A CROSS-CITY STUDY

Mapping Waste, Informing Decisions

Using existing data to strengthen solid waste management in small towns

CHIKKABALLAPUR

LEH

KUSHTIA

THREE SOUTH ASIAN CASE STUDIES ON HOW DATA REVEALED OPPORTUNITIES FOR BETTER OPERATIONS, INCLUSION AND DECENTRALISED PLANNING

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BORDA South Asia and FISH assert the moral right to be identified as the authors of this publication. The analysis, figures, and case studies presented are based on data and information received from the respective municipalities and technical partners, as well as field assessments and Waste Flow Diagram studies. While every effort has been made to ensure that the information presented is accurate and reliable, BORDA South Asia and FISH do not accept responsibility for any errors or omissions in the underlying data or for any consequences arising from its use.

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Seeing the Whole Flow





Small towns across South Asia are managing increasingly complex waste systems with limited staff, fragmented information and constrained resources. Yet the challenge is not always the absence of data. Municipalities already generate significant operational information through collection records, vehicle movements, facility registers, field observations, household surveys and informal recovery networks. The difficulty is that these data remain dispersed, making it difficult to understand how waste actually moves from generation to collection, recovery, processing and final disposal.

Mapping Waste, Informing Decisions examines how existing municipal data, when assembled and read across the waste value chain, can provide small towns with a stronger basis for planning and investment. Drawing on experiences from **Chikkaballapur in Karnataka, Leh in Ladakh, and Kushtia in Bangladesh**, the publication brings together operational records, field assessments, household and commercial surveys, facility information and insights from formal and informal waste actors. The Waste Flow Diagram is used as one analytical method to organise these fragmented inputs into a clearer picture of how each municipal system functions.

The three cases show that similar-looking waste challenges can require very different responses. In **Chikkaballapur**, relatively strong collection masked limited processing and



resource recovery; connecting operational data exposed segregation failures, contamination during collection and underutilised recovery capacity. In **Leh**, seasonal tourism, difficult terrain and dependence on a limited number of centralised facilities created system vulnerability, highlighting the need to plan infrastructure around seasonal and spatial waste patterns. In **Kushtia**, city-level figures concealed significant service gaps in low-income communities and an informal recovery system that remained largely outside municipal records, leading to more inclusive service and recovery arrangements.

Across the three towns, a common message emerges: **better waste management does not necessarily begin with more infrastructure. It begins with understanding the system that already exists.** Bringing fragmented data together can help municipalities identify where operational improvements, decentralised solutions, institutional arrangements and targeted investments can achieve greater impact.

This publication is therefore not about promoting a single methodology or prescribing one model for small towns. It demonstrates how **locally grounded evidence can make hidden system gaps visible, challenge existing assumptions and support more practical decisions**. For small towns, where resources and planning capacity are limited, improving how existing information is connected and used can be a powerful first step toward more efficient, inclusive and resilient waste management.




WASTE TOWER
ROUTE 12
TOWN
DUMP
DUMP HERE
TRASH
SMALL TOWN
SALVAGE
WASTE
WASTE

CHAPTER 1

The Context–Challenges in Small Town Waste

Introduction

India generates approximately 170,000 metric tonnes of municipal solid waste (MSW) per day, as per the Central Pollution Control Board (CPCB)[1], roughly 62 million tonnes annually, making it one of the largest waste producers in the world. As the country's urban population swells toward 600 million by 2036, as per National Commission on Population projections, the pressure on waste infrastructure is set to intensify dramatically. Yet beneath the physical challenge of collection, processing, and disposal lies a less visible but equally critical crisis: the absence of robust, standardised, and actionable data governance frameworks for solid waste management (SWM).

Effective SWM is contingent on the availability of reliable data - from waste generation rates and composition to landfill capacities, recycling yields, and informal sector contributions. This is not merely an aspirational goal but an existing regulatory requirement: the Solid Waste Management Rules, 2016 mandate that Urban Local Bodies (ULBs) to maintain and report data on waste generation, collection, and processing, yet compliance and data quality across states remain inconsistent, undermining both national aggregation and inter-state comparability. In the absence of such data, policymakers are compelled to make decisions without adequate evidence, urban local bodies (ULBs) struggle to engage in rational planning and resource allocation, and mechanisms of accountability remain severely constrained.

1 CPCB Annual Report on Implementation of Solid Waste Management Rules, 2021–22

AT A GLANCE

While India collects a large share of its MSW, **only about 70–75% of the collected waste receives any scientific processing** (such as composting, biogas production, recycling).

A significant gap remains between reported collection rates and the actual amount of waste successfully diverted from landfills. This gap is poorly understood because states and cities use inconsistent methods to measure and report progress.

Definitions:



Scientific processing / Treatment

Refers to controlled, environmentally sound methods that process waste into useful resources or reduce its volume safely. This includes composting, biogas/ biomethanation plants, material recycling facilities. It excludes open dumping, burning, or simple landfilling.



Collection efficiency

The percentage of generated waste that is actually picked up by municipal services (often reported as 90%+ nationally, but varies widely by city).



Diversion from landfill

The share of waste that is kept out of landfills through actual processing and recovery, rather than just being collected and then dumped elsewhere.

A particularly significant data gap exists within the informal waste sector, including waste pickers, kabadiwalas, and aggregators, who are estimated to recover and recycle a substantial proportion of India's post-consumer waste. Despite their critical contribution to resource recovery, their activities remain largely undocumented in official municipal solid waste MSW. This omission not only undermines an accurate assessment of the country's waste management performance but also limits the integration of informal workers into formal planning, financing, and social protection frameworks.

Data governance encompassing the policies, standards, processes, and institutional arrangements that ensure data is accurate, accessible, and actionable is not a peripheral concern. It is foundational to the entire SWM ecosystem.

The Current State of SWM Data in India

India's SWM data landscape is characterised by fragmentation, inconsistency, and significant underreporting. The Central Pollution Control Board (CPCB) and the Ministry of Housing and Urban Affairs (MoHUA) are the primary agencies responsible for compiling national SWM statistics, largely through the Annual Report on Municipal Solid Waste Management and the Swachh Survekshan rankings. However, the data flowing into these systems is of questionable quality.

This is not an India-specific problem. Data unreliability, underreporting, and weak monitoring infrastructure are

recurring features of solid waste management systems across South Asia more broadly, reflecting shared constraints in institutional capacity and standardised reporting protocols rather than deficiencies specific to any one country.

Urban Local Bodies, the frontline institutions responsible for waste services, often lack the technical capacity, staffing, and digital infrastructure to collect and report data meaningfully. Many smaller ULBs rely on manual registers or ad hoc surveys. Definitions of 'waste generated' versus 'waste collected' vary widely. Processing capacity figures frequently represent installed rather than operational capacity. Landfill data is inconsistently reported, and the contribution of the informal waste sector, which handles an estimated 20–30% of recyclable material, is largely invisible in official statistics. The gap is sharpest in small towns. While larger cities like Pune, Surat, and Indore have invested in digital monitoring systems - however fragmented - towns with populations below 1–2 lakh operate almost entirely without functional data infrastructure. These smaller ULBs typically lack dedicated SWM staff altogether, relying instead on general administrative personnel with no technical training in waste data collection, further compounding the reporting gap. This pattern repeats outside India's borders too.

While the data cited here draws primarily from India's national reporting systems, the governance challenges described are not unique to India. Across South Asia, small and secondary towns face comparable gaps in waste data infrastructure - a pattern this publication traces across three cities in two countries.

Core Challenges in Data Governance

Definitional & Methodological Inconsistency

The SWM Rules, 2016 mandated standardised reporting formats including Form III for facility-level reporting and annual reports submitted by local bodies to the SPCB, but did not establish rigorous mechanisms for verifying, validating, or enforcing compliance with them. As a result, waste generation estimates in most ULBs continue to rely on population-multiplier formulas rather than systematic empirical surveys. The Central Public Health and Environmental Engineering Organisation (CPHEEO) and CPCB have issued technical guidelines for waste quantification, characterisation, processing, and disposal - but as with much of India's SWM policy architecture, the gap is not in the guidance itself but in its application. ULBs frequently lack the technical knowledge and capacity to disseminate and operationalise these guidelines on the ground, and responsibility for data tracking, validation, and reporting is not clearly assigned within most ULB structures, leaving no single role accountable for whether the guidelines are followed in practice. This results in data that cannot be meaningfully compared across cities, states, or years. World Bank reports such as What a Waste 3.0 paint a very different picture to official reports.

Independent Verification and Self-Reporting Bias

Much of the reported data used to assess ULB performance in Swachh Survekshan rankings, star ratings, ODF+ status - is self-reported by ULBs, with limited


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independent or third-party audit. This is a distinct gap from the absence of standardised protocols above: even where reporting formats and guidelines exist and are nominally followed, there is no independent verification layer to confirm that submitted data reflects ground reality. This creates structural incentives for ULBs to over-report performance, particularly where rankings and ratings carry reputational or funding consequences, further widening the gap between official statistics and actual on-the-ground outcomes. The same pattern extends to statutory and administrative reporting channels: ULB submissions to CPCB annual reports and data entered into the SBM Urban portal follow a similar self-reported, largely unaudited model. This is particularly consequential for SBM-Urban Phase 2's targets for the remediation of legacy dumpsites where ULBs report progress on land reclamation and biomining against self-declared baselines and milestones, with limited independent verification of actual remediation outcomes.

Lack of Impact Measurement in Waste Processing Data

While Swachh Bharat Mission (SBM) portals report overall processing rates; all processing is not the same, recycling, end of life-cycle incineration, downcycling etc. represents qualitatively different outcomes which are missing in India's data architecture. Without qualitative distinctions in how processing is reported, a municipality that sends waste to an incinerator and one that achieves 40% composting and recycling appear identical in official data - making it impossible to track progress toward genuine resource recovery, circular economy goals, or environmental sustainability.

