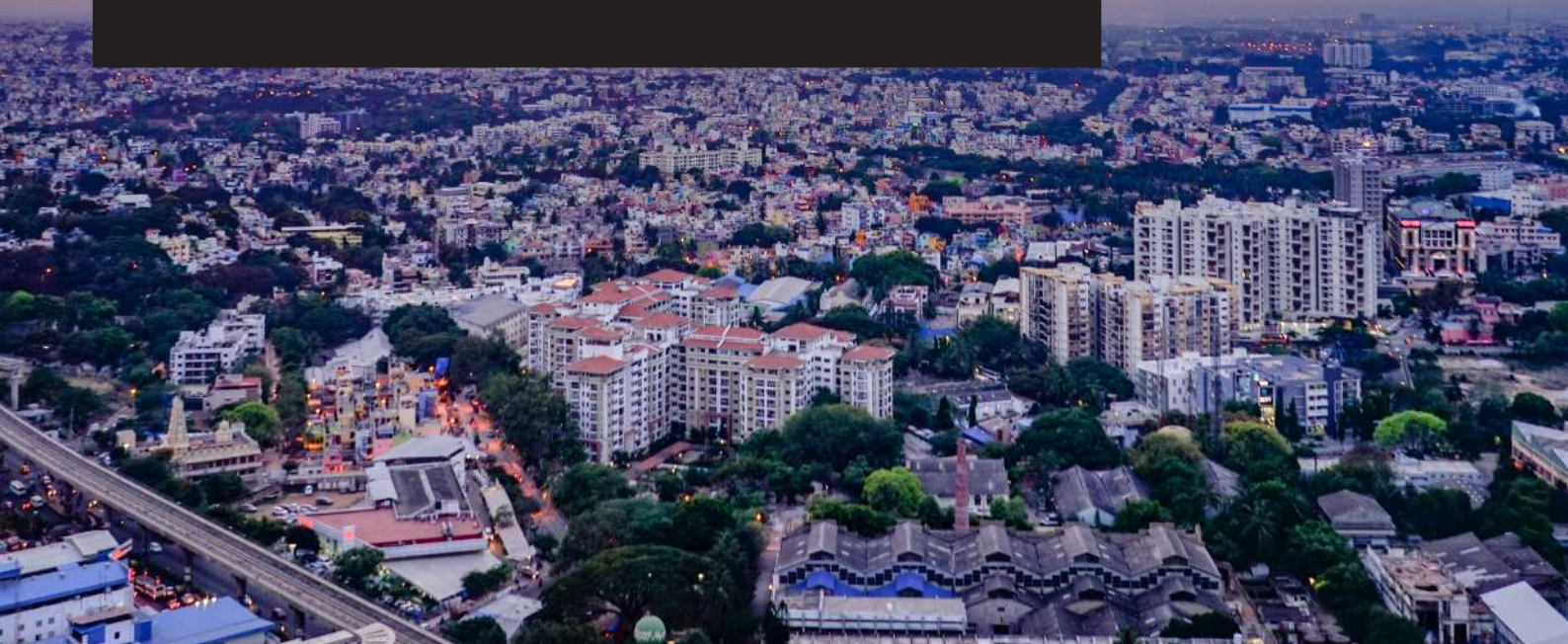


INCLUSIVE CLIMATE ACTION PARTICIPATORY APPROACHES IN SOLID WASTE MANAGEMENT FOR BULK WASTE GENERATORS IN BENGALURU

A BASELINE ASSESSMENT REPORT



**C4O
CITIES**

Acknowledgements

This assessment report received generous support in funding from Porticus as part of the C40 Cities Global Green New Deal Pilot Implementation Initiative.

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Sincere gratitude is extended to all the participants

(as detailed in Annexure 1) for their valuable insights during the stakeholder engagement process, which have greatly enriched this report.

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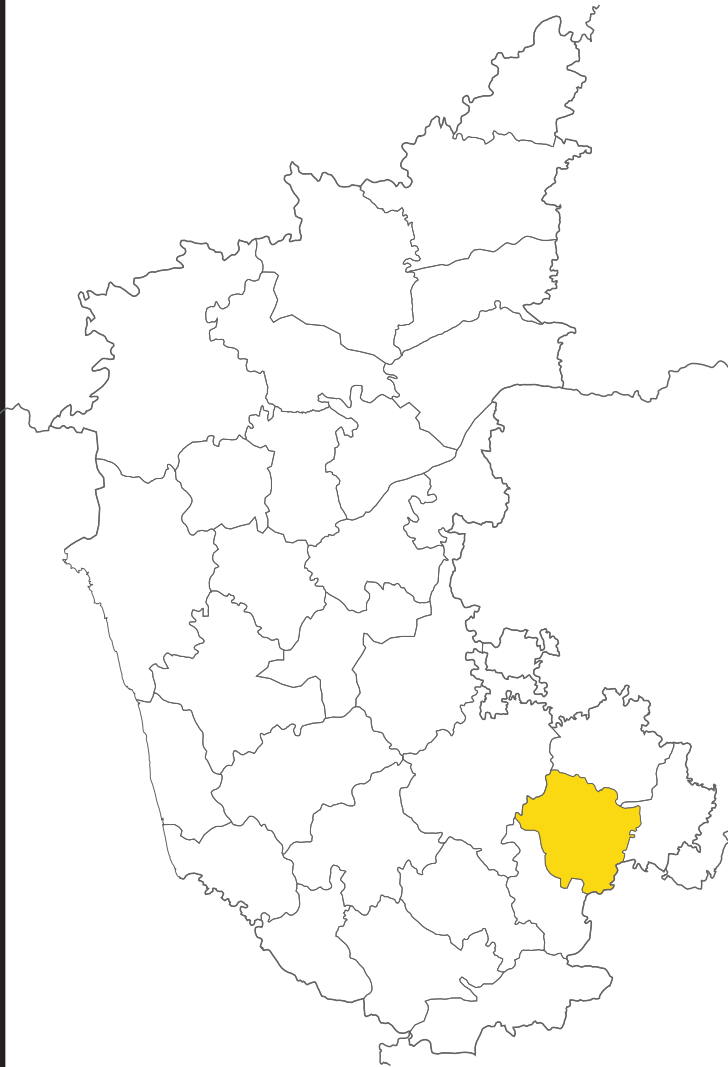
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List of abbreviations

AEE	Assistant Executive Engineer
BBMP	Bruhat Bengaluru Mahanagara Palike
BWG	Bulk Waste Generator
CAP	Climate Action Plan
CBG	Compressed Biogas
CPCB	Central Pollution Control Board
GGND	C40's Global Green New Deal
GHG	Greenhouse Gas
HCF	HSR Citizen's Forum
HDPE	High Density Polypropylene
ICA	C40's Inclusive Climate Action
IEC	Information, Education & Communication
IPCC	International Panel on Climate Change
JC	Joint Commissioner
JHI	Junior Health Inspector
NGO	Non-governmental Organisation
PET	Polyethylene Terephthalate
RWA	Resident Welfare Association
SE	Superintendent Engineer
SWM	Solid Waste Management
SWMRT	Solid Waste Management Round Table
TPD	Tons Per Day

1. Executive summary



Bengaluru, the capital of Karnataka, is one of the fastest urbanising cities in India and this rapid urbanisation has resulted in various challenges in solid waste management - lack of infrastructure, limited capacities and monitoring, inequitable working conditions for the waste workers who handle the city's waste. These challenges also provide an unequivocal opportunity to strengthen solid waste management practices in a way that delivers both social and climate benefits for the city residents. Bengaluru joined the C40 Cities network in 2017 and the Bruhat Bengaluru Mahanagara Palike (BBMP) - which is the administrative authority for the city - initiated the Climate Action and Resilience Plan for Bengaluru (BCAP) in 2021 and is now in the advanced stages of preparing its BCAP for adapting to climate change impacts including addressing concerns relating to waste management. Bengaluru is the first city in South West Asia to participate in C40's Global Green New Deal (GGND) pilot implementation initiative led by C40's Inclusive Climate Action (ICA) Programme.

For Bengaluru, under the GGND pilot, the C40 team in consultation with BBMP has identified 'bulk waste management' as an area with potentially high impact with regard to driving the inclusive climate action agenda. This is primarily because of two reasons: firstly, bulk waste management through its core idea of on-site waste management contributes significantly to climate action due to decentralised management of biodegradable waste and reduced transportation of waste to processing facilities in the outskirts of the city. Secondly, waste management in cities employs a large workforce with many vulnerable groups such as waste collection

and processing staff and these groups are more invisible when servicing bulk waste generators (BWGs) compared to non-bulk waste generators. BWGs are not serviced by the BBMP but by private service providers, hence they are more invisible and addressing their inclusion becomes more challenging.

While BWGs contribute 35-40% of the city's waste and BBMP regulations mandate BWGs to take responsibility for managing their biodegradable waste, there are several gaps in the capacity of the key stakeholders, processes, implementation, enforcement and monitoring of these regulations (CSE,2023).

This report presents an assessment of the gaps and needs in bulk waste management with respect to the policy, processes, capacities and also the conditions and needs of the vulnerable groups engaged in this system. It discusses how collaborative and participatory efforts to execute decentralised waste management systems can accelerate prior work done in the city with regard to BWGs, in an integrated and inclusive manner while also addressing the climate action needs.

Methodologically, the study adopted an in-depth approach of analysing one zone in the city, which involved identifying all types of stakeholders in the BWG ecosystem of Bommanahalli zone and thereafter, engaging with them using different participatory tools. A zonal focus helped reduce the impact of many other extraneous factors such as the role of the zonal administration, private service provider services, overall hygiene and sanitation conditions etc. A diverse set of stakeholders including BBMP officials such as Joint Commissioner (JC), Superintendent Engineer (SE), Assistant Executive Engineer (AEE) and Junior Health Inspector (JHI), civil society groups, service providers, waste collection staff, contractors and waste processors were identified.

During stakeholder engagement, participatory tools such as semi-structured interviews, focus group discussions and workshops were especially effective for working with vulnerable groups, understanding a situation from the participants' point of view and developing action-oriented interventions that are beneficial and acceptable to all stakeholders. The participation of decision makers, implementers (including those who are vulnerable) and advocacy groups in the different consultations allowed for identifying challenges and opportunities for BWG waste management practices to be strengthened in a way that is inclusive and equitable.

While the city maintains a ward wise database of the BWGs, *it is severely underestimated, and*

no state or national inventory can provide the number of total BWGs, the quantum of waste generated by them and the amount of waste processed onsite. Therefore, each city must prepare an inventory of the existing BWGs after scientifically mapping, identifying and quantifying the waste generated and treated (Sengupta, 2023). Hence, a detailed mapping exercise of BWGs was done in 5 wards of Bommanahalli Zone. This also helped in assessing the climate action potential of the interventions in the BWG ecosystem due to onsite processing of biodegradable waste.

The findings from the study show that there is a need for various stakeholders to work in confluence to enforce existing policy regulations while also bridging gaps in terms of stakeholder capacities, implementation and monitoring systems for BWGs and other stakeholders in the ecosystem. While significant work has been done in the Bommanahalli zone in the past with respect to source segregation, there is a need to build capacities of the bulk waste generator ecosystem in ways that expands the number of BWGs who carry out onsite management of biodegradable waste and are compliant to regulations. This will reduce the load on the city's waste collection and processing systems while also mitigating GHG emissions.

The findings also show that there is limited support provided to ensure occupational safety, fair wages, job security, ergonomic safety equipment and access to welfare measures across different groups of workers, the most vulnerable being migrant workers. Participants in the stakeholder consultations identified challenges in implementing decentralised waste management and barriers to ensuring optimal enforcement and monitoring systems for BWGs, while also providing possible solutions and opportunities for improving policy, implementation and capacity building as part of the GGND pilot implementation in Bengaluru.

2. Introduction



Rapid population growth and urbanisation have resulted in low-income countries struggling to cater to rising solid waste management needs, with over 90% of waste often disposed of in unregulated dumps or openly burned (World Bank, 2022). In cities across India, poorly managed waste serves as a breeding ground for disease vectors, contributes to global climate change through methane generation and creates inequitable and unsafe working conditions for sanitation workers. It is estimated that Bengaluru generates nearly 5,000 tons of solid waste per day (KSPCB, 2021).

While a portion of the city's waste is dealt with by sanitation workers (pourakarmikas in Kannada) on the city's payroll, contractual waste collection staff and informal workers collect, sort and manage a large portion of the waste that is generated daily, including waste from bulk waste generators. These workers are stratified by degrees of vulnerability - those employed by the city

are supported by certain regulatory mechanisms and unions whereas informal migrant workers employed by labour contractors are at the lowest rung of the pyramid, with low wages, no regulatory support and a lack of job security (Raghavan, 2023). These working and economic conditions result in increased vulnerabilities to climate change; workers do not have access to proper housing or health care that will allow them to cope with extreme heat, floods and other adverse effects of climate change (Michael et al., 2017). Ironically, they play a pivotal role in reducing emissions and improving the city's response to climate change by diverting large quantities of BWG waste from landfills.

As part of its extensive work to improve solid waste management in Bengaluru, the BBMP issued a notification in 2012 that provided a clear definition of Bulk Waste Generator (BWG)¹ while mandating them to take responsibility for managing their waste

on-site or collaborate with approved service providers for off-site waste management. This initiative stood as a pioneering example, being the first of its kind in the Indian waste sector. Since this notification, Bengaluru has had an enabling ecosystem with many citizen groups and organisations providing critical support to bulk waste generators in implementing source segregation, providing community composting solutions and other technical expertise for decentralised waste management. However, over a decade later, there has been little progress in the effective implementation of this notification even though it has also been adopted in the national regulatory framework of the SWM Rules, 2016.

In the above context, C40 Cities partnered with Saahas NGO to undertake a pilot study in solid waste management on BWGs in the Bommanahalli zone, to understand the on-ground challenges and potential opportunities to strengthen capacities and support systems for improved solid waste management by BWGs. The baseline assessment was conducted using participatory approaches adapted to suit stakeholder consultations on SWM, with extensive engagement of all the different stakeholder groups that operate in the SWM ecosystem in Bengaluru. In particular, there

was a **focus on engaging with groups who are marginalised, vulnerable and excluded from consultative or decision-making processes. The insights compiled from all these stakeholder engagements**

have resulted in an assessment that sheds light on the challenges that the city faces in managing the waste produced by BWGs, highlights existing best practices, and identifies opportunities to improve equity and capacity building - all of which can inform future action.

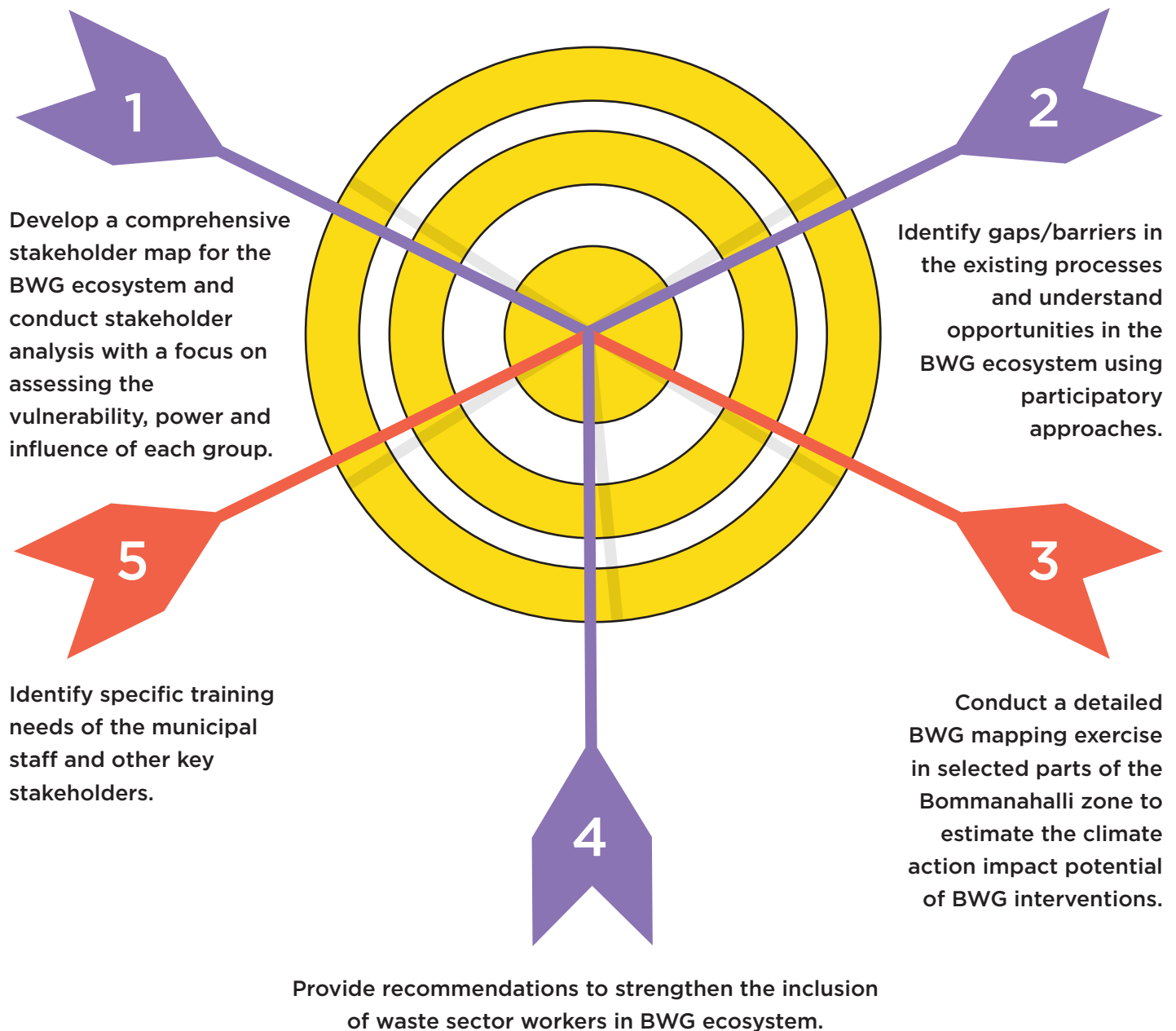
The overarching objective of the GGND pilot initiative is for cities to contribute as world leaders to the transition to net-zero and resilient economies by ensuring that local climate policies and initiatives are designed inclusively and have equitable impacts.

