



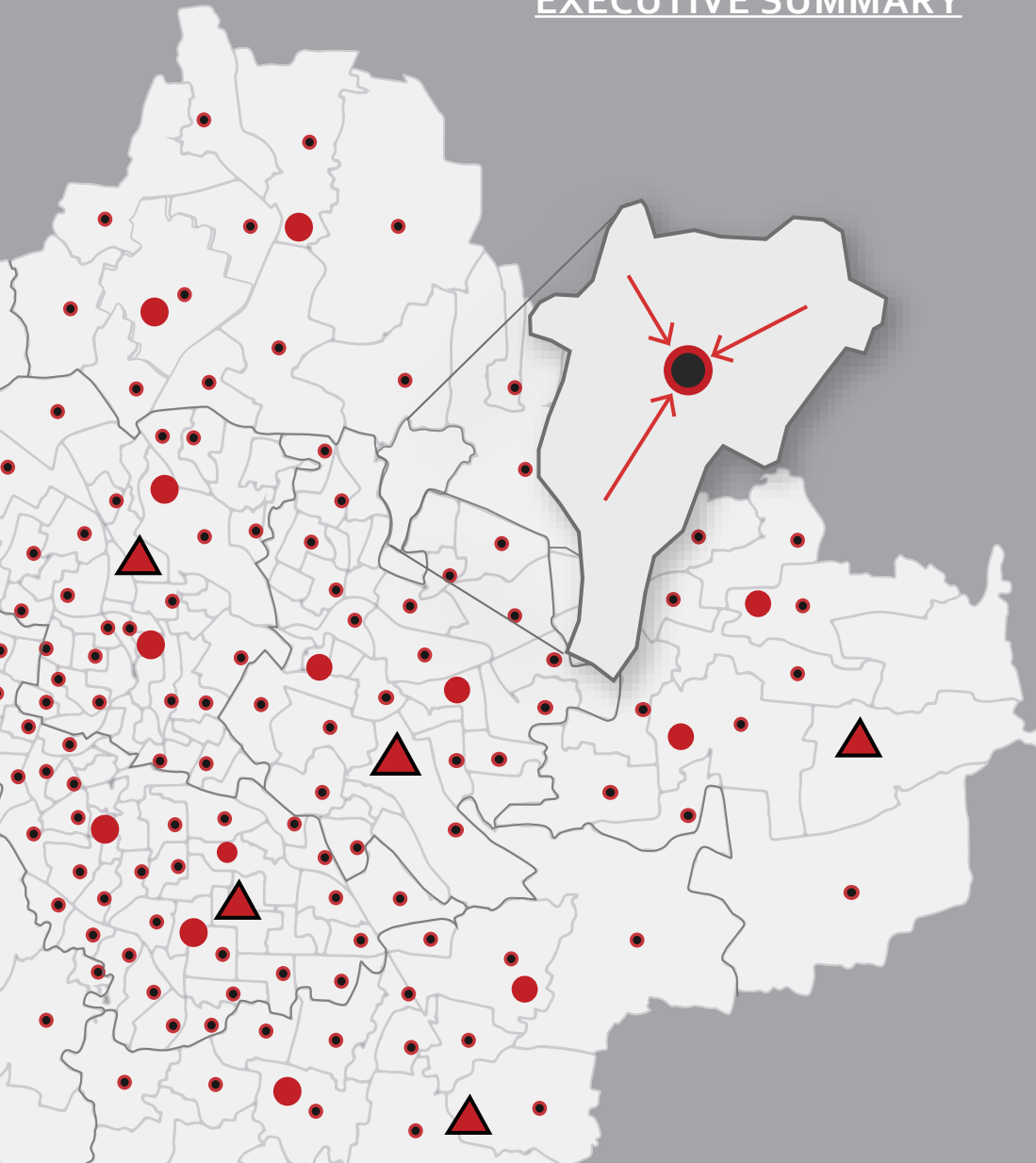
A BBMP AND KUIDFC REPORT

APRIL 2015

RE-ASSESSING NORMATIVE STANDARDS: A TIME & MOTION STUDY

BENGALURU'S MSW COLLECTION AND TRANSPORTATION SYSTEM

EXECUTIVE SUMMARY



PARTNERS:



CPPS
Centre for Public Problem Solving

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The study was commissioned by Karnataka Urban Infrastructure Development & Finance Corporation (KUIDFC) and Bruhat Bangalore Mahanagara Palike (BBMP) for the purpose of revising normative standards used in the estimation process of the New Tender for Municipal Solid Waste Collection and Transportation. It was executed by the Centre for Public Problem Solving (CPPS) in collaboration with the Infrastructure Development Corporation Karnataka (iDeCK).

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This document is an abridged version of the Time and Motion Study and is a referral document for the tender. The study explores the issues in the current Solid Waste Management System, and proposes new normative standards for stream-wise collection and transportation of MSW in a decentralised manner. These norms have been the basis for further estimation and planning.

FOREWORD

Bruhat Bengaluru Mahanagara Palike (BBMP) handles its obligatory Municipal Solid Waste (MSW) function largely by outsourcing the collection and transportation of garbage through a Tendering process. Over the years the Request For Proposal (RFP) has undergone many stages and evolved, and there is a requirement to update and refine the tender conditions and performance indicators to reflect the new SWM Directives of the Hon'ble High Court and the Principles and guidelines of the Solid Waste Management (SWM) Expert Committee adopted by BBMP. The translation of the new mandate required to be further studied for norms to be established for aspects that were being introduced like SEGREGATION AT SOURCE with a waste stream driven collection and transportation system focused on maximising DECENTRALISED PROCESSING of waste by stream and reducing to the minimum waste that reaches the landfills.

Karnataka Urban Infrastructure Development and Finance Corporation Limited (KUIDFC) commissioned Infrastructure Development Corporation Karnataka Limited (iDeCK) to work on the new RFP and Tender agreement requiring a detailed analysis of the present systems and processes to enable a deep understanding to allow for a new set of normative standards to be established, in order to set new tender guidelines.

For the purpose of the establishing a well-informed framework, the Expert Committee suggested a 'Study Group'. The intent of a study group was to bring together a group of domain experts that have been working in the field of Solid Waste Management to work with the Municipality, tabling their experiences and studies conducted. The learning from these meetings was then collated, helping in the establishment of base principles that

the tender was to address.

Moderated by members of the Expert Committee, iDeCK, KUIDFC and BBMP, the group sessions included Academicians from IIM-B, Urbanists and Planners from think-tanks like the Centre for Public Problem Solving (CPPS), subject matter specialists, members of civil society groups like the Solid Waste management Round Table, Public Affairs Centre (PAC) representatives, consultants with IIHS, domain expert members of the Expert Committee on SWM, set up by the GoK.

The highlight of the suggestions from the Study Group was the need for re-assessing the normative standards used for estimation and planning. Hence a study was commissioned for which iDeCK collaborated with CPPS to conceptualise and execute a TIME AND MOTION STUDY.

The study required a comprehensive understanding of the present systems and processes on ground for which an informal collaboration was done with practitioners and members of the SWM Expert Committee, along with field officers and members of the BBMP Health and Engineering Departments and citizens in the short-listed wards and areas. The resultant of this collaborative effort is a first in ESTABLISHING TYPOLOGIES and standards for primary collection, unloading and secondary transfer of wet, dry and special streams of waste to pre-defined destinations. It is important to note that some of these trials in special areas that have been studied would need a transition time to be provided, for the City to experiment with new practices and then move from the existing practice to the recommended new mandated system for Primary and Secondary Collection and Transportation.

The Time and Motion Study recommends NEW

NORMATIVE STANDARDS by type of waste stream and typology of generator; and recommends processes and associated vehicles while referencing it against the present Karnataka Normative Standards. The application of the NEERI report and MoUD's Service Level Benchmarks (SLBs) through the Karnataka Normative Standards have been referred to including a wider international and national search for standards to define benchmarks that could be applied to the context in Bengaluru.

As there is insufficient documentation on Time and Motion aspects of MSW collection and transportation of segregated waste by stream in Indian Cities, the study has looked at generation by typology, and vehicular and process implications that respond to the varying waste characteristics. It therefore also recommends vehicular requirements for short and long distances thereby indicating destination wise stream transportation and a separate distinct focus for Secondary transportation of waste.

In this Report there are certain gaps - the Study has not been able to address all categories of waste generators like Slums and Markets and large corporate campuses to define normative standards.

Nor has it been able to capture all categories of waste by stream.

Since the Tender addresses generation of waste from Households, small commercial establishments and MDUs and some special generators like slums and markets, this is a study to focus largely on Household generated streams namely organic waste from Kitchens and recyclable or dry waste. It also addresses the domestic sanitary waste collection and transfer to a central point (Lorry Point). Since the Tender covers Street sweeping, the inert collection and transportation has been studied and standards arrived at by definition of the road types.

We do believe that these gaps need to be studied further. The Tender has provided for these norms to be studied for three months. During this time, data will be captured and studied, and necessary modifications made, if required. This time will also provide an opportunity to capture all other waste streams and generator data to begin a data repository of sorts for the BBMP.

We are looking forward to laying the foundation for a robust and transformational system that we believe will help us deliver a clean Bengaluru!

Commissioner, BBMP



Managing Director,
KUIDFC

Special Commissioner,
BBMP



Member, BBMP Expert
Committee on SWM

Co-founder, CPPS



CEO, iDeCK Ltd.



1. EXECUTIVE SUMMARY

1.1. BENGALURU'S SOLID WASTE MANAGEMENT STRATEGY

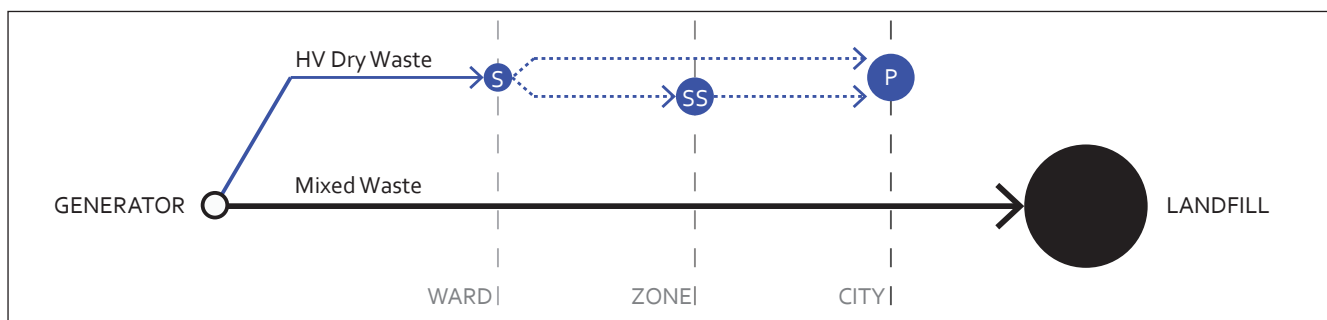
1.1.1. BACKGROUND

With a population of over 10 million, Bengaluru stands as the third most populous city in India. It has seen rapid urbanisation with its population doubling in a span of just 20 years, from 4.13 million in 1991 to a whopping 8.42 million in 2011 (Census, 2011). Though the city grew to embrace a successful and thriving IT economy, it led to an urban chaos, pushing the waste system close to its breaking point.