Technology Fragmentation & Last-Mile Gaps

A patchwork of digital systems - GPS-tracked collection vehicles, RFID-based waste monitoring, city-level dashboards, Integrated Command and Control Centres (ICCCs) - exists in larger cities like Pune, Surat, and Indore. However, these systems are siloed, developed by different vendors, and incompatible with state or national platforms. **In Tier-2 and Tier-3 cities, and rural areas under the extended ambit of SWM, digital infrastructure is minimal. Data from these geographies is sparse, delayed, or absent entirely.**

Exclusion of the Informal Sector

The informal waste economy comprising an estimated 1.5–4 million waste pickers (kabadiwalas, ragpickers, itinerant buyers) - performs a critical recycling function but operates almost entirely outside formal data systems. Their material recovery rates, livelihoods, and health conditions are unmeasured in official SWM statistics. **This creates a fundamental blindspot: formal processing data appears worse than reality (since informally recovered material is not counted), while social and occupational risks borne by informal workers go unaddressed.**

Absence of a Unified National Data Platform

Despite several digital governance initiatives under Smart Cities Mission, AMRUT, and Swachh Bharat Mission (Urban), there is no single, integrated, interoperable platform for SWM data across India. Existing portals - such as SBM-U's Management Information System (MIS) - have improved data collection but remain underutilised, poorly integrated with state-level systems, and limited in the granularity and timeliness of data they capture.

Taken together, these five gaps mean that India's SWM system is being managed largely without the information it needs - and small towns bear the sharpest end of that deficit.

The challenges outlined above are systemic and long-term. Resolving them requires sustained investment in national data infrastructure, institutional reform, and standardised reporting protocols. But small towns cannot wait. **Across Chikkaballapura in Karnataka, Leh in Ladakh, and Kustia in Bangladesh, a different question was being asked: not how to fix the national data system, but how to act on the data that already exists - fragmented, inconsistent, and incomplete as it is.** The Waste Flow Diagram was applied in three cities to test exactly that. In each case, it assembled what was already available - vehicle logs, field observations, informal sector estimates, household surveys - into a coherent picture of how the system was actually performing. And in each case, what the data revealed contradicted what the municipality believed.

Why Small Towns - and Why This Matters

South Asia's urbanisation story is not primarily a story about its megacities. It is a story about the thousands of towns that sit below the threshold of policy attention - towns that are growing rapidly, absorbing migration, and generating waste without the infrastructure, finances, or data systems to manage any of it coherently.

In this report, 'small towns' refers to urban settlements with a population below one lakh (Census of India, 2011) - the category that includes Municipal Councils, Nagar Panchayats, and Town Panchayats, but excludes city

FIELD INSIGHT

In 2019, a CSE (Centre for Science and Environment) assessment of the Swachh Survekshan found a significant gap between self-reported and independently verified performance. The Ministry of Housing and Urban Affairs (MoHUA) claimed that nationwide waste processing had reached 52 per cent and that source segregation had reached 60 per cent. CSE's own analysis estimated the ground reality to be considerably lower - waste processing at no more than 30 per cent and segregation at only about 40 per cent nationally.

A similar pattern has been observed by BORDA and its partners in its partner towns, Chikkaballapur CMC and Chintamani CMC, through physical assessments, waste quantification, and waste generation studies. The analysis found that five major cities reported waste processing rates exceeding 90% on the national SWM portal, while on-ground assessments indicated processing rates of below 50%. This discrepancy can be attributed to differences in definitions, measurement periods, and reporting practices and incentives.



corporations. This also includes census towns: settlements that meet the Census of India's urban criteria (population above 5,000, density above 400 persons/sq km, and over 75% of the male working population engaged in non-agricultural occupations)

India alone has 4,259 urban centres. Approximately 95% of them are small towns governed as Municipal Councils and Nagar Panchayats; the remaining 5% are city corporations - the institutions that absorb the lion's share of national policy attention, infrastructure investment, and technical assistance[2]. Census towns, which exhibit urban characteristics but are still classified as rural for governance purposes, grew from 1,362 to 3,892 between 2001 and 2011[3]. In 2016, MoHUA requested 28 states to convert 3,748 census towns into statutory urban local bodies; if implemented, this would effectively double the number of small and medium towns in India.[4] Between 2020 and 2030, India's urban population is projected to grow from 483 million to 607 million - a 25.7% increase - and the weight of that growth will fall on precisely the category of town least equipped to bear it.[5]

The service delivery gap is not a marginal problem. It is the defining condition of small-town governance in South Asia. Across the region, only 9% of small towns have piped water coverage - three times lower than large cities.[1] In India, the wastewater treatment capacity of small and medium towns stands at 11% of generated waste, three times lower than million-plus cities and five times lower than metropolitan centres.[6] In solid waste, the pattern is starker still: nearly half of India's total accumulated legacy waste in the landfills,- approximately 1,071 lakh metric tonnes - sits in small and medium towns, while only one-third of it has been remediated, compared to roughly half the burden already addressed in larger cities.[7] Of India's approximately 2,300 dumpsites holding 235 million tonnes of accumulated waste, only 77 are located in cities with populations above one million[8]. The remaining 97% are concentrated in smaller towns - towns that typically lack the financial resources, technical expertise, and vendor interest to remediate them.[9]

The reasons for this gap are structural and long-standing. Per capita own revenue in small towns is three times lower for Municipal Councils and six times lower for Nagar

2 State of Municipal Finance of India, ICRIER, 2019. As cited in: BORDA South Asia. Conference on Small Town Urban Agenda - Proceedings Report. December 2023. p. 7.
3 Census of India, 2011. As cited in: BORDA South Asia. Conference on Small Town Urban Agenda - Proceedings Report. December 2023. p. 7.
4 Ministry of Housing and Urban Affairs (MoHUA), Government of India, 2016. As cited in: BORDA South Asia. Conference on Small Town Urban Agenda - Proceedings Report. December 2023. p. 8.
5 UN-Habitat, World Cities Report 2022, Statistical Annex: https://unhabitat.org/sites/default/files/2022/07/statistical_annex_wcr_2022.pdf
6 Urban Wastewater Scenario in India, NITI Aayog, 2022. As cited in: BORDA South Asia. Conference on Small Town Urban Agenda - Proceedings Report. December 2023. p. 7.
7 Swachh Bharat Mission Urban (SBM-U) 2.0 Urban Dashboard, 2023. As cited in: BORDA South Asia. Conference on Small Town Urban Agenda - Proceedings Report. December 2023. p. 7.
8 SBM U 2.0 dashboard, 2024, Accessed on June 01, 2024
9 Swachh Bharat Mission Urban (SBM-U) 2.0, Ministry of Housing and Urban Affairs, Government of India, 2024. As cited in: Kiranmayee Keerthana



Panchayats than in city corporations.[1] Approximately three-quarters of urban centres in India have no spatial master plan.[10] Historically, major central schemes have concentrated funding where populations are most politically visible: JnNURM directed approximately 70% of its investment toward large cities that housed 42% of the urban population, while small and medium towns - which housed 58% - received 30%.[11] AMRUT 1.0 and the Smart Cities Mission continued this trajectory, targeting 500 and 100 large cities respectively. **The consequence is a compounding deficit: towns that were underserved a decade ago are now absorbing a larger population with infrastructure that was already inadequate, governed by institutions whose technical and financial capacity has not grown commensurately.**

Critically, this is also a data deficit. Across BORDA's partner towns - Chikkaballapur and Chintamani in Karnataka, Leh and Kargil in Ladakh, Kushtia and Savar in Bangladesh, Godawari and Kirtipur in Nepal - a consistent pattern has emerged: small towns know their problems in broad terms but cannot see them with sufficient precision to act on them.[12] In SWM specifically, this shows up as collection metrics standing in for full-system performance, processing capacity reported as installed rather than operational, and informal recovery economies that go entirely unmeasured and therefore entirely unrecognised in planning. BORDA's 2023 Conference on Small Town Urban Agenda identified data as a foundational gap: data availability at the local level, participants noted, will ultimately decide the narrative and the development agenda for small towns, and strong data and research can enable the shift in national focus that small towns require.[13]

This is the structural condition the three cities in this publication were working within. They did not have complete data systems. They had vehicle logs, health inspector sheets, field observations, informal sector estimates, and household surveys - fragments that had never been assembled into a coherent picture of how waste actually moved through their systems. The question this publication asks is not whether small towns can build the data infrastructure that larger cities have failed to build. It is whether the data small towns already have, assembled carefully and read correctly, is sufficient to act on. The cases of Chikkaballapur, Kushtia, and Leh suggest that it is.

Small-town SWM problems have not yet hardened into the wicked, expensive, politically intractable conditions of large metropolitan systems. The scale of intervention

B.S., Jeevan Roy. Forgotten Dumpsites, Forgotten Towns: India's Struggles with Small-Town Waste. BORDA South Asia. pp. 1–2.

10 Reforms in Urban Planning Capacity in India, NITI Aayog, 2021. As cited in: BORDA South Asia. Conference on Small Town Urban Agenda - Proceedings Report. December 2023. p. 7.

11 Subaltern Urbanisation in India, 2018. As cited in: BORDA South Asia. Conference on Small Town Urban Agenda - Proceedings Report. December 2023. p. 7.

12 BORDA South Asia. Conference on Small Town Urban Agenda - Proceedings Report. December 2023. Acknowledgements, p. 5.

13 BORDA South Asia. Conference on Small Town Urban Agenda - Proceedings Report. December 2023. Acknowledgements, p. 5.

required remains commensurable with the scale of institutional capacity available. As BORDA's small-town programme has consistently argued, small towns, though distressed, are ready for course correction - their problems have not yet become the seemingly unsolvable challenges of metropolises.[11] That window is not permanently open. Towns that act on what their data already reveals, while problems are still tractable, will be in a categorically different position from those that wait for data systems that may never arrive.