The GGND pilot initiative has been tailored to match the unique needs and contexts of each city. In Bengaluru, this means supporting targeted engagement by the city to advance inclusive climate action that will deliver on the priorities of the CAP through improved service delivery, planning, governance and overcoming socio-economic barriers through upskilling and capacity building of frontline workers (Junior Health Inspectors and waste workers) and zonal city officials involved in managing solid waste management by BWGs.

¹ Under the 2012 notice, "bulk waste generator" was defined as any commercial entity generating more than 10 KGs of waste per day or a residential apartment complex with more than 50 units. Since then, BWG classification for residential category has been increased from 50 units and above or 10 KGs of waste per day to 100 units. In case of commercial/institutional categories, it has been increased to 100 KGs of waste per day and/or located in an area above 5000 sq mts.

Objectives of the baseline assessment

To understand the current best practices, challenges and opportunities across the whole BWG system, stakeholder consultations were carried out in one municipal zone of the city - Bommanahalli, with the following objectives:



3. Waste and climate change

Globally, the waste sector typically accounts for 3 to 4 percent of total Green House Gas (GHG) emissions. However, this emission source only considers **direct emissions** primarily from landfill methane emissions and incinerators. In contrast, a **life-cycle perspective** of materials management-related GHG sources encompasses emissions from acquisition, production, transportation, consumption and end-of-life treatment which add up to almost 50% of the total emission (EPA).

As per the United States Environmental Protection Agency, half the global GHG emissions stem from the extraction and processing of materials, fuels, and food. Mismanaged waste is also impacting current ecosystems to sequester carbon. Plastic waste equivalent to one garbage truck is dumped in the ocean every minute across the world. This plastic breaks down into microplastics and contributes to climate change both through direct GHG emissions and indirectly by

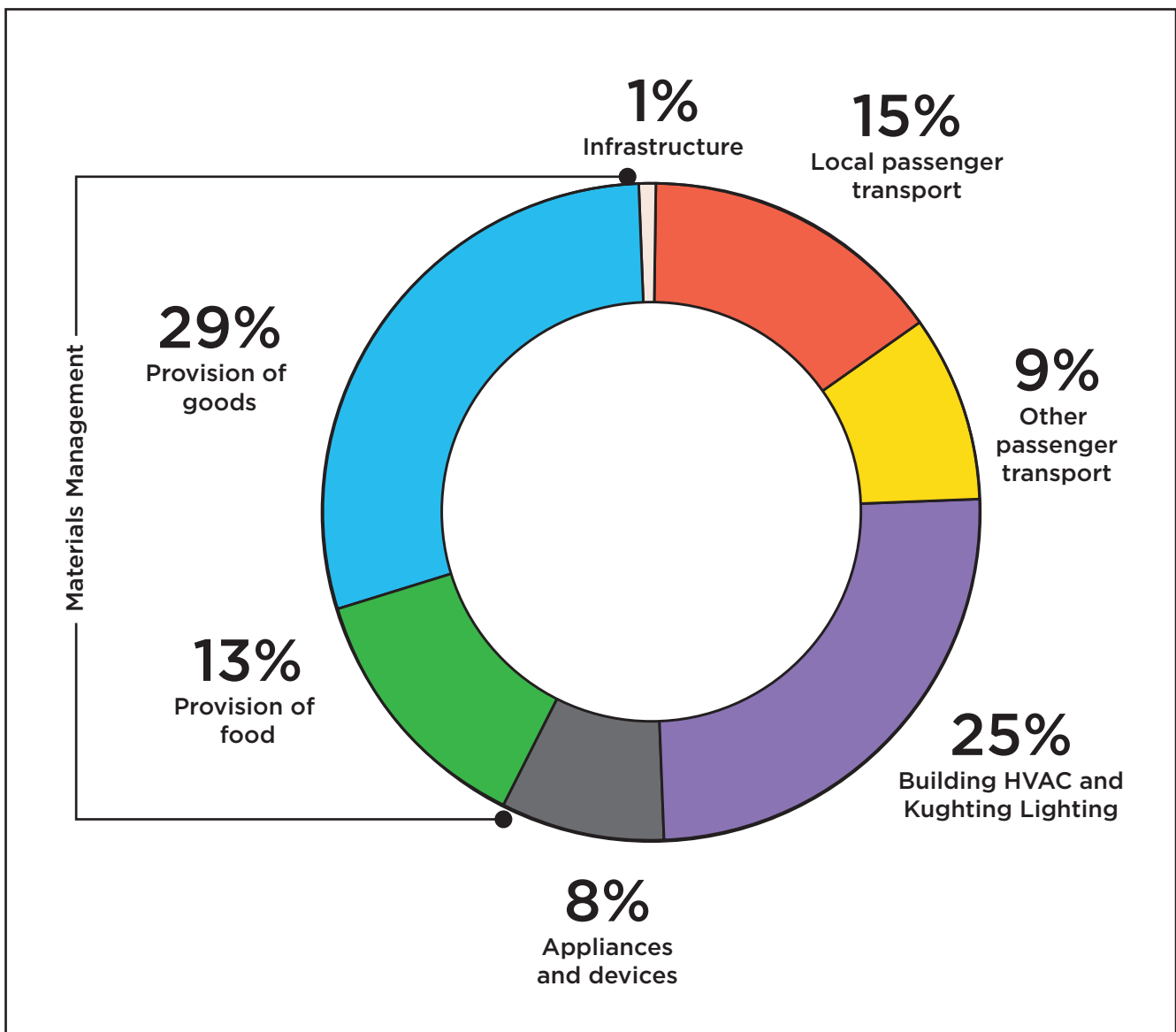


Figure 1: System-based GHG inventory US (Domestic) emissions, 2006

affecting ocean organisms. Plankton sequesters 30-50 percent of carbon dioxide emissions from anthropogenic activities, but after it ingests microplastics, plankton's ability to remove carbon dioxide from the atmosphere decreases (Bauman, 2019).

Direct waste management related emissions are primarily attributed to waste dumping, burning, incineration and transportation.

Typically in low-income countries, about 90% of the waste ends up in open dumps or is burned in the open (Kaza et al, 2018). Burning of waste in the open leads to the production of some very harmful climate pollutants such as black carbon and is responsible for half of the visible smog in cities like New Delhi.

The 20 year GWP (Global Warming Potential) of black carbon is up to 5,000 times greater than that of carbon dioxide (Tsydenova & Patil, 2021). Biodegradable waste, buried under piles of waste generates methane and carbon dioxide as it decomposes in anaerobic conditions.

India has more than 3,100 landfills and large dumpsites and it creates more methane from landfill sites than any other country

, according to GHGSat, which monitors methane via satellites.

Ghazipur is one of the biggest ones in Delhi, which on a single day in March, was spewing out more than two metric tons of methane gas every hour which if sustained for a year, would have the same climate impact as an annual emissions from 350,000 cars in the United States (Sud et al, 2022).

Transportation of waste is another big contributor to GHG emissions, which is dependent on the type of vehicles deployed and the distance travelled. With the NIMBY (Not in My Backyard) phenomenon taking hold and the lack of space within cities, waste is being transported long distances for processing and disposal. It is not uncommon in a city like Bengaluru that waste could be transported almost 80 km away from the point of generation for processing and/or disposal. The vehicles deployed for primary and secondary collection are most likely



heavy-duty diesel ones that are often poorly maintained and therefore generate significant GHG emissions.

Furthermore, cities in many developing nations faced with mounting waste management challenges are opting for waste incineration as the main solution to manage waste. It is often incorrectly promoted as a green, renewable source of energy. The energy equation in incineration is not very attractive when fed with mixed waste of low caloric value, which is the case in India, where the fraction of biodegradable waste is higher compared to developed countries.

Further, the source segregation rates are also better in many developed nations thus providing higher calorific waste for incineration. The GHG emissions from waste incineration are 580g CO₂eq/kWh (*Zero Waste Europe, 2019*) compared to 52 grams of CO₂eq/kWh (*UNECE, 2021*) emissions from rooftop solar electricity. GHG emissions of all other renewable energy sources are also much lower than that from waste incineration plants.

Hence, countries like India that are in the process of developing their waste management infrastructure must choose more sustainable solutions instead of getting tied down with capital and emission intensive waste incineration.

The lock-in impact of such capital-intensive projects has been detrimental in many developed nations because it creates a constant demand for high calorific value waste while starving the recycling industry of recyclables. Decentralised, in-situ waste management by BWGs can be a low hanging fruit in this journey of sustainable waste management practices.

4. Approach and methodology

4.1. Baseline assessment and stakeholder engagement

STEP

1

Desk based research

The first step of the baseline assessment was desk-based research on relevant regulations, various participatory approaches, documentation and case studies on solid waste management interventions. This research served as a foundation to map out potential stakeholders, their roles and their level of engagement in the waste management ecosystem in Bommanahalli zone. Through secondary research, we enlisted key government officials, community-based organisations, waste management entities, different types of BWGs and other organisations that play a role in waste management by BWGs in Bommanahalli zone. The involvement and participation of all these diverse stakeholders are key to evolving an inclusive approach to address the current gaps in the solid waste management of BWGs.

STEP

2

Stakeholder identification and mapping

A comprehensive and multi-dimensional stakeholder map for waste management in Bommanahalli zone was developed by combining the insights gained from secondary research and interviews. These interviews further helped understand the process, especially the community-led initiatives with respect to BWGs in this zone. It also helped enlist some additional stakeholders who were not prominently featured in existing literature, especially informal and vulnerable stakeholders. These informal and vulnerable stakeholders are also socially and economically disadvantaged and hence have a higher exposure to the impacts of climate change (*Michael et al., 2017*). To understand different dimensions of vulnerability, a framework was developed that classified these groups based on socio-economic conditions, nature of employment, demographic, environmental and health conditions, among others. Using these parameters, the stakeholders were assessed for vulnerability under the stakeholder map.

STEP

3

Development and execution of stakeholder engagement plan

After the identification of the stakeholders, a stakeholder engagement plan was developed using different participatory approaches for 10 (out of 12) stakeholder groups. These are a combination of decision-makers, direct actors (including those who are vulnerable) and advocacy groups. In the course of this project, community participatory appraisal tools and certain participatory urban planning tools were reviewed and adapted for the study.

Keeping these factors in mind, the stakeholder consultations and use of different participatory approaches were designed and adapted to suit each stakeholder group and to accommodate diverse sub-groups within these groups. For example, focus group discussions (FGD) were deployed to engage vulnerable groups who may be reluctant to communicate openly in a workshop format. For stakeholders with diverse interests and schedules such as service providers and waste processors, semi-structured interviews were employed as they speak more freely in one-on-one conversations. The multifaceted participatory approaches ensured the inclusion of each stakeholder group in these consultations, with special attention to reaching out to less empowered groups, to document their concerns and suggestions. Gender diversity was also integrated as a cross-cutting theme in the entire process to listen to the voices of the women as a large number of them participate in BWG waste management.

In all, **5 stakeholder workshops** and more than **25 semi-structured interviews** were carried out with **over 120 participants**. Details such as dates, engagement formats and participants for these workshops and interviews are available in **Annexure 1**. By creating safe spaces for stakeholders to openly share their experiences, opinions and thoughts, more inclusive and equitable conversations were facilitated. Intentionally listening and prioritising the experiences of those identified as most vulnerable in the solid waste management value chain helped develop insights into their specific needs and challenges. The consultations were further enriched by leveraging the resources of various agencies and stakeholders working with BWGs for solid waste management.

4.2. Mapping of BWGs

Typically, BWG databases available with the city administrators tend to be outdated and/or incomplete. Given that this data is critical for SWM planning, implementation of government schemes such as Swachh Bharat Mission (Urban) and Swachh Sarvekshan and understanding the climate impact of the waste generated by BWGs, the project included mapping of BWGs in five wards in Bommanahalli zone.

For geospatial mapping of BWGs, ward maps were obtained from the BBMP and thereafter, the field team along with the waste collection staff, mapped BWGs during the collection process using an online tool. The data from the field survey was reviewed, corrected,

harmonised and fed into Google Maps to create BWG maps. In addition, the waste collected from the BWGs was weighed in some cases and estimated in others (using the number and capacity of the bins). This led to the creation of a database of BWGs which included name, location, category of BWG and quantum of solid waste generated per day.

This database was thereafter used in interactions with BBMP representatives (as a part of stakeholder engagement) who found these to be very useful in their planning and budgeting of SWM activities. The waste data was also used to calculate the GHG-related climate impact due to onsite management of waste by BWGs.

5. Applicable legal and policy framework for the BWG ecosystem

5.1. Overview

The legal and policy framework for solid waste management in India has undergone significant evolution in recent years, with a focus on improving sanitation, cleanliness and waste management.

Several key policies and regulations have played a pivotal role in shaping this framework, including the Swachh Bharat Mission (Urban), Swachh Sarvekshan, and Solid Waste Management Rules, 2016.

The **Swachh Bharat Mission (Urban)** is a flagship program launched by the Government of India in 2014 with the primary goal of making urban areas in India clean and open-defecation-free. This mission emphasizes the construction of toilets, solid waste management infrastructure, and behaviour change campaigns to promote cleanliness and proper waste disposal.

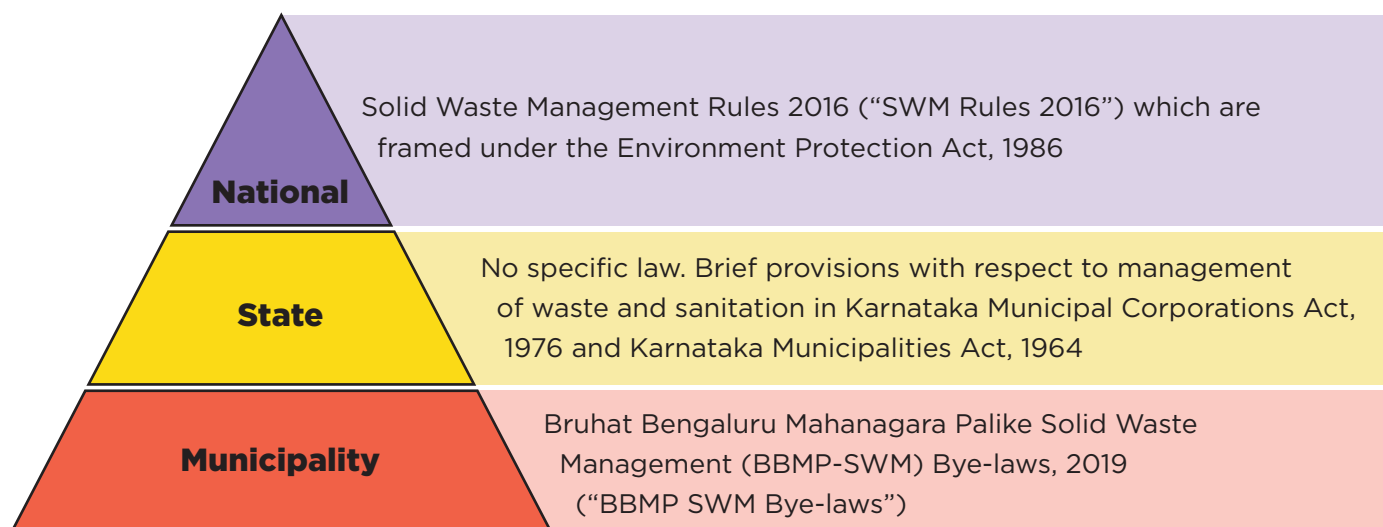
Swachh Sarvekshan is an annual nationwide cleanliness survey and competition conducted by the Ministry of Housing and Urban Affairs in India. It aims to gauge the progress of cities in maintaining cleanliness, adopting best waste management practices, and fostering behavioural change among citizens. It also ranks cities and towns based on various parameters, including waste management practices, sanitation infrastructure, and citizen feedback.