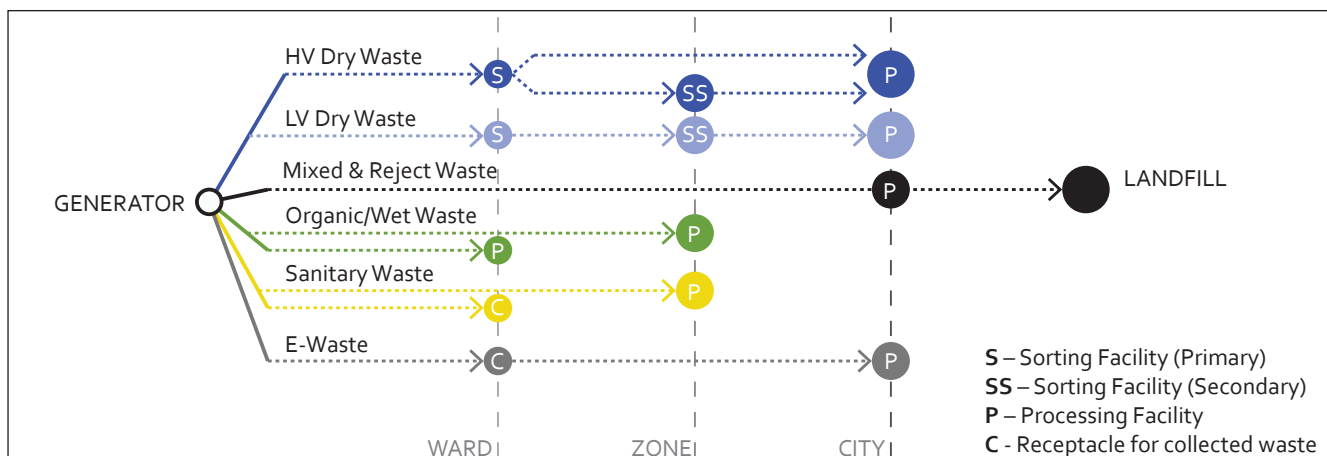
The closure of the Mavallipura landfill by the Karnataka State Pollution Control Board (KSPCB) in 2012, following the protest by the villagers of Mandur, the directives issued by the Hon'ble High

Court of Karnataka and the growing unrest in the City about the need to have a sustainable Solid Waste Management system has led to much introspection by the BBMP. This had led to the need for a new approach in Solid Waste Management as the city plans its shift towards 'A Future with No Landfills'.

The shift from a centralised 'single stream' collection and 'Landfill disposal' system to a decentralised 'multiple stream' collection and closely located 'Processing Facility' system requires a whole new approach for the Collection and Transport of Municipal Solid Waste (Figure 01).



CENTRALISED SOLID WASTE MANAGEMENT SYSTEM



DECENTRALISED SOLID WASTE MANAGEMENT SYSTEM

Figure 01: Shift from a Centralised to a Decentralised Solid Waste Management System (Source: CPPS, 2015)

1.1.2. THE CITY'S STRATEGY - 2015

In a push towards the new system, Bengaluru's Kasa Muktha Program was launched in 2013 by the Hon'ble Chief Minister of Karnataka, Sri. Siddaramaiah. Bengaluru has since then developed 6 strategies to enable its shift from 'Dumping' to 'Processing':

1. **Investing in stream-wise processing of waste:** These include aspects like the enforcement on segregation at source, investing in infrastructure and technology for processing waste, and creating an efficient collection and transportation system
2. **A data driven approach for estimation & planning:** This includes the understanding of waste generators, data collection through field validation, re-assessing of normative standards and its application for a close estimate
3. **Enabling market dynamics by creating new economic opportunities:** Opening up the private market and empanelment of vendors for the servicing of Bulk Generators, application of the polluter-pay principle to generators and enabling Public-private partnership for setting up of processing facilities
4. **Awareness creation & enabling behavioural change:** The city has already hosted large scale events and several small events for consensus building, awareness creation, training and skilling. In addition to this it continues to conduct clean-up drives, post adverts and flyers, manuals, etc.
5. **Use of technology for data collection & monitoring:** Using of technologies like GIS mapping, apps, tracking systems, biometrics etc. are being used to enable transparency, enhance efficiency, increase accountability and overall help monitor the new SWM system
6. **Capacity building & enabling legislative reforms:** This includes building institutional capacity within the government through the setting up of a SWM cell, capacity building through inclusion of the informal sector workers, exercising Extended Producer Responsibility (EPR) and enabling legislative reforms by appropriate amendments and notifications

1.1.3. PRINCIPLES FOR THE NEW TENDER

The key aspects being incorporated in the new tender for the Municipal Solid Waste (MSW) Collection and Transport system, in compliance with the city's strategy, includes:

Segregation at Source

The fundamental prerequisite for planning the MSW Collection and Transport system has to be that the waste collected and transported will be segregated at source and no mixed waste handling will be permitted. Waste will therefore be segregated at source into basic three types which is Wet (Organic) waste, Dry (Inorganic) waste and Sanitary waste.

The collection of other streams of waste, termed as 'Special Streams' will be planned for ward wise based on the need. These streams include waste like garden waste, construction and demolition waste, Coconut waste, etc.

Decentralisation

Upholding the Proximity principle and thereby the need to maximize the localized processing of waste, Decentralisation of processing and collection centres has been the favoured approach by the City of Bengaluru. It has been mandated that wherever possible, processing units are to be built at Ward level. To handle the excess, larger units are being planned at Constituency level and Zonal level. The assignment of short and long distances for the drop-off and disposal of waste based on the location of the destination for the ward has therefore to be incorporated in the New Tender.

Destination Bound Collection and Transportation

Every waste stream, Wet, Dry and Sanitary will be collected and transported to its specific destination. Further every ward will have its designated destinations, for each of the streams of waste. These destinations are built at ward, zone & city level and are for specific streams:

- DRY WASTE - Dry Waste Collection Centres (Ward), Kasa Market & aggregators (Zone) & Recycle Park (City)
- WET WASTE – Bio-methanation Units (Ward), Composting at Integrated Yards (Zone)
- SANITARY WASTE – Collection Points (Ward), Sanitary waste processing units (City)

Dry waste that is non-recyclable is to be converted to Refused Derived Fuel (RDF) at Integrated yards (Zonal level) and any Inert or post processing rejects are to be landfilled at the assigned scientific landfill.

Identification of Typologies

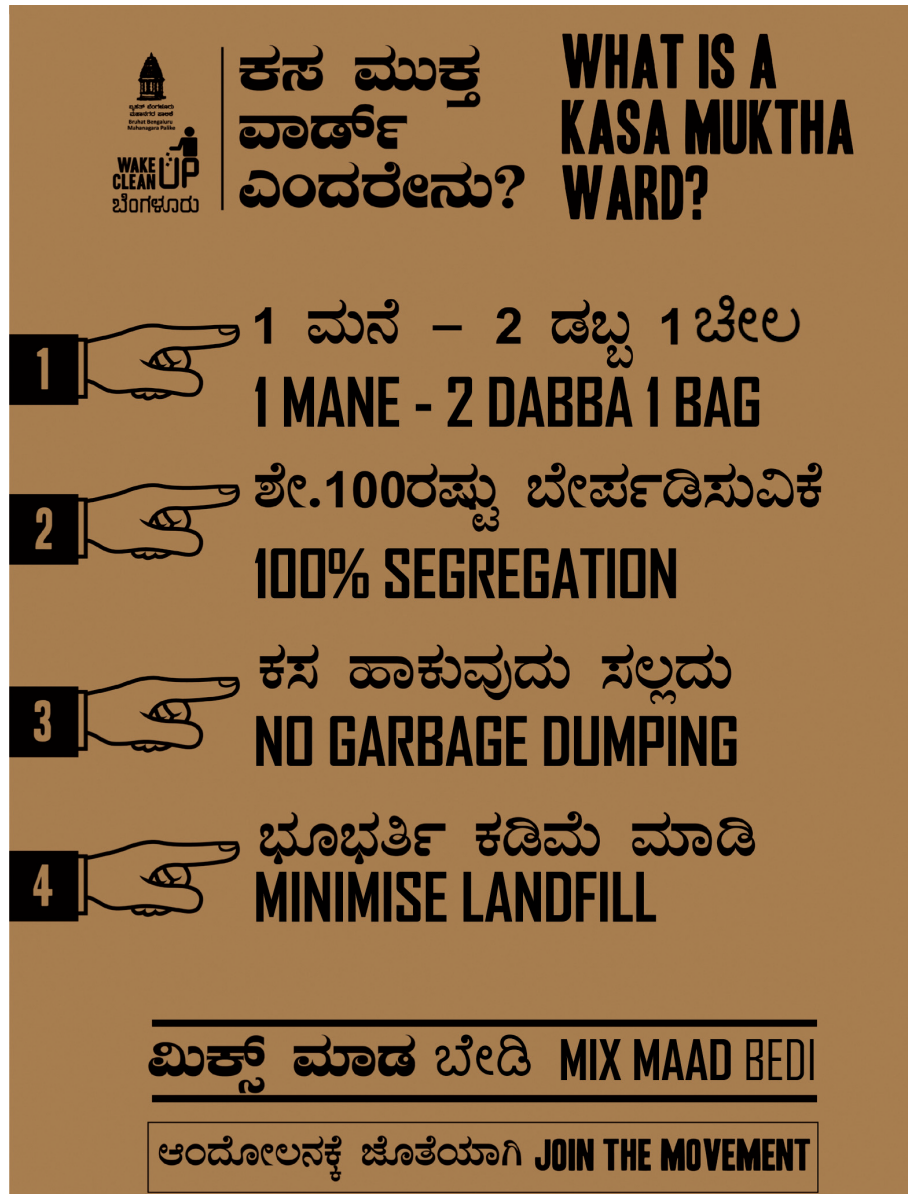
In addition to this, further reading into the complex fabric of the city and viewing it from a waste generation perspective requires an approach that captures the types of generators; by income level, by site size and/or dependent on the act or process that generates waste. A detailed discussion of the same has been taken up in the section under Generator Typology.

Removal of Bulk Generators

Bulk Generators have been identified based on the quanta of waste generated. Bulk Generators include

domestic generators - apartment complexes with more than 50 units and Commercial bulk generators viz hotel/restaurant, clubs, factory, choultry, mall, shopping complex, marriage halls, convention hall, place of worship, institution, office establishment,

railway stations, bus stand or any other commercial or public entity which accumulates MSW of a quantity not less than 10 kg per day. These generators are required to set up in-situ systems to manage their own waste.



The poster is titled "ಕಸ ಮುಕ್ತ ವಾರ್ಡ್ ಎಂದರೇನು?" (WHAT IS A KASA MUKTHA WARD?) and lists four key goals. It features a logo for "WAKE UP CLEAN ಬೆಂಗಳೂರು" (WAKE UP CLEAN BANGALORE) in the top left corner. The goals are numbered 1 to 4, each with a hand icon pointing to the text.

- 1 ಮನೆ - 2 ಡಬ್ಬ 1 ಬೇಲ
1 MANE - 2 DABBA 1 BAG
- ಶೇ.100ರಷ್ಟು ಬೇರ್ಪಡಿಸುವಿಕೆ
100% SEGREGATION
- ಕಸ ಹಾಕುವುದು ಸಲ್ಲದು
NO GARBAGE DUMPING
- ಭೂಭರ್ತಿ ಕಡಿಮೆ ಮಾಡಿ
MINIMISE LANDFILL

ಮಿಕ್ಸ್ ಮಾಡ ಬೇಡಿ MIX MAAD BEDI

ಆಂದೋಲನಕ್ಕೆ ಜೊತೆಯಾಗಿ JOIN THE MOVEMENT

Figure 02: Kasa Muktha Program's key goals (Source: BBMP, 2013)

1.1.4. WASTE STREAMS

As we move towards a mandated stream-wise collection and transportation, it would be pertinent to identify the types of wastes which the Study refers to and define their composition. The following streams have been identified:

Basic waste streams

These are those waste streams that have been identified under the Draft MSW Rules 2015, to be segregated at source and subsequently collected, transported & processed separately. These include:



WET WASTE is biodegradable waste and includes food waste, vegetable and fruit cuttings, egg shells, coffee powder, fish and bones.



DRY WASTE is non-biodegradable wastes and includes paper, plastic, glass, metal, thermocole, cloth, and wood



SANITARY WASTE includes hygiene products like sanitary napkins and baby or adult diapers contaminated with blood, urine and faeces. It includes bandages and sharp objects like syringes and needles.



INERT WASTE includes street sweeping inert (like silt from drains) and post processing rejects from the wet waste processing units or dry waste collection centres. It does not refer to mixed waste or construction and debris wastes



MIXED WASTE is a result of the mixing of organic waste with dry recyclable like plastic and

paper, which cannot be separated. The quanta is estimated to reduce with an increase in segregation at source.