Purpose and Audience

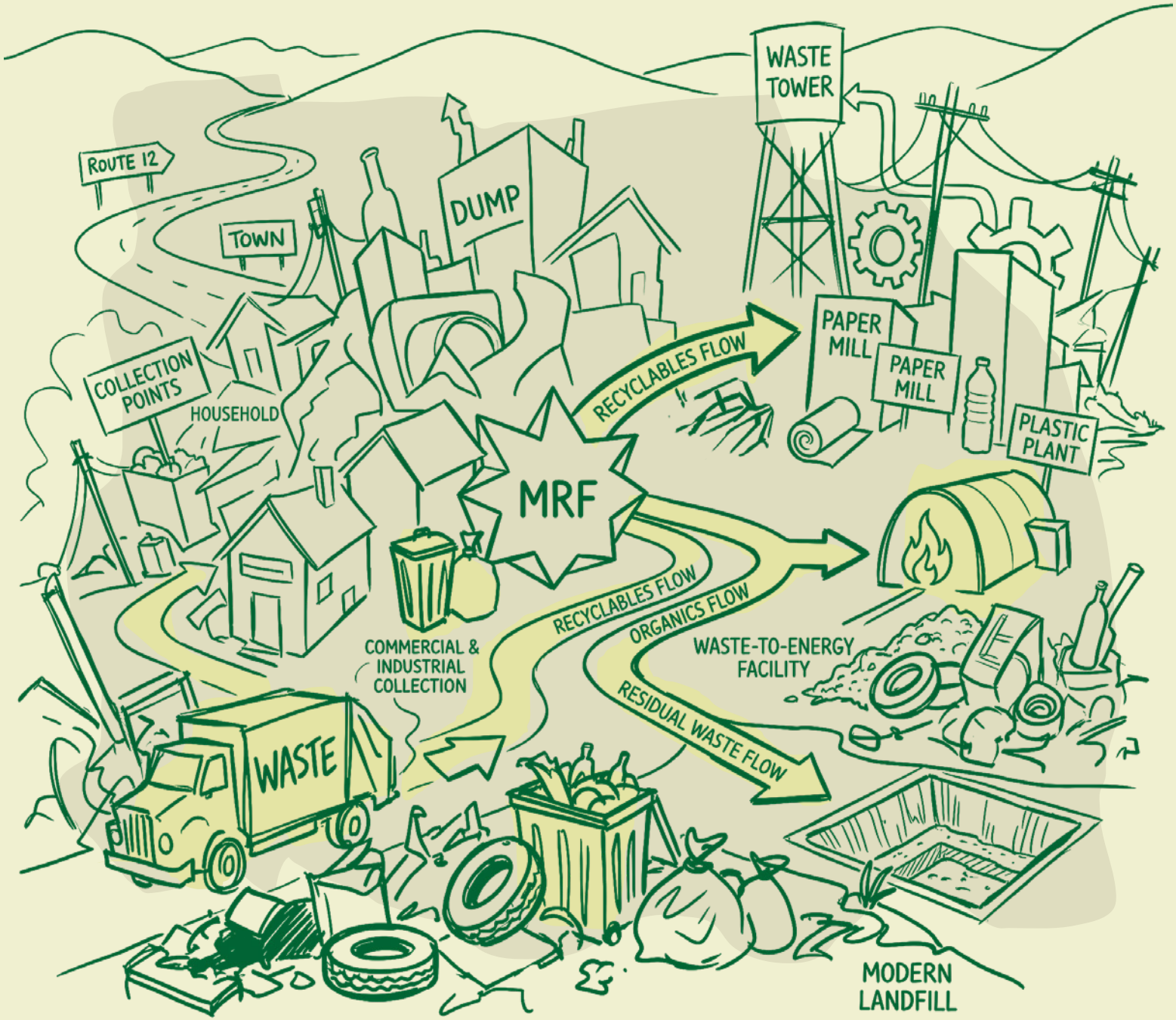
This report offers no solution to South Asia's small-town waste crisis. It offers something narrower and more useful: proof that traceable data, from generation through aggregation, processing, and disposal, changes what a municipality understands its problem to be, and what it does about it. Chikkaballapur (Karnataka), Kushtia (Bangladesh), and Leh (Ladakh) each entered the Waste Flow Diagram exercise with an assumption about where their system was failing. In each case, the data revealed something different, and decisions diverged from the default path. Chikkaballapur had a waste processing problem it was managing as a collection problem. Kushtia had an informal-recovery and exclusion problem it was managing as a capacity issue. Leh had a structural problem it was managing as a collection-coverage problem. None of these corrections required new data infrastructure. They required only that existing data be assembled, traced, and read.

Traceability here covers financial flows too: identifying a system's CapEx and OpEx needs, mapping funding against them, and exposing gaps that cannot close at the ULB level and so require escalation to state or national policy. A WFD exercise helps a municipality fix what it can, and articulate, with evidence, not advocacy, what it cannot fix alone.

The WFD is one of several tools for visualising a waste value chain; Sankey diagrams serve this role more broadly. WFD was used here because it suits data-scarce conditions, assembling what exists rather than waiting for what doesn't.

This publication addresses two audiences. For ULB officials and municipal commissioners in small towns, it shows how three municipalities read their data differently and acted on it. The operational, institutional, and budget shifts followed. For technical and policy actors, state DMAs, development partners, researchers, programme designers, it offers town-level evidence the small-town advocacy case has long needed: not assertions, but documented records of what towns found, and what changed.

It is not a WFD manual; the methodology is documented elsewhere. This is a record of what three towns found, proof that looking closely at what you already know is often enough to begin. Later sections detail each town's findings and the resulting shifts in strategy and investment.


ROUTE 12
TOWN
DUMP
WASTE TOWER
COLLECTION POINTS
HOUSEHOLD
RECYCLABLES FLOW
PAPER MILL
PAPER MILL
PLASTIC PLANT
MRF
RECYCLABLES FLOW
ORGANICS FLOW
RESIDUAL WASTE FLOW
COMMERCIAL & INDUSTRIAL COLLECTION
WASTE-TO-ENERGY FACILITY
WASTE
MODERN LANDFILL

CHAPTER 2

The Method: WFD

Most small and medium towns across South Asia lack sufficient and reliable data to plan for better municipal solid waste management. Waste generation estimates are often based on thumb rules 0.2 to 0.3 kg per capita rather than empirical surveys. Collection is routinely reported as a proxy for the entire system. What happens between collection and final disposal how much is recovered, how much leaks into drains and open land, and how much moves through informal channels is largely untracked.

A range of tools exist for visualising waste data and modelling the waste value chain. Sankey diagrams, for instance, have been applied across domains including budget flows, water balances, wastewater systems, and faecal sludge management - wherever the question is: where does a flow originate, where does it go, and how much is lost or transformed in between? The Waste Flow Diagram (WFD) is a Sankey-based methodology adapted specifically for municipal solid waste. It is one of several tools available for this purpose, chosen for these three case studies because of its particular suitability to the data conditions of small towns - specifically, its capacity to produce coherent system maps from fragmented, non-standardised inputs rather than requiring complete baseline datasets that most small towns do not possess.

The WFD tool used across the three cities in this publication was developed by Eawag (Swiss Federal Institute of Aquatic Science and Technology), GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit), and Lund University.

The WFD is a rapid assessment methodology for mapping the flow of municipal solid waste through a city's system - from generation at source through collection, transportation, treatment, recovery, and disposal - including the flows that bypass the formal system entirely. Rather than waiting for standardised, longitudinal datasets that most small towns do not have, the WFD draws on

what already exists: primary surveys of households and commercial establishments, observations along the collection chain, and interviews with sanitation workers, informal waste collectors, truck drivers, municipal officials, and community members. It assembles these fragments into a single coherent picture of how waste moves through a town - and where it is lost.

The Tool: Structure and Assumptions

The WFD is an Excel-based model comprising six sheets: baseline data entry, scenario data entry, calculations, flow diagrams, results summary, and settings.



- The baseline sheet maps current waste flows using primary field data and on-the-ground observations, covering five inputs: waste generation, waste treatment and disposal, waste managed in controlled facilities, plastic leakage potential per leakage influencer, and plastic pollution levels per fate.

- The scenario sheet allows users to test the potential impact of interventions (e.g., improved segregation or processing capacity) on system performance.

- The flow diagram sheet generates two outputs: a system map showing all flows in tonnes per year, and a Sankey diagram with arrow widths proportional to mass flows.

The tool relies on a combination of primary field data and calibrated assumptions to calculate environmental leakage - the proportion of waste that exits the formal system into drains, open land, or water bodies at each stage of the chain. It does not require comprehensive baseline data as a precondition; rather, the methodology is designed to make the most of what a town can realistically generate through a structured field assessment. Where empirical data is unavailable, the tool uses default leakage coefficients derived from comparable contexts, which can be refined as better local data becomes available. This assumption-dependency is a feature, not a limitation: it makes the tool usable in precisely the conditions where it is most needed, while the scenario function allows municipalities to test how changes in key parameters - segregation rates, collection coverage, processing capacity - would alter system-wide outcomes.

