www.rvbriggs.com
CIN : U51109WB1931PTC007007

TEST REPORT

NO. G(D)/19-20/117C **Date: 19 June 2019** **Page 1 of 1**

Issued to	:	**M/s. MARSS CONSULTANCY** Kolkata
Your Ref. No.	:	E mail dtd. 13.05.2019
Description of sample	:	Municipal Waste (Legacy)
Collection Source	:	Legacy waste from Promodnagar Dump site
Sample Drawn by us on	:	30.05.2019
Analysis completed on	:	19.06.2019

TCLP REPORT:

Sl. No.	Test Parameters	Unit	Results
1.	Lead as Pb	mg/lt	< 0.1
2.	Cadmium as Cd	mg/lt	< 0.01
3.	Iron as Fe	mg/lt	3.750
4.	Zinc as Zn	mg/lt	0.928
5.	Nickel as Ni	mg/lt	0.160
6.	Copper as Cu	mg/lt	0.105
7.	Chromium as Cr	mg/lt	0.10
8.	Sulphide as S	mg/lt	< 0.1
9.	Cyanide as CN	mg/lt	< 0.1

Note : Minimum Detection Limit of Pb, S & CN .. 0.1 mg/lt.,
Cd .. 0.01 mg/lt.

(T. NANDI)
Authorised Signatory

R. V. BRIGGS & CO. PRIVATE LTD.

ANALYTICAL CONSULTING & TECHNICAL CHEMISTS

TAHER MANSION, 1ST FLOOR
9, BENTINCK STREET, KOLKATA - 700 001
Ph. : 2248-3661/2698/7803, 2262-4153/4154, Fax : 33 2248-0447
E-mail : rvbriggs.kolkata@gmail.com, Website : www.rvbriggs.com
CIN : U51109WB1931PTC007007

TEST REPORT

NO. G(D)/19-20/146A **Date: 19 June 2019** **Page 1 of 1**

Issued to	:	**M/s. MARSS CONSULTANCY** Kolkata
Your Ref. No.	:	E mail dtd. 13.05.2019
Description of sample	:	Municipal Waste (Legacy)
Collection Source	:	Kamarhati Municipality waste from Dumping ground
Sample Drawn by us on	:	14.06.2019
Analysis completed on	:	19.06.2019

A. PHYSICAL PROPERTIES

Sl. No.	Test Parameters	Unit	Results
01.	Texture	..	Solid
02.	Smell	..	Slight Foul Smell
03.	Solids Constituent :		
	a) Plastic	%	20
	b) Vegitable Waste	%	--
	c) Soil	%	50
	d) Grass	%	--
	e) Leather	%	10
	f) Glass Bottle	%	05
	g) Other Waste	%	15
4.	Probe Moisture	%	14

B. TCLP REPORT:

Sl. No.	Test Parameters	Unit	Results
1.	Lead as Pb	mg/lt	< 0.1
2.	Cadmium as Cd	mg/lt	< 0.01
3.	Iron as Fe	mg/lt	0.109
4.	Zinc as Zn	mg/lt	0.05
5.	Nickel as Ni	mg/lt	0.188
6.	Copper as Cu	mg/lt	< 0.05
7.	Chromium as Cr	mg/lt	< 0.1
8.	Sulphide as S	mg/lt	< 0.1
9.	Cyanide as CN	mg/lt	< 0.1

Note : Minimum Detection Limit of Pb, Cr, S & CN .. 0.1 mg/lt., Cd .. 0.01 mg/lt., Cu .. 0.05 mg/lt.

(T. NANDI)
Authorised Signatory

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TEST REPORT

NO. G(D)/19-20/144 **Date: 18 June 2019** **Page 1 of 1**

Issued to	:	**M/s. MARSS CONSULTANCY** Kolkata
Your Ref. No.	:	E mail dtd. 13.05.2019
Description of sample	:	Municipal Waste (Fresh)
Collection Source	:	New Barrackpore Municipality waste from Dumping Spot
Sample Drawn by us on	:	14.06.2019
Analysis completed on	:	18.06.2019

A. PHYSICAL PROPERTIES

Sl. No.	Test Parameters	Unit	Results
01.	Texture	--	Solid
02.	Smell	--	Rotten Odour
03.	Solids Constituent :		
	a) Plastic	%	10
	b) Vegitable Waste	%	50
	c) Soil	%	08
	d) Grass	%	12
	e) Leather	%	--
	f) Glass Bottle	%	10
	g) Other Waste	%	10
4.	Probe Moisture	%	31

B.GENERAL PARAMETERS:

Sl. No.	Test Parameters	Unit	Results
01.	Bulk Density	gm/cc	0.48
02.	Total Organic Carbon	%	7.30
03.	Moisture Content	%	70.71
04.	Ash Content (Dry Basis)	%	9.53
05.	Nitrogen	%	0.33
06.	C : N Ratio	--	1 : 22.12
07.	Gross Calorific Value (Dry Basis)	kcal/kg	3891

(T. NANDI)
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TEST REPORT

NO. G(D)/19-20/145 **Date: 18 June 2019** **Page 1 of 1**

Issued to	:	**M/s. MARSS CONSULTANCY** Kolkata
Your Ref. No.	:	E mail dtd. 13.05.2019
Description of sample	:	Municipal Waste (Fresh)
Collection Source	:	Kamarhati Municipality waste from Dumping ground
Sample Drawn by us on	:	14.06.2019
Analysis completed on	:	18.06.2019

A. PHYSICAL PROPERTIES

Sl. No.	Test Parameters	Unit	Results
01.	Texture	..	Solid
02.	Smell	..	Rotten Odour
03.	Solids Constituent :		
	a) Plastic	%	14
	b) Vegitable Waste	%	50
	c) Soil	%	12
	d) Grass	%	10
	e) Leather	%	--
	f) Glass Bottle	%	--
	g) Other Waste	%	16
4.	Probe Moisture	%	31

B.GENERAL PARAMETERS:

Sl. No.	Test Parameters	Unit	Results
01.	Bulk Density	gm/cc	0.49
02.	Total Organic Carbon	%	6.85
03.	Moisture Content	%	45.55
04.	Ash Content (Dry Basis)	%	34.80
05.	Nitrogen	%	0.28
06.	C : N Ratio	..	1 : 24.5
07.	Gross Calorific Value (Dry Basis)	kcal/kg	2715