Special waste streams

Special Streams include those streams of waste that do not fall under the categories of wet, dry, sanitary or reject waste. The generators of these streams are specific and usually found in clusters, which makes the stream easy to segregate and process. These include:



LEAF/ GARDEN WASTE is all horticulture waste and includes leaf litter, garden pruning, branch cuttings

COCONUT WASTE includes the exterior shell of tender coconut left over after the water is consumed



DEBRIS include any construction/demolition waste and left overs from any civil work.



DEAD ANIMAL WASTE includes carcass' and bodies of dead animals (ex. stray dogs, cows, etc.)

Other streams considered are Cottage Industry waste, Bakery Waste, Meat Waste, etc.

1.2. THE ESTIMATION AND PLANNING PROCESS

1.2.1. KEY ASPECTS

Any planning and estimation exercise therefore, needs to carefully consider the composition and make-up of the City. This is especially relevant for an activity like Municipal Solid Waste Management. The following aspects that influence such a system are:

1. **REACH AND SCALE:** The enormity of the nature of service of Solid Waste Management (SWM), an obligatory function of the Urban Local Body (ULB), needs to be recognized, since MSW can be seen as primarily coming from households, but also includes wastes from offices, hotels, shopping complexes/shops, schools, institutions, and from municipal services such as street cleaning and maintenance of recreational areas. For an effective SWM, the primary goal of the Municipality is therefore to plan and operationalise the reach of its services such that the Collection and transportation of MSW has to take place from each and every Household, Commercial, Institutional and Industrial unit in the City.
2. **DESTINATION BOUND WASTE STREAM COLLECTION:** Further, this waste has to then reach its destination, given that the City is now committed to Collection and Transportation of segregated waste.
3. **PERFORMANCE:** Also, taking into account the various progressive policies that the City has adopted, there is a real need to review and modernize the Collection and Transportation, keeping in mind not only the delivery of the pure SWM requirements, but to offer timely and efficient services and to ensure cleanliness in the process. This cannot be done

without keeping at the centre of the planning the 'human factor', which is the realistic work and output possible by the workers .

There are a number of challenges which need to be managed during the implementation of operations strategy with respect to solid waste management:

- The scale of the operations required, considering all of the above, therefore, is a mammoth, considering that the City of Bengaluru has a population of 10.8 million people with very vibrant commercial activity levels.
- The costs of carrying out the Collection and Transportation of waste, its processing and disposal
- The limitations of administrative and managerial competence of the Municipality machinery
- The varied composition and make up of every ward, its demographics, the land use and its geographical attributes. These vary from Ward to ward and constitute a spectrum of generators.

1.2.2. STRUCTURE AND APPROACH

In order for a comprehensive tender that aligns with the city's new strategy, some key requirements that were required to be addressed were:

- Quantification of waste at the present time
- The rate of growth during the tenure of the contract
- Norms to cater to the diversities of the ward demographics
- Manpower outputs and efficiencies
- Processes which will ensure stream-wise collection of waste and uninterrupted service flow, for ensuring a clean city
- Mapping the collection and transport of waste to set a basis for monitoring the system
- Building in phases or milestones to provide flexibility during transition stages as the city transforms itself

The new tender agreement created an opportunity to analyse in detail the present systems and processes to enable a deeper understanding

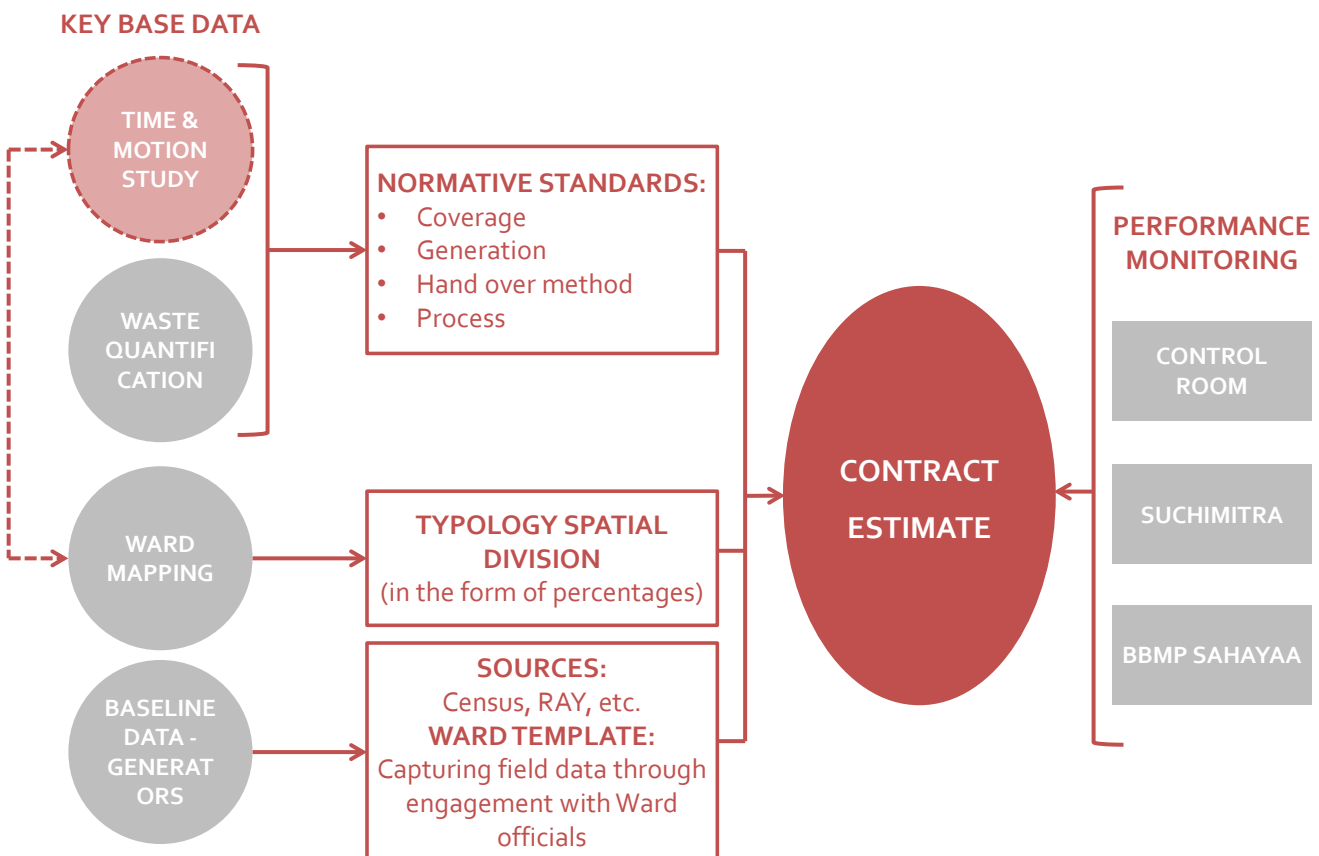


Figure 03: Structure of the MSW Collection and Transport Tender Process

of estimating the SWM requirements of the city. This required a comprehensive understanding of the present systems and processes on ground from which the need of a Time and Motion Study was further evident.

The findings of this study would input into the key base data that is required to estimate and cost the collection and transportation process of MSW for every ward in the city (Figure 03).

1.2.3. DATA COLLECTION & RATIFICATION

Data has been collected from both primary and secondary sources.

Secondary data collection:

- Census 2011 - Data for Population & Households
- DMA (Slum Households) - Data from Slum Free City Plan of Action Study by DMA
- GIS Data (Typologies within Wards) - Predominantly High Income, Low Income or Mixed Category of Households based on plot sizes
- Property Tax Data - For number of Multi-dwelling Units (No. of floors)
- Bulk Generators - Data from BBMP, BESCOM Data, etc.

Primary data collection and verification from field:

This was done through the circulation of a two part ward template for capturing generator (Figure 04) and infrastructure (Figure 05) data currently existing on ground.

Other documents/studies referred to:

- IIM-B Study for Waste Generation & Characterization
- Master Plan for Bengaluru SWM in 2008
- Review of Other Cities – New Delhi, Ghaziabad, Rajkot, etc.
- Time & Motion Study for the new adapted normative standards

PART A: DATA COLLECTION & RATIFICATION


BBMP WARD TEMPLATE FOR MSW COLLECTION AND TRANSPORTATION PART A: DATA COLLECTION & RATIFICATION									
	ZONE NAME:		WARD NAME & WARD NO:		DATE				
Household Data			Small Commercial Establishments						
Estimated Population (2015)			Shops & wholesalers						
Total No. of HHs			Clinics (small)						
No. of Slum HHs			Retail Units & Offices (small)						
HHs in Large Apartments (>50 units)			Industrial Units/Godowns etc.						
Regular HHs for D2D			Educational Institutions (small)						
Low Income HHs			Total						
Mixed HHs									
High Income HHs									
Street Sweeping (in kms)									
Major Roads	Intermediate Roads	Minor Roads	Total	Minor Roads (by Frequency)					
				Daily	Alternate Day	Twice a Week	Once a Week		
Burial Grounds				Play Grounds					
Bulk Generators									
HHs in Large Apts				Gated Communities	PGs	Govt., Education, Private Institutions	Large Hotels		
Small Hotels and Clubs				Malls & Large Shops	Choultries	Large markets	Religious Institutions		
Special Days									
Season				Addl. MSW (TPD)			No. of Days		
REMARKS									
High Income - Independent HH and small Apts. with plot area >= 2400 sq.ft.									
Mixed - Small apartments & independent HH with plot area >= 1200 & <2400 sq.ft.									
Low Income - Low Income HHs (independent & Apts.) with plot area < 1200 sq.ft.									
Commercial & Institutional (small, <10kgs)				Road Typologies					
				Major - Road width >=80'					
				Intermediate - Road width <80' & >40'					
				Minor - Road width <40'					
Sweeping every Day									
SIGNATURE: _____									
DESIGNATION: _____									
DATE: _____									
				Asst. Exec Engineer Sub			Exec. Engineer		

Figure 04: Ward Template for data collection and ratification

PART B: INFRASTRUCTURE & ISSUE MAPPING

BBMP WARD TEMPLATE FOR MSW COLLECTION AND TRANSPORTATION PART B: WARD INFRASTRUCTURE & SPECIAL NEEDS									
ZONE NAME:		WARD NAME & WARD NO.:				DATE			
DECENTRALISED INFRASTRUCTURE (WITHIN WARD)									
INFRASTRUCTURE / SPECIFICATIONS		WET WASTE (W)		DRY WASTE (D)		SANITARY WASTE (+)		LEAF WASTE (P)	
Organic Waste Converter Bio-Methanation Plant		Dry Waste Collection Centre PHC/BBMP maternity home BBMP-Neighborhood parks		OTHERS - Eg.Coconut Waste, Garden Waste, etc.					
Numbers									
Area of centre (sq. ft.)									
Capacity of centre (TPD)									
Current Status									
Address (lat, long)									
LORRY POINTS									
Number		Location of LORRY POINTS							
How many lorry points do you have?		●							
ILLEGAL DUMPING (BLACK SPOTS)									
Number		Location of BLACK SPOTS							
Are there any illegal Dumping Spots in your Ward? Y/N		⊗							
OTHER SUPPORTING SERVICES & FACILITIES FOR WORKERS									
Yes/No		Location (if yes)							
Are there any Public toilets within the ward?		T							
Are there any Public bathing facilities within the ward?									
Are there any Vehicle Washing Facilities within the ward?									
SIGNATURE:		Junior Health Inspector		Senior Health Inspector		Asst. Engineer		Exec. Engineer	
DESIGNATION:		Junior Health Inspector		Senior Health Inspector		Asst. Engineer		Exec. Engineer	
DATE:		Junior Health Inspector		Senior Health Inspector		Asst. Engineer		Exec. Engineer	

Figure 05: Ward Template for infrastructure and issue mapping

1.3. RE-ASSESSING NORMATIVE STANDARDS: TIME & MOTION STUDY

1.3.1. NEED FOR THE STUDY

The Time and Motion study is designed for the purpose of assessing, standardizing and improving the time taken for Primary / Secondary collection and transportation by waste stream and Street Sweeping activity. The need for the study has been established because of several gaps in the SWM system in the city. These are as follows:

- Issues with the existing Municipal Solid Waste Collection & Transportation System
- Shortcomings of the Karnataka Normative Standards
- Lack of adaptation & inadequacy of the Service Level Benchmarks

The Time study is a measurement of the time required to complete a normal cycle of collection and transportation, with a well-qualified and trained operator, working at a normal pace and doing a specific task.