Primary Data Requirements

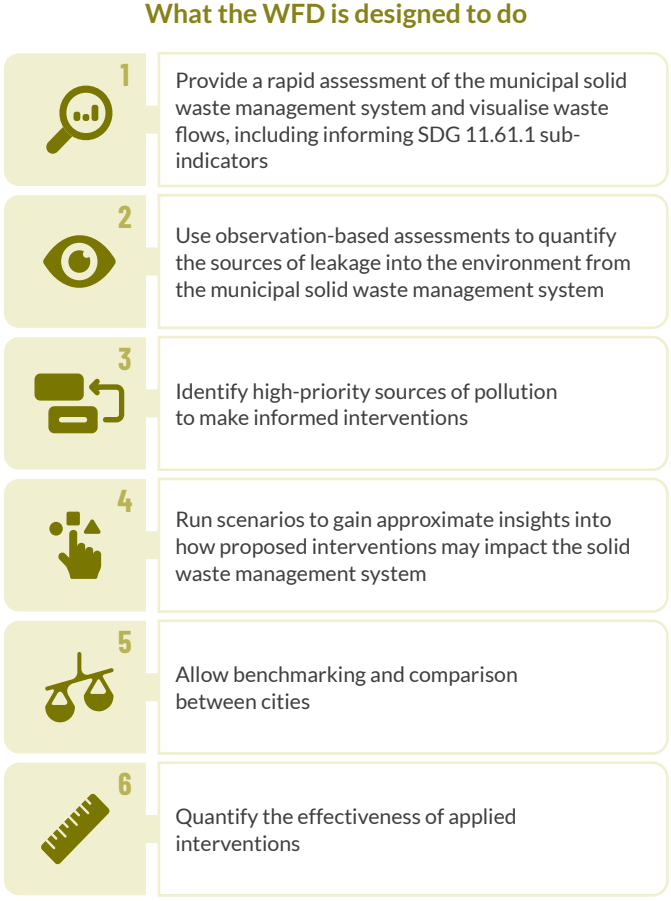
For other small towns seeking to replicate this methodology, the following table summarises the types of primary data required at each stage of the waste value chain, and the collection methods used across the three cities in this publication:

Table 1: Primary data requirements and collection methods across the waste value chain

	Stage / Value Chain	Type of Input Required	Source / Collection Method
	**Waste Generation**	Total daily waste generation (tonnes/day); per capita waste generation rate; waste composition (organic, dry recyclable, inert, others)	Household and commercial waste audits; physical waste composition sampling across representative wards
	**Formal Waste Collection**	Quantity of waste collected daily by the ULB or authorised service providers; collection coverage by ward/zone	ULB operational records; vehicle logbooks; weighbridge records; direct vehicle volume/weight measurements
	**Informal Waste Collection**	Quantity or percentage of waste recovered by informal waste pickers and scrap dealers before or alongside formal collection	Scrap dealer mapping; structured interviews; waste picker enumeration; collection route observations
	**Waste Transfer and Transportation**	Quantity transferred from primary collection to secondary storage/transfer points; transfer losses	Secondary storage point observations; vehicle trip sheets; transport records
	**Waste Processing**	Waste received at each processing facility; throughput vs. installed capacity; reject/residual rates	ULB consultations; facility registers; direct measurements at facility entry/ exit points
	**Waste Disposal**	Quantity of waste reaching disposal sites (dumpsites/sanitary landfills); quantity disposed outside the formal system	Dumpsite/landfill entry records; triangulation using waste generation and collection data
	**Environmental Leakage**	Quantity of waste entering drains, open land, water bodies, or other uncontrolled pathways at different stages	Field observations along collection routes; drain surveys; community interviews; hotspot assessments
	**Plastic Flows**	Plastic waste quantity by polymer/type; plastic leakage potential across different disposal pathways	Waste composition analysis; plastic characterisation; facility/recycler records; informal-sector interviews; field observations and triangulation

The key functions of the Waste Flow Diagram (WFD) are summarized below.

Figure 1: Key functions of the Waste Flow Diagram (WFD)



Administrative Context

One element that shapes how the WFD findings translate into decisions is the administrative hierarchy of each town - who is responsible for SWM operations, who has authority to redirect resources, and who is accountable for outcomes. This hierarchy differs across India and Bangladesh, and within India across state governance frameworks. The City Spotlights section that follows defines the specific administrative structure for each of the three cities - the tier of ULB, the sanctioned staff structure for SWM, and the relationship between elected representatives and technical officers - since understanding who is in charge is a precondition for understanding why certain decisions were possible and others were not.

The three cities in this publication Chikkaballapur in Karnataka, Kushtia in Bangladesh, and Leh in Ladakh each applied this methodology under different conditions and at different scales. These contexts are substantially heterogeneous climatically (Leh's cold desert vs. Chikkaballapur's semi-arid tropics), administratively (India's ULB system vs. Bangladesh's Pourashava system), and seasonally (Leh's tourist population fluctuates by 144%). Given this, our findings are not presented as statistically comparable across cities; rather, the value lies in demonstrating how the same WFD protocol surfaces distinct types of "invisible" gaps under different conditions. Direct cross-city comparisons of absolute figures (e.g., cost per tonne) are not attempted, and we do not adjust for purchasing power parity or wage differentials. In each case, the WFD mapped what routine municipal records had left invisible, and the findings shifted what the municipality understood its core problem to be.

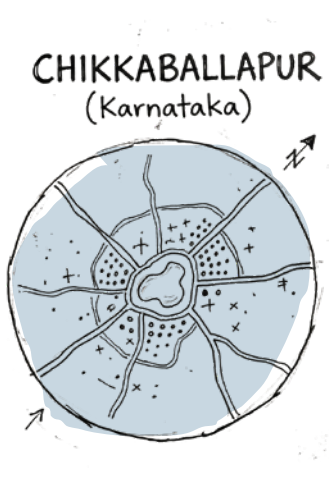

LONG GRAIN
RICE


CHIKKABALLAPUR
KUSHTIA
LEH

CHAPTER 3

City Spotlights - Translating Data into Local Action

The three cities examined in this section - Chikkaballapur in Karnataka, Kushtia in Bangladesh, and Leh in Ladakh - differ in geography, scale, governance context, and the nature of their waste challenges. What they share is this: each municipality entered the WFD exercise with a working assumption about its core problem, and in each case the data revealed something different. The decisions that followed were not prescribed by the methodology - they emerged from what each city's specific data made visible for the first time.



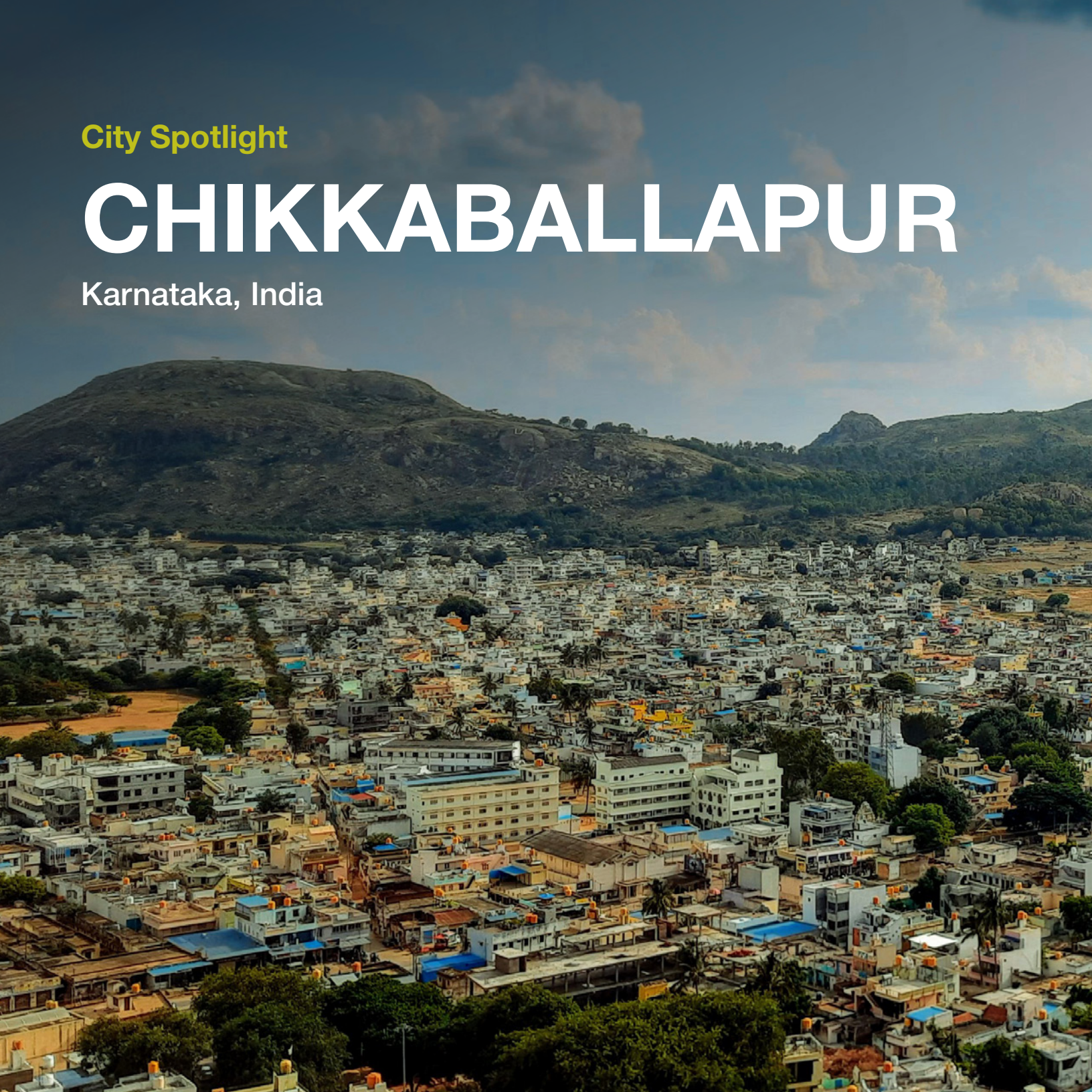




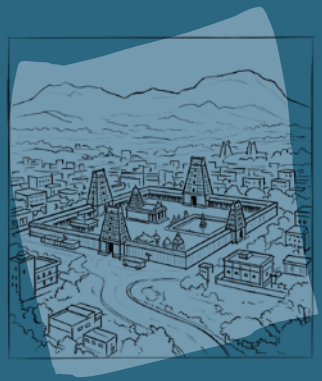
City Spotlight

CHIKKABALLAPUR

Karnataka, India







CHIKKABALLAPUR

An emerging Tier-3 urban centre

Location
North Bengaluru corridor

Economy
Diversifying: horticulture, education, industry, logistics

Population
63,985

Households
15,050

Wards
31

Waste generation
34.32 TPD

Growth in horticulture, education, small-scale industries and logistics is increasing the pressure on the city's solid waste system.