(T. NANDI)
Authorised Signatory

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TEST REPORT

NO. G(D)/19-20/113 **Date: 11 June 2019** **Page 1 of 1**

Issued to	:	**M/s. MARSS CONSULTANCY** Kolkata
Your Ref. No.	:	E mail dtd. 13.05.2019
Description of sample	:	Municipal Waste (Fresh)
Collection Source	:	Baranagar Municipality waste from Promodnagar Dump site
Sample Drawn by us on	:	30.05.2019
Analysis completed on	:	10.06.2019

A. PHYSICAL PROPERTIES

Sl. No.	Test Parameters	Unit	Results
01.	Texture	..	Solid
02.	Smell	..	Rotten Odour
03.	Solids Constituent :		
	a) Plastic	%	08
	b) Vegitable Waste	%	40
	c) Soil	%	10
	d) Grass	%	05
	e) Leather	%	12
	f) Glass Bottle	%	20
	g) Other Waste	%	05
4.	Probe Moisture	%	26

B.GENERAL PARAMETERS:

Sl. No.	Test Parameters	Unit	Results
01.	Bulk Density	gm/cc	0.55
02.	Total Organic Carbon	%	8.40
03.	Moisture Content	%	64.67
04.	Ash Content (Dry Basis)	%	28.50
05.	Nitrogen	%	0.39
06.	C : N Ratio	..	1 : 21.5
07.	Gross Calorific Value (Dry Basis)	kcal/kg	3403

(T. NANDI)
Authorised Signatory

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TEST REPORT

NO. G(D)/19-20/114 **Date: 11 June 2019** **Page 1 of 1**

Issued to	:	**M/s. MARSS CONSULTANCY** Kolkata
Your Ref. No.	:	E mail dtd. 13.05.2019
Description of sample	:	Municipal Waste (Fresh)
Collection Source	:	North Dum Dum Municipality waste from Promodnagar Dump site
Sample Drawn by us on	:	30.05.2019
Analysis completed on	:	10.06.2019

A. PHYSICAL PROPERTIES

Sl. No.	Test Parameters	Unit	Results
01.	Texture	--	Solid
02.	Smell	--	Rotten Odour
03.	Solids Constituent :		
	a) Plastic	%	12
	b) Vegitable Waste	%	50
	c) Soil	%	15
	d) Grass	%	--
	e) Leather	%	10
	f) Glass Bottle	%	05
	g) Other Waste	%	08
4.	Probe Moisture	%	30

B.GENERAL PARAMETERS:

Sl. No.	Test Parameters	Unit	Results
01.	Bulk Density	gm/cc	0.62
02.	Total Organic Carbon	%	8.95
03.	Moisture Content	%	66.85
04.	Ash Content (Dry Basis)	%	15.99
05.	Nitrogen	%	0.31
06.	C : N Ratio	--	1 : 28.87
07.	Gross Calorific Value (Dry Basis)	kcal/kg	5489

(T. NANDI)
Authorised Signatory

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TEST REPORT

NO. G(D)/19-20/115 **Date: 11 June 2019** **Page 1 of 1**

Issued to	:	**M/s. MARSS CONSULTANCY** Kolkata
Your Ref. No.	:	E mail dtd. 13.05.2019
Description of sample	:	Municipal Waste (Fresh)
Collection Source	:	South Dum Dum Municipality waste from Promodnagar Dump site
Sample Drawn by us on	:	30.05.2019
Analysis completed on	:	10.06.2019

A. PHYSICAL PROPERTIES

Sl. No.	Test Parameters	Unit	Results
01.	Texture	..	Solid
02.	Smell	..	Rotten Odour
03.	Solids Constituent :		
	a) Plastic	%	09
	b) Vegitable Waste	%	15
	c) Soil	%	25
	d) Grass	%	05
	e) Leather	%	08
	f) Glass Bottle	%	05
	g) Other Waste	%	33
4.	Probe Moisture	%	27.5

B.GENERAL PARAMETERS:

Sl. No.	Test Parameters	Unit	Results
01.	Bulk Density	gm/cc	0.59
02.	Total Organic Carbon	%	12.81
03.	Moisture Content	%	75.91
04.	Ash Content (Dry Basis)	%	56.32
05.	Nitrogen	%	0.27
06.	C : N Ratio	..	1 : 47.4
07.	Gross Calorific Value (Dry Basis)	kcal/kg	2154

(T. NANDI)
Authorised Signatory

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CIN : U51109WB1931PTC007007

TEST REPORT

NO. G(D)/19-20/116 **Date: 11 June 2019** **Page 1 of 1**

Issued to	:	**M/s. MARSS CONSULTANCY** Kolkata
Your Ref. No.	:	E mail dtd. 13.05.2019
Description of sample	:	Municipal Waste (Fresh)
Collection Source	:	Dum Dum Municipality waste from Promodnagar Dump site
Sample Drawn by us on	:	30.05.2019
Analysis completed on	:	10.06.2019

A. PHYSICAL PROPERTIES

Sl. No.	Test Parameters	Unit	Results
01.	Texture	..	Solid
02.	Smell	..	Rotten Odour
03.	Solids Constituent :		
	a) Plastic	%	10
	b) Vegitable Waste	%	12
	c) Soil	%	30
	d) Grass	%	07
	e) Leather	%	08
	f) Glass Bottle	%	05
	g) Other Waste	%	28
4.	Probe Moisture	%	29

B.GENERAL PARAMETERS:

Sl. No.	Test Parameters	Unit	Results
01.	Bulk Density	gm/cc	0.53
02.	Total Organic Carbon	%	10.40
03.	Moisture Content	%	63.51
04.	Ash Content (Dry Basis)	%	33.69
05.	Nitrogen	%	0.36
06.	C : N Ratio	..	1 : 28.9
07.	Gross Calorific Value (Dry Basis)	kcal/kg	2343

(T. NANDI)
Authorised Signatory

Annexure – V

Information shared by ULB for primary and Secondary waste collection vehicles:

Name of the ULB BARANAGAR

A. Primary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitoned (Y/N)	Outsourced (Y/N)
	Vehicle	Equipment							
1		Cycle Van	Local Made	0.24		80	240	YES	NO
2		Handcart	Local Made	0.16		220	660	NO	NO
3									

*Add more serial number if required

B. Secondary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitoned (Y/N)	Outsourced (Y/N)
	Vehicle	Equipment							
1	Compactor		TATA / HYVA	14 cm	4.9 MT	4	1	NO	NO
2	Compactor		TATA / HYVA	8 cm	2.8 MT	2	1	NO	NO
3		Stationary Compactor	TATA / HYVA	10 cm	3.5 MT	1	1	NO	NO
4	Tractor Tailors		Local Made	1.5 cm	0.5 MT	10	2	NO	NO
5		JCB	ROBOT 155			2	1	NO	NO
6		Skid Stare Loader	ROBOT 135			2	1	NO	NO
7		JCB	Super Loader			1	1	NO	NO
8	Hydraulic Tipper		Porter 1000 BSIV	2.2 cm	0.77 MT	3	2	NO	NO

