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From Waste Disposal to Resource Recovery: Municipal Solid Waste Management and Circular Economy Opportunities in Imphal, Manipur

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ABSTRACT

Municipal solid waste management in Imphal, Manipur, is challenged by changing consumption patterns, constrained urban services, inadequate segregation and the environmental risks associated with poorly controlled disposal. At the same time, the composition of the waste stream creates opportunities for resource recovery, particularly through biological treatment of organic waste and recycling of recoverable dry materials. This paper examines these challenges and opportunities through an integrative, secondary-source case study of Imphal, with attention to the Lamphelpat disposal context and the Nambul River. The analysis synthesises peer-reviewed studies on municipal solid waste management in Imphal, a seasonal waste-characterisation study conducted in the city's main market, research on surface-water quality in the Nambul River and near Lamphelpat, a regional review of solid waste management in North-East India, and the national regulatory framework. The 2023 market-area waste-characterisation study reported that organic and biodegradable materials accounted for 63.50% of the sampled dry waste in summer and 68.75% in winter; compostable organic material alone accounted for 46.25% and 50.15%, respectively. These results

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indicate a substantial opportunity for source-separated biological treatment, although the sampling locations do not represent the entire city. Historical research also documented concerns about waste collection and disposal in Imphal and examined surface-water parameters at sites along the Nambul River and near Lamphelpat. Because those observations relate to earlier study periods, they cannot establish present-day environmental conditions. The paper argues that a locally appropriate circular approach should prioritise waste prevention, four-stream source segregation, decentralised processing of clean biodegradable waste, material recovery, safe residual disposal, worker protection and transparent environmental monitoring. The Solid Waste Management Rules, 2026, which came into force on 1 April 2026, provide the current national regulatory framework. The paper concludes with a phased implementation framework and a research agenda for generating current, ward-level evidence. It contributes a place-based synthesis linking environmental management, local governance, community participation and livelihood development in Manipur.

1. Introduction

Municipal solid waste (MSW) management is a core urban environmental service with direct implications for public health, water and soil quality, local amenity, greenhouse-gas emissions and the use of material resources. Waste systems are often discussed in terms of collection and disposal, but their performance depends on a longer chain that includes waste prevention, segregation at source, storage, collection, transportation, sorting, treatment, recovery and final disposal. Weakness at one stage can undermine the entire chain. When biodegradable and recyclable materials are mixed, the quality of recoverable resources declines, processing becomes more difficult and the volume requiring disposal increases.

These issues are particularly important in the North-Eastern region of India. Ao and Ngullie (2024) identify the region's hilly terrain, diverse settlement patterns, infrastructure constraints and limited data availability as factors shaping municipal solid waste management. Their regional review estimated that the North-Eastern states collectively generated approximately 2,907 tonnes of MSW per day, with substantial gaps between collection, treatment and disposal. These are regional estimates and should not be read as figures for Manipur or Imphal alone. The authors also identify biodegradable waste as a major component of the

regional waste stream, strengthening the case for locally appropriate biological treatment where waste is segregated and suitable facilities are available.

Imphal, the capital city of Manipur, has been the subject of earlier studies examining municipal waste generation, collection, disposal and institutional constraints. Yadav and Devi (2016) reported that the municipal system at the time of their study faced substantial collection and disposal deficiencies. Their estimate of approximately 120 tonnes per day and the reported collection rate of 40–50% are historical findings from that study and must not be treated as current city statistics. More recently, Meetei et al. (2025) conducted a seasonal physical characterisation of waste sampled from temporary disposal locations in and around Imphal's main market. Their results showed that organic and biodegradable materials formed the largest category in both summer and winter.

The Lamphelpat disposal area and the Nambul River are relevant to the environmental dimension of waste management in Imphal. Singh and Dey (2014) examined surface-water quality at three locations along the Nambul River and one location near the Lamphelpat disposal site. Their sampling extended from April 2010 to March 2012. The study provides a historical environmental evidence base, but it cannot establish current water quality. Current assessment requires new sampling, appropriate reference sites, documented methods and transparent laboratory quality assurance.