The Baseline

SWM operations are overseen by the Chikkaballapur City Municipal Council (CMC) through the Municipal Commissioner and a dedicated Environment Section, comprising engineering staff, health inspectors, supervisors and community mobilisers, supported by 135 sanitation workers, including permanent, direct-payment and contract pourakarmikas, drivers and helpers.

Figure 2: Baseline of the solid waste management system – Chikkaballapur

34+ TPD generated

↓

23 TPD formally collected

↓

<6 TPD existing processing capacity

↓

Most collected waste - dumpsite

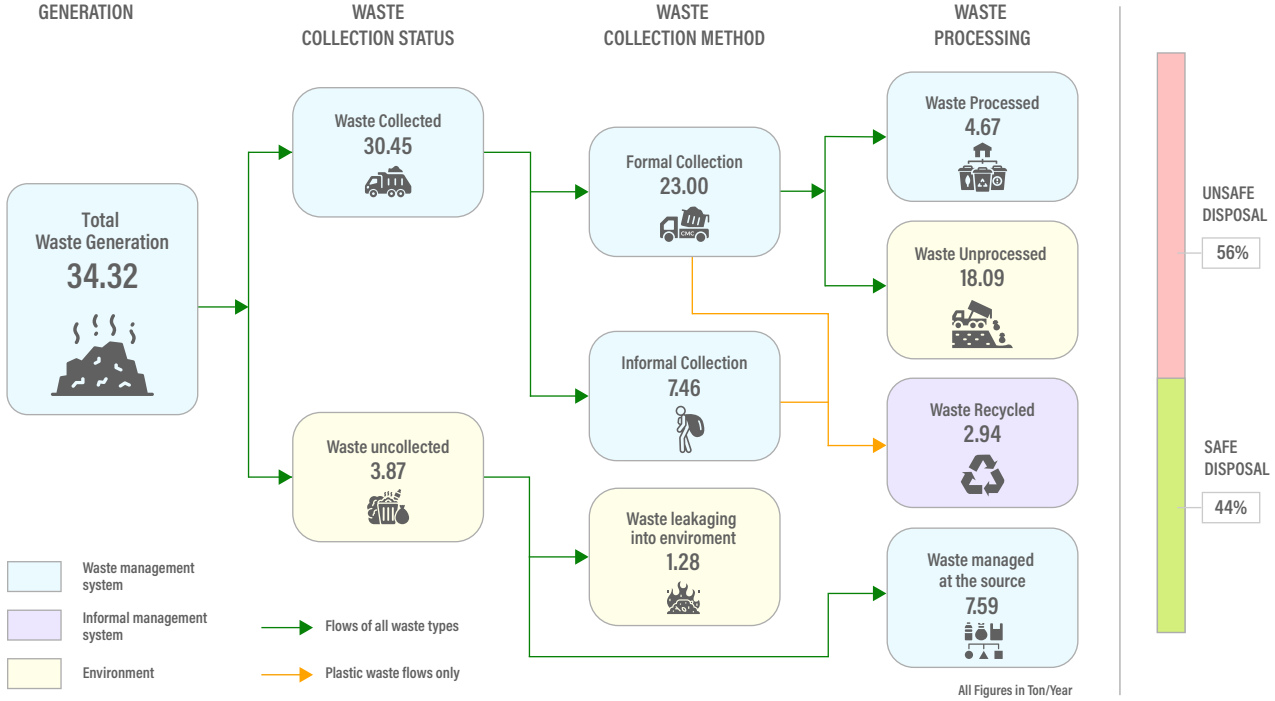
Puttathimmanahali Dumpsite

15 acres	10 km	15+ yrs	48,871 t
site area	from city centre	in use	legacy waste

Key Insight: Despite high collection coverage, the municipal waste system remains predominantly collection-focused, with limited processing and resource recovery capacity.



Figure 3: Waste Flow Diagram – Chikkaballapur



WFD assessment year 2024

Note: Minor mass-balance variations between waste-flow stages reflect field-level data constraints, estimation assumptions and rounding of reported values.

Table 2: Waste-flow categories and pathways – Chikkaballapur

Waste-flow category	What it represents	Pathway
Processed waste	Segregated biodegradable waste treated through scientific processing	Segregated wet waste → City–farmer linkage → Pit composting → Compost use
Unprocessed waste	Collected mixed waste that receives no sorting or treatment before disposal	Municipal collection → Dumpsite → Unscientific disposal
Recycled waste	Dry recyclable material recovered through formal and informal value chains	Formal: DWCC/MRF → Aggregator → Authorised recycler Informal: Waste picker → Scrap trader/aggregator → Recycler
Managed at source	Waste managed by the generator without entering municipal collection	Households: Home composting/animal feeding BWGs: Segregated food waste → Animal feed/piggeries
Environmental leakage	Waste escaping the managed system and entering uncontrolled pathways	Uncollected/mismanaged waste → Open environment

The Data Fragmentation Problem

Small-town municipalities generate substantial operational data, but it is often fragmented across departments, facilities and actors. In Chikkaballapur, data from vehicle movement and collection records, facility registers, health inspector records, field observations and informal-sector estimates captured individual stages of the waste value chain, but were not integrated to establish a complete material flow from generation to final destination.

While waste generation and collection quantities, workforce deployment and vehicle operations were relatively well documented, there was limited visibility on post-collection flows—including quantities processed, recovered, informally diverted, disposed of or otherwise unaccounted for. This information gap was particularly significant for the dry-waste recovery chain, where material quantity and quality changed between source, collection and processing.

Integrating these operational data points identified three critical gaps in the recovery chain: segregation failure at source, contamination during collection, and underutilisation of available recovery capacity. These findings informed three targeted municipal interventions.





Three Small Decisions. Big System Shift

These gaps pointed to three targeted operational responses, focused on improving the performance of the existing system rather than creating large-scale new infrastructure.

Table 3: From system insight to municipal decision – Chikkaballapur

1 Activate existing capacity

System Insight	*Municipal response*	*Observed Outcome*	
3.68 TPD of relatively clean commerical dry waste was going to disposal while the existing 2 TPD DWCC sat underutilised.	Set up a new DWCC using pre available space and infrastructure, redeployed sanitation workers and trained information waste workers for sorting.	+1.8 TPD existing DWCC capacity brought into use 45% of incoming material identified as recyclable	*Improve utilisation before adding infrastructure.*

2 Separate the collection flow

System Insight	*Municipal response*	*Observed Outcome*	
Nearly 1 TPD of recoverable commercial dry waste was losing value through mixing and contamination during collection.	Introduced separate commerical collection timings, dedicated routes and optimised route sequencing to move dry waste directly to the DWCC.	~1 TPD clean dry waste diverted directly to recovery. Reduced contamination, improved recovery potential	*Protect material quality before it reaches the DWCC.*

3 Strengthen segregation at source

System Insight	*Municipal response*	*Observed Outcome*	
111 BWGs generating over 20 kg a day were identified as a major point of segregation failure affecting downstream recovery.	Issued segregation notices, provided colour-coded bins and IEC support, and introduced regular compliance monitoring.	0.5 → 1.8 TPD dry waste reaching the DWCC Improved utilisation of existing recovery infrastructure	*Upstream compliance strengthens downstream recovery.*



Learnings

Chikkaballapur reflects a wider challenge across many Tier-3 towns: relatively strong collection systems coexist with limited processing and recovery, fragmented informal flows, and continued investment in collection infrastructure.

The case demonstrates that connecting existing operational data across the waste value chain can reveal specific system gaps and support targeted, lower-cost interventions, rather than defaulting to additional infrastructure.

Smaller ULBs, with lower waste volumes and relatively simpler logistics, also offer opportunities for faster operational improvements, decentralised solutions and stronger local recovery systems.

This diagnostic, data-led approach therefore has potential for replication across similar small towns, enabling incremental system improvement with limited additional investment.





City Spotlight

LEH

Union Territory of Ladakh, India





LEH

A high-altitude tourism hub

Location
Ladakh – ~3,500m AMSL

Economy
Tourism-dominated, strongly seasonal

Population
Grew from 30,870 to 56,800

Households
7,360

Wards
Expanded from 13 to 21

Waste generation
7,317 t/yr (~20 TPD avg*)

Tourism seasonality pushes summer waste generation to nearly four times the winter load, against fixed year-round infrastructure.

The Baseline

SWM is overseen by Municipal Committee Leh (MCL), in coordination with the Ladakh Autonomous Hill Development Council (LAHDC) and Housing & Urban Development Department (H&UDD). Field operations are supported by 113 sanitation workers across door-to-door collection, transportation and processing.