For example, the indicators under Swachh Sarvekshan 2023 for scoring and points in the competition include:

- Benefits extended to all sanitary workers include provision of personal protective equipment, training on waste management, linkages to government schemes and recognition of workers at ward level.
- Capacity building of all staff, from Sanitary Inspector and above which includes completion of 4 courses through e-Learning platform of Swachh Bharat Mission (U).
- Skill development training of sanitation workers through e-Learning platform of Swachh Bharat Mission (U).
- Bulk waste generators doing onsite processing of wet waste or getting the wet waste collected and processed by private players authorised by the municipality.

In this context, cities that want to perform well at Swachh Sarvekshan 2023 and its later editions would seek to provide benefits to their sanitary and waste workers, carry out capacity building and training sessions and encourage onsite management of wet waste by bulk waste generators. This can be leveraged to ensure participation and cooperation of BBMP representatives in carrying out skill development and empowerment training for different stakeholders in the BWG waste value chain.

The **regulatory framework** for solid waste management and BWGs in India is at national, state and municipality levels.



5.2. Who are BWGs

Under the BBMP SWM Bye-laws, BWGs are divided into residential, commercial and institutional and they are defined as:



Residential BWGs

• Apartments • Multi-dwelling units • Gated communities housing greater than 100 Units



Institutional BWGs

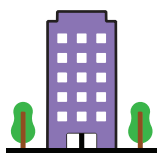
A • Any government, religious, educational, corporate, industrial, academic, research institution, campus, buildings occupied by the government departments or undertakings.

• Public sector undertakings or hospitals, nursing homes, markets, and milk sales.

• Outlets dealing with timber and horticulture like yards, nursery, gardens, all of which generates on an average more than 100 kgs of waste per day and/or located in an area above 5000 sq mts.

and/or

B • Any entity which carries out public outdoor events (trade fairs, public events, entertainment events/shows, rallies, sporting events), irrespective of any quantity of waste generated and area occupied.



Commercial BWGs

• All commercial entities which **generate on an average more than 100 kgs of waste per day and/or are located in an area above 5000 sq mts.**

5.3. Duties of BWGs

Source segregation

Under the BBMP SWM Bye-laws, BWGs are required to segregate solid waste at source of generation into the following categories:



↓

↓

↓

Authorized waste processor for collection, processing and disposal of segregated solid waste (including non-biodegradable waste, domestic hazardous waste and sanitary waste) on mutually agreed terms including fees for such services.

↓

Onsite management of biodegradable waste
(Processed through composting or bio-methanation within the premises itself, to the extent of space available)

↓

Offsite management of biodegradable waste
(If space within the premises is not available)

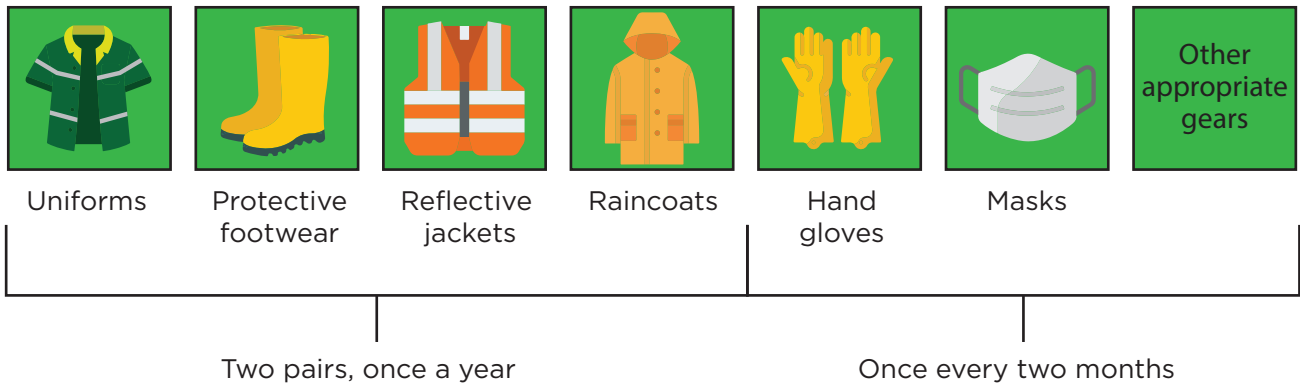
5.4. BBMP SWM bye-laws: Welfare, occupational safety and training

Welfare and Occupational Safety

Under the BBMP SWM Bye-laws, BBMP is required to comply with the following:

1. Issue identity cards to pourakarmikas and other eligible waste workers.
2. With regard to pourakarmikas and other eligible waste workers, compliance with all labour and welfare regulations, including wages, working hours, holidays, and statutory benefits like provident fund, employee's state insurance, and maternity benefits.

3. Provide regular medical check-ups for pourakarmikas² and other eligible waste workers to monitor occupational diseases.
4. Ensure the provision of following protective equipment and facilities to pourakarmikas, door-to-door waste collection staff, waste processing facility staff and other eligible workers:



Training

Under BBMP SWM Bye-laws, BBMP has the duty to provide the following:

1. Periodic training through reputable institutes or government agencies to educate pourakarmikas and its other workers involved in handling and management of solid waste on various topics relating to waste management.
2. Information to the public about composting, bio-gas generation, reuse and recycling and decentralised processing of waste at a community level by conducting training classes, seminars, workshops and Compost Santhes (markets or events promoting composting).

² Street sweepers who collect street sweeping wastes and carry out cleaning of public places.

6. Overview of Bommanahalli zone

Bommanahalli Zone is one of the zones located in the south of the city and it is further divided into 2 distinct divisions: Bommanahalli and Bengaluru South. Each of these divisions comprises 8 wards (which are proposed to be further split into 27 wards in the future) and the details of these wards are annexed as **Annexure 2**.

With respect to management of solid waste, the officials at BBMP are split between the head/central office and at zonal levels. The organisation structure below highlights the officials that are critical for the supervision and monitoring of solid waste management activities and processes at the head and zonal offices.

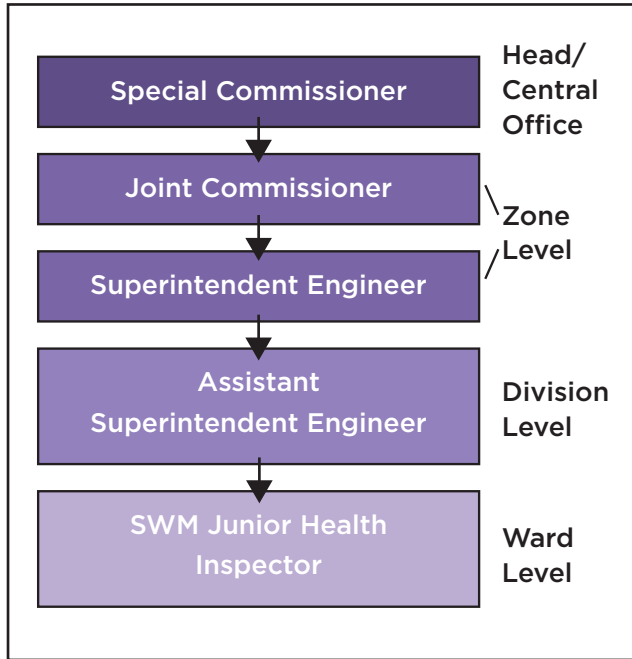


Figure 2: Organization structure

In addition, there is also involvement of the Health Department through Senior Health Inspectors who are also responsible for monitoring waste generators such as restaurants and hotels from a hygiene perspective.

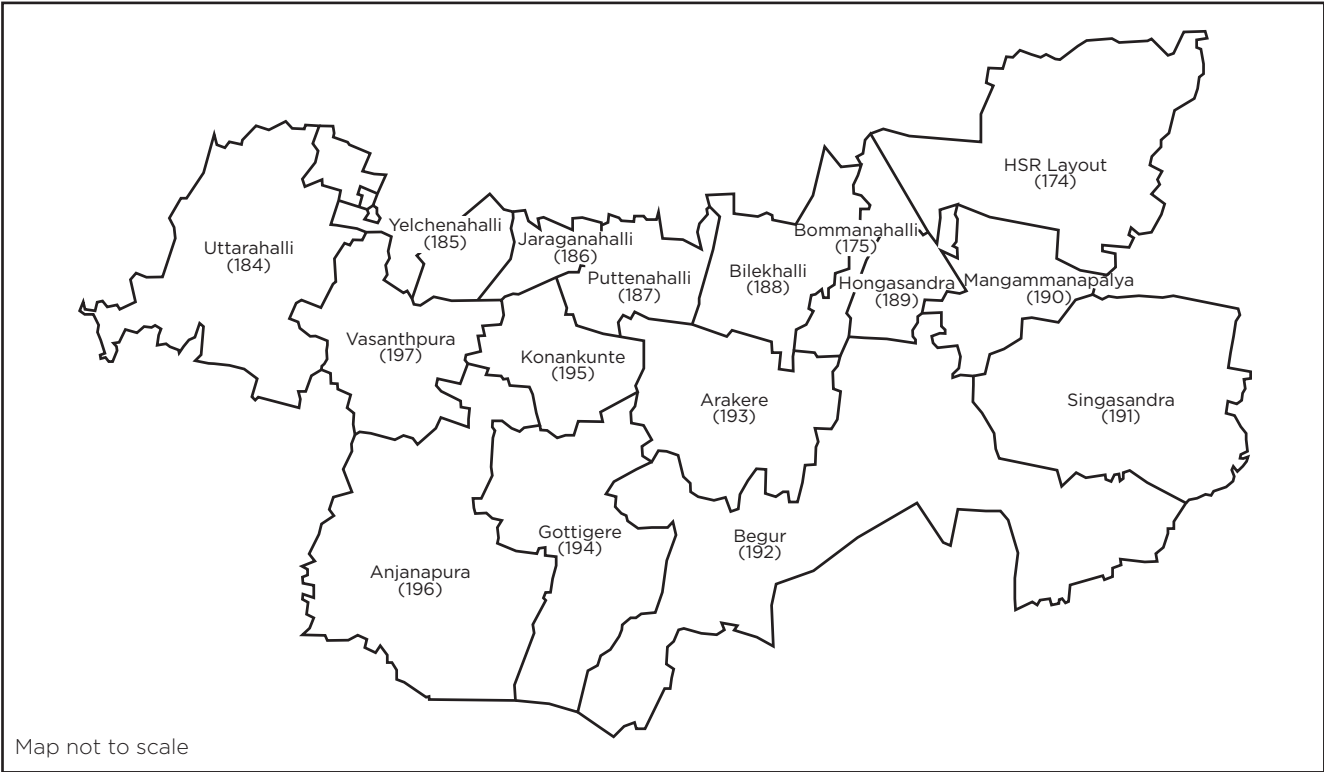
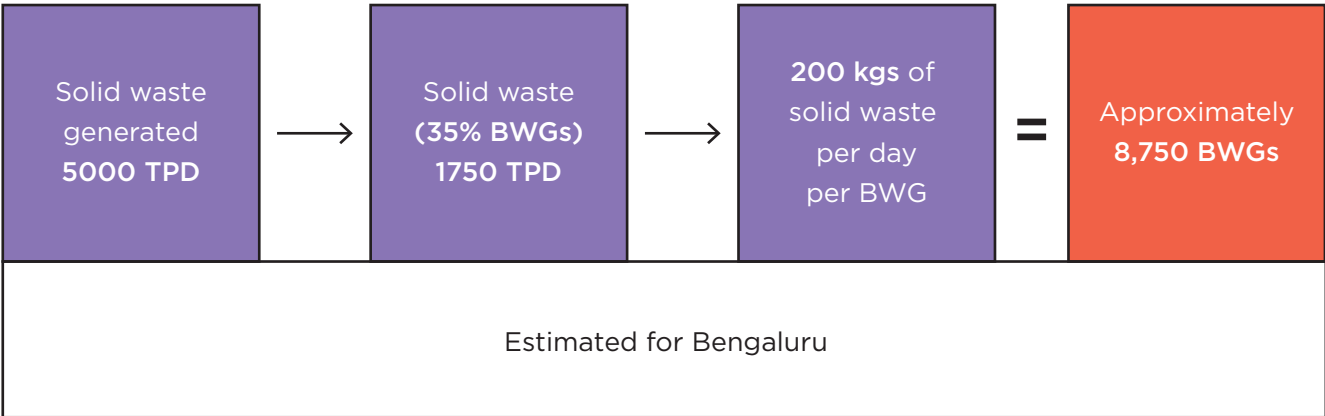


Figure 3: Bommanahalli zonal map with ward spatial distribution

7. BWGs in Bommanahalli and their climate impact

It is estimated that almost 30-40% of solid waste in a city like Bengaluru is generated by BWGs.

(CPHEEO, 2017)



7.1. Mapping of BWGs

As a part of this project, BWGs in 5 wards in Bommanahalli zone which included HSR Layout (Ward 174), Bommanahalli (Ward 175), Hongasandra (Ward 189), Mangammanapalya (Ward 190) and Singasandra (Ward 191) were mapped. The BWGs were categorised into:

Residential BWGs

Apartment complexes

Commercial BWGs

Hotels, restaurants with and without seating, supermarkets, tea shops/bakery/juice shops, marriage halls, office buildings, religious places & technology parks