The Motion study captures the nature of collection and lays down the best possible process standards for collecting segregated waste, whilst ensuring visual cleanliness. This is captured from the generator source to its transportation to the closest destination for processing, while ensuring appropriate receptacles are provided for interim transfer stage.

1.3.2. UNDERSTANDING TYPOLOGY

The time and motion study identified two main typologies - Waste Generator and Road Typologies, for door to door collection and street sweeping respectively.

Waste Generator Typologies

The **WASTE GENERATOR** may be defined as *'any person, by site, whose act or process produces MSW waste, This definition contains three important terms - The first term, by site refers to where the waste is generated; The definition of person encompasses any entity involved with a process that generates waste; The third key component of the generator definition is the act or process by which the waste is generated'*

Source :<http://www.epa.gov>

Adapting the findings from the Time and Motion study (2015), the tender has adopted the following generator typologies:

1. Residential Generators

- High Income Households: Area with a predominance of Independent Households (>75%) where plot sizes are greater than 2400 sq.ft.



R (HI)

- Mixed Households: Area with a mix of Independent Households (<75%) & MDUs (>30%) where plot sizes are between 1200 sq.ft. to 2400 sq.ft.



R (MI)

- Low Income Households: Area with a predominance of Low Income Households (>75%) where plot sizes are less than 1200 sq.ft.



R (LI)

- Slum households: A slum is a compact settlement of at least 20 Households with a collection of poorly built tenements, mostly of temporary nature, crowded together usually with inadequate sanitary and drinking water facilities in unhygienic conditions



R (SL)

Commercial Generators

- Category 1 (2 kgs/unit): Areas in wards with sparse commercial activity (>60%) where units generate 2 kgs of waste/day. These include small Shops, Wholesalers and small Clinics.
- Category 2 (6 kgs/unit): Areas where 60% of the commercial units are offices and/or retail units, Industrial godowns, Educational Institutes, independent hawkers and vendors generating 6 kgs of waste/day.
- Category 3 (10 kgs/unit): These include generators like small markets and temples, which generate around 10 kgs of waste/day.

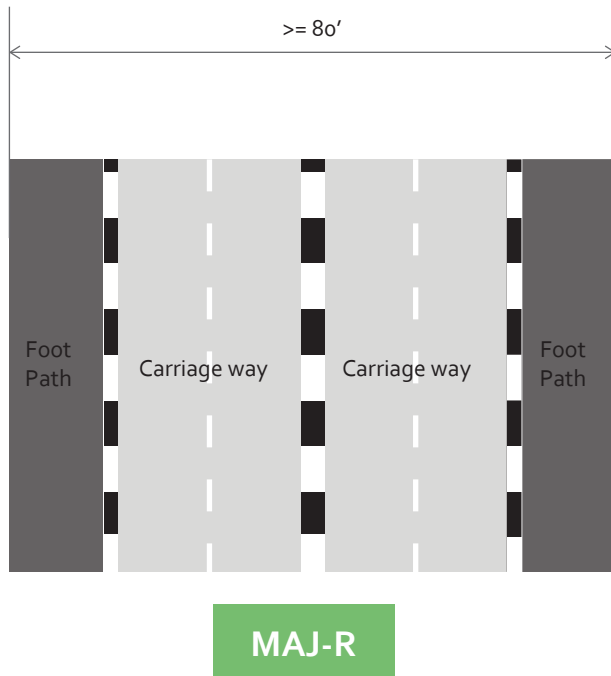
Road Typologies

ROADS are defined as 'any highway, street, lane, pathway, alley, stairway, passageway, footway, square place, grade separator, subway or bridge, whether a thoroughfare or not, over which the public have a right of passage or access, and includes any bunds, channels, ditches, storm water drains, culverts, sidewalks, traffic islands, road side trees and hedges, retaining walls, fences, barriers and railings within the street lines.'

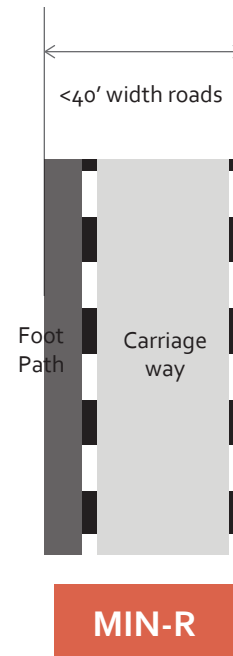
Source: Mysore CDP (2031)

Adapting the findings from the Time and Motion study (2015), the tender has adopted the following road typologies:

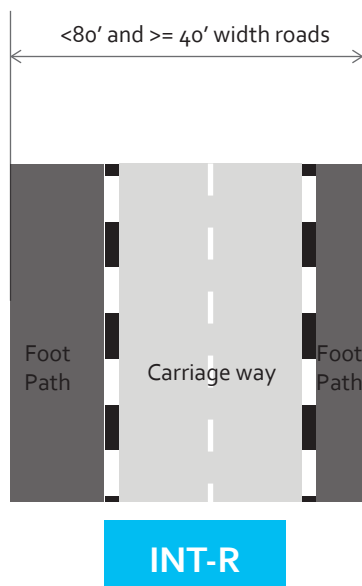
- Major Roads: These include roads that are greater than or equal to 80 ft in width



- Minor Roads: These are less than 40 ft roads. They may be tarred, concreted or just a mud road and also include Conservancy Lanes.



- Intermediate Roads: These are less than 80 ft and include those that are up to 40 ft wide



1.3.3. NEW NORMATIVE STANDARDS

The normative standards that have been used in the tender are adapted from the Time and Motion Study (Table o6). These are in contrast variation from the current Karnataka Norms. These normative standards have been established for both Primary & Secondary Collection and Transportation.

Primary Collection, Transportation & Transfer:

For primary collection, transportation & transfer of waste, the normative standards have been established under four heads for each typology (Table o1-o3)

1. GENERATION NORMATIVE

This looks at the quanta of waste generated by that generator type and the characterisation of waste streams (% of Wet, Dry, Sanitary & Reject)

2. COVERAGE NORMATIVE

This looks at establishing the vehicle type, timing for collection and coverage

3. HAND-OVER METHOD

This emphasises the use of specific receptacles for waste streams generated by the type of generator, and the ways in which waste has to handed over to the collector

4. PROCESS

This defines the entire cycle completed by the vehicle, from collection, to the drop-off of the waste stream collected and transfer of waste at the assigned destination

Note: Co-ordination for the transfer of waste from the primary to secondary vehicle may require interim

holding areas. Hence the placement of receptacles at Lorry Points (LP) and Decentralised Processing Facilities (DPF) have been suggested in the tender.

Secondary Collection & Drop-off:

Normative standards for secondary collection have been mandatory for receiving waste and its transportation to specified stream-wise destination. Drop-off's have been divided into two levels based on distances.

1. DROP-OFF WITHIN WARD

This looks at mapping potential destinations within the ward boundary, within a radius of 2.5 kms (Table o4, Figure o6).

2. DROP-OFF OUTSIDE WARD

This looks at destinations outside of the ward boundary, which may be at constituency, zone or city level (Figure o7)

3. TRANSFER AT LORRY POINT

The normative standard for number of lorry points has also been established as a ratio to the number of vehicles and holding capacity (Figure o8).

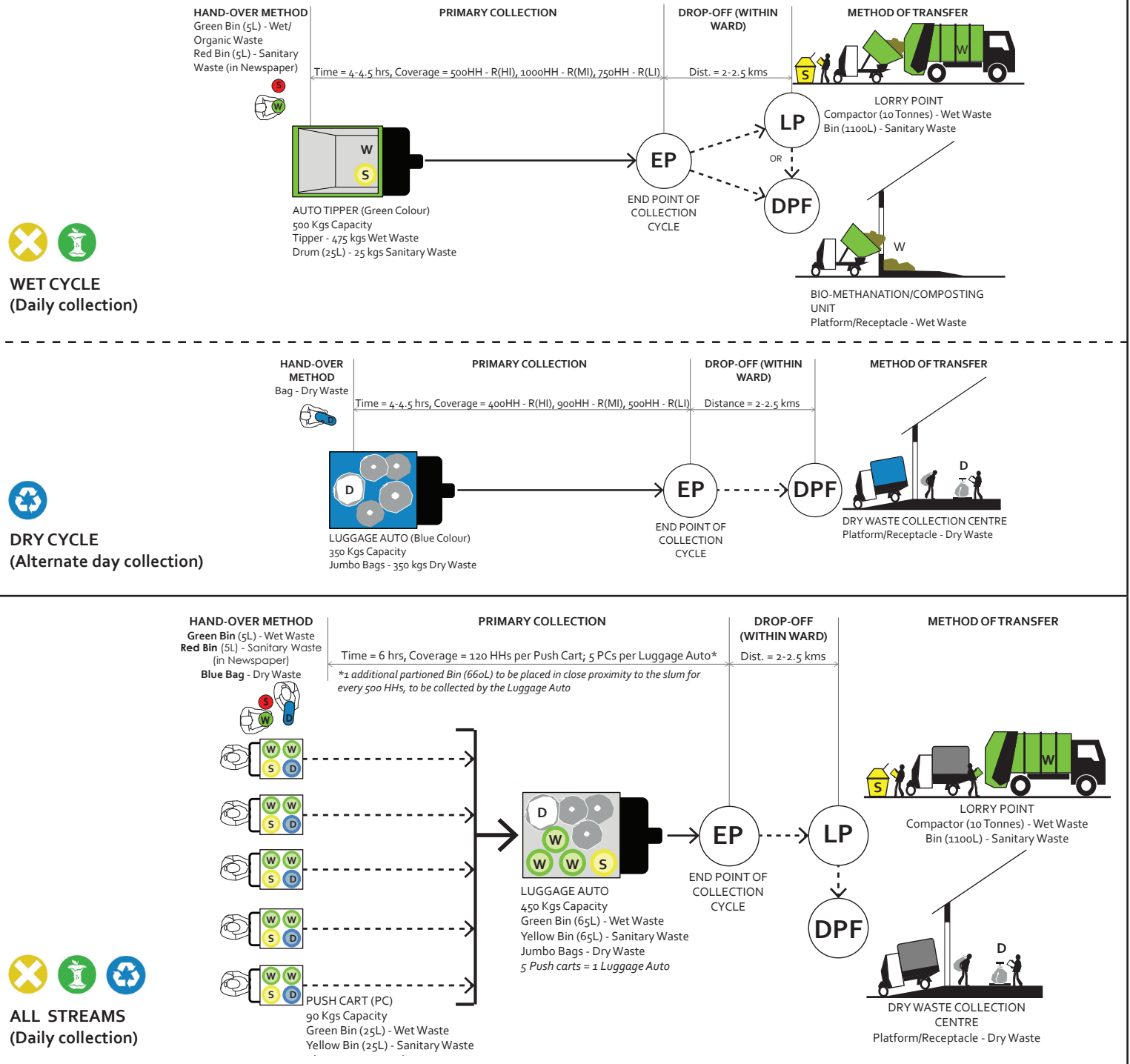
PRIMARY COLLECTION, TRANSPORTATION & TRANSFER - RESIDENTIAL GENERATORS

RESIDENTIAL GENERATORS							
SL NO	GENERATOR TYPOLOGY	1. GENERATION NORMATIVE		2. COVERAGE NORMATIVE			3. HAND OVER METHOD
		QUANTA (Kgs/HH)	COMPOSITION (%)	VEHICLE	COVERAGE	HOURS	
1.	High Income Residential Typology (R-HI)	1.24 kgs/HH	Wet : Dry : Sani 70.6% : 24.5% : 4.9%	Auto Tipper (Wet)	500 HHs	4 hrs	Independent homes: 2 BINS 1 BAG Green Bin (5L) – Organic/Wet Waste Blue Bag – Dry Waste Red Bin (5L) – Inert or Sanitary Waste (wrapped in newspaper) Multi-dwelling Units: 3 BINS (for every 120 kgs generated) Green Bin (6oL) – Organic Waste Blue Bin (6oL) – Dry Waste Red Bin (6o L) – Inert or Sanitary Waste
				Luggage Auto (Dry)	400 HHs		
2.	Mixed Residential Typology (R-MI)	1.24 kgs/HH	Wet : Dry : Sani 70.6% : 24.5% : 4.9%	Auto Tipper (Wet)	1000 HHs		
				Luggage Auto (Dry)	900 HHs		
3.	Low Income Residential Typology (R-LI)	1.24 kgs/HH	Wet : Dry : Sani 70.6% : 24.5% : 4.9%	Auto Tipper (Wet)	750 HHs		
				Luggage Auto (Dry)	500 HHs		
4.	Slums (R-SL)	1.50 kgs/HH	Wet : Dry : Sani 74.5% : 24.5% : 1.0%	Push Cart (All Streams)	120 HHs	6 hrs	Slum Household: 2 BINS 1 BAG Green Bin (5L) – Organic/Wet Waste Blue Bag – Dry Waste Red Bin (5L) – Inert or Sanitary Waste (wrapped in newspaper) Slum Settlement: 1 SKIP BIN (for every 500 HHs) - This would be a partitioned bin, designed to collect segregated waste
				Luggage Auto (All Streams)	360 HHs (3 Push Carts)		