Figure 4: Baseline of the solid waste management system – Leh

~56,800 Estimated resident population

↓

85,000 - 90,000 Peak summer service population

↓

~20 TPD average Total waste geneation (7.317 t/yr)

↓

~4x seasonal variation
Applied to average, driven by summer tourism

↓

Fixed processing capacity
Existing MRF/Waste-management infrastructure

↓

Seasonal pressure on processing and disposal

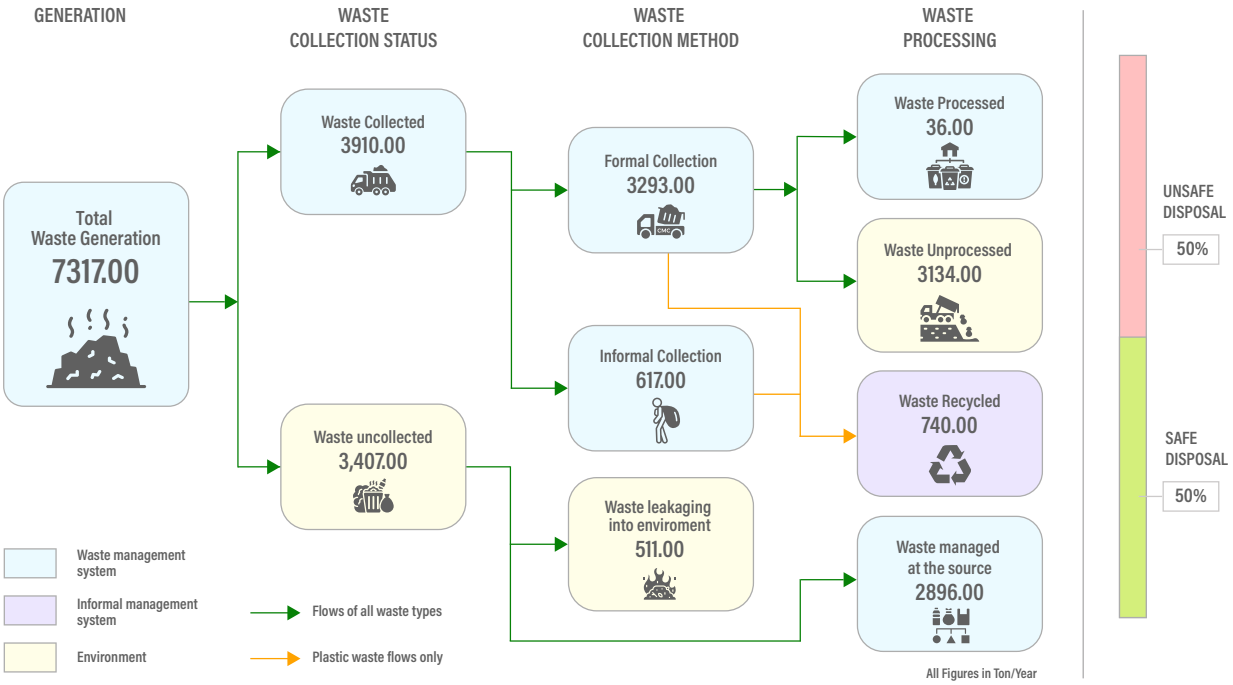
Existing facility capacity

30 TPD	3 TPD	~1 lakh MT
MRF capacity, Skampari (partly functional)	Composting facility (intermittent use)	Legecy waste remediated, Bomb Guard (by 2023)

Key Insight: Leh's waste system operates with relatively fixed processing capacity against a highly seasonal waste load, creating periods of increased pressure on processing, recovery and disposal infrastructure



Figure 5: Waste Flow Diagram – Leh



WFD assessment year 2022

Table 4: Waste-flow categories and pathways – Leh

Waste-flow category	What it represents	Specific pathway (per WFD Leh)
Processed waste	Wet waste completing composting through the municipal system	Formal collection → Skampari MRF → Shredding → Composting (3 TPD, seasonal) → Compost testing → Sale/use by local farmers
Unprocessed waste	Formally collected waste that is not sorted, recovered or treated	Formal collection → Skampari MRF → On-site disposal/holding of rejects and excess waste → Previously directed to Bomb Guard dumpsite
Recycled waste	Dry recyclables recovered and channelled into the material value chain through formal and informal systems	Formal: MRF → Picking belt → Sorting → Baling → Vendors → Recycling markets in Srinagar/Delhi. Informal: Kabadiwalas/waste pickers → PET, tin, iron and other recyclables → Aggregators → Off-region recycling
Managed at source	Organic waste diverted and beneficially used before entering municipal collection	Households → Source-separated wet waste → Animal feeding and/or home composting → Reduced municipal collection load
Environmental leakage	Uncollected waste entering uncontrolled disposal or burning pathways	Uncollected waste → Open dumping and/or burning → Roadsides, water bodies, low-lying areas and other uncontrolled locations

The Seasonal Surge Problem

Operational data in high-altitude tourism towns can obscure the vulnerability of a centralised system to seasonal and terrain load. Waste generation, collection, and disposal in Leh were quantified across summer and winter regimes through primary surveys of households, commercial establishments, sanitation workers, and waste pickers, reconciled against Waste Flow Diagram methodology.

The system's binding constraint was not collection coverage but processing redundancy. A single 30 TPD MRF at Skampari and a single dumpsite, Bomb Guard, provided no fallback capacity, no buffer against terrain-driven haulage cost, and no mechanism for tracking ward-level variance in generation as the municipal area expanded from 13 to 21 wards. When Bomb Guard was taken offline for bioremediation in 2022, the MRF had no alternate disposal outlet: 95% of the 3,293 t/yr formally collected was diverted to disposal without processing, against a 4% (123 t/yr) recovery rate at the facility. Informal collectors, operating closer to the point of generation, recovered 617 t/yr — approximately five times the formal facility's throughput.

These findings established the technical basis for a transition from single-facility centralisation to a five-zone decentralized Integrated Solid Waste Management (ISWM) system, specified in Table below.



Three Decisions. From Centralised To Decentralized Processing

These gaps pointed to three targeted decentralisation decisions, focused on distributing processing capacity to where waste is generated rather than expanding capacity at a single central facility.

Table 5: From system insight to proposed actions – Leh

1 Decentralise processing into a five-zone ISWM system

System Insight

A single 30 TPD facility and single dumpsite provided no redundancy. When Bomb Guard closed, 95% of collected waste (3,134 t/yr) was dumped rather than processed. Ward-level data showed generation variance one citywide facility could not track.

Proposed Action

Divide the municipal area into five zones under the City SWM-Action Plan (SBM-Urban 2.0); size dry and wet infrastructure to each ward-cluster's own generation.

Expected Outcome

76 TPD processed locally 70% diversion target by 2027

2 Decentralise dry waste recovery into zonal MRFs

System Insight

The centralised MRF recovered only 4% of collected waste (123 t/yr); informal collectors recovered nearly 5x more (617 t/yr) working closer to source. Volumes surged ~4x from winter to summer.

Proposed Action

Five solar-powered zonal MRFs (1-30 TPD each), weighbridge-equipped, with 16-category manual-mechanised sorting sited within each zone.

Expected Outcome

62 TPD dry processing capacity 25-30% recyclables recovery rate

3 Decentralise wet waste treatment

System Insight

Organic waste was the dominant fraction (up to 64% in summer), but existing composting capacity (3 TPD) could not absorb peak inflow, 2,589 t/yr was already managed informally as animal feed.

Proposed Action

Zone-wise wet facilities in place of one expanded plant: composting at Skampari (10 TPD) and Tsangda (2 TPD), a ward-level unit at Bombgrah (2 TPD), bio-methanation at Agling (1 TPD).

Expected Outcome

~14 TPD wet processing capacity distributed across zones

**Expected outcomes are DPR projections – not yet implemented*



Learnings

Leh illustrates a broader planning challenge for high-altitude, tourism-dependent towns, where seasonal waste generation, dispersed settlements and difficult terrain interact with relatively concentrated waste infrastructure. In such contexts, annual-average waste quantities alone are insufficient for infrastructure planning. Seasonal peaks can place substantially higher demands on collection, transportation and processing, while distance, gradients and dispersed service areas increase the operational burden of moving waste to a single central facility. Dependence on a limited number of processing and disposal assets further reduces system resilience when one component becomes unavailable or reaches its operational limit.

Leh also demonstrates the importance of analysing where recovery occurs within the value chain. The contribution of informal collectors operating closer to waste-generation points indicates that proximity can be an important factor in capturing recyclable material before it is mixed, contaminated or transported for disposal. The transferable lesson is therefore not decentralisation as a predetermined solution, but the need to design infrastructure around the town's actual spatial and seasonal waste profile. For hill towns, this means assessing peak versus off-season generation, transport distances, facility utilisation, recovery points and system redundancy before determining the appropriate balance between centralised and decentralised infrastructure.





City Spotlight

KUSHTIA

Southwestern Bangladesh



KUSHTIA

A river-port gateway town

Location
Khulna Division- on the Padma River

Economy
Regional trade & administrative gateway

Population
226,800

Households
58,295

Wards
Expanded from 12 to 21

Waste generation
99.8 TPD

Only 14 of 21 wards fall under formal collection – the remaining service gap falls hardest on low-income settlements outside the municipality's line of sight.

The Baseline

Solid waste management in Kushtia is overseen by Kushtia Municipality (Paurashava), an 'A'-category municipality established in 1869. The municipality operates door-to-door collection in parts of the town, two secondary transfer stations, an ageing municipal composting facility, and a fleet of collection vehicles, but has no operational framework for source segregation, material recovery, or scientific processing across large parts of its service area.