The policy context has also changed. The Government of India notified the Solid Waste Management Rules, 2026, on 27 January 2026; the Rules came into force on 1 April 2026 and superseded the 2016 Rules (Ministry of Environment, Forest and Climate Change [MoEFCC], 2026). Among other provisions, the 2026 framework establishes mandatory segregation into wet, dry, sanitary and special-care waste streams and clarifies responsibilities across urban and rural local bodies and other stakeholders.

Against this background, the present paper reframes the original proposition of 'rethinking waste' as a question of how Imphal can move from disposal-oriented management towards resource recovery and a more accountable circular system. It does not claim to present new field measurements. Instead, it critically synthesises available published evidence, identifies what can and cannot be concluded from it, and develops a context-sensitive action framework.

2. Aim, Objectives and Research Questions

2.1 Aim

The aim is to examine municipal solid waste management challenges and circular-economy opportunities in Imphal, Manipur, using published evidence and the Lamphelpat–Nambul environmental context.

2.2 Objectives

1. To synthesise published evidence on the composition and management of municipal solid waste in Imphal.
2. To examine the environmental significance of the Lamphelpat–Nambul context based on available water-quality research.
3. To assess the potential and conditions for organic-waste treatment, dry-waste recovery and community-based livelihood opportunities.
4. To analyse the relevance of the Solid Waste Management Rules, 2026, for local implementation.
5. To propose a phased framework for evidence-based, inclusive and decentralised solid waste management in Imphal.

2.3 Research questions

- What does the published evidence indicate about the composition and management of municipal solid waste in Imphal?
- What environmental concerns are raised by historical research on the Lamphelpat disposal area and the Nambul River, and what further evidence is needed?
- Which resource-recovery pathways are most consistent with the documented composition of Imphal's municipal waste?
- What governance, institutional and community conditions are required to translate resource-recovery opportunities into a sustainable local system?

3. Review of Literature and Conceptual Orientation

3.1 Municipal solid waste management in the North-Eastern region

Ao and Ngullie (2024) provide a region-wide synthesis of municipal solid waste management in the North-Eastern states. They report that the region faces linked challenges involving waste collection, limited source segregation, insufficient treatment infrastructure and reliance on open dumping and burning. Their review is important because it situates Imphal within a wider regional context in which topography, settlement distribution, institutional capacity and data limitations affect service delivery. However, regional averages

conceal substantial differences among states, towns and local bodies. They should therefore guide contextual understanding rather than substitute for local data.

3.2 Evidence on waste management in Imphal

Yadav and Devi (2016) assessed the municipal solid waste management system in Imphal Town and identified weaknesses in collection, transportation and disposal. The authors reported an estimated generation of approximately 120 tonnes per day at the time of their study, with only 40–50% collected by the management authorities. Their work is useful as a historical diagnosis of system weaknesses, but its estimates are tied to the period and methods of the study. They cannot be used as current operational figures without verification.

Meetei et al. (2025) provide more recent local evidence through physical characterisation of waste from temporary dumping locations in and around the main market of Imphal. Samples were collected during summer and winter 2023, and the authors classified materials into organic and biodegradable, inorganic and non-biodegradable, and inert categories. The study reported that organic and biodegradable materials constituted 63.50% of the sampled dry waste in summer and 68.75% in winter. The compostable organic fraction was 46.25% and 50.15%, respectively. This study is especially relevant to treatment planning, but its sampling frame was the main-market area and should not be generalised to every household, ward or institutional generator in Imphal.

3.3 Environmental evidence relating to Lamphelpat and the Nambul River

Singh and Dey (2014) investigated surface-water quality in the Imphal Municipality area in relation to municipal solid waste disposal. Their study included three locations along the Nambul River—upstream, within the municipal area and downstream—and a fourth location near the Lamphelpat disposal site. Parameters included pH, total dissolved solids, dissolved oxygen and biochemical oxygen demand, among others. The study is relevant because it links waste-disposal practices with the need to monitor receiving waters. Its observations cover April 2010 to March 2012; accordingly, the paper treats it as historical evidence and does not use it to assert present-day contamination levels.

