Assessment of Provisioning an Appropriate Solid Waste Management Approach in Urban Agglomerations in Ganga River Basin

A Thesis Submitted
In Partial Fulfillment of the Requirements
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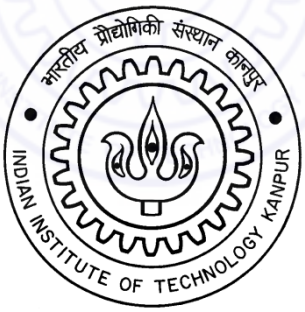
Master of Technology

By

Smriti Gupta



To the
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Certificate

This is to certify that the work contained in the thesis titled: ***Assessment of Provisioning an Appropriate Solid Waste Management Approach in Urban Agglomerations in Ganga River Basin***, by Ms Smriti Gupta has been carried out under my supervision.

July 2014

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Dedicated to

Shree Mata Ji

&

My Loved Ones

Acknowledgement

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Abstract

An appropriate frame work is a prerequisite to provide solutions for solid waste management in urban centres. The first and foremost step towards it is to have an assessment of having the management plan in economic sense. Dumping the solid waste as landfills may appear to be a very low cost solution and may have certain advantages in low lying areas, but it has very serious effects on land, agriculture, underground water and surface water bodies as well. So having a plan for complete treatment of solid waste with an approach towards minimal landfill and more recycling/reuse is the need of the hour. On the other hand achieving 100% collection efficiency and encouraging more recycling/reuse of solid waste with use of advanced treatment technologies may lead to resource recovery and also help in energy regeneration.

The present study aims at estimating the per capita expenditure on solid waste management with provision of segregation of the total solid waste generated, proper collection and conveyance of waste and subsequent recycling and treatment of different types of wastes. It is also important to note that energy consumption and footprint are also important along with expenditure incurred and hence are also estimated separately. The study also aims at estimating the financial layout for provisioning infrastructure for solid waste management in all Class I and Class II towns of the Ganga River Basin (GRB) with the objective of recycling and reuse of non-biodegradable waste and minimizing landfill sites.

Results indicate that footprint for waste treatment is approximately 0.7m^2 per person. The electrical energy consumption in complete solid waste management comes out to be 0.001 KW-h per person per day while the equivalent energy in the form of fuel consumption is 0.017KW-h per person per day for Class I towns and subsequent value for Class II towns is 0.016KW-h per person per day. The total per capita expenditure for having complete solid waste management system is estimated to be INR 1.15 per capita per day.

Proper solid waste management and more reuse/recycle is aesthetically good and have many other benefits as well. The cost of provisioning solid waste management systems does not appear to be unaffordable on per capita per day basis considering the benefits and savings in ensuring good quality of agricultural land availability, no groundwater or surface water hazards and hence, minimum health hazards.

Keywords: Solid Waste Management Systems, Waste Collection, Waste Conveyance, Waste Treatment, Cost Estimates, Minimum Landfill, Waste Segregation, Capex, Opex, Ganga River Basin, Ganga River Basin Management Plan.

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1. Introduction

Government of India asked the consortium of 7 IITs (Indian Institute of Technology) to prepare Ganga River Basin Management Plan (GRBMP). One of the most important challenges/vision of the Consortium was to prepare an action plan for "Un-polluted Flow" or "Nirmal Dhara" in all rivers of the Ganga Basin. To achieve this objective of proper sanitation in towns of our country, an effective and efficient solid waste management is needed. The main approach to achieve the ultimate objective of "Nirmal Dhara" has been to identify the type of polluting wastes, their sources of generation (point and non-point sources), and the techno-economic feasibility of collecting and treating them for their safe environmental discharge and/or possible recycle or reuse. Figure 1.01 illustrates the main identification results and the tasks.