Figure 6: Baseline of the solid waste management system and service coverage – Kushtia

99.8 TPD generated (36,427 t/yr)

↓

38 TPD formally collected (13,870 t/yr – 38% of generation)

More than half of Kushtia's waste remains uncollected – concentrated in low-income communities

↓

226 LICs mapped across Kushtia Municipality

↓

28 LICs without regular waste collection

↓

9 priority LICs in Garai Badh

↓

18,200 resident | 3,440 households

DPR-verified, independent of the WFD mapping

↓

No regular municipal SWM service reaches this population

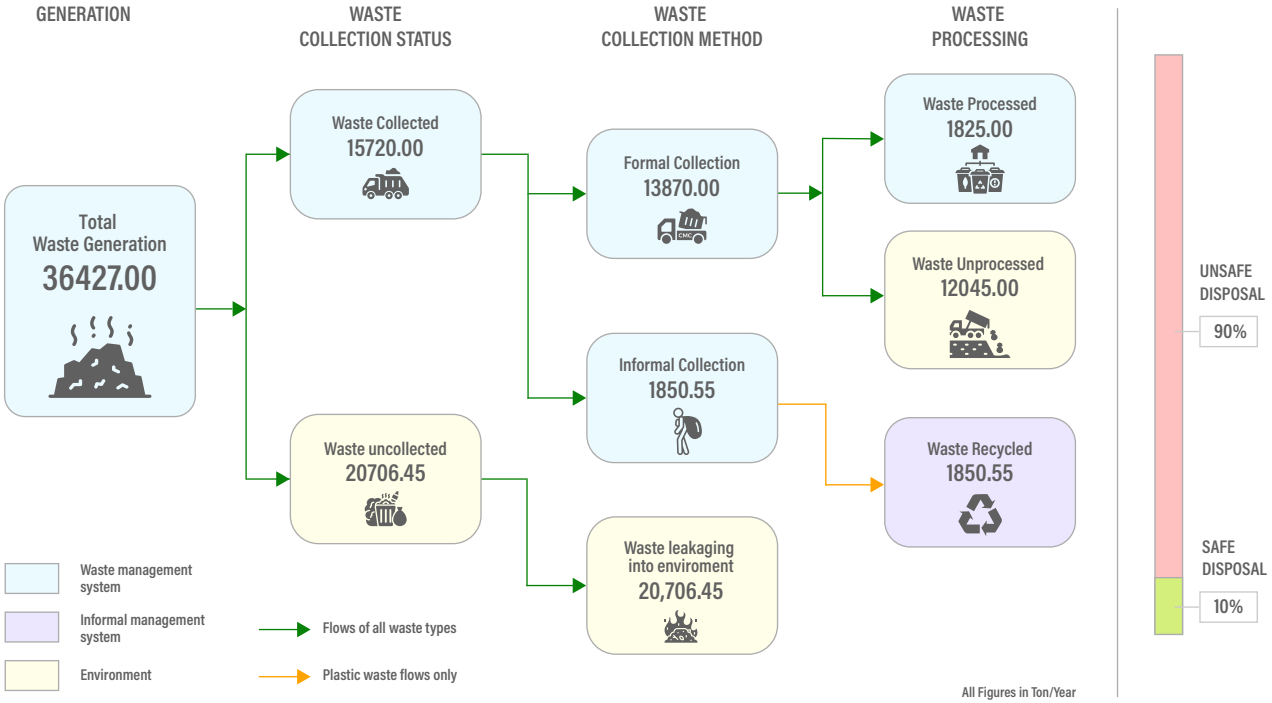
Without service, residents resorted to		Yet the same households said	
45%	Open-space disposal	89.2%	Preferred D2D collection
34%	Rivers / water bodies	85%	Willing to segregate at source
0%	Satisfied with existing disposal		

Vulnerable communities are not being serviced



Key Insight: More than half of Kushtia's waste remains uncollected, with service gaps concentrated in low-income communities. Poor disposal practices reflect limited access to regular collection, rather than low community participation, with surveys indicating strong willingness to use and support formal waste services.

Figure 7: Waste Flow Diagram – Kushtia



WFD assessment year 2022

Table 6: Waste-flow categories and pathways – Kushtia

Waste-flow category	What it represents	Kushtia pathway / facility
Processed waste	Formally collected organic waste treated through the existing municipal resource-recovery system	Formal collection → Municipal composting plant → Compost production
Unprocessed waste	Collected municipal waste receiving no treatment or recovery before disposal	Formal collection → Majhidanga disposal site, Ward 14 → Uncontrolled disposal
Recycled waste	Inorganic recyclables recovered outside the formal municipal processing system	Informal collection → Vangari shops / aggregators → Recycling market
Uncollected waste	Waste generated but not captured through formal or informal collection	Generation → No collection → Uncontrolled disposal
Environmental leakage	Uncollected waste entering drains, riversides, low-lying land, roadsides and open spaces	Uncollected waste → Open drains / low-lying areas / open spaces / natural drainage pathways

The Service Exclusion Problem

Municipal waste data can indicate overall collection performance while obscuring where service gaps are concentrated and which populations remain outside the formal system. In Kushtia, city-level collection and disposal data did not adequately capture the spatial distribution of service access across low-income communities or the contribution of informal recovery actors operating outside municipal records.

The assessment showed that 226 low-income communities (LICs), comprising 53,265 residents, accounted for about 23% of the municipal population, with significant deficiencies in access to solid-waste services. Within this wider group, 28 LICs lacked regular waste collection, and nine priority communities in the Garai Badh area—home to approximately 18,200 people in 3,440 households—were identified for intervention. Existing disposal into open spaces, drains and water bodies reflected a service-access constraint rather than low willingness to participate: 89.2% of surveyed households preferred formal collection, while 85% were willing to segregate waste at source.

The assessment also made visible an informal recovery system operating alongside municipal services, while community institutions within the LICs provided an existing platform for participation in service delivery and O&M. These findings established the basis for an inclusive service-delivery model combining source segregation, door-to-door collection, locally appropriate primary transport, resource recovery through an MRF and the existing compost plant, and community participation in operations.



Three Inclusion-Led Decisions. One Service Chain

These gaps pointed to three targeted inclusion decisions, focused on extending formal waste services to underserved communities, sizing infrastructure to demonstrated demand, and integrating existing informal recovery into the municipal system.

Table 7: From system insight to proposed actions – Kushtia

1 Formalise inclusive service delivery

System Insight

Nine Garai Badh LICs (-18,200 residents) remained outside regular municipal waste collection, despite strong community willingness to participate. The gap was primarily one of service access and institutional responsibility.

Municipal response

A four-party operating structure was established: 9 CDCs for source segregation and door-to-door collection; GAPCS as MRF operator; Kushtia Town Federation for monitoring; and Kushtia Municipality for ownership and oversight.

Observed change

9 previously underserved LICs integrated into an organised municipal service chain, with defined responsibilities for collection, recovery, monitoring and oversight.

Service inclusion required clear institutional responsibility, not only infrastructure.

2 Size infrastructure to local waste flows

System Insight

Waste assessment showed that 88.87% of LIC waste was organic, while approximately 500 kg/day of dry waste required a dedicated recovery pathway. Existing municipal composting capacity could receive the organic fraction.

Municipal response

Source-separated organic waste was linked to the existing municipal compost plant, while a 69 m2 Garai Badh MRF was established for dry-waste sorting, baling and recovery, designed for -500 kg/day with 1.5 tonnes buffer storage.

Observed change

A segregated local service chain became operational: organic waste → municipal composting; dry waste → Garai Badh MRF → sorting/baling → recycling market.

Infrastructure investment: BDT 53,25,101 (-USD 47,000), including MRF and tractor/trailer.

Infrastructure was sized to measured local waste flows.

3 Integrate informal recovery

System Insight

Informal recovery was already contributing to Kushtia's recycling system but remained largely outside formal municipal planning, infrastructure and institutional arrangements.

Municipal response

Existing informal recovery was mapped and recognised, and GAPCS — an existing local cooperative — was integrated into the municipal service chain as the MRF operator under a no-cost municipal lease.

Observed change

Informal recovery shifted from unrecognised activity to an institutional role within the formal service chain, linking local recovery with the MRF and downstream recycling markets.

Recognise existing recovery systems before creating new ones.