3.4 Circular economy and the waste hierarchy

The circular-economy perspective shifts attention from end-of-pipe disposal to preventing waste and keeping materials in productive use for as long as practicable. In the context of municipal waste, this requires prioritising prevention and reduction, reuse, repair, recycling and biological recovery, with safe

treatment and disposal reserved for residual materials. Awino and Apitz (2024) review the relationship between the waste hierarchy and circular-economy frameworks and emphasise that implementation must account for environmental, institutional and practical constraints. For Imphal, this means that circularity should not be equated with a single technology such as composting or waste-to-energy. It requires a coordinated system that matches treatment options to the actual composition and quality of segregated waste.

3.5 Community participation and inclusive livelihoods

Waste systems depend on households, market associations, institutions, local authorities, private operators, sanitation workers, waste pickers, recyclers and community organisations. Yadav and Devi (2016) discussed public awareness and stakeholder participation as elements of an improved municipal system. The implications extend beyond awareness campaigns: participation requires reliable collection services, accessible segregation instructions, transparent handling of separated streams and mechanisms for feedback and grievance redressal. Livelihood initiatives should recognise the contribution of informal waste workers and avoid displacing them without consultation, protection and fair alternatives.

4. Methodology

4.1 Research design

This study adopts an integrative, desk-based case-study design. It synthesises published research and official regulatory material to examine municipal solid waste management in Imphal. The geographical focus is Imphal, with specific reference to published studies concerning the main-market waste stream and the Lamphelpat–Nambul environmental context. The paper is analytical and policy-oriented; it is not a primary field survey, a laboratory study or a systematic review registered under a formal review protocol.

4.2 Sources of evidence

The core evidence base comprises: (a) a regional peer-reviewed review of municipal solid waste management in North-East India (Ao & Ngullie, 2024); (b) an Imphal-focused assessment of municipal waste management practices (Yadav & Devi, 2016); (c) a seasonal waste-characterisation study of Imphal's main-market area based on 2023 sampling (Meetei et al., 2025); (d) a surface-water quality study involving the Nambul River and the Lamphelpat disposal vicinity (Singh & Dey, 2014); and (e) the Solid Waste Management Rules, 2026 (MoEFCC, 2026).

4.3 Inclusion and analytical approach

Sources were included where they directly addressed the geographical focus, waste composition, collection and disposal practices, environmental monitoring or the current regulatory framework. Evidence was organised into five analytical themes: waste composition; collection and segregation; environmental risk; resource recovery and livelihoods; and governance and regulation. Quantitative results were retained with their original study context and units. Figures from different years, sampling frames and methods were not pooled or treated as directly comparable.

4.4 Limitations and research integrity

The available literature does not provide a consistent, current, ward-level dataset for Imphal, nor does it provide a recent independent assessment of water, soil or leachate quality at Lamphelpat. The 2016 municipal assessment and 2014 water-quality study are historical. The 2023 waste-characterisation study is geographically limited to temporary dumping locations in and around the main market. Consequently, the findings of this paper are bounded by the scope of the published sources. No new interviews, household questionnaires, community workshops, waste audits, water sampling or laboratory analyses are claimed. Any future addition of primary human-participant data will require appropriate ethical review, informed consent and transparent reporting.

5. Findings

5.1 Composition of municipal solid waste in Imphal

The most specific recent quantitative evidence identified for Imphal comes from Meetei et al. (2025), who sampled temporary waste-dumping locations in and around the city's main market during summer and winter 2023. The study reported the composition of sampled waste on a dry-weight basis. Organic and biodegradable materials—including paper, textiles and compostable organic material—accounted for 63.50% in summer and 68.75% in winter. The compostable organic component alone represented 46.25% in summer and 50.15% in winter.