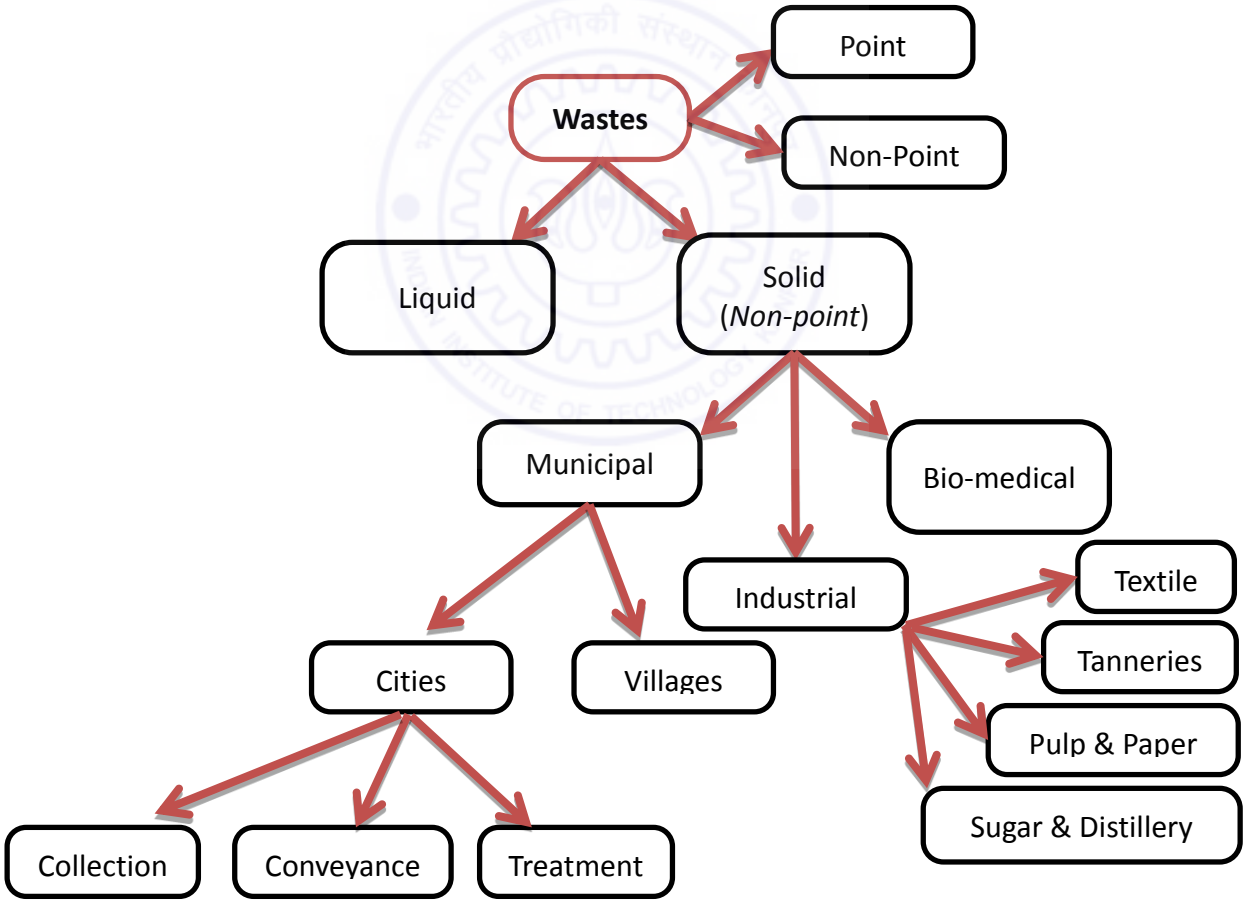

Figure 1.01: Types and Sources of Wastes and Main Identification Tasks

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Solid waste is a major non-point source of pollution which adversely affects land, ground water, surface water bodies if not managed and treated properly. Among the three types of solid waste namely, municipal, industrial and bio-medical waste, municipal waste is a major concern because of its huge quantity.

In consideration of the magnitudes of municipal solid waste generation from different urban locales, urban settlements are divided into Class I Towns (having population over 100,000) and Class II Towns (having population between 50,000 to 100,000). The following main steps concerning solid waste management are considered essential.

1. All solid waste generated in Class I and Class II towns of GRB needs to be collected and transported efficiently ensuring proper hygiene and sanitation.
2. Segregation of the collected waste.
3. Suitable treatment or disposal methods should be meted out to different types of waste.
4. Minimum landfill Concept needs to be ensured to prevent environmental hazards.
5. Recycling of optimum amount of recyclable or reusable waste is the need of the hour.