Institutional BWGs

Schools, colleges, government and private institutions

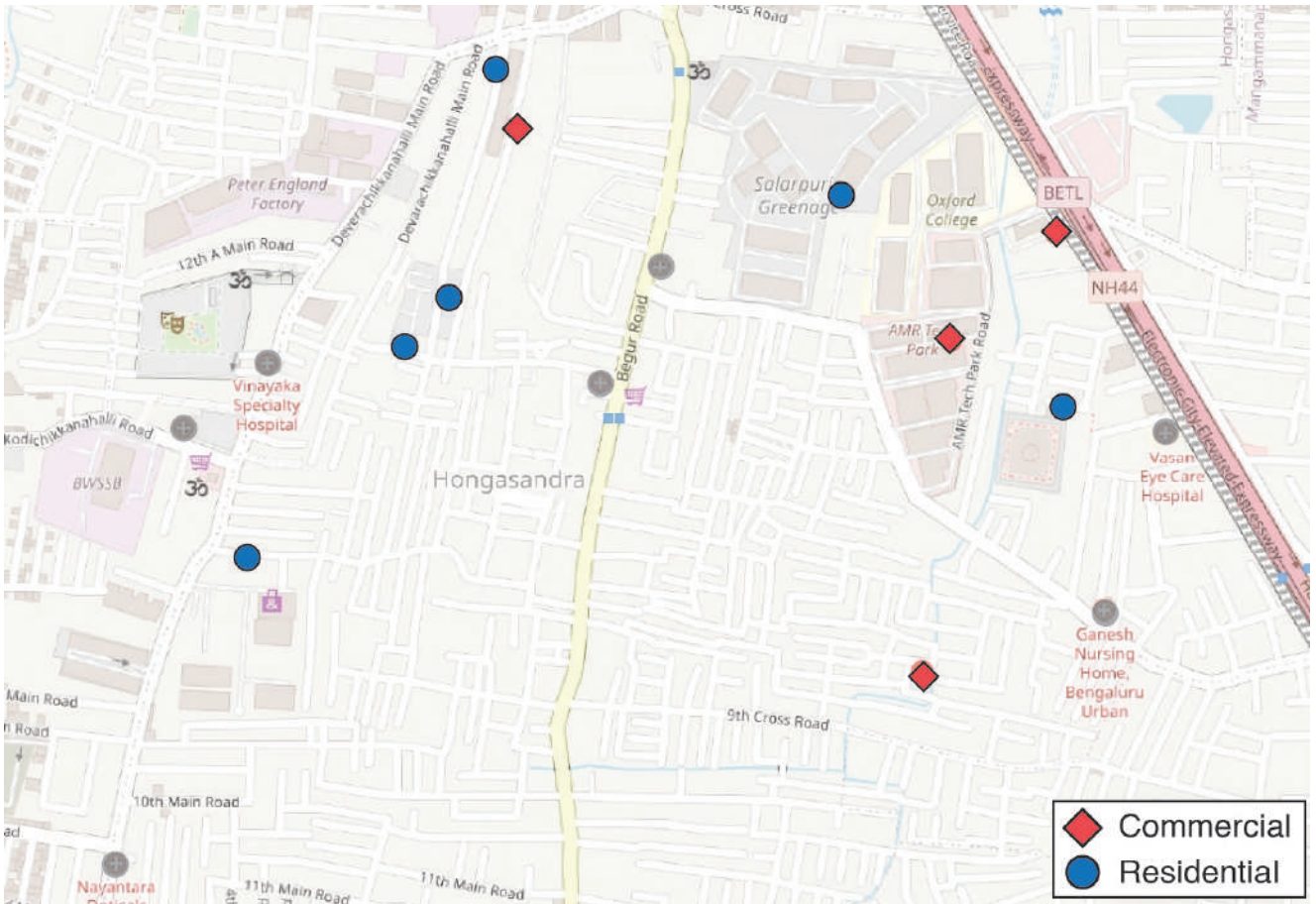


Figure 4: BWGs mapped in Hongasandra

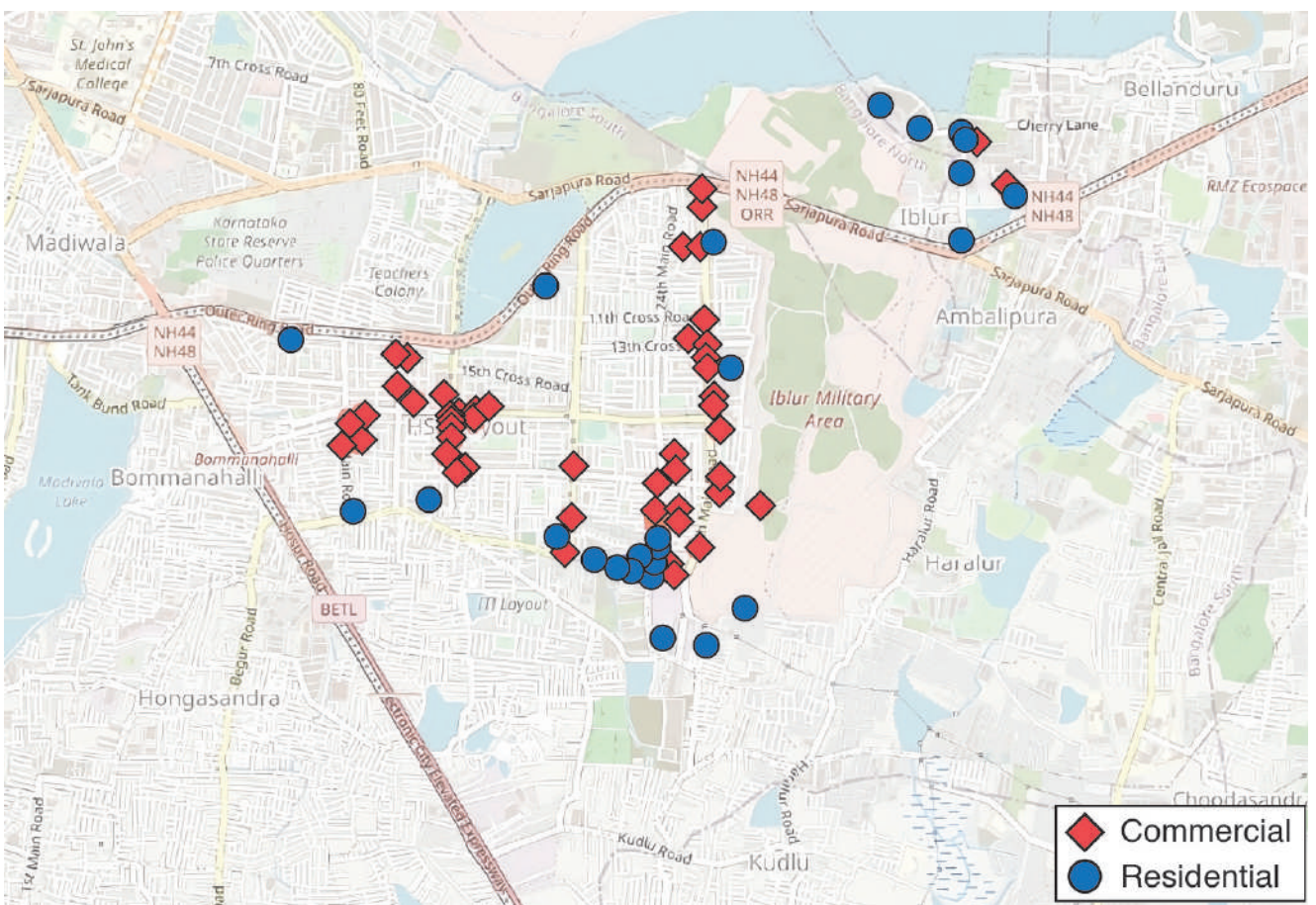


Figure 5: WGs mapped in HSR Layout

The mapping exercise identified a total of 183 BWGs in five wards and it was estimated that they generate approximately 42 TPD of solid waste. The graphs below illustrate the ward-wise and category-wise bifurcation of BWGs across the five wards. By applying the extrapolation methodology after removing outliers to encompass a broader scope of 16 wards, it can be reasonably inferred that the entirety of the Bommanahalli zone comprises of over 447 BWGs, thereby contributing to an approximate solid waste generation of 100 TPD.

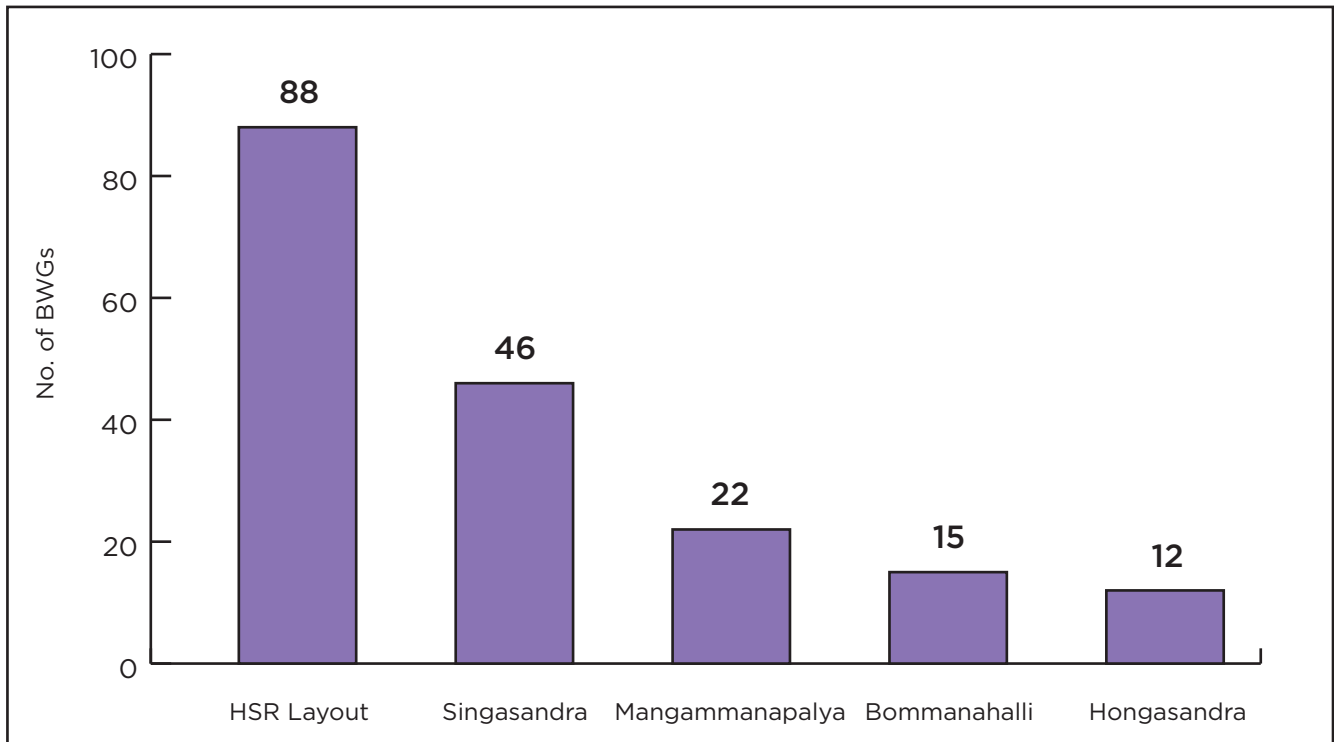


Figure 6: Ward-wise split of BWGs in 5 wards

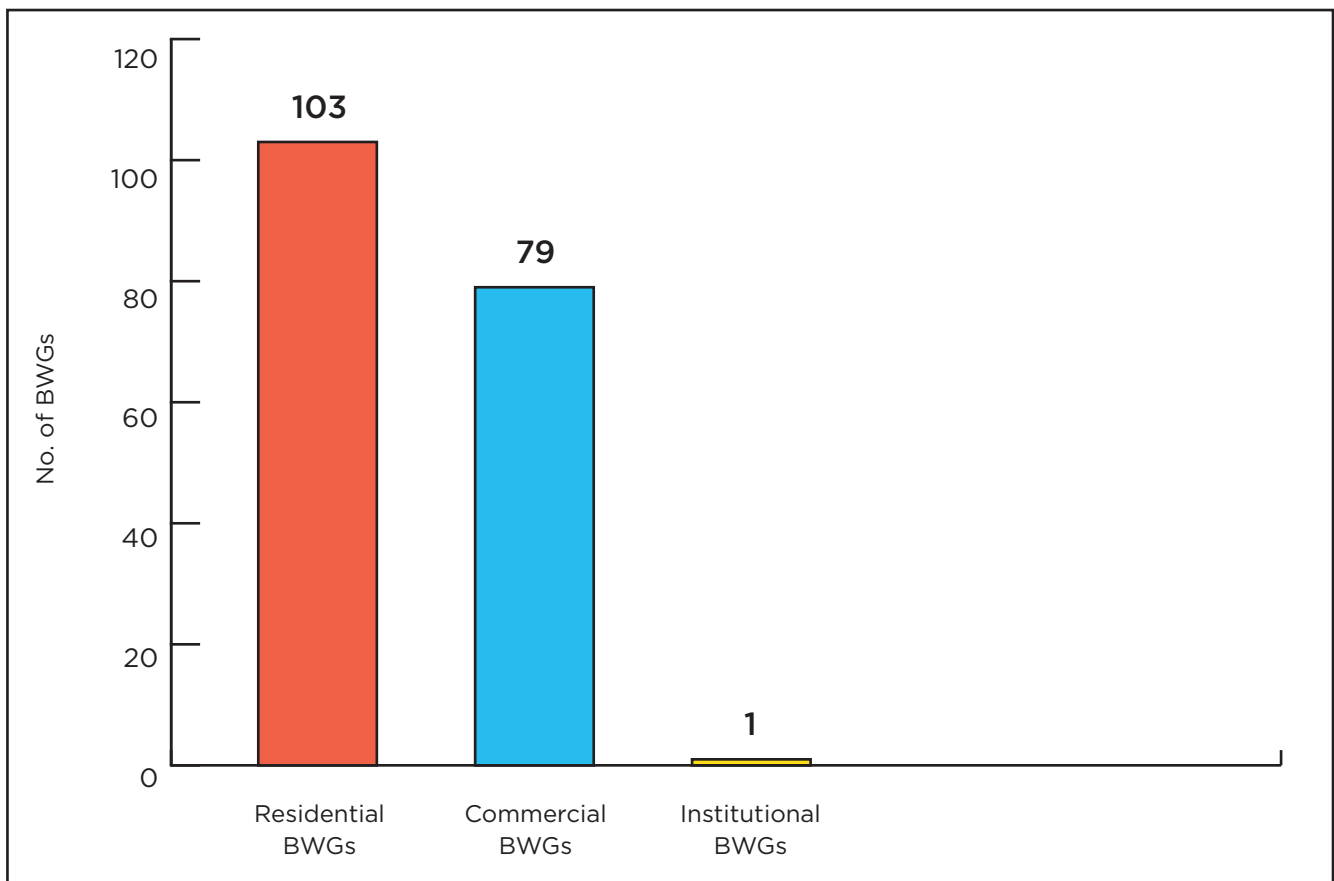


Figure 7: Category-wise split of BWGs in 5 wards

7.2. GHG emissions by BWGs

Overall GHG emissions per ton of waste managed at a city level are dependent on multiple factors, most importantly the waste composition. To get an estimate on the likely contribution of the BWGs, data was taken from a recent study done for the city of Ho Chi Minn in Vietnam, using the IPCC guidelines (Verma RL, Borongan G., 2022). The following section details the impact of BWGs segregating their waste and managing it within their premises as required by the regulations.



(i) Impact of segregation and biomethanation

Segregation would significantly improve the recycling potential of non-biodegradable waste. India has a large informal sector that sorts and channels non-biodegradable waste for resource recovery. Further, waste generated from residential BWGs or commercial BWGs such as offices and/or technology parks has a higher proportion of cardboard, white paper and high-value plastic waste such as PET and HDPE which has a better value proposition and recycling rates. Hence, the segregation of waste by BWGs is especially important to ensure improved resource recovery. **As per the US EPA estimate, every ton of waste recycled results in 2.89 tons of CO₂e reduction.**

Apart from the recycling of non-biodegradable waste, the segregated biodegradable waste from BWGs can be composted or sent to biogas plants. Waste generated by restaurants, hotels and other food joints is especially suitable for anaerobic digestion in biogas plants.

As per the study done in China, the **GHG reduction of about 1 ton CO₂e (Zhang et al., 2020) was estimated for 1 ton of food waste diverted from landfills and processed through anaerobic digestion.**

While reduction in GHG emissions due to anaerobic digestion of biodegradable waste is significant, it is challenging to operate decentralised plants that have a capacity of 100 kg to 5 TPD in a financially and operationally viable manner. Therefore, from a GHG perspective, it is best to transport biodegradable waste from BWGs to large biogas plants where the gas can be deployed

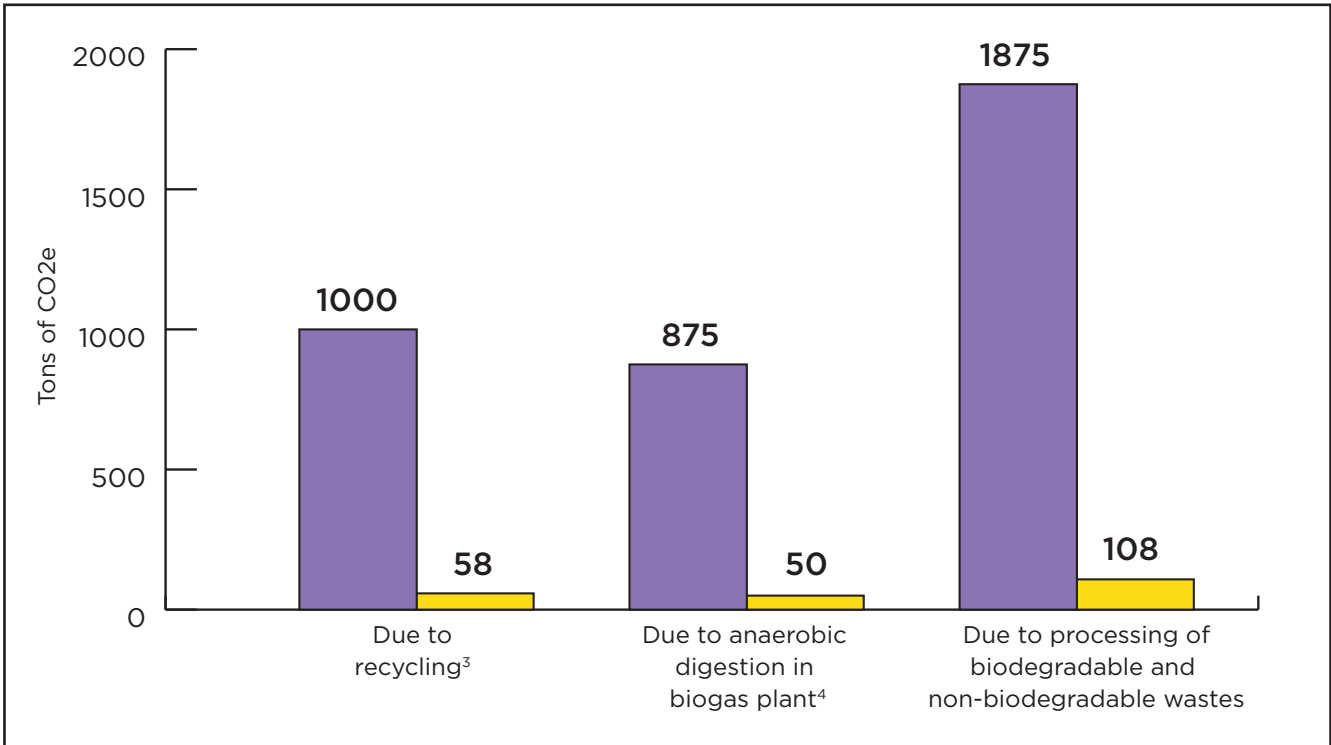


Figure 8: Daily GHG emissions reduction due to processing of waste at city and zonal level

as a replacement for fuel in the form of CBG (used for cooking or transportation) instead of the gas being used for electricity generation which is not attractive from energy generation (only 35% efficiency⁵) or GHG perspective (EPA, 2016). India’s energy neutrality is tied with expanding solar and shifting to electric or gas based transportation (Jain, 2023). The CNG infrastructure is getting ramped up with plans to finally replace CNG with CBG. This further tilts the scale in favour of CBG instead of direct power generation from biogas.

heavy-duty diesel compactor (most compactors deployed have a 10-ton loading capacity for transporting biodegradable waste) generates about 0.893 kg CO2e per kilometre⁶.