The inorganic and non-biodegradable category accounted for 24.25% in summer and 20.10% in winter, while inert materials accounted for 12.25% and 11.15%, respectively. Plastic represented 10.10% of the sample in summer and 9.15% in winter. E-waste was also identified within the sampled waste stream, at 3.65% in summer and 2.55% in winter. The presence of e-waste in a mixed municipal stream underscores the need for separate collection and management through the applicable dedicated regulatory system.

Table 1: *Physical composition of sampled municipal solid waste in Imphal's main-market area*

Waste category	Summer 2023 (%)	Winter 2023 (%)
Organic and biodegradable (total)	63.50	68.75
Compostable organic material	46.25	50.15
Paper	12.80	11.80
Textile	4.45	6.80
Inorganic and non-biodegradable (total)	24.25	20.10
Plastic	10.10	9.15
Rubber	1.80	1.30
Leather	2.00	1.10
Glass	4.45	3.85
Metal	1.15	1.45
Ceramic	1.10	0.70
E-waste	3.65	2.55
Inert (total)	12.25	11.15
Fine earth and ash	6.95	5.50
Gravel, stone and pebble	4.25	4.75
Brick	1.05	0.90

Note. Percentages are reproduced from the dry-weight composition reported by Meetei et al. (2025, Table 1).

The study sampled temporary dumping locations in and around Imphal's main market; these values are not a representative estimate for all waste generated across Imphal.

5.2 Collection, segregation and disposal

The historical municipal assessment by Yadav and Devi (2016) identified deficiencies in collection and disposal and reported open dumping in the absence of adequate sanitary landfill arrangements at the time of study. Meetei et al. (2025) subsequently described temporary accumulation of market waste in available open spaces before transportation to a permanent disposal site. They recommended improved temporary storage or transfer arrangements, segregation facilities and better recovery of recyclable materials. The two studies differ in date, purpose and method, but together they indicate the importance of managing waste at the point of generation and along the collection chain.

The available sources do not establish the current collection efficiency, current daily waste generation, present processing capacity or the current proportion of waste scientifically treated in Imphal. These operational indicators must be obtained from updated municipal records and verified through independent audits before being used in a contemporary status assessment.

5.3 Environmental concerns and evidence gaps

The Lamphelpat–Nambul context has been examined in historical surface-water research. Singh and Dey (2014) sampled the Nambul River at three points and a site near the Lamphelpat disposal area, analysing a range of physical and chemical parameters. This study confirms that the potential relationship between waste disposal and surface-water quality has been investigated in the area. It does not, however, establish the current state of the river, the present condition of the disposal site or the contribution of any single pollution source.

A contemporary environmental assessment should include seasonal sampling upstream and downstream of relevant discharge or runoff pathways, a suitable reference location, and site-adjacent sampling where justified. Parameters should be selected according to the suspected pathways and applicable standards, potentially including pH, electrical conductivity, total dissolved solids, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, nutrients, selected metals and microbiological indicators. Groundwater, soil and leachate should be assessed through separate, properly designed protocols. Results should report sampling dates, coordinates, sample handling, analytical methods, laboratory accreditation and quality-control procedures.

5.4 Opportunities for organic-waste recovery

The reported compostable organic fraction in the main-market samples—46.25% in summer and 50.15% in winter—provides a strong rationale for evaluating biological treatment of clean, source-separated organic waste (Meetei et al., 2025). Suitable options may include household composting, community composting, market-based composting and institutional-scale treatment. Selection should depend on the volume and consistency of feedstock, land availability, proximity to users, operator capacity, odour and vector controls, drainage, process monitoring and the quality requirements of the final product.

Composting is not automatically successful because the feedstock is biodegradable. Contamination by plastics, glass, sanitary waste, batteries or other special-care materials can compromise product quality and create occupational and environmental risks. A viable programme therefore requires source segregation, separate collection, contamination checks, process records and quality testing of finished compost. Potential users include horticultural operations, landscaping programmes, nurseries and agricultural producers, subject to product quality and applicable standards.