Table 01: New Normative standards for Door-to-door collection from Residential Generators

RESIDENTIAL GENERATORS

4. PROCESS OF COLLECTION & TRANSFER



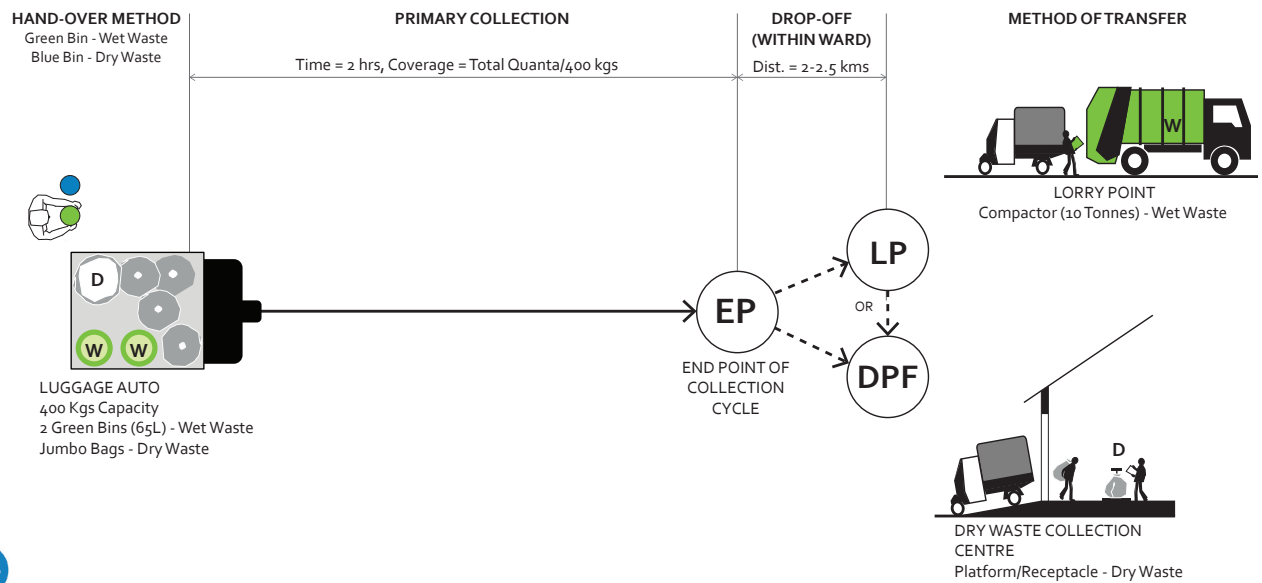
PRIMARY COLLECTION, TRANSPORTATION & TRANSFER - COMMERCIAL GENERATORS

COMMERCIAL GENERATORS							
SL NO	GENERATOR TYPOLOGY	1. GENERATION NORMATIVE		2. COVERAGE NORMATIVE			3. HAND OVER METHOD
		QUANTA (Kgs/Unit)	COMPOSITION (%)	VEHICLE	COVERAGE	HOURS	
1.	Shops & Wholesalers	2 kgs/Unit	Wet : Dry 35% : 65%	Luggage Auto (All Streams)	200 Units	2 hrs	Commercial: 2 BINS Green Bin – Organic/Wet Waste Blue Bin – Dry Waste <i>*Capacity of bins to be decided based on the requirement and daily generation</i>
	Clinics						
2.	Retail units & Offices	6 kgs/Unit	Wet : Dry 25% : 75%		65 Units		
	Industrial Units / Godowns & Small Education Institutes						
	Hawkers & Vendors (Fruit & Veg)		Wet : Dry 91% : 9%				
3.	Temples (small)	10 kgs/Unit	Wet : Dry 75% : 25%		40 Units		

Table 02: New Normative standards for Door-to-door collection from Commercial Generators

COMMERCIAL GENERATORS

4. PROCESS OF COLLECTION & TRANSFER



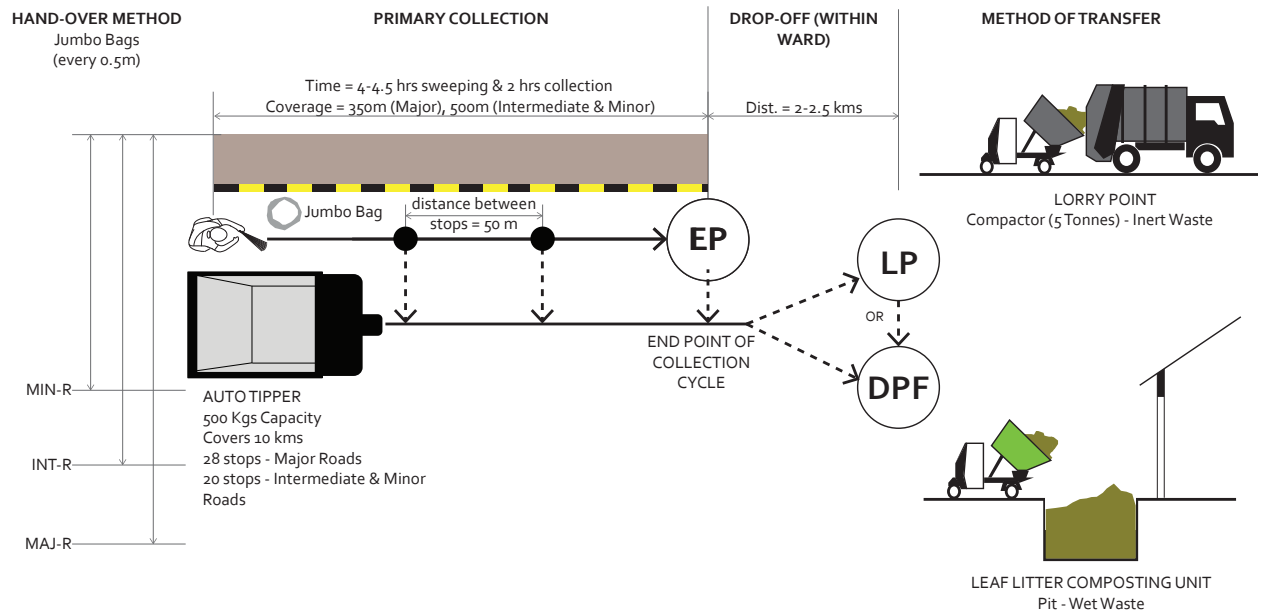
PRIMARY COLLECTION, TRANSPORTATION & TRANSFER - STREET SWEEPING

ROADS & STREETS							
SL NO	GENERATOR TYPOLOGY	1. GENERATION NORMATIVE		2. COVERAGE NORMATIVE			3. HAND OVER METHOD
		QUANTA (Kgs/km)	COMPOSITION (%)	VEHICLE	COVERAGE	HOURS	
1.	Major Road	30 kgs/km	Inerts 100% OR Leaf Litter* 100% <i>*Leaf litter waste would be easier to collect in large volumes only in specific streets with dense foliage</i>	Sweeper (1 bag)	0.35 kms	4 hrs	Sweeper: 2 Bags Small volume bags of 5 - 7.5 kg volume (carried, to collect waste at the time of sweeping) Large volume bags of 15 kg capacity (remain stationary at the mid point of the area - collection point) Auto Tipper: Collect the Street sweeping inert / leaf waste from the Large Volume bag and directly tip into tipper. Bags collected to be re-used
				Auto Tipper	10 kms (28 stops)	2 hrs	
2.	Intermediate Road			Sweeper (2 bags)	0.50 kms	4 hrs	
				Auto Tipper	10 kms (20 stops)	2 hrs	
3.	Minor Road			Sweeper (2 bags)	0.50 km	4 hrs	
				Auto Tipper	10 kms (20 stops)	2 hrs	

Table 03: New Normative standards for Street Sweeping of Roads & Streets

ROADS & STREETS

4. PROCESS OF COLLECTION & TRANSFER



LEAF WASTE OR INERT WASTE
 (Daily sweeping for Major and Intermediate roads
 Alternate day for minor roads)

SECONDARY COLLECTION & DROP-OFF - WITHIN WARD






WASTE STREAM	VEHICLE	PICK-UP FROM	DROP-OFF DESTINATION
 WET WASTE	Auto Tipper (Tipper)	Residential (High Income, Mixed & Low Income)	Bio-methanation / Composting Facility (Upto 5 TPD capacity) <u>OR</u> Lorry Point (Excess above 5 TPD & if no Bio-methanation / Composting Facility)
	Luggage Auto (Bins)	Commercial (All) & Residential (Slum)	
 DRY WASTE	Luggage Auto (Jumbo Bags)	Residential & Commercial	Dry Waste Collection Centre / Designated location
 SANITARY WASTE	Auto Tipper (Bin)	Residential	Lorry Point (Holding receptacle) <u>TO</u> Dry Waste Collection Centre (Collection point)
 LEAF WASTE	Auto Tipper (Tipper)	Roads with dense foliage	Leaf Waste Composting Facility/Shredder/ Designated location
 INERT WASTE	Auto Tipper (Tipper)	Roads & Streets	Lorry Point (to be put in a separate 5 Tonne compactor)
	Auto Tipper (Tipper) / Luggage Auto (Bags)	Dry Waste Collection Centre (DWCC)	Lorry Point (to be put in a separate 5 Tonne compactor)