Name of the ULB _____DUM DUM_____

A. Primary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Total waste collected (cum/day)	Partitoned (Y/N)
	Vehicle	Equipment							
1	Van Rickshaw		Generic, Fabricated	0.4		24	3	28.8	36.36
2	Battery-operated Tipper		KPT, Pawanputra	0.6		18	3	32.4	40.91
3	Hand Cart		Generic, Fabricated	0.2		30	3	18	22.73

*Add more serial number if required

Page 1

Page 3

Total 79.2

B. Secondary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Total waste collected (cum/day)	Partitoned (Y/N)
	Vehicle	Equipment							
1	Tractor	MS Trailor	Escorts Powertrac 440	3.8		1	2	7.6	
2	Tractor	MS Trailor	Escorts Powertrac 445	3.8		1	2	7.6	
3	Tractor	MS Trailor	Escorts Powertrac 60	3.8		1	2	7.6	
4	Dumper		Piaggio, Porter 1000	2.2		2	2	8.8	
5	Dumper		Ashok Leyland, 1618	10.5		1	2	21	
6	Dumper		Eicher	10.5		1	2	21	
7	Compactor		HYVA, Mobile Compactor	14		2	2	56	
8	Compactor		HYVA, Mobile Compactor	8		1	2	16	
9	Backhoe Loader	1 Loader and 1 Bucket	JCB, 2DX-2WD Side Shift			1			
10	SuperLoader	Loader	JCB			1			
							Total	145.6	

A. Primary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Total Waste Collected	Percentage of waste collection
	Vehicle	Equipment							
1	WB-37TC-261	TRACTOR	475DI	59.5	7.5	1	3	178.5	9.68
2	WB-37TC-258	TRACTOR	475DI	59.5	5	1	2	119	6.45
3	WB-37TC-263	TRACTOR	475DI	59.5	7.5	1	3	178.5	9.68
4	WB-37TC-255	TRACTOR	475DI	59.5	5	1	2	119	6.45
5	WB-37TC-265	TRACTOR	475DI	59.5	7.5	1	3	178.5	9.68
6	WB-37TC-260	TRACTOR	475DI	59.5	7.5	1	3	178.5	9.68
7	WB-37TC-259	TRACTOR	475DI	59.5	5	1	2	119	6.45
8	WB-37TC-262	TRACTOR	475DI	59.5	7.5	1	3	178.5	9.68
9	WB-37TC-254	TRACTOR	475DI	59.5	7.5	1	3	178.5	9.68
10	WB-37TC-257	TRACTOR	475DI	59.5	5	1	2	119	6.45
11	WB-37TC-264	TRACTOR	475DI	59.5	5	1	2	119	6.45
12	WB-37TC-256	TRACTOR	475DI	59.5	7.5	1	3	178.5	9.68
							total	1844.5	100

B. Secondary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitioned (Y/N)	Outsourced (Y/N)
	Vehicle	Equipment							
1	WB-37TC-3337	TRACTOR	EMMU925	59.5	7.5	1	3		
2	WB-23C-4350	TRACTOR	4455DX	59.5	5	1	2		
3	WB-23C-4351	TRACTOR	4455DX	59.5	7.5	1	3		
4	WB-23C-4352	TRACTOR	4455DX	59.5	7.5	1	3		
5	WB-23C-4353	TRACTOR	4455DX	59.5	5	1	2		
6	WB-23C-4349	TRACTOR	4455DX	59.5	7.5	1	3		
7	230H	TRACTOR	3522	59.5	5	1	2		
8	6522/D	TRACTOR	6522	59.5	7.5	1	3		
9	6522	TRACTOR	6522	59.5	5	1	2		
10	230D	TRACTOR	3511	59.5	7.5	1	3		
11	4022	TRACTOR	4022	59.5	7.5	1	3		

Types of Vehicles/Equipment Used

Name of the ULB:NEW BARRACKPORE MUNICIPALITY

A. Primary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitoned (Y/N)	Outsourced (Y/N)
	Vehicle	Equipment							
1	TRICYCLE			18CFT		33			
2	Hand Trali			5 CFT		25			

**Add more serial number if required*

B. Secondary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitoned (Y/N)	Outsourced (Y/N)
	Vehicle	Equipment							
1	TRACTOR	TRACTOR	HMT	2 MT		1	2		
2	TRACTOR	TRACTOR	HMT	2 MT		1	2		
3	TRACTOR	TRACTOR	HMT	2 MT		1	2		
4	TRACTOR	TRACTOR	HMT	2 MT		1	2		
5	TRACTOR	TRACTOR	HMT	2 MT		1	2		
6	TRACTOR	TRACTOR	HMT	2 MT		1	2		
7	TRACTOR	TRACTOR	HMT	2 MT		1	2		
8	TRACTOR	TRACTOR	MAHINDRA (ARJUN)	2 MT		1	2		
9	TRACTOR	TRACTOR	MAHINDRA (ARJUN)	2 MT		1	2		

Types of Vehicles/Equipment Used

Name of the ULB: NORTH DUM DUM MUNICIPALITY

A. Primary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitoned (Y/N)	Outsourced (Y/N)
	[illegible]	[illegible]							
1	Try-cycle van	Spade	Spade- Tata			170	3	Yes	No
2	Tractor	Trailer	Tractor- HMT		5 tpd	2	5	Yes	No
3	Tractor	Cover trailer	Tractor- HMT		2 tpd	1	4	Yes	No
4	Tractor	Container	Tractor- HMT						

B. Secondary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)	Partitoned (Y/N)	Outsourced (Y/N)
	Vehicle	Equipment							
1	Tractor	Trailer	Tractor- HMT					Yes	No
2	Tractor	Cover trailer	Tractor- HMT		4 tpd		2	Yes	No
3	Tractor	Container	Tractor- HMT		26 tpd	1 (tractor)+17 (container)	13	Yes	No
4	Compactor	Spade	Compactor- Tata & Eichar	36.5 cum		3	3		No
5	Stationary Compactor	Try-cycle van & Spade	Stationary compactor- Tata	10.5 cum		1	1		No

Types of Vehicles/Equipment Used

Name of the ULB: SOUTH DUM DUM

A. Primary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)
	Vehicle	Equipment					
1	Tricycle Van		Iron made angel,Patti with Iron Sheet	0.42	1.01	490	560
2	Hand Cart		Iron made angel,Patti with Iron Sheet	0.21	0.51	120	35