The above measures are essential to overcome the declining state of urban solid waste management in GRB. An appropriate techno-commercial frame work needs to be developed for sustainable solid waste management system for the urban centers.

A lot can be achieved if solid waste is considered as a "resource" rather than "dirt". Adequate disposal strategy with recycling as an integral part will provide an effective management of such huge amount of waste being generated in towns and cities of our country. The present study was thus initiated to persuade the policy makers and make them understand the costs and benefits in quantitative terms.

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2. Background and Review of Literature

2.1 General

The genesis of this study has been the recommendations of the Environment Quality and Monitoring (EQP) Group of the Consortium of 7 IITs preparing the Ganga River Basin Management Plan to have "unpolluted flow" in the rivers of the basin and addresses one of the aspects which is provisioning of solid waste management systems in all urban agglomerations in the basin. Firstly, it is important to have an appropriate ballpark estimates of expenditure on provisioning solid waste management systems, and the tangible and intangible benefits that would accrue as solid waste management can be considered as one of the major activities which a municipality undertakes. A complete solid waste management system includes waste collection, waste conveyance and waste treatment.

A recent study by Central Pollution Control Board (CPCB), New Delhi has estimated through a survey of 299 Class-I cities in India that manual collection comprises 50%, while collection using trucks comprises only 49% (CPCB, 2000).

Further India is facing challenges for efficient waste conveyance and treatment as well. Waste littering all over the place is not only aesthetically unpleasant but also affects public health, agricultural land, ground water and surface water. Hence to address these burning issues it is necessary to have an estimate of expenditure on having complete infrastructure for solid waste management for full coverage of urban agglomerations in the country, in general, and Ganga River Basin (GRB) in particular.

2.2 Cost Estimates of Solid Waste Management Systems: Conventional Approach

The Manual on municipal solid waste management - CPHEEO - Ministry of Urban Development (2000) briefly mentions following about planning and arriving at the cost of solid waste management projects.

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a) Capital expenditure shall include all the costs such as civil construction, material supply and erection costs, land acquisition costs, engineering design and supervision charges, interest charge on loan, and
b) Operation and Maintenance cost, after the project is started, shall consider, amortization and interest charges on capital borrowing, expenditure made on staff, chemicals, energy, transport, repair work, all the equipment/tools, insurance and overheads.

The planning for such projects starts generally with a preliminary study to provide guidelines for suitable methods to be adopted. These studies are then used for the preparation of City Master Plan (CMP) and Detailed Project Report (DPR) for a particular town. Ideally CMPs should form the base for solid waste management systems. Currently only few towns have CMPs. And most of these are based on inadequate data and information.

2.2.1 Collection of Information

To calculate the expenditure on solid waste management systems, all the basic information is required to be collected. Some of the essential information/data includes,

a) population and number of households of the town,
b) per capita per day waste generation of that town,
c) identification of types of waste to be collected,
d) deciding the criteria for sweepers and equipment to be used,
e) City Master Plan, long-term comprehensive development plans for cities and towns, urban planning, city planning area, urbanization zone, and urbanization control area, land use plan, road plan, urban development as rezoning, residential estates, and industrial complexes, etc.,
f) possible locations for composting site, sanitary landfill site, site for setting up transfer stations and sorting cum treatment plant,
g) traffic and land use patterns of the city,
h) details of the roads like, length, width and conditions to ensure proper and efficient conveyance,
i) assessment of present coverage and future expansion possibilities,
j) preparation of service area maps and other relevant documents.

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After collection of aforementioned information several other reports like feasibility reports, pre-feasibility reports, and identification reports are to be made. This generally ends with preparation of DPR which also looks at the salient features of financial and administrative aspects.