(ii) Impact due to reduction in transportation

The impact of on-site waste management in terms of GHG emissions is also seen through reduction in transportation. A typical

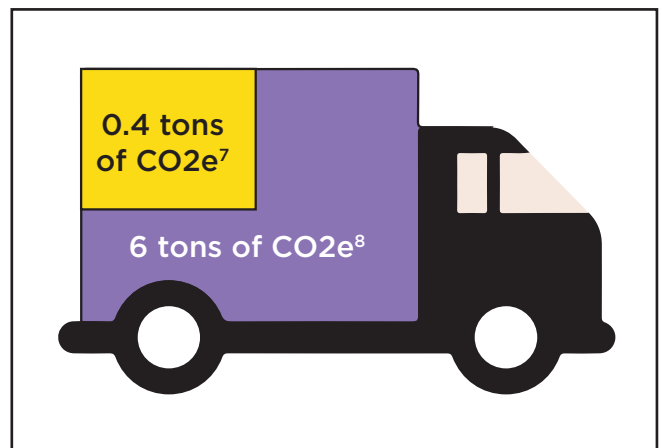


Figure 9: Estimated GHG emissions from transportation of waste

³ Assuming, 20% of the waste generated by BWGs is the recyclable non-biodegradable waste.
⁴ Assuming 50% of the total waste generated by the BWGs is biodegradable, this translates into 875 TPD of biodegradable waste being generated in Bengaluru and 50 TPD of biodegradable waste being generated in Bommanahalli Zone.
⁵ Beschkov, 2021 (Source: <https://www.intechopen.com/chapters/79776>).
⁶ 1 ltr of diesel generates 2.68 kg of CO2e. (Source: <https://connectedfleet.michelin.com/blog/calculate-co2-emissions/>) and the typical fuel efficiency is 3 km per ltr hence 0.893 kg of Co2e per km.
⁷ Assuming the waste needs to be transported 40 km one way. To haul 875 tons of waste, about 88 such trips would be deployed and they would cover 7040 Km per day. This would translate into about 6 tons of CO2e of savings per day.
⁸ Assuming the waste needs to be transported 50 km one way. To haul 50 tons of waste, about 5 such trips would be deployed and they would cover 500 Km per day. This would translate into about 0.4 tons of CO2e of savings per day.

8. Identification of stakeholders, their vulnerabilities and spheres of influence

8.1. Stakeholder identification

The landscape for the key stakeholders in BWG ecosystem in Bommanahalli Zone, Bengaluru can be grouped under four categories: Waste Generators, Waste Collectors and Processors, Regulators and Others, where some of these groups have further levels/layers, such as in the

case of Waste Processors and BBMP. The details of the stakeholders in the BWG ecosystem in Bommanahalli zone are mapped in Figure 10 below and their roles and responsibilities are set out in **Annexure 3**.

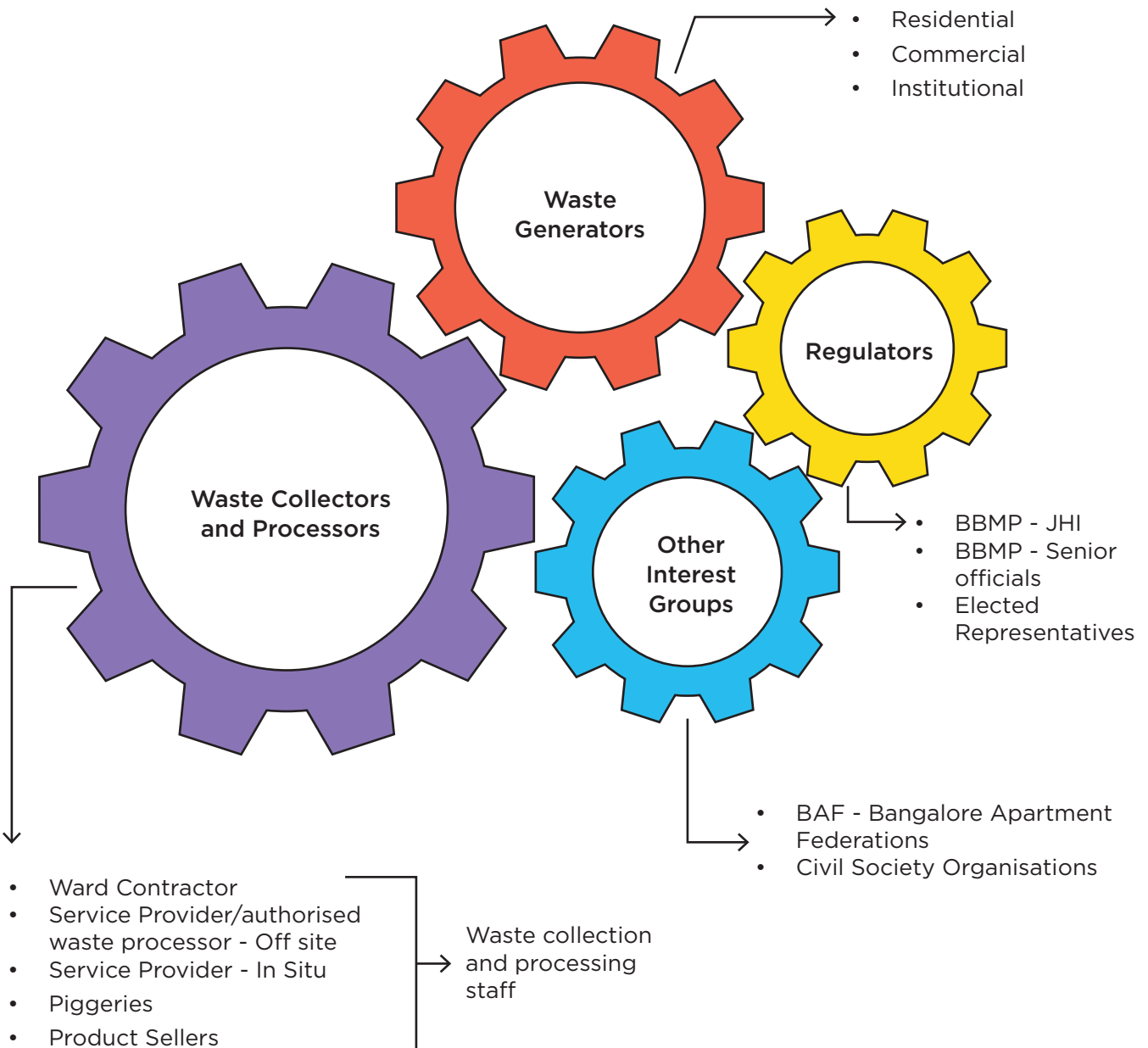


Figure 10: Categories of stakeholders in BWG ecosystem

(i) Waste Generators

Under the BBMP SWM Bye-laws, BWGs are classified into “Residential”, Commercial”, and “Institutional”. The **key decision makers** at these BWGs are the following:



Residents Welfare Association (RWA) and/or Apartment Owners/resident’s Association.



Owners which could be individuals, proprietorships, partnerships, companies etc.



Depending on the type of institution such as educational, government, religious etc., it could be the managing committee of such institution.

These **decision-makers** decide on how the waste generated in their premises is managed i.e., on-site, off-site by service providers or through BBMP ward contractors. As evident from various types of generators within BWGs, it is not a monolith group and their concerns, aspirations, engagement and understanding of waste management vary significantly.

(ii) Waste Collectors and Processors

These are private entities that are **implementers** which collect and process the waste generated by the BWGs, some of them are authorised while others are not. There are a variety of waste collectors and processors as some only collect (such as Ward Contractor), some process waste on-site through composting and/or biomethanation and finally, there are off-site processing and disposal entities (both formal such as authorised waste processors and informal such as piggeries). Within this group, there is a **second level of stakeholders** i.e., the group that handles the waste first hand which are the following:



Primary waste collectors deployed by ward contractors and off-site vendors.
Housekeeping staff and waste workers who collect and process waste on-site.
Waste workers who process waste off-site.

(iii) Regulators

This group of stakeholders are **decision makers** and **enforcers** who are responsible for formulating the rules and policies on waste management and thereafter, enforcing these. In the BWG system, this primarily consists of the municipality i.e., BBMP and the elected representatives such as the mayor, ward councillors, members of the legislative assembly etc.

BBMP has also been split into two groups with a **second level consisting of Junior Health Inspectors (JHIs)** as they are the frontline staff for monitoring SWM systems and enforcing related regulations.

(iv) Other Interest Groups

This is an umbrella group covering **advocacy groups** such as civil society and community-based organisations such as the HSR Citizen’s Forum (HCF) and Solid Waste Management Round Table (SWMRT) have carried out significant work in increasing awareness and building capacities of waste generators and BBMP staff for source segregation and onsite management of biodegradable waste.

The involvement of various stakeholders in waste collection and the flow of biodegradable waste from generation to disposal is visually depicted in the figure below:

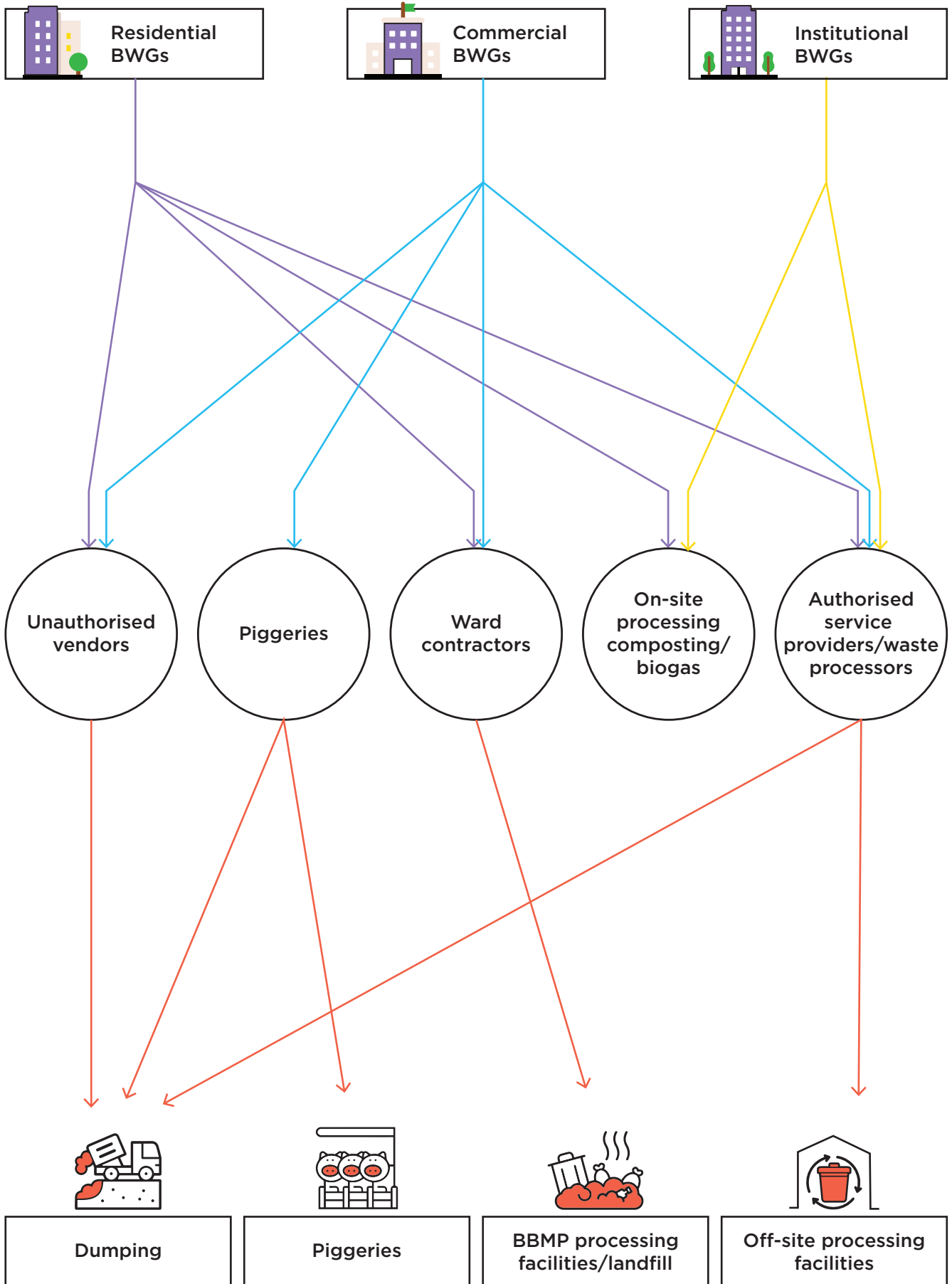


Figure 11: Waste flow from BWGs

8.2. Vulnerability and power analysis

The stakeholders in the BWG ecosystem range from powerful decision makers such as elected representatives, senior administrative officers to certain marginalised groups who have been historically and presently excluded from the decision-making processes. Therefore, it was considered important to do an assessment of the levels of vulnerability and the power to influence among the stakeholders. These assessments allowed for a clear understanding of the difference in equity

of power amongst these stakeholders and their possible engagement in the study.

At the start of the study, 6 indicators were considered to assess the vulnerability of the stakeholders. However, as the project evolved, the criteria for vulnerability of all stakeholders was expanded to 15 indicators to ensure inclusivity and equity within the BWG ecosystem (Srivastava, 2020; Mohapatra, 2012; Michael et al., 2017).

Socio-economic indicators

- **Income and poverty levels:** Low income or living below the poverty line
- **Education levels:** Low educational attainment or lack of access to education
- **Employment status:** Contractual or impermanent nature of employment
- **Housing conditions:** Poor housing conditions

Environmental and health indicators

- **Environmental degradation:** Exposure to pollution
- **Risk of occupational health concerns:** High risk of Occupational Health concerns
- **Access to healthcare:** Inability to/limited access to governmental and private healthcare facilities and services

Demographic indicators

- **Age:** The very young and the elderly are more vulnerable
- **Gender:** Women are typically more vulnerable than men
- **Migration status:** Vulnerability is higher among migrant labour

Institutional and governance indicators

- **Access to legal rights:** Limited access to legal protections and rights
- **Recognition:** Lack of registration or recognition with regulatory authorities
- **Protection from harassment:** Absence or inadequacy of safety nets to protect from work-related harassment

Economic and financial indicators

- **Savings and assets:** Lack of savings or assets to cope with economic shocks
- **Access to financial information:** Limited financial literacy and access to banking services

A stakeholder has been rated as 'High' on vulnerability if the group satisfies 10 or more criteria out of the 15 listed above. A stakeholder has been rated as "Medium" if the group satisfies 5-7 criteria out of the 15. A stakeholder has been rated as "Low" if the group satisfies 3 or fewer criteria out of the 15. Each stakeholder was also assessed to gauge the power they have over influencing change in the BWG ecosystem. This access to power determines their ability to resolve existing issues with regard to BWGs.

Residential BWG represented by RWA



- Inadequate safety nets for SWM related harassment in some cases



Generate biggest quantum of waste among BWGs and have the power to implement onsite biodegradable waste processing facilities with no outside influence.

Commercial / Institutional BWG represented by owners



- Inadequate safety nets for SWM related harassment in some cases



Generate significant quantum of waste among BWGs, have the monetary resources and power to implement onsite biodegradable waste processing facilities with no outside influence.