**Add more serial number if required*

B. Secondary Collection & Transportation

S.No.*	Type of Machinery		Make and Model No.	Capacity (in cum.)	Capacity (in TPD)	No. of Such units	No. of trips (per day)
	Vehicle	Equipment					
1	Tractor		Tata/Mahindra	1.06	2.55	13	28
2	Lorry		Outsourced	N.A	N.A	22	77
3	Dumper		Tata & Eicher	4.97	11.98	2	2
4	Hook loader		Tata & Eicher	N.A	N.A	4	18

Annexure – VI

Calculation of Distance to be travelled for Secondary Transportation

North Dum Dum (SCP in ward number)	Distance from plant	Unit	Assumptions if any
2	9	km	
4	7	km	
7	6	km	
32	8	km	
17	5	km	
11	8	km	
Average distance	7.166666667	km	
Buffer	1.433333333	km	20% of the average Distance
Average distance used for calculation	**9**	km	

South Dum Dum (SCP in ward number)	Distance from plant	Unit	Assumptions if any
10	6.2	km	
17	7.4	km	
20	7.1	km	
28	10.8	km	
31	13	km	
29	11.8	km	
Average distance	9.383333333	km	
Buffer	1.876666667	km	20% of the average Distance
Average distance used for calculation	**12**	km	

Dum Dum (SCP in ward number)	Distance from plant	Unit	Assumptions if any
4	5	km	
1	4	km	
11	7	km	
21	5	km	
5	6	km	
6	5	km	
Average distance	5.333333	km	
Buffer	1.066667	km	20% of the average Distance
Average distance used for calculation	**7**	km	

Baranagar (SCP in ward number)	Distance from plant	Unit	Assumptions if any
4	8	km	
31	6	km	
28	5	km	
3	5	km	
23	5	km	
25	4	km	
Average distance	5.500000	km	
Buffer	1.100000	km	20% of the average Distance
Average distance used for calculation	**7**	km	

Kamarhati (SCP in ward number)	Distance from plant	Unit	Assumptions if any
17-20	3	km	
25-28	2	km	
29-35	3	km	
12 to 16	3	km	
1 t 7	3	km	
21-24	3	km	
Average distance	2.833333333	km	
Buffer	0.566666667	km	20% of the average Distance
Average distance used for calculation	**4**	km	

New Barrackpore (SCP in ward number)	Distance from plant	Unit	Assumptions if any
6	11	km	
4	12	km	
14	12	km	
17	9	km	
12	12	km	
2	11.2	km	
Average distance	11.2000	km	
Buffer	2.2400	km	20% of the average Distance
Average distance used for calculation	**14**	km	

Annexure – VII

ULB Wise Secondary Collection Points List:

Summary sheet		
ULB Name	**Total no. of SCP**	**Total no. of Static Compactor**
Dum Dum	31	0
Kamarhati	53	1
New Barrackpore	13	0
Barranagar	7	1
South Dum Dum	71	11
North Dum Dum	23	1
	198	**14**

SOUTH DUM DUM MUNICIPALITY					
Ward No.	No. of SCP's	SCP location	Area	No. of static compactor (as per survey)	Transportated to
1	3	Surya Sen Pally beside sitala mandir	NA	0	PramodNagar processing facility
		Sukanta pally beside belghariya exp.way	NA	0	PramodNagar processing facility
		sukanta pally beside medicine shop	NA	0	PramodNagar processing facility
2	2	Health 's Ground	1430 sqft	2	PramodNagar processing facility
3	3	Promod nagar bazar	NA	0	PramodNagar processing facility
		back side of Promod Nagar Police fari	NA	0	PramodNagar processing facility
		near mangal's tea shop	NA	0	PramodNagar processing facility
4	4	vidyasagar road	NA	0	PramodNagar processing facility
		chandsi bhaban road	NA	0	PramodNagar processing facility
		beside of post office	NA	0	PramodNagar processing facility
		front of f.l shop	NA	0	PramodNagar processing facility
5	5	subhash nagar 4th bye lane	NA	0	PramodNagar processing facility
		khudiram sarani infront of Rekha Singh's House	NA	0	PramodNagar processing facility

		front of dudh pukur	NA	0	PramodNagar processing facility
		front of amtala pukur	NA	0	PramodNagar processing facility
		sarat bose road	NA	0	PramodNagar processing facility
6	4	front of dum dum biri's house	NA	0	PramodNagar processing facility
		near deshbandhu school	NA	0	PramodNagar processing facility
		sarat bose road	NA	0	PramodNagar processing facility
		nikhil aich sarani (teler drum)	NA	0	PramodNagar processing facility
7	5	padrihata	NA	0	PramodNagar processing facility
		beside of post office	NA	0	PramodNagar processing facility
		beside of ganesh mashla	NA	0	PramodNagar processing facility
		front of mahendra colony	NA	0	PramodNagar processing facility
		beside 1no.rail gate	NA	0	PramodNagar processing facility
8	3	ramgarh (sisu uddan)	NA	0	PramodNagar processing facility
		rastraguru avenue banik das's house	NA	0	PramodNagar processing facility
		golpark	NA	0	PramodNagar processing facility
9	3	Front of Motijheel Big Pond	NA	0	PramodNagar processing facility
		Lakshmi Nagar Mazit Math Corner	NA	0	PramodNagar processing facility
		Old quarter	NA	0	PramodNagar processing facility
10	2	Near Bagjola ground	1000 sqft	2	PramodNagar processing facility
11	1	Near Motish Roy bridge	NA	0	PramodNagar processing facility
12	1	Near Military Camp	NA	0	PramodNagar processing facility
13	2	Khal Par	NA	0	PramodNagar processing facility
		Jahor Tea Stall	NA	0	PramodNagar processing facility
14	2	Gibson Gully	NA	0	PramodNagar processing facility
		Near Gostobihari Transformer	NA	0	PramodNagar processing facility
15	3	4 no. Daga Colony (Near Kali Mandir)	NA	0	PramodNagar processing facility