2.2.2 Methodology

There are no detailed methods provided for cost estimation in the Manual on Solid Waste (2000), but, to arrive at the total annual fund requirements for the project execution, DPRs recommend that cost estimation of all the components of the project is prepared and thus annual requirement of funds for each year is worked out making due allowance for physical contingencies and annual inflation. Further it is required to prepare recurring annual costs of the project for the next few years (say 10 years) covering operation and maintenance expenditure for the entire system (staff, chemicals, energy, spare parts and other materials for system operation, transportation, etc.). The cost estimates are prepared considering the following points:

a) Outlining the basic assumptions made for unit prices, physical contingencies, price contingencies and escalation.
b) Summarising the estimated cost of each component for each year till its completion and working out total annual costs to know annual cash flow requirements.
c) Estimation of foreign exchange cost if required to be incurred.
d) Working out per capita cost of the project on the basis of design population, cost per tonne of the waste collected, conveyed and treated, and comparing these with the government norms, if any.

Once the estimation of cost of solid waste management systems is done, the need for an Institutional and Financial Plan rises which needs the identification of responsible and capable organization which can be trusted for the completion of the project and also the identification of all sources of funds for implementation of the project, indicating year-by-year requirements from these sources, to meet expenditure as planned for completing the project as per schedule, stating how the interest during construction period will be paid, or whether it will be capitalized and will be paid in loan, explaining the procedures involved in obtaining funds from the various sources.

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2.3 Cost Estimates of Solid Waste Management Systems: Other Approaches

The conventional approach followed is to follow the DPRs and prepare bill of quantities (BOQ) for various items and use unit costs to get the total expenditure. However, this approach requires availability of detailed design and specifications which in most cases are not available and preparation of DPRs and BOQs are not possible at the planning stage.

2.3.1 Waste Collection

Collection of solid waste requires huge manpower in form of sweepers, cart workers, drivers etc. and also small vehicles like mini-waste collectors to collect the waste from different localities. In order to have cost estimates, the first step is to evaluate the number of workers (sweepers, push-cart workers, etc.), number and type of vehicles, other equipment like brooms, bins etc. Generally the unit costs can be easily worked out for different settings. However, the other information is generally not available. Generally the operation and maintenance expenditures on waste collection is taken as the 10% of the capital cost.

2.3.2 Waste Conveyance

Waste conveyance requires large number of vehicles and thus operation and maintenance expenditures are very high (fuel cost, repair and maintenance of vehicles). Different types of vehicles can be used for transportation of waste and vary from city to city. The number of trips to be made and after deciding the location of transfer station/treatment site the distance to be travelled and thus incurred fuel cost is calculated. Generally the operation and maintenance expenditures on waste conveyance is taken as 30% of the capital cost.

According to a Guidance note (MoUD, 2009) following assumptions are taken to calculate the number of vehicles and cost of waste conveyance along with incurred fuel cost:

a) Quantum of waste generated/collected (TPD): 300
b) Rejects from composting facility (@35%) (TPD): 105
c) Vehicle capacity - long haul compactor truck (MT): 12
d) Average one-way distance to regional facility (km): 40
e) Maximum number of trips per truck per day: 3
f) Vehicle speed - including tipping time, stoppages and halts considered (average) (km/hr): 25

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g) Vehicle mileage (km per litre): 4.5

h) Cost of vehicle (Rs.): 2,500,000

i) Maintenance of vehicle (% of Capex): 6%

j) Current diesel price (Rs./litre): 42

k) Salary of driver (Rs. per month): 8,000

l) Salary of helper (Rs. per month): 5,000

Following table*(MoUD, 2009) gives an idea for estimation of distance and cost calculation in waste conveyance

Table 2.01: Cost estimate for Transportation of Rejects for the Distances Varying from 40 km to 70 km

Waste quantity (TPD) ⟶	**10**				**20**				**40**				**75**			
One-way travel distance (between source and disposal site) in km ⟶	**40**	**50**	**60**	**70**	**40**	**50**	**60**	**70**	**40**	**50**	**60**	**70**	**40**	**50**	**60**	**70**
C & T cost																
Capex (Rs. Crore)	0.18	0.18	0.18	0.18	0.18	0.36	0.36	0.54	0.36	0.54	0.54	1.08	0.72	1.08	1.08	1.98
Unit Capex (Rs./tonne)	49.32	49.32	49.32	49.32	24.66	49.32	49.32	73.97	24.66	36.99	36.99	73.97	26.30	39.45	39.45	135.62
O & M Cost (Rs. Lakh)	8.74	10.10	11.42	14.57	11.42	15.24	17.30	21.10	21.29	27.12	31.20	40.58	38.33	49.32	56.71	73.11
Unit O & M cost for transport (Rs./tonne)	239.4	276.7	312.9	399.2	156.4	208.8	237.0	289.0	145.8	185.8	213.7	277.9	140.0	180.2	207.2	267.1

* While this is an illustration of the argument, it is recommended that every ULB undertake an estimation of costs in its specific context to arrive at a financially viable distance for transporting waste (MoUD, 2009).