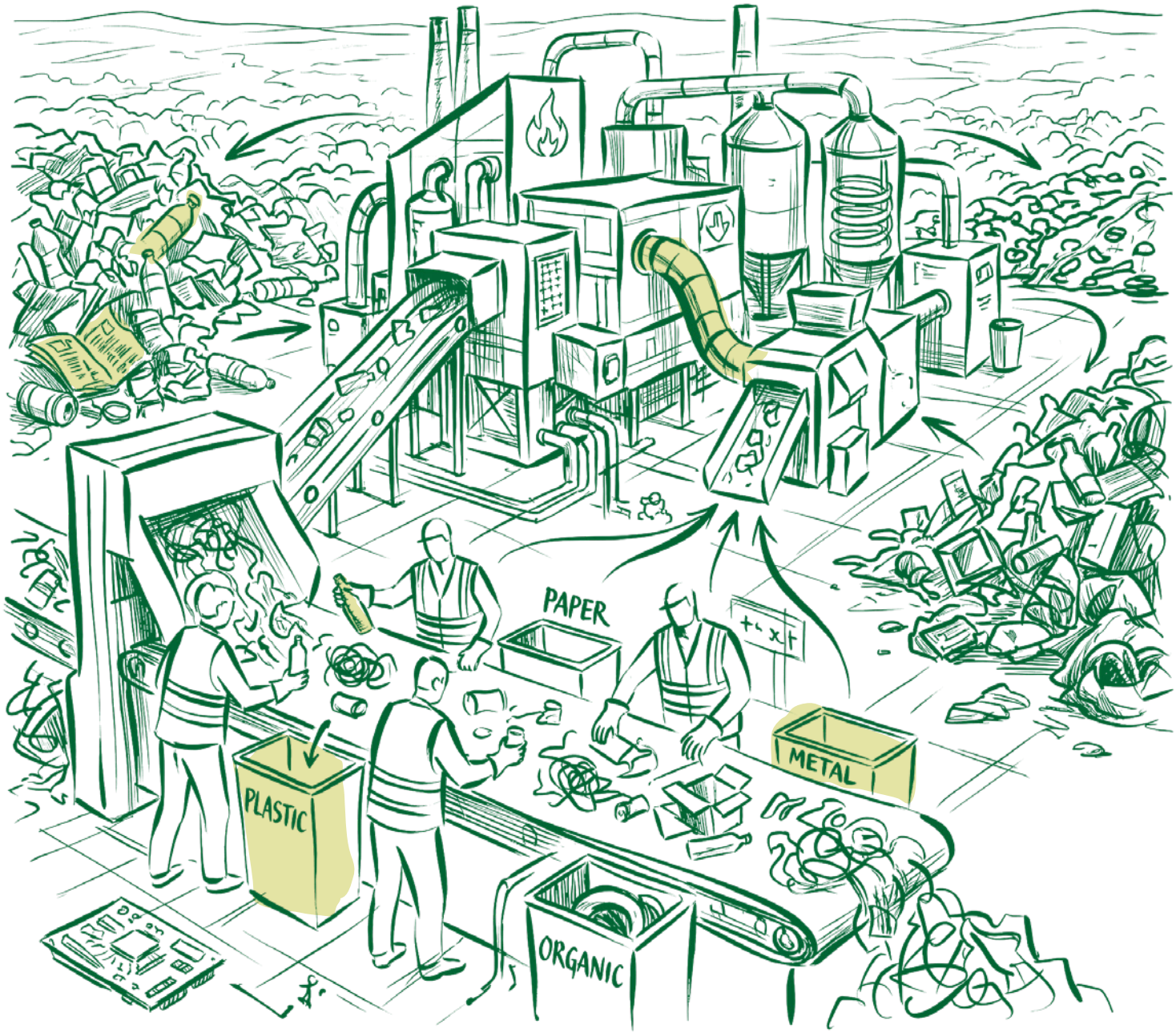
Learnings

Kushtia's findings are not unique to a single municipality; they describe a structural condition common to secondary towns managing rapid, unplanned urban growth. Such towns typically expand faster than their formal service boundaries: wards are added, but collection coverage, budgeting, and planning continue to reference the town's earlier footprint. This produces two invisible systems by default, not by neglect — an informal recovery economy that fills gaps in formal processing capacity, and low-income or peripheral settlements that fall outside collection coverage. Because neither is captured in routine municipal data, both remain absent from infrastructure planning, however consistently they appear in the town's daily waste stream.

Formal inclusion does not require replacing informal systems; it requires recognising and incorporating them. Small towns and secondary cities frequently have functioning, community-rooted institutions, cooperatives, informal recovery networks, resident welfare or community development committees, operating where formal municipal systems have not reached. Where these exist, formalising their role in service delivery closes coverage gaps faster than building parallel infrastructure from scratch, without displacing the livelihoods built around them.

A secondary town facing unmapped informal recovery and underserved settlements does not require Kushtia's specific institutional structure, four-party model, ward boundaries, or MRF capacity. It requires the same diagnostic step: surveying who is unserved, what they do with their waste, and whether existing community institutions can be formalised into service delivery rather than requiring new ones to be built from scratch. Inclusion follows from what that diagnostic shows, not from an assumption that informal actors need to be replaced rather than recognised.




PAPER
METAL
PLASTIC
ORGANIC

CHAPTER 4

Conclusion

The three studies show meaningful small-town waste management improvements do not require a single technical solution, but consistent, locally grounded data-driven planning. In Leh, it revealed the limits of centralised systems in a tourism-driven mountain context, prompting decentralised, seasonally adaptive solutions. In Chikkaballapur, it highlighted operational inefficiencies and recovery opportunities through better segregation, infrastructure optimisation, and targeted operational change. In Kushtia, it uncovered invisible waste flows and underserved communities, enabling more inclusive, socially responsive planning.

Across these contexts, the common lesson is that effective waste management improvements do not depend on large infrastructure investment. Locally grounded data can reveal where targeted operational, governance, and social interventions deliver the greatest impact. The Waste Flow Diagram (WFD) is one such tool: quick and inexpensive to execute, giving small towns, many of which lack dedicated planning capacity or budget for a full system audit, a practical starting point for such planning.

This approach supports key global priorities, including circular economy transition, climate change mitigation, urban resilience, and inclusive service delivery, extending its impact beyond the waste sector. By generating baseline data and identifying actionable pathways, governments, development agencies, and financial partners can direct resources towards the highest-impact interventions.

The scalability of this approach presents a significant investment opportunity. Hundreds of small and medium-sized towns across the Global South face challenges but lack the data and planning capacity to design effective solutions. Supporting data-driven planning, using lightweight tools like the WFD, across town networks can enable rapid diagnostics, evidence-based investment, and locally appropriate waste management improvements at scale.



Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BORDA	Bremen Overseas Research and Development Association
BWG	Bulk Waste Generator
CapEx	Capital Expenditure
CDC	Community Development Committee
CMC	City Municipal Council
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organisation
CSE	Centre for Science and Environment
D2D	Door-to-Door
DMA	Directorate of Municipal Administration
DPR	Detailed Project Report
DWCC	Dry Waste Collection Centre
FISH	Foundation for Inclusive and Sustainable Habitats
GAPCS	Garai Ashar Alo Primary Cooperative Society*
GPS	Global Positioning System
H&UDD	Housing & Urban Development Department
HH	Household
ICCC	Integrated Command and Control Centre
ISWM	Integrated Solid Waste Management
LAHDC	Ladakh Autonomous Hill Development Council
LIC	Low-Income Community
MCL	Municipal Committee Leh
MIS	Management Information System
MoHUA	Ministry of Housing and Urban Affairs
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
O&M	Operation and Maintenance
ODF	Open Defecation Free
OpEx	Operational Expenditure
RFID	Radio-Frequency Identification
SBM-U	Swachh Bharat Mission – Urban
SPCB	State Pollution Control Board
SWM	Solid Waste Management
TPD	Tonnes per day
ULB	Urban Local Body
UT	Union Territory
WFD	Waste Flow Diagram



Glossary

Biodegradable Waste	Waste of plant or animal origin that can be degraded by microorganisms, including food waste, kitchen waste, vegetable and fruit waste, and other organic material.
Bulk Waste Generator (BWG)	A waste generator meeting the quantity or institutional criteria prescribed under the applicable Solid Waste Management Rules and having specific responsibilities for segregation and management of the waste generated.
Domestic Hazardous Waste	Household waste with hazardous characteristics, including discarded paint drums, pesticide containers, expired medicines, used batteries, broken mercury thermometers, contaminated materials and similar waste requiring separate handling.
Dry Waste	Waste other than biodegradable and sanitary waste, generally comprising recyclable and non-recyclable materials such as paper, plastic, metal, glass, packaging and similar materials.
Processing	Scientific treatment of solid waste to facilitate reuse, recycling, recovery, treatment or transformation into useful products and to minimise the quantity requiring final disposal.
Recycling	The process of transforming segregated waste materials into raw materials or products that can be returned to productive use.
Sanitary Landfill	An engineered facility for the final disposal of residual solid waste on land, designed and operated with measures to minimise environmental impacts.
Segregation at Source	Sorting and separate storage of different categories of solid waste at the point of generation to facilitate appropriate collection, processing, recycling, treatment and disposal.
Solid Waste	Solid or semi-solid waste generated from domestic, commercial, institutional and other applicable activities within the scope of the Solid Waste Management Rules, excluding waste streams regulated separately under other rules.
Waste Generator	Any person, household, establishment, institution or other entity whose activities generate solid waste.
Waste Picker	A person or group engaged in the collection and recovery of reusable and recyclable materials from waste streams for reuse, recycling or sale.

Dry Waste Collection Centre (DWCC)	A decentralised facility for aggregation, temporary storage and, where required, basic sorting of segregated dry waste before onward transfer to recyclers, scrap dealers or an MRF.
Material Recovery Facility (MRF)	A facility where segregated dry waste is further sorted into recoverable material streams such as paper, plastics, metals and glass for recycling, with residual fractions directed to appropriate downstream management.
Biomethanation	Anaerobic biological treatment of segregated biodegradable waste to produce biogas and digestate, enabling biological treatment with energy and nutrient recovery.
Windrow Composting	An aerobic composting process in which segregated biodegradable waste is arranged in elongated piles or windrows and periodically turned to maintain aeration and facilitate decomposition.
Refuse Derived Fuel (RDF)	Fuel prepared from segregated combustible fractions of municipal solid waste after recyclable and inert materials have been removed, for use in approved energy-recovery applications such as cement kilns or industrial boilers.
Scrap Combustible Fraction (SCF)	The non-recyclable but combustible fraction of segregated dry waste that can be channelled for RDF production, co-processing or other appropriate energy-recovery applications.
Decentralised Waste Management	Management of segregated waste through appropriately sized facilities located closer to the point of generation, such as household-, community-, ward- or cluster-level composting, dry-waste aggregation or recovery systems.
Waste Flow Diagram (WFD)	An analytical tool used to map waste generation, collection, treatment, recovery and final disposal within a defined geographical area to support planning and decision-making.
Environmental Leakage	Waste that escapes the managed waste system and enters uncontrolled environmental pathways such as open land, drains or water bodies.
Managed at Source	Waste appropriately reused, composted, fed to animals or otherwise managed by the generator without entering the municipal collection system.
Uncollected Waste	Waste generated within the defined study area that is not captured by the identified formal or informal collection systems.
Unprocessed Waste	Collected waste that does not undergo identified processing, treatment or material recovery before reaching its disposal pathway.



Scan for our resources

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