Table 04: Secondary transfer & drop-off within ward

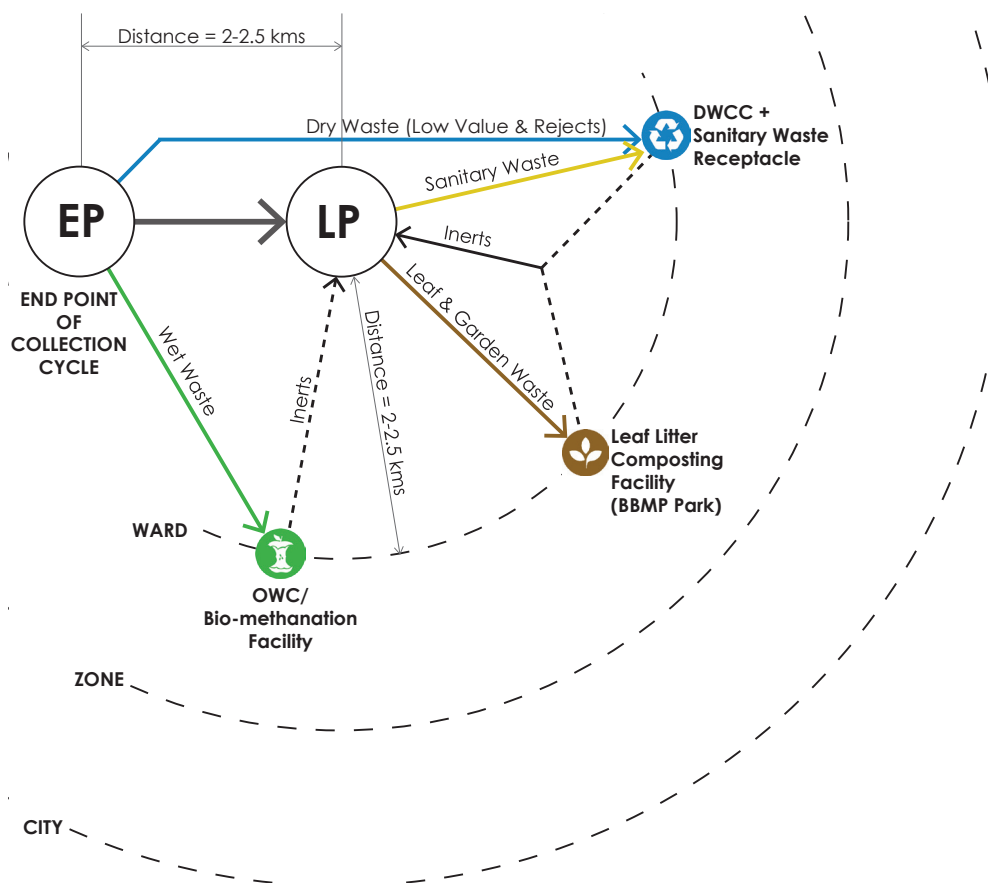


Figure 06: Drop-off destinations at ward level

(These locations are indicative of planned facilities and will finally be assigned by the BBMP)

SECONDARY COLLECTION & DROP-OFF - OUTSIDE WARD







WASTE STREAM	VEHICLE	PICK-UP AT WARD DESTINATION	DROP-OFF DESTINATION OUTSIDE WARD
 WET WASTE	Compactor (10 tonne)	Lorry Point	Composting Facility (Zonal Integrated Yard)
 SANITARY WASTE	Auto Tipper/ Luggage Auto (Bags)	Dry Waste Collection Centre (Collection point)	Sanitary Waste Processing Facility (City Facility - Private)
 COCONUT WASTE	Auto / Special Vehicle	Processor pick up / Lorry Point	Briquetting Facility (Zonal Yard)
 INERT WASTE	Compactor (5 tonne)	Lorry Point	Landfill (City or Zonal Level)
	Compactor (5 tonne)	Lorry Point (includes low-value rejects from DWCC)	Aggregation Centre (Zonal Integrated Yard/ Constituency Yard)
 ANIMAL WASTE	Compactor / Auto	Collection Point	Dead Animal Incinerator (City Level)
 DEBRIS	Compactor / Auto	Lorry Point	Quarry (Zonal Level)

Table 05: Secondary pick-up & drop-off outside ward

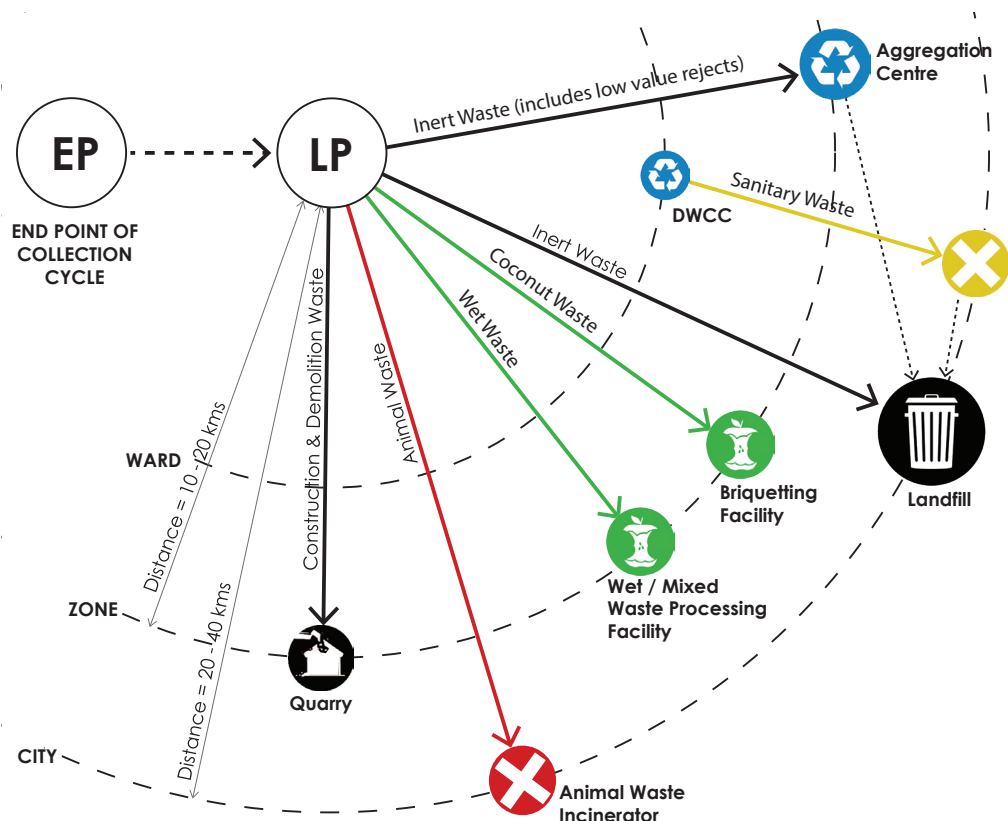


Figure 07: Drop-off destinations at zonal and city level
 (These locations are indicative of planned facilities and will finally be assigned by the BBMP)

SECONDARY COLLECTION & DROP-OFF - TRANSFER AT LORRY POINT

Lorry Point Specifications:

- Minimum 2-3 Lorry points to be allotted/ ward
- Area footprint can range from 270 to 300 sq.m.
- Should not be at crossroad or junction/main road area
- Preferably with a roof cover
- No Garbage on Ground is ensured as the method of transfer is only through Tipping and/or transfer from bin

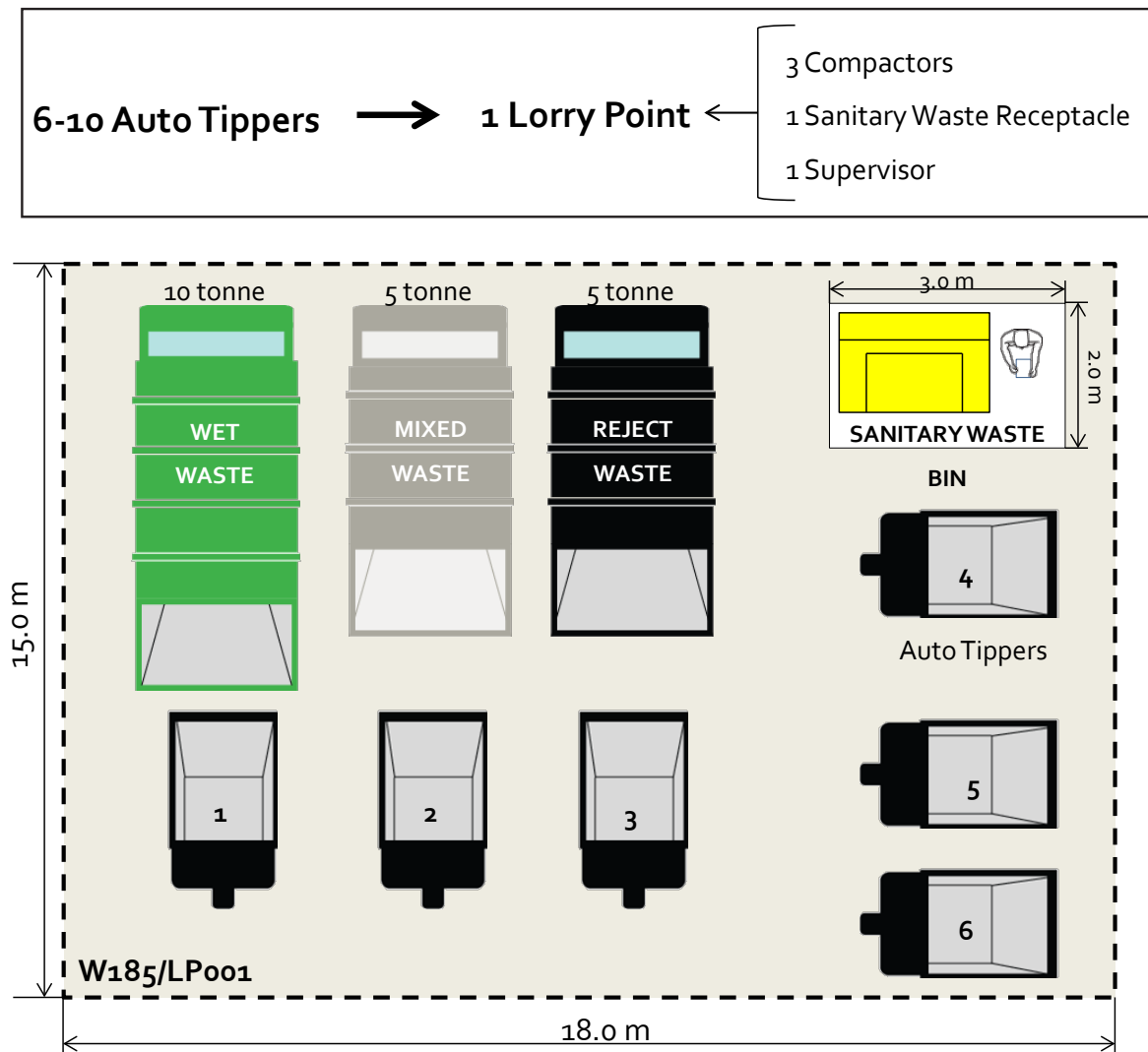


Figure o8: Layout for a typical lorry point (this is tentative and subjected to change post the 3 month pilot phase)

COMPARISON OF NORMATIVE STANDARDS

PARTICULARS	DETAILS	CATEGORY	NORMATIVE STANDARDS		
			Current Norm	Time & Motion Study	Proposed
Auto Tipper - Wet Waste	Door-to-door Collection From Households (HH)	High Income	1000 HHs	430	500 HHs
		Mixed		1250	1000 HHs
		Low Income		790	750 HHs
Luggage Auto - Dry Waste		High Income		390	400 HHs
		Mixed		820	900 HHs
		Low Income		440	500 HHs
Push Carts - Segregated Waste		Slum HHs	160	-	120 HHs
Sweepers (Pourakarmikas - PK)	Street Sweeping	Major Roads	1 km/PK	-	350 m/PK
		Intermediary Roads			500 m/PK
		Minor Roads			500 m/PK
Luggage Auto/Auto Tipper - Segregated Waste	Small Commercial Establishments (10 kgs)	Small Shops and Clinics	240 Units	-	200 Units
		Retail Units, Offices & Educational Institutions			67 Units
		Small Markets & Temples			40 Units
		Vegetable vendors			73 Units

Table o6: Comparison of Normative Standards

1.3.4. SPATIAL MAPPING OF WASTE TYPOLOGIES

GIS mapping is a tool that can be used at different stages of planning for Bengaluru's MSW Collection & Transportation System. The use of data to understand the spatial mapping of these generators identified by the study has resulted in the distribution of typologies as percentages, which then feeds into the estimation process.