		Hanuman Mandir	NA	0	PramodNagar processing facility
		***	NA	0	PramodNagar processing facility
16	2	Bipin Ganguly Road (Shani Mandir)	NA	0	PramodNagar processing facility
		Bipin Ganguly Road (Uren Trailors)	NA	0	PramodNagar processing facility
17	1	Near Prachya Bani School	NA	0	
18	2	Near Jaibya Hut	NA	0	PramodNagar processing facility
		Front of Jawpur rd.	NA	0	PramodNagar processing facility
19	2	Near ward committee office	NA	0	PramodNagar processing facility
		moyra bagan G.C. ghosh rd.	NA	0	PramodNagar processing facility
20	1	Near Kalindi Bazaar	1000 sqft	1	PramodNagar processing facility
21	4	Front of Durgabati Colony Pond	NA	0	PramodNagar processing facility
		Front of Debendra Colony School	NA	0	PramodNagar processing facility
		M.M. Ghosh Road	NA	0	PramodNagar processing facility
		Front of Ajoy Nagar Pond	NA	0	PramodNagar processing facility
22	4	Beside of Bagala Mandir	NA	0	PramodNagar processing facility
		R.P. Sweet Gully	NA	0	PramodNagar processing facility
		Near Prafullya Nagar Park	NA	0	PramodNagar processing facility
		Near Amarpally Pond	NA	0	PramodNagar processing facility
23	2	Beside of Arunadoi Club	NA	0	PramodNagar processing facility
		Carbala Math	NA	0	PramodNagar processing facility
24	3	P.N.T. Vat	NA	0	PramodNagar processing facility
		Prafulayan Club	NA	0	PramodNagar processing facility
		Kol tola Beside of Axis Bank	NA	0	PramodNagar processing facility
25	1	Near Ajitesh Mancha	1000 sqft	1	PramodNagar processing facility
26	2	Krishnapur Road opposite Maszid	NA	0	PramodNagar processing facility
		Baguihati Road Front of 4th Bye Lane	NA	0	PramodNagar processing facility
27	3	Opposite of	NA	0	PramodNagar

		United Club			processing facility
		Harihar Nagar Colony	NA	0	PramodNagar processing facility
		Rail Line (Near Udbastu Park)	NA	0	PramodNagar processing facility
28	1	Near Dumdum Park Bazaar	NA	0	PramodNagar processing facility
29	2	Barat	5000 sqft	2	PramodNagar processing facility
30	1	Laketown PS (new Building)	1000 sqft	1	PramodNagar processing facility
31	1	Tetultola Bus Stop	2700 sqft	1	PramodNagar processing facility
	1	Sardar Para	NA	0	PramodNagar processing facility
32	4	Rail quarter	NA	0	PramodNagar processing facility
		End of Priya Mitra Road	NA	0	PramodNagar processing facility
		Gazi Danga	NA	0	PramodNagar processing facility
			NA	0	PramodNagar processing facility
33	6	Front of Municipal Primary school	NA	0	PramodNagar processing facility
		front of Post Office	NA	0	PramodNagar processing facility
		Front of Maszid	NA	0	PramodNagar processing facility
		26 no. Rail Gate	NA	0	PramodNagar processing facility
		Front of Ambedkar Colony	NA	0	PramodNagar processing facility
		Front of Manasha Mandir	NA	0	PramodNagar processing facility
34	1	Golaghata Busstop	NA	0	PramodNagar processing facility
35	1	Near Burd & Jute Company	1000 sqf	1	PramodNagar processing facility
TOTAL SCP's	86			11	

DUM DUM MUNICIPALITY

Ward No.	No. of SCP's	SCP location	Area	No. of static compactor	Transportated to
1	1	Delhi Road Vat	29.7 SQ.M./ 320 SQ.FT.	0	PramodNagar processing facility
4	1	2 no. Motilal Bazar	40 sq ft (approx)	0	PramodNagar processing facility
5	1	Majumderpara (Punjab Goli)	40 sq ft (approx)	0	PramodNagar processing facility
6	1	Padma Pukur Vat	45.77 SQ.M./ 493 SQ.FT.	0	PramodNagar processing facility
8	1	Badra Vat	18.98 SQ.M./ 204 SQ.FT.	0	PramodNagar processing facility

9	2	Auxalium Vat (3 No Rail Gate)	15.04 SQ.M./ 162 SQ.FT.	0	PramodNagar processing facility
		Litchi Bagan Vat	9.25 SQ.M./ 100 SQ.FT.	0	PramodNagar processing facility
11	2	H.M.V. (Joshore Road)	36 SQ.M./ 387 SQ.FT.	0	PramodNagar processing facility
		Radhashree	40 sq ft (approx)	0	PramodNagar processing facility
14	2	Kamalapur	300 sq ft (approx)	0	PramodNagar processing facility
		ESI Battala	300 sq ft (approx)	0	PramodNagar processing facility
15	3	King's Becary Vat	21.96 SQ.M./ 236 SQ.FT.	0	PramodNagar processing facility
		School Vat (St. Steven)	25 sq ft (approx)	0	PramodNagar processing facility
		Hospital	40 sq ft (approx)	0	PramodNagar processing facility
17	1	1 no. Rail Gate	60 sq ft (approx)	0	PramodNagar processing facility
18	3	Gora Bazar vat (Bazar) Tel Mill Goli	24.24 SQ.M./ 261 SQ.FT.	0	PramodNagar processing facility
		Panthanibas	50 sq ft (approx)	0	PramodNagar processing facility
		Bandhab Nagar	50 sq ft (approx)	0	PramodNagar processing facility
19	4	Central jail	30.3 SQ.M./ 326 SQ.FT.	0	PramodNagar processing facility
		Manu Saha	12 sq ft (approx)	0	PramodNagar processing facility
		Jailor House	50 sq ft (approx)	0	PramodNagar processing facility
		Hanuman Mandir Lampport	16 sq ft (approx)	0	PramodNagar processing facility
20	1	Siddheswari Lamppost	40 sq ft (approx)	0	PramodNagar processing facility
21	7	Mall Road Vat (Bazar)	18.76 SQ.M./ 202 SQ.FT	0	PramodNagar processing facility
21		Mall Road Vat (New water tank) Sirishtala	25.92 SQ.M./ 279 SQ.FT.	0	PramodNagar processing facility
21		Mall Road Vat (Bhutan House & Christ Church	15.51 SQ.M./ 167 SQ.FT.	0	PramodNagar processing facility
21		Nepali Patty	30 sq ft (approx)	0	PramodNagar processing facility
21		Ajoy Sib Kali Mandir	20 sq ft (approx)	0	PramodNagar processing facility
21		Metro Goli	10 sq ft (approx)	0	PramodNagar processing facility
21		Naidu College	50 sq ft (approx)	0	PramodNagar processing facility
22	1	Tata Gate	30 sq ft (approx)	0	PramodNagar processing facility
TOTAL	31			0	PramodNagar