5.5 Dry-waste recovery and special waste streams

The main-market characterisation study identified plastics, paper, textiles, glass and metals, alongside e-waste (Meetei et al., 2025). Clean, separated dry materials can be channelled through sorting and material-recovery arrangements and then transferred to authorised recyclers. The economic value of these materials depends on purity, volume, aggregation, transport cost and access to buyers. Local recovery initiatives should therefore be designed around verified market demand rather than assumed profitability.

E-waste and other special waste must not be treated as ordinary recyclable dry waste. The Solid Waste Management Rules, 2026, exclude specified waste streams—including industrial hazardous waste, biomedical waste, e-waste, battery waste and radioactive waste—from the general municipal solid-waste rules because they are governed by separate regulatory frameworks (MoEFCC, 2026). Local systems should provide clear identification, safe temporary storage and handover routes to authorised collection or processing channels.

5.6 Community participation, employment and equity

The reviewed literature supports the need for public participation and stronger local service arrangements (Yadav & Devi, 2016). A functioning circular system also depends on the labour of sanitation workers, waste pickers, aggregators, recyclers, self-help groups, market associations and local enterprises. Their

contribution should be recognised through consultation, training, safe working conditions, protective equipment, fair payment arrangements and access to formal recovery systems.

Women's groups and community-based organisations may contribute to household awareness, segregation, composting, product development and local enterprise. Such participation should not be assumed to be cost-free or automatically empowering. Projects should assess time burdens, access to equipment and finance, decision-making roles, remuneration and control over enterprise income. Any claim about specific indigenous or ethnic waste-management customs in Manipur requires dedicated, ethically conducted local research; it should not be generalised across communities without evidence.

6. Discussion

6.1 Interpreting the evidence without overgeneralisation

The strongest quantitative evidence in the current literature is the 2023 seasonal characterisation of waste from temporary dumping locations in Imphal's main-market area. Its finding that organic and biodegradable materials formed nearly two-thirds of the sampled dry waste is operationally important. However, a market-area sample cannot be treated as a city-wide composition estimate. Household waste, institutional waste, commercial waste and seasonal festival-related waste may have different profiles. The immediate research priority is therefore a representative, stratified waste audit across different generator types and wards.

Likewise, older estimates of daily generation and collection performance should be used as historical benchmarks only. The 2016 assessment by Yadav and Devi is valuable for understanding earlier system constraints, but it does not provide current service statistics. This distinction is essential for policy credibility: a paper that repeats old numbers as current conditions risks misinforming infrastructure planning and public debate.

6.2 A circular approach suited to Imphal

A locally appropriate circular model should begin with waste prevention and source segregation, rather than with a decision to build a particular processing plant. The waste composition evidence supports prioritising the separate handling of wet biodegradable waste and clean dry recyclables. Biological treatment can reduce the quantity of organic waste requiring long-distance transportation and disposal, while material recovery can return usable materials to production chains. Residual waste still requires safe treatment and disposal; circularity does not eliminate the need for properly managed residual infrastructure.

The model must also be financially and institutionally realistic. Decentralised units require land, equipment, trained operators, maintenance, monitoring and a dependable end-use market for outputs. Centralised facilities require reliable collection and transport systems and must be sized using current, representative waste data. Public investment decisions should compare life-cycle costs and environmental performance rather than rely solely on nominal plant capacity.

6.3 The 2026 regulatory framework

The Solid Waste Management Rules, 2026, are the current national regulatory basis for the management of solid waste. The Gazette notification states that the Rules apply to urban and rural local bodies and came into force on 1 April 2026, superseding the 2016 Rules (MoEFCC, 2026). The framework requires source segregation into wet, dry, sanitary and special-care streams and defines responsibilities for waste generators, local bodies, bulk waste generators and other stakeholders. It also establishes mechanisms for registration, reporting and regulatory oversight.