The spatial mapping has been done ward wise for each of the 198 wards. As an example, the spatial mapping and its relation to estimation have been projected for a sample ward - Ward A. The three key maps that have been used for the process of estimation are as follows:

1. **Residential Generator Map** (Figure 09) - This map highlights the percentage distribution of household units within the ward.
 - *High Income Households (R-HI): 7%*
 - *Mixed Households (R-MI): 25%*
 - *Low Income Households (R-LI): 68%*
 - *Slums: Boundaries have been marked*
2. **Commercial Generator Map** (Figure 10) - This map is used to identify the spread of commercial units within the ward, and is used for the identification of roads with high commercial activity.
3. **Road Typologies Map** (Figure 11) - This map gives the distribution of road length to be swept within the ward limits
 - *Major Roads: 3.5 kms*
 - *Intermediate Roads: 1.9 kms*
 - *Minor Roads: 48 kms*

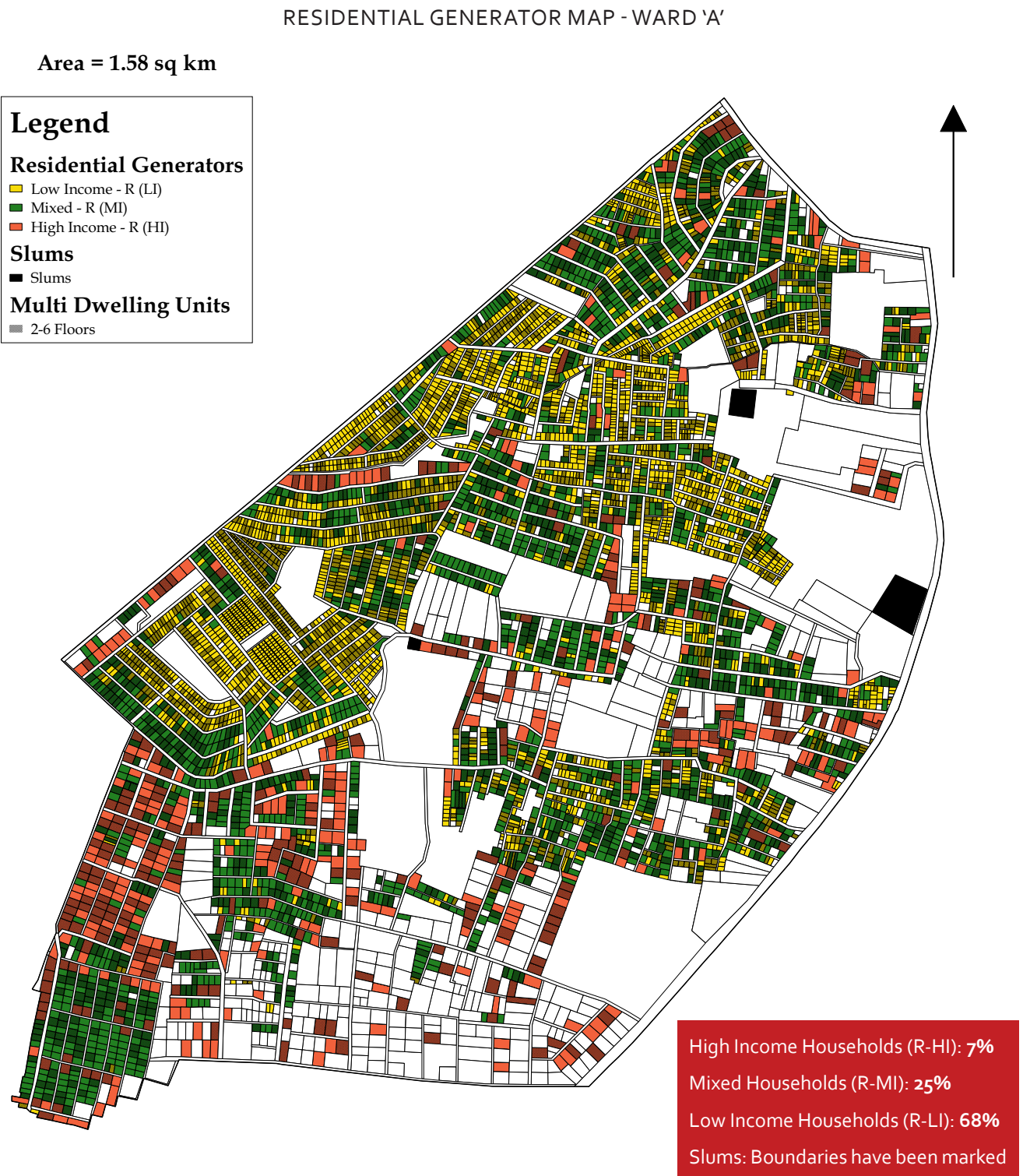


Figure 09: Residential Generator Map (Source: Data - BBMP, Map - CPPS, 2015)

COMMERCIAL GENERATOR MAP - WARD 'A'

Area = 1.58 sq km

Legend**Commercial Stretch**

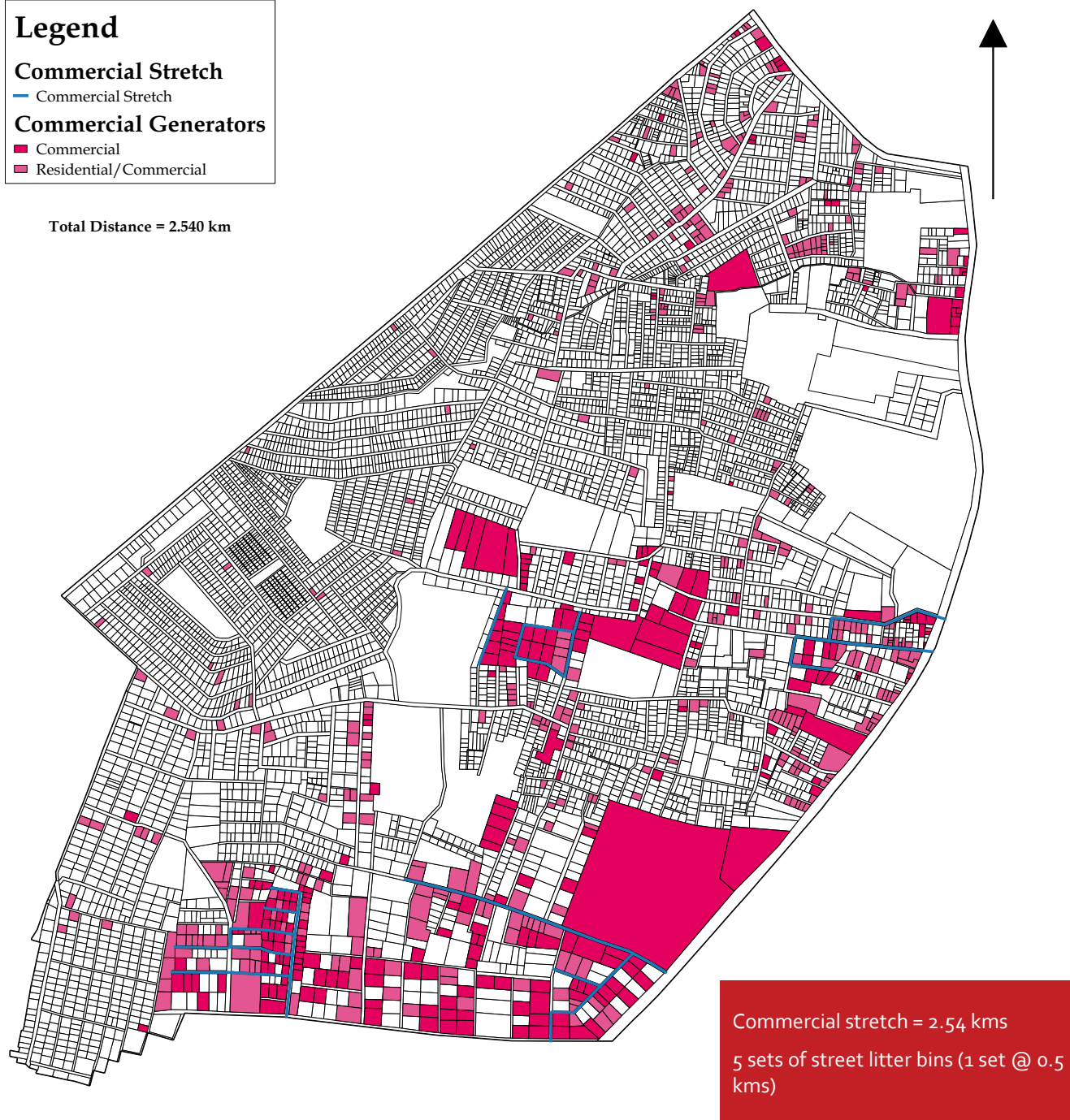
— Commercial Stretch

Commercial Generators

■ Commercial

■ Residential/Commercial

Total Distance = 2.540 km

**Figure 10:** Commercial Generator Map (Source: Data - BBMP, Map - CPPS, 2015)

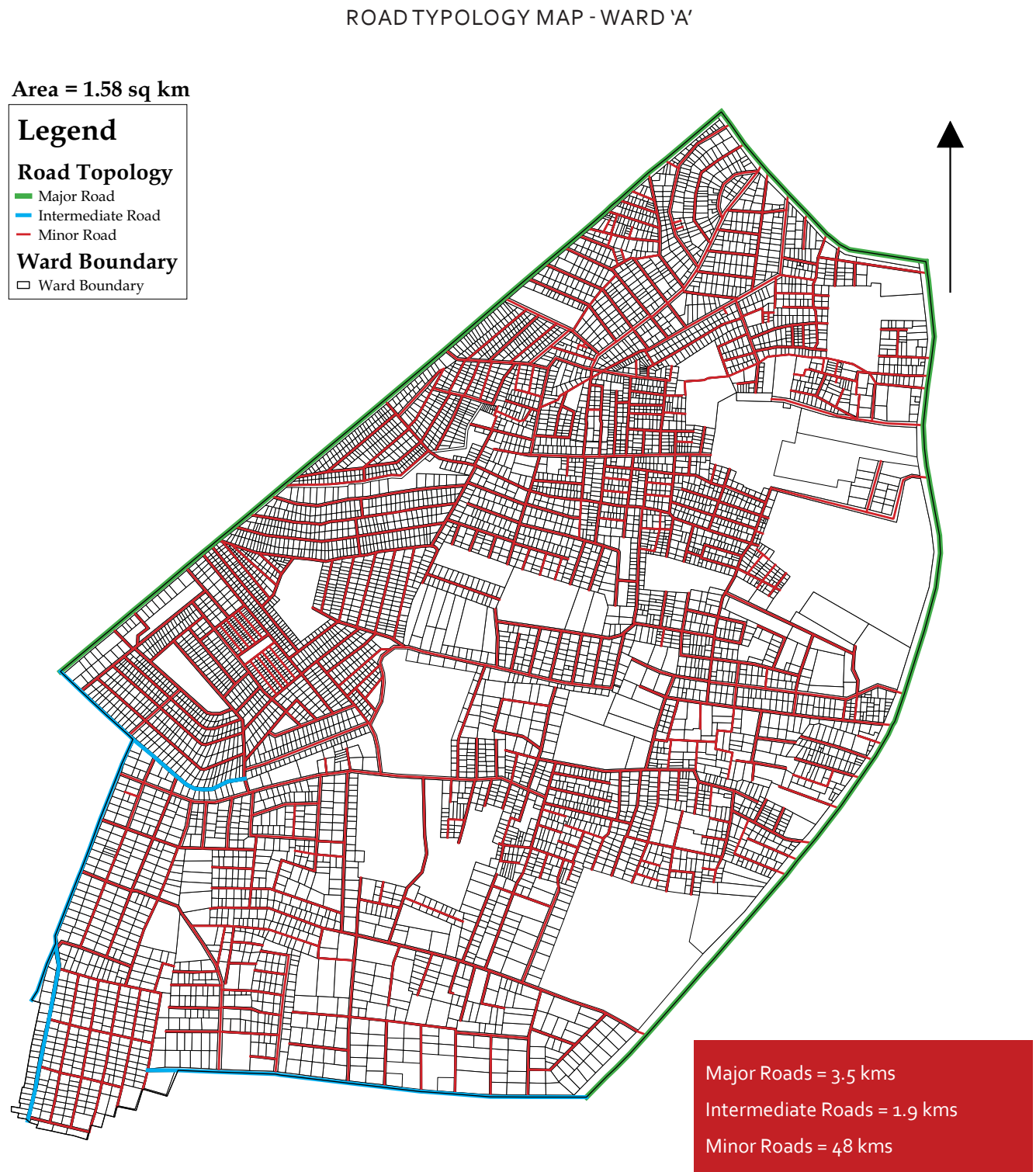


Figure 11: Road Typology Map (Source: Data - BBMP, Map - CPPS, 2015)

1.3.5. USE OF NORMATIVE FOR ESTIMATION

To further demonstrate the use of the new normative standards, figure 12 shows the break-up and use of the norms from multiple sources and the methodology of their application in the estimation process of the tender. These have then been applied to the above discussed ward (Ward 'A') as an example that demonstrates the estimation process.