BBMP - JHI



- Insufficient Training
- Contractual nature of employment
- Limited access to legal protections
- Inadequate safety nets for work related harassment
- Low income
- Limited access to legal protection due to contractual nature of employment



JHIs are the front-end team for enforcement of BWG regulations at the ground level. Therefore, they are the regulator that interacts with BWGs continuously and can influence their waste management processes.

BBMP - Others



- Inadequate safety nets for work related harassment in some cases



As the lack of enforcement has emerged as a key issue based on the analysis, senior officials at BBMP have been rated as the most important stakeholder to influence the BWG ecosystem

Service provider/authorised waste processor - Off Site & onsite



- Contractual nature of engagement
- Lack of registration given that the empanelment system is in abeyance
- Exposure to mixed waste



With an enabling ecosystem, they can offer waste handling and processing services to BWGs. Their influence is limited to professional and holistic waste management services to willing BWGs.

Piggeries



- Lack of registration
- Low income
- Poor education
- Operating in the outskirts of the city and challenging working hours
- Exposure to mixed waste
- Limited access to healthcare facilities
- Migrant labour
- Inadequate safety nets for work related harassment
- Limited access to legal protections
- Limited financial literacy and access to financial services



One of the biggest disposal destinations for biodegradable waste generated by BWGs which are completely unregistered, unmonitored and regulated. Given their vulnerability and invisibility, they do not wield any power to bring about systemic change.

Ward contractor



- Contractual nature of engagement
- Lack of registration to service BWGs
- Exposure to mixed waste



To an extent, the ward contractor is the channel through which the regulations with respect to BWGs are flouted because the door-to-door system caters to BWGs as well in some cases.

Waste collectors and off-site processing staff - ward contractor and service providers/authorised waste processors



- Low income
- Poor education
- Contractual nature of employment
- Poor quality of housing
- Exposure to mixed waste
- Limited access to healthcare facilities
- Migrant labour
- Lack of registration
- Inadequate safety nets for work related harassment
- Limited access to legal protections
- Lack of savings or assets
- Limited financial literacy and access to financial services



Waste collection staff implement waste segregation and primary collection.

Waste processing staff work on the recovery of resources from waste.

They have no power to change processes or systems in the BWGs waste value chain

Elected representatives



- None



Significant on-ground change with respect to SWM requires political will and therefore, political buy-in is crucial for enforcement of BWG regulations.

Waste management staff – onsite and housekeeping staff at BWGs



- Low income
- Attainment of low education
- Contractual nature of employment
- Poor quality of housing
- Exposure to mixed waste (in some cases)
- Primarily, women
- Limited access to healthcare facilities
- Limited access to legal protections
- Lack of savings or assets
- Limited financial literacy and access to financial services



Housekeeping staff play an important role in waste collection and source segregation. On-site waste management staff process the waste. While they have an important role in proper segregation and efficient waste processing, they do not have the power to bring systemic change in the BWG ecosystem.

Civil society & community-based organisations



- Lack of recognition
- Lack of financial assets



They play a very important role in behaviour change and capacity building of BWGs

Figure 12: Vulnerability assessment and power analysis of stakeholders

As a result of these assessments, it is evident that stakeholder groups who are the front-end team that conducts waste management operations at the BWG level such as waste collection staff and housekeeping staff are the most vulnerable. They also have very limited power to influence systemic change in the BWG ecosystem. On the contrary, decision-makers and implementation agencies who manage and govern the BWG ecosystem such as elected representatives, and senior personnel at BBMP and BWGs are not vulnerable. The power to influence change also largely rests with these least vulnerable groups of decision-makers at BBMP, elected representatives and BWGs. While the inputs of these groups are consistently taken into account by virtue of the power they enjoy, the inputs of the most marginalised groups are not. Private service providers exist as businesses in the BWG ecosystem and are not very vulnerable; however, they do not enjoy much power to influence systemic change given that they remain subject to SWM regulations and

policies of the regulators. In the absence of an enabling environment such as enforcement of BBMP SWM Bye-laws and regular monitoring by the BBMP, it is challenging for the private service providers to offer their services to BWGs on a sustainable basis.

The vulnerability and power analysis assessment not only served as a vital framework for understanding the dynamics of the BWG ecosystem but also informed the approach to engage with these stakeholders. These assessments amplify the need for participatory approaches that create avenues for all stakeholders to provide inputs, especially those that are most invisible and unheard. While these stakeholder groups may not be very influential in resolving a majority of issues relating to waste management by BWGs, the engagement was planned with them as a part of the project due to their vulnerability. This ensured insights for developing tailored strategies and support mechanisms to address the unique needs and challenges faced by each group.

9. Stakeholder engagement using participatory approaches



Stakeholder workshop with BWG collection staff

9.1. Overview

In the context of solid waste management in India, there is limited literature or documentation available on deploying participatory approaches to engage stakeholders. Solid waste management is a critical issue and traditional top-down approaches have often proven ineffective. As a result, participatory approaches have emerged as a promising methodology that actively involves varied groups of stakeholders in the decision-making processes.

9.2. Objectives of stakeholder engagement

The overall objectives of the stakeholder engagement were the following:

- Documenting the current situation of waste management by BWGs.
- Identifying current problems and challenges.
- Identifying steps to improve the current situation.
- Defining roles and responsibilities of the different stakeholders in the improved situation.

9.3. Participatory approaches adopted in stakeholder consultations

A brief description of the key consultations is provided below:

(i) Stakeholder consultation workshop with Junior Health Inspectors (JHIs)

The stakeholder consultation workshop was initiated through a participatory tool called Life Histories, which allowed participants to share personal accounts of their experiences working as JHIs and ease into the workshop. This was followed by using Stratified Resource Mapping, where they identified roles and responsibilities relevant to themselves, BWGs and other stakeholders.

For each of the stratified responsibilities assigned to themselves, JHIs then formed groups and worked on formulating a Constraint Analysis where they identified and described problems/constraints related to each of the responsibilities in detail. Once resources and constraints were identified, the JHIs formulated a Solutions Matrix where they detailed the possible ways and tools to mitigate the identified constraints.

“We started monitoring BWGs recently and are therefore not completely clear about the rules relating to BWGs and our related responsibilities. Having clarity about the regulations and our responsibilities would go a long way in improving the confidence with which we can approach the BWGs and the effectiveness of our monitoring”

- JHI, Bommanahalli



Stakeholder workshop with JHIs

(ii) Stakeholder consultation workshop with waste collection staff and housekeeping staff for BWGs

The workshop for these two stakeholder groups was carried out as Focus Group Discussions (FGD) given the vulnerability of the group and possible reluctance to communicate openly in a workshop format. Each FGD was guided by context setting and a list of questions that allowed participants to provide an in-depth understanding of the challenges they face, the interventions required to address them and their inputs on the prioritization of certain interventions over others.

“We know that our work is critical to the city, however, there is a lack of recognition of it by the government and the public. At the very least, we should be given identity cards and one day off in a week for our well-being.”

- BWG collection staff



Stakeholder workshop with housekeeping staff at Salarpuria Serenity

(iii) Semi-structured interviews with residential and commercial BWGs, BBMP officials, service providers and civil society groups

For residential & commercial BWGs as well as BBMP officials, given the diverse interests and schedules of these stakeholders, semi-structured interviews were conducted to thoroughly document their inputs, as and when participants were available within the duration of this project. For service providers and civil society groups, it was noted that these were not homogenous groups and very divergent work was being undertaken by individual stakeholders in these two groups. As a result, it was decided that semi-structured interviews would be the most appropriate tool to capture their distinct inputs on the BWG ecosystem.

“Our work is dignified because the residents segregate their waste properly and the RWA members support us whenever there is a problem in the waste management system.”

- Housekeeping staff at a BWG

10. Key findings from stakeholder engagement

Stakeholder group outcomes/findings

BBMP

- Mapping of BWGs at scale
- Training and capacity building needs
- Need for reporting and monitoring formats
- Necessity of enforcing existing provisions
- Replicating existing best practices
- Enhancing collaboration between departments
- Limited knowledge of impact of SWM on climate change

JHIs

- Importance of defining roles & powers wrt BWGs
- Training and capacity building needs
- Improved administrative & political support
- Requirement for IEC campaign design & implementation
- Relevance of recognition & job security
- Limited knowledge of impact of SWM on climate change

Waste Collection Staff

- Provision of identity cards, uniforms & safety equipment
- Demand for improved working conditions
- Enhancing access to quality healthcare & housing
- Relevance of recognition & job security

BWGs

- Importance of awareness & IEC
- Training and capacity building needs
- Development of market for compost
- Improved financial viability of in-situ biodegradable waste management
- Need for incentives and rebates

Civil Society Groups

- Necessity of regular funding support
- Increased administrative & political support

Service Providers

- Enhanced collaboration with BBMP
- Training and capacity building needs
- Necessity of monitoring mechanisms

This section provides the findings from the stakeholder consultation workshops and semi-structured interviews conducted in the course of this study. The stakeholder engagement sought to understand the diverse inputs of various stakeholders on the challenges they face, the opportunities they foresee and the solutions that need to be devised or implemented to improve the systems governing BWGs in Bommanahalli zone, Bengaluru.

10.1. Policy and enforcement

All stakeholders detailed the gaps in enforcement of policy and stressed on the need for robust institutional mechanisms, specifically in the following areas:

(i) Enforcement of existing provisions

There is a need for enforcing existing provisions relating to management of waste by BWGs under the SWM Rules, 2016 and the BBMP SWM Bye-laws. Additionally, a range of responsibilities can only be fulfilled by the BBMP such as creating databases of BWG, establishing roles and powers of JHIs with regard to BWGs, instituting an effective empanelment process for service providers and for in-situ vendors and authorised waste

processors, ensuring the BBMP door-to-door collection and processing systems does not cater to BWGs, providing incentives/rebates for BWGs carrying out in-situ waste management, establishing internal reporting systems for BWGs and service providers/authorised waste processors and ensuring on ground implementation such as no dumping and burning of waste in the open.

(ii) Need for collaboration



There are several areas of SWM where collaboration between stakeholders could prove effective. Some examples include:

- Increased coordination between different departments like Bengaluru's electricity supply entity (BESCOM) for sharing databases of waste generators and mapping of BWGs,
- Karnataka State Pollution Control Board (KSPCB) which provides permits and conducts monitoring on different aspects of urban infrastructure and waste,
- Collaboration with market associations could increase enforcement of the single-use plastic (SUP) ban,
- Collaboration with education institutions could increase citizen involvement and awareness,
- Collaboration with experts and NGOs could increase capacity building and training opportunities,
- Involvement of police could be considered for enforcement of penalties for non-compliance.

In addition, regular dialogue with political leaders could be maintained to share updates on solid waste management systems and to seek their intervention in case of issues or bottlenecks that can be resolved by them.

10.2. Criticality of source segregation



For any successful implementation of in-situ biodegradable waste management and dignity of work for any workers handling solid waste, a crucial first step that was identified is segregation of waste at source. When waste is received with consistently high segregation levels, stakeholders report an increased ability to smoothly operate in-situ biodegradable waste management, increased resource recovery of non-biodegradable waste and increased access to dignified and safer working conditions. The level of segregation also impacts the efficiency of the waste processing systems because contaminated waste creates the need for additional infrastructure, human resources and time that goes into sorting and

salvaging different waste types, in a waste collection and processing system that is already overloaded.

Certain stakeholder groups like commercial BWGs were flagged for consistently providing mixed waste and workplace injuries associated with handling mixed waste that consists of hazardous waste types (like broken glass, metal, needles, etc.) were also reported. In cases of contamination, the issue is often plugged by providing awareness, printed instruction sheets, refusing to collect mixed waste, penalties, and strict enforcement of the city's legislation on solid waste management among others.

Leading the way for in-situ composting

Salarpuria Serenity, a residential BWG with 200 apartments, is a model for in-situ composting and worker welfare in Bommanahalli Zone after years of consistent resident interventions. A group of residents at Salarpuria Serenity had a long-standing interest in waste management and they fine-tuned their in-situ composting practices from 2016 to 2023. In 2016, in-situ composting began with 2 composters (“Aaga” Composters from the brand Daily Dump), now expanded to 24 which manages approximately 150 kgs of biodegradable waste generated daily. They took several steps to ensure sustainable in-situ composting and these include discontinuation of trash chutes to discourage dumping of mixed waste. New tenants receive printed waste management instructions, and resident volunteers conduct awareness campaigns and communication. Strict waste segregation into three categories is enforced, and staff can reject mixed waste collection. A chain of command, involving RWA members and building manager, addresses issues relating to source segregation and other complaints.

The aesthetic appeal of this composting unit, outdoor location and regular cleaning have ensured a lack of smell, visibility and more know-how among the residents regarding the composting process underway. The housekeeping staff also receive waste management training, health checkups, protective gear, uniforms, and bonuses. Very importantly, the RWA members ensure that a general sense of respect and gratitude is extended to the staff by all residents. The limited space requirement, resident participation and worker welfare make this an ideal replicable model for in-situ composting in residential BWGs.

10.3. Capacity building opportunities

In several stakeholder workshops, clear gaps in training and capacity building were identified and opportunities to bridge these gaps were formulated by the participants.

(i) In most residential BWGs, in-situ interventions hinge on personal interest and there is a need for building capacities, creating awareness and building institutional processes that ensure installation and continuity in operating in-situ composting or biogas units, irrespective of availability of persons with personal interest in the matter. For residents who have a personal interest in operationalising in-situ biodegradable waste management, there is a need for building their capacities in terms of technical expertise, ability to troubleshoot, and ability to engage with other residents on matters related to SWM, among others to ensure that they can continue to champion in-situ biodegradable waste management in their respective buildings.

(ii) Junior Health Inspectors (JHIs) in the BBMP started monitoring BWGs approximately 18 months back and their roles and responsibilities concerning BWGs have not been documented in writing. In addition, there is limited knowledge of the BBMP SWM Bye-laws, which along with a lack of clearly defined roles and responsibilities results in an inability to confidently enforce regulations. Additionally, a lack of technical expertise in in-situ biodegradable waste management limits their ability to effectively monitor in-situ biodegradable processing systems, provide support and issue fines for defaulters among others.

JHIs also highlighted that effective Information,

Education & Communication (IEC) materials could result in positive reinforcement of SWM-related obligations and activities, as opposed to enforcement only through communicating notices, fines and penalties.

They detailed how well-designed IEC tools and campaigns could establish lines of communication between them and BWGs so that a relationship is built and processes like

sensitisation and training of BWGs, sharing references of experts and vendors for in-situ biodegradable waste management, ensuring that collection and transportation is only done by an authorized service provider, conducting monitoring visits, documenting non-compliance and understanding the reasons for it, collecting data, issuing notices, and fines can be done in a more conducive environment.



Stakeholder workshop with JHIs

(iii) For senior BBMP officials, a diverse job profile limits their ability to dedicate time to build expertise in solid waste management. They reported a need for capacity building on all relevant legislation related to solid waste management as well as a need for best practices from other cities and countries to be brought to their attention, so that these practices may be replicated in their jurisdiction. They also highlighted the need for experts who could provide them with technical assistance and advice with respect to waste management.

Several BBMP officials also detailed the need

for support in establishing digital reporting and monitoring systems for BWGs and monitoring formats for data collection, reporting, capacity building, monitoring and evaluation of BWGs. In the absence of these formats, stakeholders are unable to track existing efforts, document challenges, plan for the future and implement work with BWGs effectively. There is also a need to strengthen internal channels of communication within the BBMP to ensure that there is adequate planning, discussion, troubleshooting and escalations, support required with regard to BWGs.

(iv) For vendors and service providers, varied methods are reported for transportation of waste, safety standards for workers, waste processing and end destinations for collected waste. There is a need for training and capacity building on maintaining adequate documentation, ensuring occupational safety, leachate management and verifying end destinations for processing of all waste types.

(v) For waste management personnel, there is a need for on-the-job training on topics such as operating a healthy in-situ composting or biogas unit, collection of waste in a segregated manner and effective communication with waste generators.

(vi) Knowledge of climate change: Despite working in solid waste management, across the stakeholder groups, there is limited understanding of the climate crisis and how GHG emissions from landfills are affecting local, regional and global climates or even the long-term direct and indirect impacts of climate change.