SCP's					processing facility
BARANAGAR MUNICIPALITY					
Ward No.	No. of SCP's	SCP location	Area	No. of static compactor	Transportated to
15	1	Central Toolroom	90 sqm	0	PramodNagar processing facility
15	1	R.I.C Gate no. 2	500 Sqft	1	PramodNagar processing facility
14	1	B.T. Road (Uttarayan Housing Estate)	130 sqm	0	PramodNagar processing facility
23	1	B.T. Road (CESC Ghosh para)	90 sqm	0	PramodNagar processing facility
27	1	B.T. Road (Bhattacharjee para)	44 sqm	0	PramodNagar processing facility
13	1	Gilta Road (Shilpa Pith)	77 sqm	0	PramodNagar processing facility
31	1	Basak Bagan	90 sqm	0	PramodNagar processing facility
TOTAL SCP's	7			1	PramodNagar processing facility
NORTH DUM DUM MUNICIPALITY					
Ward No.	No. of SCP's	SCP location	Area (Sqm)	No. of static compactor	Transportated to
2	1	Sahabagan	40	0	PramodNagar processing facility
3	1	Chota Finga	28	0	PramodNagar processing facility
4	1	Fatellapur (on service road PWD - Kalyani expressway)	40	0	PramodNagar processing facility
6	1	Patna Shishu Sangha	42	0	PramodNagar processing facility
7	1	Patna Jhilpara	25	0	PramodNagar processing facility
8	1	Pubmora road (on service road PWD - MB Road)	40	0	PramodNagar processing facility
9	1	Beside of Milan Samity play ground	13.5	0	PramodNagar processing facility
10	1	Beside of Golbagan stadium (on service road PWD - Kalyani expressway)	200	0	PramodNagar processing facility
11	1	Pratapgarh (on service road PWD - Kalyani expressway)	20	0	PramodNagar processing facility
13	1	Opposite of Nimita P.S	50	0	PramodNagar processing facility
15	1	Kalabagan	35	0	PramodNagar

		beside of LLK2 canal			processing facility
17	1	Opposite of Rajbari Police	35	0	PramodNagar processing facility
18	1	Birati mini Bus stand	35	0	PramodNagar processing facility
19	1	Khalishakota	70	0	PramodNagar processing facility
21	1	Sreenagar	35	0	PramodNagar processing facility
23	1	Dhalaikharkhana	80	0	PramodNagar processing facility
24	1	Iteetkhola Shivachal	500 Sqft	1	
25	1	Birati abashan	120	0	PramodNagar processing facility
26	1	Kalyani highway 201 Bus stand	80	0	PramodNagar processing facility
28	1	Nimta Rabindrapally	12	0	PramodNagar processing facility
29	1	Udaipur	35	0	PramodNagar processing facility
31	1	Adarsha Nagar	35	0	PramodNagar processing facility
33	1	Nabadarsha gate	50	0	PramodNagar processing facility
TOTAL SCP's	23			1	PramodNagar processing facility

KAMARHATI MUNICIPALITY

Ward No.	No. of SCP's	SCP location	Area	No. of static compactor	Transportated to
1 to 7	2	Kamarhati Loha gate	NA	0	Kamarhati processing facility
		Opposite side of Chota Mosque	NA	0	Kamarhati processing facility
	1	Kathal Bagan	NA	0	Kamarhati processing facility
6	2	Police Phari	NA	0	Kamarhati processing facility
		Sastitala Vat	NA	0	Kamarhati processing facility
8 to 11	8	Beside Ashoke Foundary M.M. Feeder road	NA	0	Kamarhati processing facility
		Shree Gopal Mullick Road Vat	NA	0	Kamarhati processing facility
		Ramakrishna Pally Vat	NA	0	Kamarhati processing facility
		Bagan Vat	NA	0	Kamarhati processing facility
		Ishwar Banerjee Lane	NA	0	Kamarhati processing facility
		Anushree Pally Vat	NA	0	Kamarhati processing facility
		Bhagawan Mondal Street Vat	NA	0	Kamarhati processing facility

		A.C.pal street Vat	NA	0	Kamarhati processing facility
12 to 16	8	May Day Pally	NA	0	Kamarhati processing facility
		34 Bus stand	NA	0	Kamarhati processing facility
		Runway Math	NA	0	Kamarhati processing facility
		U.N. Mukherjee Phari	NA	0	Kamarhati processing facility
		Vat near Sarada Math	NA	0	Kamarhati processing facility
		Govt quarter Vat	NA	0	Kamarhati processing facility
		Vat near Maa Kali Kanta B.T. road	NA	0	Kamarhati processing facility
		Vat opposite side of L9 Bus storage B.T. road	NA	0	Kamarhati processing facility
17 to 20	10	Present Compactor station beside allied ceramics	600 sqft	1	Kamarhati processing facility
		Prafulla Nagar sarat Pally Vat	NA	0	Kamarhati processing facility
		Prafulla Nagar Kali tala more vat	NA	0	Kamarhati processing facility
		Belghoria Bazar vat	NA	0	Kamarhati processing facility
		Ambika Mukherjee road Vat	NA	0	Kamarhati processing facility
		Flower shop vat near Belghoria Flyover	NA	0	Kamarhati processing facility
		Vat Near C.S.T.C head Office	NA	0	Kamarhati processing facility
		B.M. Banerjee Road Vat	NA	0	Kamarhati processing facility
		Indra Puri Vat	NA	0	Kamarhati processing facility
		Priya Nath Middha Road Vat	NA	0	Kamarhati processing facility
21 to 24	7	Present Compactor station beside allied ceramics	150-200 sqft	0	Kamarhati processing facility
		Vat near Nilgunj road near Vivekananda association	NA	0	Kamarhati processing facility
		Belghoria station Bazar vat	NA	0	Kamarhati processing facility
		Vat near	NA	0	Kamarhati processing

		Mahakali School			facility
		Vat near Barthala	NA	0	Kamarhati processing facility
		Vat near B.N. Ghosal Road	NA	0	Kamarhati processing facility
		Vat near Uchu Pole Nilgunj road	NA	0	Kamarhati processing facility
27	1	Central Vat Ward	150-200 sqft	0	Kamarhati processing facility
28	1	Central Vat Ward	150-200 sqft	0	Kamarhati processing facility
25 to 28	5	Beside Hind Ceramics factory	NA	0	Kamarhati processing facility
		Vat near 2 no. Railway gate	NA	0	Kamarhati processing facility
		Vat near 3 no. Railway gate	NA	0	Kamarhati processing facility
		D.P. Nagar Bazar Vat	NA	0	Kamarhati processing facility
		Adarsha Pally Vat	NA	0	Kamarhati processing facility
32	1	Central Vat Ward	150-200 sqft	0	Kamarhati processing facility
29 To 35	7	Gitanjali Vat	NA	0	Kamarhati processing facility
		Baluchar Vat Nandan Nagar	NA	0	Kamarhati processing facility
		Ghola Road Bazar Vat	NA	0	Kamarhati processing facility
		Opposite Baisakhi Math Vat	NA	0	Kamarhati processing facility
		Vat near Sarkal Bari	NA	0	Kamarhati processing facility
		Vat near 5 no. uncha bridge	NA	0	Kamarhati processing facility
		Vat naer Bandhab nagar Yuba Sangha	NA	0	Kamarhati processing facility
TOTAL SCP's	53			1	