For Imphal, this regulatory shift means that awareness programmes and collection contracts should be aligned with the four-stream framework. Bulk waste generators—including qualifying institutions, commercial premises and other entities meeting the criteria in the Rules—need clear guidance on their responsibilities. The precise legal duties and thresholds should be taken directly from the Gazette text when preparing municipal by-laws, institutional compliance plans or formal policy documents.

6.4 Environmental justice and worker protection

The distribution of environmental burdens matters as much as aggregate waste-management performance. Communities living near disposal and processing sites may experience odour, litter, traffic, vectors and concerns about water or soil quality. Workers who collect, sort and transport waste may face sharp objects, biological hazards, dust and unsafe working conditions. A robust local programme should therefore include occupational health and safety measures, transparent grievance channels, community consultation and environmental monitoring that is publicly accessible.

6.5 Contribution of the paper

This paper contributes a place-based synthesis that connects waste composition, historical environmental evidence, circular-economy opportunities and the updated national regulatory framework for Imphal. Its principal contribution is not a new measurement of waste generation or pollution; it is an evidence-bounded

interpretation of the available research and a practical framework for designing the next stage of empirical and policy work.

7. Proposed Implementation Framework for Imphal

A phased approach is recommended so that the city can improve the quality of its evidence while progressively strengthening services and resource recovery.

7.1 Phase I: Establish a verified baseline

- Conduct a stratified seasonal waste-characterisation study covering residential wards, markets, institutions, hotels, commercial areas and public spaces.
- Publish ward-level estimates of waste generation, collection coverage, segregation quality, processing, rejects and final disposal.
- Map transfer points, collection routes, processing facilities, disposal locations and environmentally sensitive receiving waters.
- Commission an independent baseline assessment of surface water and, where justified, groundwater and soil around priority waste-management sites.

7.2 Phase II: Improve segregation and collection

- Introduce consistent four-stream segregation instructions in accordance with the Solid Waste Management Rules, 2026.
- Provide separate collection and transport arrangements so that segregated streams are not remixed.
- Establish clear collection schedules and a public grievance mechanism for missed collection or mixing of waste.
- Prioritise markets and qualifying bulk waste generators for monitored segregation and on-site or authorised processing.

7.3 Phase III: Develop resource-recovery systems

- Pilot decentralised composting at selected markets, institutions and residential clusters using clean biodegradable feedstock.
- Establish or strengthen material-recovery facilities for dry waste, with transparent weighing and authorised downstream recycling partners.

- Provide dedicated handover arrangements for sanitary and special-care waste, including e-waste and batteries, under their applicable rules.
- Test compost quality and establish user agreements with horticulture, landscaping and agricultural stakeholders before scaling production.

7.4 Phase IV: Ensure inclusion and accountability

- Engage sanitation workers, waste pickers, self-help groups, community organisations and market associations in programme design.
- Provide protective equipment, training, safe facilities and fair contractual or payment arrangements.
- Publish periodic performance reports and environmental-monitoring results in accessible formats.
- Use independent audits to verify reported quantities, facility performance, compliance and environmental outcomes.

8. Monitoring Indicators

The following indicators are proposed for future monitoring. Baseline values should be established through current field measurement and official records; no unverified baseline values are assigned in this paper.

Monitoring domain	Suggested indicator
Service coverage	Percentage of households and establishments receiving scheduled door-to-door collection
Segregation performance	Percentage of sampled generators handing over the prescribed streams separately; contamination rate in each stream
Organic-waste recovery	Tonnes of clean biodegradable waste treated through approved biological processes per month
Dry-waste recovery	Tonnes of recyclable material sorted and transferred to authorised recyclers per month
Residual disposal	Tonnes and composition of residual waste sent to authorised disposal or treatment
Environmental	Seasonal results for selected surface-water, groundwater and soil

performance	indicators at monitored sites
Worker protection	Percentage of workers provided with training and appropriate protective equipment; reported injuries and corrective actions
Financial viability	Operating cost per tonne, revenue from recovered materials, and proportion of recurrent costs covered
Equity and participation	Participation and remuneration of informal workers, women's groups and community organisations

9. Limitations and Future Research

This study is limited by the small number of directly relevant published studies and the differences in their dates, geographical coverage and methods. The recent waste-characterisation study focuses on temporary dumping locations in and around the main market rather than a representative sample of all waste generators in Imphal. The municipal assessment dates from 2016, while the surface-water study reports sampling from 2010 to 2012. The regional review provides context but does not substitute for Manipur-specific operational data. The present analysis therefore does not quantify current waste generation, collection efficiency, treatment capacity, current pollution levels, disease prevalence or the economic returns of local recycling enterprises.