Capacity building fosters improved wet waste management

Over the past year, the HSR Citizens Forum (HCF) and Swachh Graha Kalika Kendra (SGKK) has continuously engaged the 100+ JHIs, field supervisors, drivers and collection staff who work in HSR Layout (Ward 174) on training, capacity building and recognition. This has resulted in robust waste collection teams who are well-versed on different waste types, source segregation and collection of segregated waste. The field supervisors are trained on how to generate awareness, communicate with residents who flout SWM regulations, manner of escalation etc. JHIs have been capacitated over time to actively engage in troubleshooting, identifying challenges and devising solutions. Notably, the due recognition given to this entire team has fostered a deep sense of ownership amongst the staff and a desire to sustain best practices in SWM for door-to-door collection and for BWGs. This has also resulted in HSR Layout being one of the best performing wards in Bengaluru in different editions of Swachh Sarvekshan.



Meetings with ward contractor

10.4. Risks and vulnerabilities associated with social inclusion

There are several issues with regard to the working conditions and welfare of vulnerable groups who handle waste collection at the BWG level. These issues have long persisted due to the system of contract labour and the terms associated with contractual work. Of all groups that work directly with waste, migrant workers that are involved in handling of waste are the most vulnerable in the entire BWG ecosystem. These workers are critical to waste the management system and play a crucial role in the circular economy, whilst often being the group most susceptible to the impacts of climate change. They have limited access to education and healthcare, live in poverty,

suffer regular harassment and extortion and have little linkage to social support systems. They are also not familiar with labour laws and legal rights, do not know the local language/culture, have limited political representation, do not have adequate legal documentation and are recruited through labour contractors, who exercise significant control over them. All these factors contribute to their vulnerability and make them more susceptible to exploitation and poor working conditions, as compared to local labour. Along with the collection staff, other stakeholder groups also articulated the following concerns with regard to their work and lives:

(i) Working conditions

Conditions of work for BWG waste collection staff are sub-optimal. Stakeholders like the migrant BWG waste collection staff detailed how long working hours (14-16 hours) handling waste every day is debilitating and despite the extent of work carried out by them, they have no identification document and/or government authorisation which provides proof and legitimacy to their work. While they are

working overtime hours, they are not paid wages commensurate with the number of hours worked. There are no holidays and no provision for paid leave for the entire year. The participants stated that there should be a reduction in their working hours and introduction of a weekly paid leave. Along with fair wages and leaves, they also stressed on the need to provide recognition and legitimacy to their role in the city's waste collection, transport and processing systems by issuing identity cards.

(ii) Safety equipment

There is a lack of personal protective equipment that is functional and distributed at regular intervals. Workers report that the rubber gloves and gumboots issued to them are slippery, reduce the speed at which they can work and

wear out in a matter of weeks. Additionally, there are no suitable uniforms provided to safely work with waste - at present, waste comes in direct contact with the worker's body and clothing. In the absence of adequate safety equipment, workers have higher exposure to a range of health hazards and grievous injuries.

(iii) Workplace harassment

There are several instances where migrant BWG waste collection staff have been harassed during working hours because they are migrant workers, do not speak Kannada - the local language and do not have work identification cards. They are often looked down upon and face verbal and physical harassment during

waste collection. The collection staff are forced to apologise or comply, in order to avoid conflict and protect themselves. During night shifts, they are frequently stopped and are asked to provide identity cards to prove that they are waste collection staff. Issuance of identity cards can help combat harassment and provide safety to these workers.

(iv) Occupational health and access to healthcare

For both waste collection staff and housekeeping staff, there are no provisions for access to quality healthcare services for themselves and their families. Additionally, there are no regular medical checkups provided by their contractors, which are essential to ensure general well-being, early detection of health issues and improved

occupational safety, considering their close physical proximity to waste on a daily basis. These stakeholder groups also report their increased vulnerability in cases of medical emergencies because government healthcare (which is free/cheaper) requires considerable paperwork and approvals. This results in them opting for private clinics or hospitals which causes them to rely on borrowing money from friends, relatives and money lenders.

(v) Access to proper housing

The stakeholder groups of waste collection staff and housekeeping staff report that the housing they can afford and have access to is in dilapidated condition, while also being several hours away from their place of work, which is usually located in gentrified

neighbourhoods. As a result, they are required to begin travelling to work extremely early in the morning, in order to be able to make it in time for their shift. They also report high rent, inflated cost of utilities and in some cases discrimination, wherein building owners express unwillingness to rent out available houses to them because of their work, caste or religion.

(vi) Barriers to equitable transition:

Some workers stated that they would like to receive training that allows them to transition to careers that generate more income while others stated that they would continue to work for the city's waste collection system if their income and working conditions were improved. All the participants also emphasised that while they might do manual

work their whole lives (because of a lack of education), they would like to ensure that their children receive a good education and are qualified to work white-collar jobs, access healthcare and live enriching lives. However, a lack of quality education and support systems leads them to believe that their children might end up in similar manual labour jobs to support themselves and their families.



Stakeholder workshop with housekeeping staff at Indian Institute of Management, Bengaluru

10.5. Necessity of recognition and job security

Despite strenuous working conditions and critical nature of service being provided by them, the migrant BWG waste collection staff and housekeeping staff state that there is no job security because they are contractual employees who can be easily replaced. If they make too many demands, fall sick or need to travel home for emergencies, they lose their job and are replaced with another worker by

the labour contractor. For JHIs, there is a unanimous fear of losing employment if they ask too many questions/flag issues, as they are all contractual staff of the BBMP and not on the municipality payroll. As a result of being contractual staff, there are also no incentives, benefits or upward mobility for them in terms of promotions, salary hikes, etc.

10.6. Financial viability of in-situ biodegradable waste management

There are various financial factors that have influenced the slow uptake of in-situ biodegradable waste management:

(i) Costs of in-situ biodegradable waste management

Various BWG stakeholders and service providers have detailed how it is more economical to opt for a service provider/vendor who collects segregated waste and processes and/or disposes it off-site. The cost of infrastructure, staff salaries, consumables, monitoring, troubleshooting, dealing with complaints, storage, etc. in a situation where there is no enforcement or incentive from the BBMP is regarded as an unnecessary expenditure and time commitment. The push for in-situ biodegradable processing is heavily contested because the associated costs and lack of return on investment do not make a strong case for financial viability of in-situ systems.

(ii) Lack of market for compost

In addition, BWGs that successfully manage in-situ composting report that there is no market for the sale of the large quantities of compost that they generate. This is because of a range of issues; inability to aggregate contacts of farmers, transportation costs for farmers to move compost from the city to the outskirts and varying compost qualities means that ready compost is either distributed to

terrace gardeners or given away for free to farmers who are willing to bear the transportation costs. This results in compost generating little or no revenue for BWGs that carry out onsite composting.

(iii) No return of investment required

However, other stakeholders like BBMP officials contend that in-situ biodegradable waste management does not have to be justified by its financial viability and is simply the responsibility of BWGs, enforceable by law. They liken the requirement of installing in-situ SWM similar to the requirement of installing in-situ sewage treatment plants in all buildings - it is waste management infrastructure that needs to be maintained and operated, without giving any returns on investment.



10.7. Ancillary support

While the BBMP's own officials and staff members can fulfil their roles with regard to BWGs, there is a significant need identified for various forms of ancillary support:

(i) Political support

Even in the presence of good laws and policies, effective models of waste management for BWGs, cooperative service providers / authorised waste processors, enterprising BBMP officials and committed civil society groups, a lack of political buy-in and support can stall all efforts. Stakeholder inputs suggest that local vendors, residents in residential BWGs and owners at commercial BWGs frequently use political alliance and pressure to subvert the enforcement of BBMP SWM Bye-laws. To ensure effective implementation of at-source segregation, reducing black spots, enforcing in-situ biodegradable waste management, waste collection by authorized service providers and enforcement of ban on single-use plastic (SUP) items, there is a need for support from senior leaders, both at administrative and political positions. This support is needed to rebuff those trying to use political alliances for personal gain and avoid enforcement of BBMP SWM Bye-laws.

In certain wards of Bommanahalli Zone, unequivocal support and interest from the local Member of Legislative Assembly (MLA) has bolstered efforts for more transparent and improved waste management systems. There is a need for similar support to deter unethical practices that result in waste dumping, burning and other unscientific methods of waste management.

(ii) Technical and design expertise support

Even in cases where BWGs are interested in installing in-situ biodegradable waste management, they report operational and technical issues like tenant-owner contentions, inappropriate technology, insufficient space to install in-situ composting or biogas units and

issues of smell, flies and rodents in their composting units because of lack of expertise.

Across Bengaluru, there is wide popularity of 24 hour composting machines and other disproved technologies as well as a range of vendors who provide substandard models of in-situ biodegradable waste management. This is further exacerbated by officials who have not been equipped to provide technical expertise and the unavailability of a list of verified vendors and service providers published by the BBMP or KSPCB. There is a need for technical support from experts to improve existing onsite management systems for technologies and processes.

The need for developing better waste management facilities and residential building infrastructure that by design encourages communities to support these initiatives was also strongly felt by the experts. Ideally, a multidisciplinary team of practitioners with deep knowledge of the waste sector along with architects, designers, IT professionals, government, homeowners, housekeeping staff is best to ideate and create a new paradigm. (*Daily Dump, 2023*).

In Bommanahalli Zone, some promising models like the Swachgraha Kalika Kendra (SGKK) learning centre have been able to provide both a physical space for residents and officials to understand various active in-situ composting models as well as technical expertise on best practices, designing roadmaps and plans, hand-holding the implementation of in-situ composting, troubleshooting, capacity building, etc.

Community learning centre inspires widespread action

Swachgraha Kalika Kendra (SGKK) is an innovative SWM learning centre set up in a public park in HSR Layout, that displays active community composting models and provides training to BWGs and citizens alike. Initiated in 2018 by SWMRT with active support from BBMP, Department of Horticulture, HCF and the local MLA, this learning centre engages citizens on home composting, community composting for BWGs and gardening. There are 12 vendor models for community composting units on display so that BWGs may assess space, quantity of waste, design, etc while picking the model that works best for their facility. The learning centre staff actively compost in each of the 12 composting units, so that visitors can see the process underway, note the lack of smell, understand technicalities, etc. Volunteers and staff also provide expertise on in-situ composting for BWGs, making it considerably easier for BWGs to move ahead with the procurement and implementation of these systems. Additionally, free-of-cost sessions on home composting, volunteering activities, community engagement, formal consultations for BWGs, etc all create a participatory ecosystem around local, decentralised wet waste management. SGKK hosts exposure visits regularly for students, employees at organisations, BWGs, government officials from Bengaluru and other cities, to display best practices in dealing with wet waste and inspire action.

Through training and capacity building of BBMP field staff, SGKK has managed to improve segregation and in situ and home composting levels in HSR Layout. In addition, skilling programs hosted at SGKK have resulted in young persons being trained as experts in in-situ composting for BWGs and community awareness, with some also finding employment in the SWM sector. The innovative use of shared, public spaces to mitigate climate change through direct citizen engagement allows SGKK to show BWGs in-situ composting models that work, provide expertise, involve the local community and generate jobs.



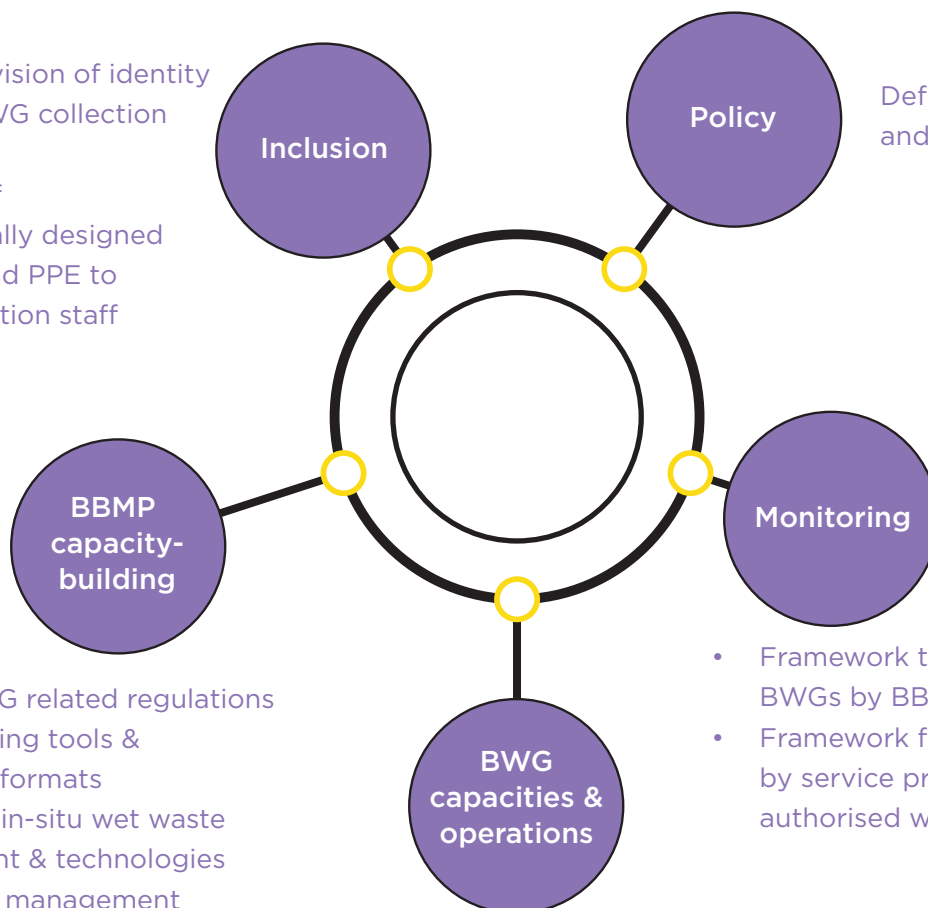
Community composting model at SGKK

11. Recommendations

A diverse set of significant challenges were highlighted by different stakeholders during various consultations and engagement in this study. Therefore, to address this complex problem of waste management by BWGs, it is essential to adopt a phased approach. While the overarching goal is to develop a comprehensive waste management solution, it is often impractical and resource-intensive to tackle all challenges simultaneously. Therefore the recommendations are specifically tailored for the C40's focus area which is inclusive

climate action with the understanding that they are not intended to solve all the challenges associated with BWGs at once. The immediate priority is on building the capacity of the key stakeholders and improving visibility and inclusivity for vulnerable groups such as waste collection staff. This phased approach would allow for a more targeted and manageable intervention while laying the groundwork for a broader, sustainable and equitable waste management strategy.

- Enable provision of identity cards to BWG collection staff
- Provision of ergonomically designed uniforms and PPE to BWG collection staff



Defining JHI roles and responsibilities

- SWM & BWG related regulations
- BWG mapping tools & monitoring formats
- Training on in-situ wet waste management & technologies
- Solid waste management and climate change
- Government schemes for vulnerable groups
- Communication for awareness, escalation, enforcing penalties
- IEC strategy and content

- Framework to monitor BWGs by BBMP
- Framework for self reporting by service providers and authorised waste processors

- Training and capacity building to 10 BWGs on source segregation & onsite wet waste management
- Handbook of in-situ biodegradable waste management
- Pilots for onsite biodegradable waste management with 3-5 BWGs

11.1. Policy

Defining roles and responsibilities

JHIs are the frontline officers who monitor compliance by the BWGs. Given that the written roles and responsibilities of JHIs do not specify how they are supposed to fulfil this duty they are at a loss and further, their reporting managers are also unable to monitor their output. It is recommended to define roles and responsibilities for the JHIs in the management of waste by BWGs in consultation with the BBMP officials.

Defining roles and responsibilities of JHIs is also a crucial step in the process of empowering them as many of them had expressed a lack of confidence in dealing with the BWGs. Empowerment in the context of government officials means giving them the authority, knowledge, and resources to perform their duties effectively and contribute to the overall goals of the municipality specific to waste management. The documentation of

JHIs' responsibilities will promote transparency, accountability and ownership in BWG waste management because JHIs will have a clear understanding of their duties, reducing ambiguity in their roles. With well-defined responsibilities, JHIs will be better equipped and empowered to enforce waste management regulations among BWGs, provide support and carry out effective monitoring. Clear and confident communication from JHI would help improve awareness among BWGs regarding their waste management responsibilities which in turn, could encourage greater compliance. Thus, effective waste management, driven by well-defined roles and responsibilities of JHIs and their enforcement, would have a positive impact on the environment, GHG mitigation steps and public health.