The estimation on the quanta of waste by stream and the coverage determines the number of vehicles

required for both Primary and Secondary Collection and Transportation. The estimation process is shown in the form of three tables:

Part I: Primary Collection & Transportation (Table 07)

Part II: Secondary Collection & Transportation (Table 08)

Part III: Summary of Estimate (Table 09)

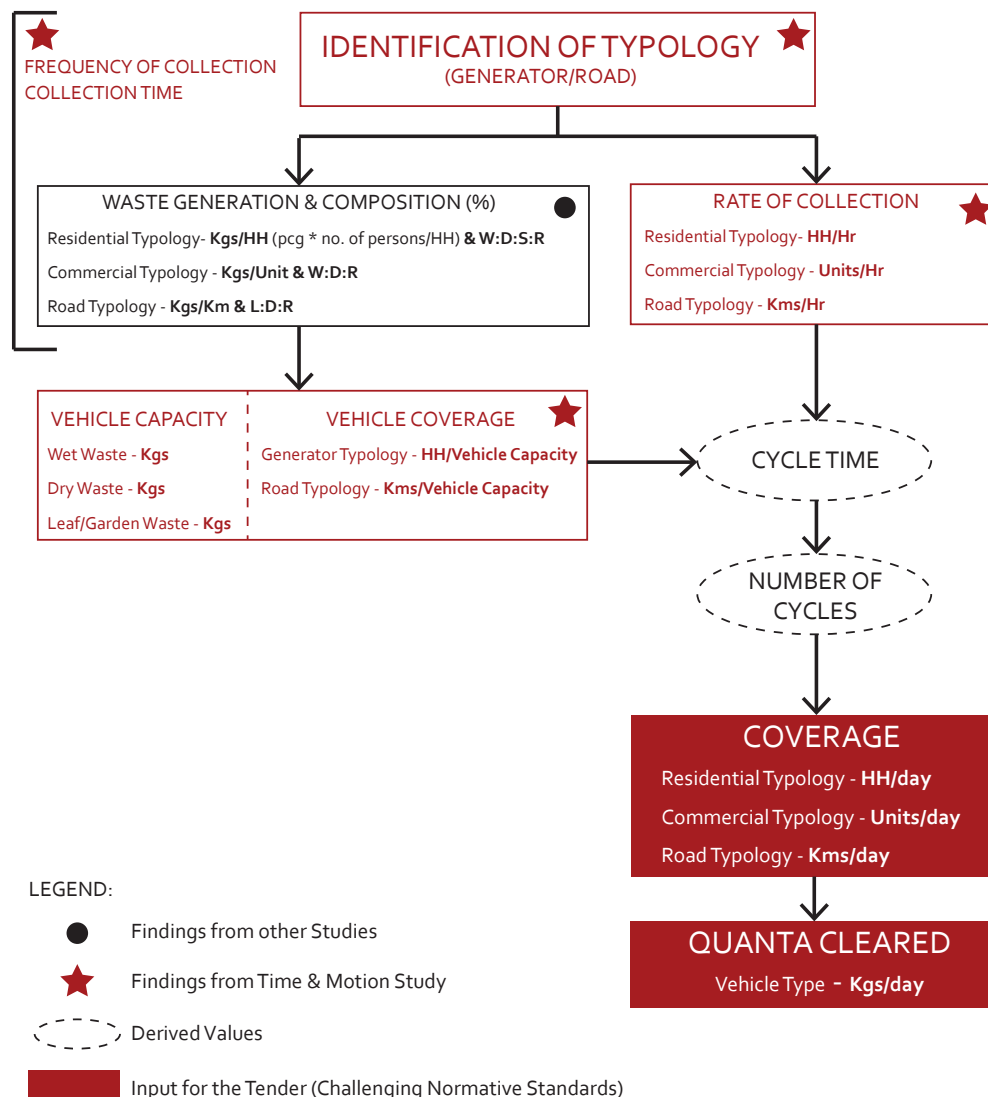


Figure 12: Application of New Normative Standards in the estimation and planning

PART I: ESTIMATION FOR PRIMARY COLLECTION & TRANSPORTATION - WARD 'A'

DESCRIPTION	NO OF HOUSEHOLDS / UNITS / KMS	GENERATION NORMATIVE	QUANTA (tonnes)	COVERAGE NORMATIVE	VEHICLES/LABOUR
Total Households	13397 Households		16.72 Tonnes		17 Auto Tippers 12 Luggage Autos (Alternate day collection) 4 Push carts 29 Drivers 33 Helpers/Collectors
Residential High Income (7%)	933	1.24 kgs/HH	1.16	500 HH (Wet Cycle) 400 HH (Dry Cycle)	2 Auto Tippers (Wet Cycle); 1 Luggage Auto (Dry Cycle)
Residential Mixed (25%)	3290	1.24 kgs/HH	4.08	1000 HH (Wet Cycle) 900 HH (Dry Cycle)	3 Auto Tippers (Wet Cycle); 2 Luggage Auto (Dry Cycle)
Residential Low Income (68%)	8759	1.24 kgs/HH	10.86	750 HH (Wet Cycle) 500 HH (Dry Cycle)	12 Auto Tippers (Wet Cycle); 9 Luggage Auto (Dry Cycle)
Slum	415	1.50 kgs/HH	0.62	120 HH (All streams)	4 Push Carts (All streams)
Total Commercial Establishments	322 Units		1.16 Tonnes		3 Luggage Autos (Redeployed)
Category 1	192	2 kgs/Unit	0.4	200 Units	1 Luggage Auto (All streams)
Category 2	130	6 kgs/Unit	0.8	65 Units	2 Luggage Autos (All streams)
Category 3	0	10 kgs/Unit	0	40 Units	-
Total Road Length	53.4 kms		0.9 Tonnes		5-6 Auto Tippers (Redeployed) 62 Sweepers
Major Roads	3.5	30 kgs/km	0.1	350 m/Sweeper 10 km/Vehicle	10 Sweepers
Intermediate Roads	1.9	30 kgs/km	0.06	500 m/Sweeper 10 km/Vehicle	4 Sweepers
Minor Roads	48 (only 24 kms swept daily)	30 kgs/km	0.72	500 m/Sweeper 10 km/Vehicle	48 Sweepers

Table 07: Estimation of Vehicles and Manpower - Primary Collection and Transportation

PART II: ESTIMATION FOR SECONDARY COLLECTION & TRANSPORTATION - WARD 'A'

DESCRIPTION	COMPOSITION (%)	ESTIMATED QUANTA (kgs)	TOTAL QUANTA (tonnes)	VEHICLES/LABOUR
Wet Waste			12.3 Tonnes	1 Compactor (10 Tonne) 1 Compactor (5 Tonne) 2 Drivers 2 Helpers <i>Outside the Ward - to Integrated Yard</i> <i>*if there was a Bio-methanation Facility within the ward then the vehicle requirement would be:</i> 1 Compactor (10 Tonne) 1 Driver 1 Helper
Residential - High Income, Mixed & Low Income	70.6%	16.1	11.37	
Residential Slum	74.5%	0.62	0.46	
Commercial Category 1	35%	0.4	0.14	
Commercial Category 2 (offices & godowns)	25%	0.6	0.15	
Commercial Category 2 (Vendors)	91%	0.2	0.18	
Commercial Category 3	75%	0	0	
Dry Waste			4.8 Tonnes	1 Compactor (5 Tonne) 1 Driver 1 Helper <i>Outside the Ward - to aggregator at the Constituency Yard or Integrated Yard</i>
Residential - High Income, Mixed, Low Income & Slum	24.5%	16.72	4.10	
Commercial Category 1	65%	0.4	0.26	
Commercial Category 2 (offices & godowns)	75%	0.6	0.45	
Commercial Category 2 (Vendors)	9%	0.2	0.02	
Commercial Category 3	25%	0	0	
Sanitary Waste			0.8 Tonnes	2 Auto Tippers (1 Tonne) - redeployed <i>Inside the Ward - Lorry Point to Dry Waste Collection Centre (Collection Point)</i>
Residential - High Income, Mixed & Low Income	4.9%	16.1	0.79	
Residential Slum	1%	0.62	0.01	
Inert Waste			0.9 Tonnes	1 Compactor (1 Tonne) 1 Driver 1 Helper <i>Outside the Ward - to Integrated Yard/ Landfill</i>
Roads (Major, Intermediate & Minor)	100%	0.9	0.9	

Table o8: Estimation of Vehicles and Manpower - Secondary Collection and Transportation

PART III: SUMMARY OF ESTIMATE - WARD 'A'

TOTAL ESTIMATE	
Total Quanta	18.8 Tonnes (per day)
Wet Waste	12.3
Dry Waste	4.8
Sanitary Waste	0.8
Inert Waste	0.9
No. of Primary Vehicles	29 Autos, 4 Push Carts
Auto Tippers	17
Luggage Autos	12
Push Carts	4
No. of Secondary Vehicles	4 Compactors
10 Tonne Compactors	1
5 Tonne Compactors	2
1 Tonne Compactors	1
Labour	133 Employees
Supervisors (3 Lorry Points)	3
Drivers	33
Helpers	37
Sweepers	62

Table 09: Summary of Ward Estimate

1.3.6. CONCLUSION

The four part normative that has been established through the learnings of the Time and Motion study are not exhaustive for each generator typology or stream of waste. This however lays ground for the method of understanding these in order to plan for a better and more efficient MSW collection and transportation system.

The city adopting these for its new tender has kept a ratification period of three months from the roll-out date to check and ratify the norms proposed, as well as establish new norms through similar studies being conducted for other typologies and streams.

In addition to testing of the proposed norm, this three month period will look at collecting and ratifying base data on generators (including special needs specific to that ward), hence in the process creating a 'Data Repository' for city to have a better informed system. This will lay the basis for a closely monitored and accountable system.

As we move closer towards our vision of achieving a cleaner city amidst the challenges that come with rapid urbanisation and consumerism, it becomes crucial that normative standards are revised and assessed periodically. This enables the city to address the system in a way that helps better planning and accountability in the future.

THREE MONTH PILOT PHASE IN TENDER

A three month 'ratification period' has been included in the new tender, once the contract begins. During this time, the BBMP will further assess, ratify and establish the following:

- Proposed normative standards used for estimation
- Pilots conducted to help establish new normative standards for other streams & generators not captured (ex. Markets)
- Update and check base data on generators, leading to the creation of a data repository
- Special needs specific to wards will be identified and normative standards derived for that specific stream (ex. garden waste, bakery waste, etc.)

This document is an abridged version (Executive Summary) of the Time and Motion Study and is a referral document for the tender. The study explores the issues in the current Solid Waste Management (SWM) System in Bengaluru, and proposes new normative standards for stream-wise collection and transportation of Municipal Solid Waste in a decentralised manner.

The new tender includes door-to-door collection of waste from residential generators (independent homes and multi-dwelling units with < 50 units), small commercial generators (< 10 kgs) and street sweeping. The Time and Motion study reads the city spatially and classifies these generators and roads into typologies, which in turn are assigned normative standards. The proposed norm for Primary collection and transportation is divided into four parts - generation, composition, hand-over method and process. The norm for Secondary collection and transportation includes - drop-off destinations and method for transfer of waste. These norms have already been applied in the estimation and planning process for the ward collection and transportation tender released in 2015.