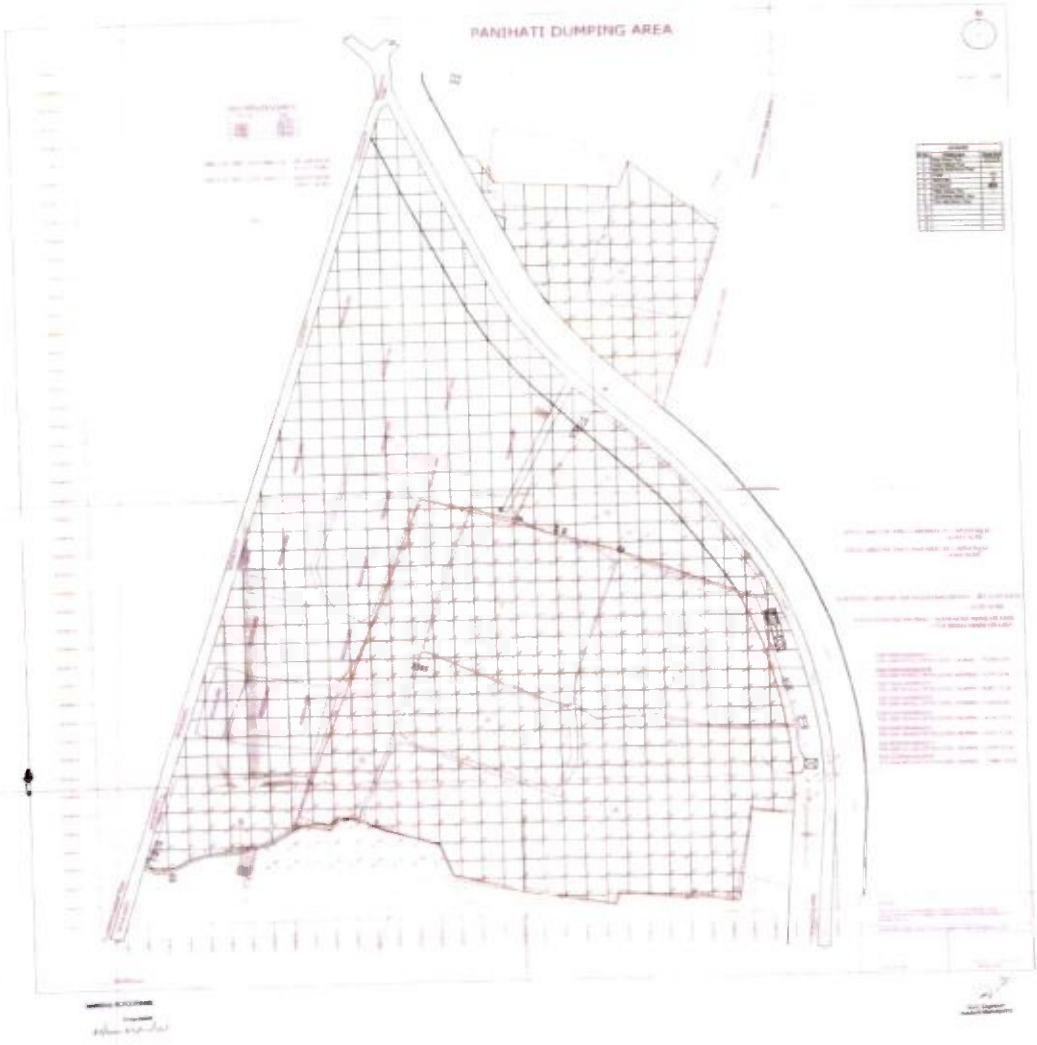
NEW BARRACKPORE MUNICIPALITY

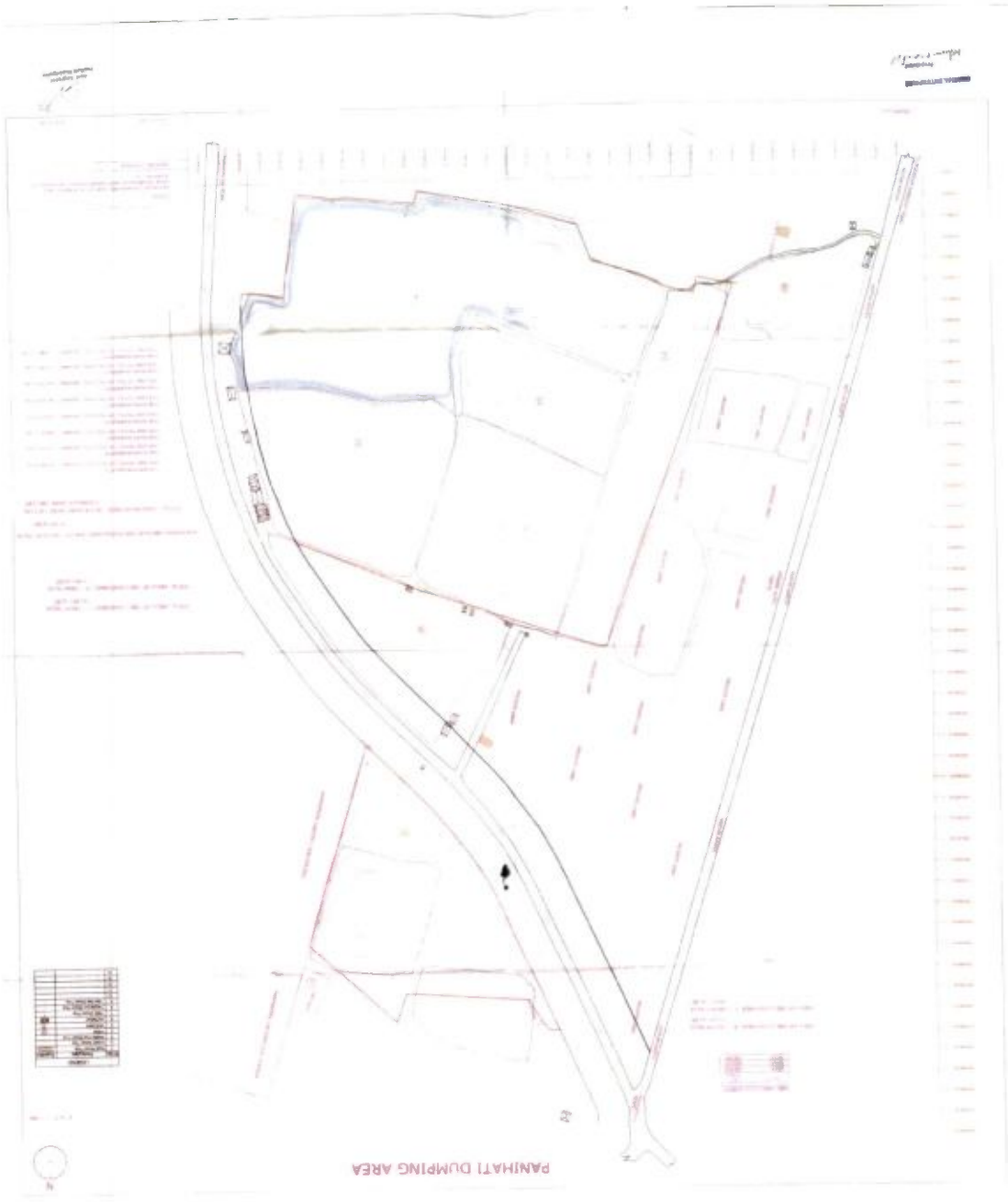
Ward No.	No. of SCP's	SCP location	Area/No. of Bins (4.5MT)	No. of static compactor	Transportated to
3	1	beside railway gate no - 8	2	0	Kamarhati processing facility
2	1	Vivekananda Road, near Ghasher Math.	1	0	Kamarhati processing facility
6	2	Sajirhat Bazar	1	0	Kamarhati processing facility
		Barabattala	2	0	Kamarhati processing facility
7	1	Kamargathi Road, Nazrul Sarani	2	0	Kamarhati processing facility