11.2. Capacity building of BBMP zonal officials

(i) Training / upskilling / capacity-building of JHIs



Stakeholder workshop with JHIs

From the JHI workshop, it was concluded that the capacities of the JHIs need to be built so that they can interact with and monitor BWGs effectively. This includes being equipped to direct BWGs to experts and vendors for in-situ biodegradable processing, ensure that collection and transportation are only done by an authorised service provider, conduct surprise site inspections, document non-compliance and understand the reasons for it, collect data, issue notices and fines, escalate persistent non-compliance as required. Training and capacity-building sessions for all 29 JHIs in Bommanahalli can be organised on the following topics with customised training materials focused on:

- BBMP SWM Bye-laws and all other relevant legislations that apply to solid waste management and BWGs.
- Clarity and training on their roles, responsibilities and powers as JHIs with respect to BWGs.
- BWG mapping tools and standard formats for monitoring mechanisms for BWGs and training on how to use these tools to collate data, qualitative information, etc.
- Standard formats for awareness, escalation, enforcing penalties and fines and training on how to implement these.
- Training on in-situ composting/ biomethanation technologies, models, vendors and processes.
- Training on the correlation between solid waste management and climate change and training on how to disseminate this information.
- Financial literacy training which focuses on government schemes that are beneficial to waste collection and processing staff.

These capacity-building exercises can lead to better compliance with regulations, improved execution of roles, enhanced data management, consistent enforcement, sustainable waste management practices, increased climate change awareness and better access to government schemes for vulnerable groups such as waste collection and processing staff. These outcomes collectively contribute to a more effective, resilient and inclusive BWG

waste management system in Bommanahalli. At an individual level, JHIs are likely to acquire skills and knowledge that not only enable them to perform their roles more effectively but also empower them in their professional development.

(ii) Preparation and implementation of IEC strategy and content

For BWGs, it is recommended that BBMP, either by itself and/or through competent third parties create multilingual content for building awareness and bringing about behavioural change among BWGs such as life cycle of waste, source segregation and onsite management of wet waste. This content should be for different mediums such as handy flip charts, posters, banners, short clips, PowerPoint presentations etc. The IEC content must also showcase best practices for waste management by BWGs. BBMP must also allocate appropriate budgets and ensure regular monitoring and evaluation of the effectiveness of IEC materials, activities and interventions.

Such IEC content, if disseminated by the JHIs, can lead to increased awareness among more than 400 BWGs across Bommanahalli zone.

These initiatives could bring about behavioural change, and a more informed and engaged BWG community, contributing to the overall enhancement of the waste management system and a cleaner, more sustainable urban environment in Bengaluru.

11.3. Monitoring

Under BBMP SWM Bye-laws, the officers authorised/nodal office by BBMP have the power to carry out various monitoring activities including source segregation, collection, transportation, processing and disposal of solid waste, implementation of ward micro plan, functioning of processing facilities and generally, supervision

compliance of various provisions of SWM Rules and BBMP SWM Bye-laws.

As highlighted above, there are currently no consistent monitoring systems and formats to oversee the BWG system. Therefore, **it is recommended to develop formats for the BBMP to notify and monitor the BWGs, in-person and virtually. Having standardised formats for monitoring BWG activities ensures consistency in data collection and reporting across different areas and periods. Such consistent data enables government officials to make informed decisions about resource allocation, policy adjustments, and intervention strategies.** It also becomes easier to assess the performance and impact of waste management initiatives including social and environmental impact. If this data is shared with the public, it can facilitate public engagement, fostering awareness and support for sustainable waste management practices.

In addition, if feasible, a self-reporting format for compliance with BBMP SWM Bye-laws by service providers and authorised waste processors can be uploaded/reported on a common IT platform. This could include names of the BWG, location, quantum of waste, how waste is being managed, manpower details and compliance with labour and environmental regulations. Similar to the monitoring, standardised self-reporting formats lead to consistent and timely submission of data, allowing for efficient monitoring, performance assessment and decision-making by the city authorities. It also promotes transparency and accountability, encouraging compliance with regulations and contractual obligations. Reporting on manpower and compliance with labour regulations also contribute to a safer and more equitable environment for waste workers by reducing the likelihood of exploitation.



11.4. Inclusion

Under the BBMP SWM Bye-laws, BBMP is required to issue ID cards, comply with labour regulations for working conditions and provide medical checkups and personal protective equipment (PPE) to pourakarmikas and other eligible waste workers in waste management. The BWG collection staff do not seem to have basic amenities for their work such as identity cards, ergonomically designed uniforms and personal protective equipment. It is recommended that identity cards be provided to these workers and conditions for these be included in contractor agreements. **The provisions of identity cards will provide much-needed recognition to the BWG collection staff and protect them in cases of work-related harassment.** This would also be the first step towards having an inclusive waste management system in Bommanahalli. In addition, as a part of the C40 project, there can be provision of ergonomically designed uniforms and personal protective equipment as a one-time pilot which the BBMP can scale if positive feedback is received from the collection staff. Given the limited access to healthcare for these workers, this initiative could be beneficial because these uniforms and personal protective equipment could be the first line of defence against occupational hazards relating to working with waste.

11.5. Capacity building of BWGs and other support



Stakeholder workshop with BWG collection staff

(i) Under the BBMP SWM Bye-laws, BBMP is required to provide information to the public about composting, bio-gas generation, and decentralised processing of waste at a community level by conducting training classes, seminars, workshops and compost santhes (markets or events promoting composting). In this context and as per the findings from the stakeholder engagement, **there is a need to provide training and capacity building to BWGs on the following:**

- **Source segregation, especially among commercial BWGs**
- **In-situ biodegradable waste management technologies and vendors**

The next phase of the project could consider providing these training and capacity building sessions to 10 BWGs of different types.

(ii) In this context, **it is recommended that a handbook of in-situ biodegradable waste management technology providers be prepared and published with support of the BBMP, for the reference of the BWGs in Bengaluru city.** Such a handbook would equip BWGs with a comprehensive directory of technology providers specialising in in-situ biodegradable

waste management, enabling them to make well-informed decisions. It would facilitate vendor selection by presenting trustworthy options, exploring competitive pricing, streamlining the technology assessment process, and ensuring compliance with local regulations. By fostering the adoption of sustainable waste management technologies, this handbook would not only benefit more than 8000 BWGs in Bengaluru but also contribute to environmental preservation and climate mitigation strategies.

(iii) **Pilots for onsite biodegradable waste management, especially onsite composting and/or biogas units in 3-5 different types of BWGs can be considered in the next phase.** These pilots would assist in evaluating the feasibility and effectiveness of different waste management technologies and practices, including potential challenges. They could also provide valuable data and insights into the performance, cost-effectiveness, and environmental impact of different waste management solutions. Most importantly, pilots create opportunities for stakeholder engagement and education, raising awareness, bringing about behavioural change and building support for sustainable waste management practices because practical demonstrations of workable models have proven to be far more successful for long-term behavioral change than written documentation.

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Annexure 1: Details of stakeholder engagement

Date	Type of stakeholder	Type of activity/ engagement	Details of stakeholders
06/07/2023	JC (SWM) (transferred during the project)	Meeting (in person)	Mr. Parashuram
11/07/2023	Zonal JC (transferred during the project)	Semi structured interview (in person)	Mr. Krishnamurthy
22/06/2023 - 04/07/2023	Residential BWGs	Semi structured interviews (online)	Salarpuria Serenity Adarsh Rhythm Apartments Prestige Falcon City
30/06/2023 - 01/08/2023	Civil Society Groups	Semi structured interviews (online)	<ul style="list-style-type: none"> Vasuki Iyengar, Solid Waste Management Round Table, Bangalore (SWMRT) and Soil & Health BNS Ratnakar, HSR Citizens Forum (HCF) Suresh Balasubramanian, Swachgraha Kalika Kendra (HCF) Sandhya Narayan and Anuradha Govind, Solid Waste Management Round Table, Bangalore (SWMRT)
21/07/2023 - 21/08/2023	Service Providers/Product Sellers/Authorized Waste Processors	Semi structured interviews (online)	<ul style="list-style-type: none"> Malini Parmar, Founder, Stonesoup Ravindra Karnad, Founder, Marigold Composters Poonam Kasturi, Founder, Daily Dump Marwan Abubaker, Co-Founder, Hasiru Dala Innovations Private Limited Nityanand Surendra, CEO, Material Solutions for Green Planet (MSGP) Infratech Private Limited
02/08/2023	JC (SWM) (transferred during the project)	Meeting (in person)	Mr. Dharampal
09/08/2023	Ward Contractor & Service Provider	Semi structured interview (in person)	Roopesh Kumar
17/08/2023 & 19/08/2023	Housekeeping staff at BWG	Stakeholder Workshop (in person)	<ul style="list-style-type: none"> 10 housekeeping staff of Salarpuria Serenity which included 9 women and 1 man 41 housekeeping staff of IIM-B, including 20 women and 21 men

Date	Type of stakeholder	Type of activity/engagement	Details of stakeholders
23/08/2023	BBMP Junior Health Inspectors (JHIs)	Stakeholder Workshop (in person)	21 JHIs attended the workshop which included 16 male and 5 female
26/08/2023	Commercial BWGs	Semi structured interviews (in person)	<ul style="list-style-type: none"> • Food Palace, supermarket • Mughal Treat, restaurant with seating • White House, marriage hall • Indiqube, office space • My Chicken, commercial shop
30/08/2023	BWG waste collection staff	Stakeholder Workshop (in person)	23 BWG waste collection staff who were all male
02/09/2023	Zonal JC and AEE, Bommanahalli	Stakeholder Workshop (in person)	<ul style="list-style-type: none"> • Mr. Ajit M • Ms. Nethra
11/09/2023	Zonal SE Bommanahalli	Semi structured interviews (online)	Mr. Mahadesh
12/09/2023	Chief General Manager, Bengaluru Solid Waste Management Company	Semi structured interview (in person)	Basavaraj Kabade
12/09/2023	Technical Assistant to Chief General Manager, Bengaluru Solid Waste Management Company	Semi structured interview (in person)	Chitra Jayaramiah
12/09/2023	AEE, Bommanahalli	Semi structured interview (in person)	Ms. Nethra

Annexure 2: List of wards in Bommanahalli zone

S.No.	Sub division	Ward number	Name of the ward
1	Bommanahalli	174	HSR Layout
2	Bommanahalli	175	Bommanahalli
3	Bommanahalli	186	Jaraganahalli
4	Bommanahalli	187	Puttenahalli
5	Bommanahalli	188	Bilekhali
6	Bommanahalli	189	Hongasandra
7	Bommanahalli	190	Mangammanapalya
8	Bommanahalli	193	Arakere
9	Bengaluru South	184	Uttarahalli
10	Bengaluru South	185	Yelchenahalli
11	Bengaluru South	191	Singasandra
12	Bengaluru South	192	Begur
13	Bengaluru South	194	Gottigere
14	Bengaluru South	195	Konanakunte
15	Bengaluru South	196	Anjanapura
16	Bengaluru South	197	Vasanthpura

Annexure 3: Roles and responsibilities of stakeholders in BWG ecosystem

In the table below, the stakeholders under the categories of “Waste Collectors and Processors” and “Regulators” have been further bifurcated and described. The description along with examples, roles and responsibilities of all the stakeholders involved in management of waste generated by BWGs in Bommanahalli Zone have been listed in the table below.

1. Residential BWG represented by RWA (Resident Welfare Association)

Stakeholder description	RWA is typically an elected body that manages the activities in an apartment complex.
Roles and responsibilities with respect to solid waste management (SWM)	<ul style="list-style-type: none">• All decisions and budgets for SWM activities• Enforcement of source segregation among households (as per SWM Rules, 2016 and BBMP SWM Bye-laws)• Onsite or off-site management of biodegradable waste along with selection of service providers/contractor etc. (as per SWM Rules, 2016 and BBMP SWM Bye-laws)• Decisions on manpower for SWM activities in the premises• Awareness, training and capacity building activities

2. Commercial/Institutional BWG represented by Owners

Stakeholder description	Owner
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none">• Same as residential BWGs (as per SWM Rules, 2016 and BBMP SWM Bye-laws)• In addition, commercial BWGs have to enforce source segregation by a larger floating population such as tourists, restaurant patrons, office goers, students etc.

3. BBMP - JHI

Stakeholder description	There are 29 JHIs in Bommanahalli Zone, out of which 5 are women and 24 are men. The BWG to JHI ratio in each of the wards differs because it depends on the number of BWGs in a ward, for example, the ratio is 42:1 (number of BWGs: number of JHIs) in HSR ward where the BWG number and density is high and 15:1 in Bommanahalli ward where the number of BWGs are lower.
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Roles and responsibilities with respect to SWM	<ul style="list-style-type: none"> • Front end team of BBMP that directly interacts with BWGs • Monitoring waste management by the BWGs (as per BBMP SWM Bye-laws) • Monitoring services provided by Waste Contractors and Service providers/ Authorised Waste Processors (as per BBMP SWM Bye-laws) • Enforcement of BBMP SWM Bye-laws including reporting of non-compliances to senior health inspectors and imposition of spot fines and penalties. (as per BBMP SWM Bye-laws)
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4. BBMP - Others

Stakeholder description	<p>Central</p> <ul style="list-style-type: none"> • Joint Commissioner (SWM) • Bengaluru Solid Waste Management Company <p>Zonal</p> <ul style="list-style-type: none"> • Joint Commissioner (JC, Bommanahalli) • Superintendent Engineer (SE, Bommanahalli), • Assistant Executive Engineer (AEE, Bommanahalli)
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none"> • Second level monitoring of waste management activities in the zone including work of the JHIs • Enforcement of BBMP SWM Bye-laws including imposition of penalties • To appoint and empower SWM marshals (as per BBMP SWM Bye-laws) • Awareness, training and capacity building activities (as per BBMP SWM Bye-laws) • Empanelment and authorisations of waste processors/service providers and monitoring their operations (as per BBMP SWM Bye-laws) • Reporting and data management with respect to BWGs (as per BBMP SWM Bye-laws) • Appeal against levy of penalties is with the JC (as per BBMP SWM Bye-laws)

5. Service Provider/authorised waste processor - Off Site

Stakeholder description	Service providers/waste processors who collect from BWGs and manage/process such waste at offsite locations
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none"> • Registration with BBMP (as per BBMP SWM Bye-laws) • Collection & transportation of waste from BWGs (as per BBMP SWM Bye-laws) • Processing of waste at non-BBMP facilities which are authorised under environmental regulations (as per BBMP SWM Bye-laws) • Collection of service free from BWGs (as per BBMP SWM Bye-laws) • Periodic reporting of data to BBMP (as per BBMP SWM Bye-laws)

6. Service provider / authorised waste processor / product sellers - Onsite

Stakeholder description	Service providers/waste processors who collect and process biodegradable waste generated by BWGs within their premises
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none">• Registration with BBMP for Service providers/waste processors (and not product sellers) (as per BBMP SWM Bye-laws)• Collection and processing of biodegradable waste at the premises (as per BBMP SWM Bye-laws)• Collection of service free from BWGs (as per BBMP SWM Bye-laws)• Periodic reporting of data to BBMP (as per BBMP SWM Bye-laws)

7. Piggeries

Stakeholder description	Informal unregistered vendors who operate piggeries and collect biodegradable waste from BWGs such as hotels and restaurants
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none">• Collection of biodegradable waste from BWGs such as hotels and restaurants at no cost and/or very low rates• Biodegradable waste is fed to pigs at the piggeries

8. Ward contractor

Stakeholder description	The contractor selected through the BBMP tender system that is supposed to carry out door-to-door collection of waste from non-BWGs in the ward
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none">• Door-to-door collection of all waste streams from non-BWGs and transportation of waste to processing and disposal sites upon payment of tipping fee by BBMP (as per BBMP tender conditions and contract with BBMP)• Procurement of vehicles and manpower for the above services (as per BBMP tender conditions and contract with BBMP)

9. Waste collectors and off-site processing staff - ward contractor and service providers/authorised waste processors

Stakeholder description	Staff of the ward contractor and service providers/authorised waste processors who are the primary collectors of waste from BWGs
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none">• Primary waste collection and informing BWGs on source segregation• Transportation of waste in a segregated manner• Processing of waste at an offsite location by staff of authorised waste processors

10. Waste management staff - onsite and housekeeping staff set BWGs

Stakeholder description	Housekeeping staff and staff of the service providers/authorised waste processors who process waste onsite
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none">• Primary waste collection and informing BWGs on source segregation by housekeeping staff• Processing of biodegradable waste through onsite composting and/or biomethanation systems• Aggregation of non-biodegradable waste and thereafter, sorting into different categories.

11. Civil society and community-based organisations

Stakeholder description	Non-profit and community-based organisations working in solid waste management
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none">• Inputs to policies and laws on waste management• Public engagement through awareness and capacity building programs

12. Elected representatives

Stakeholder description	Member of Legislative Assembly residing in Bommanahalli, Mayor and Ward Councillors
Roles and responsibilities with respect to SWM	<ul style="list-style-type: none">• Formulate policies and laws on waste management• Approval of bureaucrats appointed in senior SWM-related roles including their transfers• Provide inputs in selection of ward contractor and service providers/authorised waste processors• Approval of waste management activities/projects