Future research should include: (a) a stratified, multi-season waste audit across Imphal; (b) a service-delivery assessment based on current municipal records and route-level verification; (c) contemporary water, soil and leachate monitoring around relevant sites; (d) qualitative research with households, market associations, sanitation workers, waste pickers, women's groups and local enterprises; and (e) a cost-benefit and life-cycle assessment of decentralised composting and material-recovery options. Research involving people should document ethics approval, informed consent, sampling and analysis procedures. Such work would allow future studies to move from a secondary-source synthesis to a fully empirical case study.

10. Conclusion

The available evidence indicates that Imphal's municipal waste stream contains a substantial biodegradable component and that improved segregation and resource recovery are important priorities. The 2023 main-market characterisation study reported that organic and biodegradable materials represented 63.50% of sampled dry waste in summer and 68.75% in winter, with compostable organic material alone accounting for 46.25% and 50.15%, respectively (Meetei et al., 2025). These findings support the evaluation of

decentralised biological treatment, provided that organic waste is separated at source and processing is properly managed.

Historical research has identified weaknesses in Imphal's waste collection and disposal system and has examined surface-water quality in the Nambul River and near the Lamphelpat disposal site. These studies are valuable, but their dates must be respected: they cannot be used as evidence of present-day service performance or current environmental contamination. Updated waste audits and independent environmental monitoring are essential before new infrastructure or remediation decisions are made.

The transition from waste disposal to resource recovery is therefore a governance task as much as a technological one. It requires prevention, four-stream segregation, reliable collection, decentralised treatment of suitable organic waste, material recovery, safe residual disposal, worker protection, inclusive livelihoods and public reporting. The Solid Waste Management Rules, 2026, provide the current national framework for this transition. With a verified evidence base and locally accountable implementation, Imphal can strengthen environmental protection while creating opportunities for community participation and resource-based livelihoods.

References

Ao, M., & Ngullie, N. (2024). Overview of municipal solid waste management in sub-tropical climatic region of North Eastern India. Environmental Science and Pollution Research, 31, 23307–23321. https://doi.org/10.1007/s11356-024-32689-0

Awino, F. B., & Apitz, S. E. (2024). Solid waste management in the context of the waste hierarchy and circular economy frameworks: An international critical review. Integrated Environmental Assessment and Management, 20(1), 9–35. https://doi.org/10.1002/ieam.4774

Meetei, W. C., Suma, S., & Singh, L. S. (2025). Physical compositions and characteristics of municipal solid waste: A case study of Imphal City, Manipur. The Holistic Approach to Environment, 15(2), 78–84. https://doi.org/10.33765/thate.15.2.4

Ministry of Environment, Forest and Climate Change. (2026). Solid Waste Management Rules, 2026 (S.O. 388(E), January 27, 2026). The Gazette of India, Extraordinary. https://egazette.gov.in/WriteReadData/2026/269620.pdf

Singh, C. R., & Dey, M. (2014). Surface water quality with respect to municipal solid waste disposal within the Imphal Municipality Area, Manipur. International Journal of Scientific and Research Publications, 4(2). https://www.ijsrp.org/research-paper-0214.php?rp=P262320

Yadav, I. C., & Devi, N. L. (2016). Municipal solid waste management in Imphal Town, Northeast India: A critical analysis of existing management practices and proposed action plans. International Journal of Waste Resources, 6(3), Article 238. https://doi.org/10.4172/2252-5211.1000238