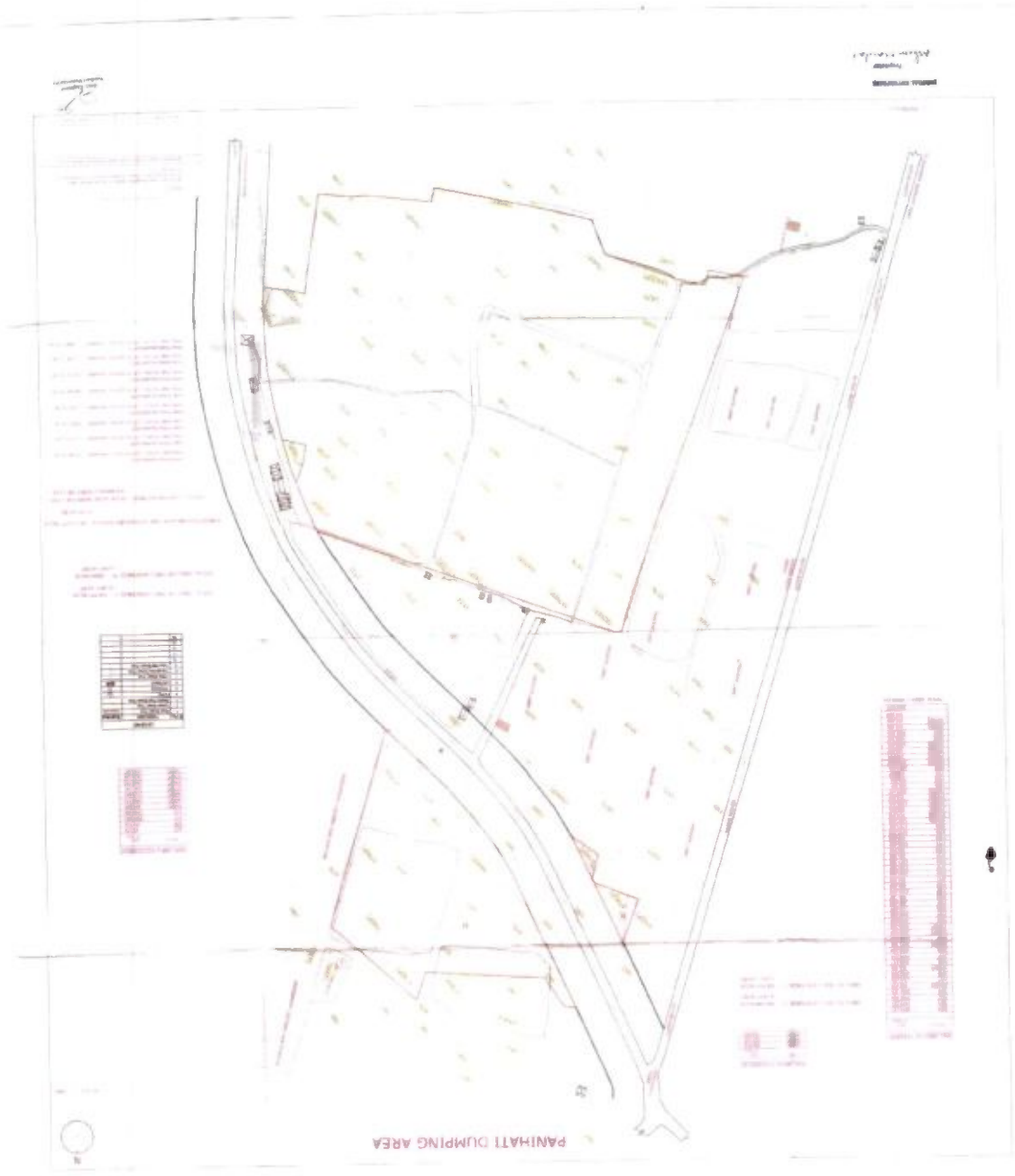
8	1	Kamarshala Battala	2	0	Kamarhati processing facility
9	1	Rabi Dutta's House	1	0	Kamarhati processing facility
11	1	Ganguly Bari	2	0	Kamarhati processing facility
12	1	Puratan Bazar	1	0	Kamarhati processing facility
13	1	Anubhab Bazar	1	0	Kamarhati processing facility
14	1	Madhumita Sarani	2	0	Kamarhati processing facility
17	1	Lanin Sarani	1	0	Kamarhati processing facility
19	1	Angana	1	0	Kamarhati processing facility
TOTAL SCP's	13				

Annexure – VIII

Topographical Maps of Panihati Land




PANIHATI DUMPING AREA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