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2.3.3 Waste Treatment

Estimation of waste treatment costs requires information on treatment technology adopted, unit costs and quantity of waste to be treated. In India, use of advanced treatment technologies is considered impractical and hence generally not practised. Use of landfills (mostly unsanitary) is widely used which is not a good option as such. The next commonly used process is composting. The cost of these is done by identifying the unit costs of all the items and cost of land acquisition for the same.

Generally the operation and maintenance expenditures on waste conveyance is taken as the 20% of the capital cost.

2.4 Concluding Remarks

The conventional solid waste management systems calls for segregation of solid waste at source only but this is not widely practised and hence the cost of segregation of solid waste is not available, which calls for proposing the strategies for waste segregation at either source or treatment plant.

The conventional approach for estimation of expenditure on provisioning solid waste management systems calls for detailed specifications of waste collection network, waste conveyance and waste treatment plants. The required information to get a ball park estimate is often not available at the planning stage. This creates the requirement of having a suitable approach for ballpark estimates of solid waste management systems at the planning stage which does not depend on the detailed specifications. Essentially not much published literature is available on such approaches and not much information could be obtained through practicing engineers, professionals and consulting organisation. It is reasonable to develop approaches based on information available on solid waste management systems in India and worldwide, for ballpark estimates of solid waste management systems with some reasonable assumptions.

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3. Objectives and Scope

State of solid waste management infrastructure in India in general, and in Ganga River Basin in particular is extremely poor. Even though the adequate resources required to develop such infrastructure are mostly available but lack of awareness, bad habits of littering around, poor planning, and improper and unscientific treatment leads to a mess, and the waste generation is increasing at a rapid rate. The day is not very far away when all open lands in urban centers will become dumping grounds.

The Ministry of Environment & Forest (MoEF), created a framework in 2000, with the introduction of MSW (Management & Handling) Rules, 2000 under the Environment Protection Act, 1986 that entrusted the ULBs with the responsibility of managing MSW. But in most of the towns these guidelines are not followed efficiently and most of the MSWM budget is spent only on collection of the waste. Further lack of systematic execution and maintenance of the equipment decrease the collection efficiency after some time. As a result not much benefit has been seen and no viable model is in the sight. It is very vital that an appropriate techno-commercial frame work is developed for sustainable solid waste management system for the urban centers.

Solid waste management requires proper infrastructure, which is becoming complex due to the unplanned growth of urban centers and this is why the first and foremost prerequisite is to have an assessment of provisioning solid waste management system in economic sense. This necessity has been the genesis of the present study. Provisioning of solid waste management systems yields certain benefits depending upon the choice of technologies and components, their designs, and efforts and investments made. Because of all above mentioned reasons, Consortium of 7 IITs preparing the Ganga River Basin Management Plan (GRBMP) is considering complete and efficient collection of solid waste and treatment of waste in a scientific manner so that most of the waste could be recycled and/or reused and we approach towards the goal of “Minimum Landfill” instead of disposal in open lands, water bodies of urban agglomerations in the basin.

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This study is a part of the larger framework of having “Unpolluted Flow” in rivers and aims at estimating the financial requirements for provisioning of solid waste management system in all Class I and Class II towns of the Ganga River Basin (GRB) with the objectives of recycle/reuse of the waste along-with “Minimum Landfill”. Following specific objectives are set for this study to achieve this goal.

1. Develop suitable methodology for obtaining ballpark estimates for efficient and complete waste collection in Class I and Class II towns of GRB.
2. Develop suitable framework for obtaining ballpark estimates for waste conveyance and waste treatment while promoting waste recycle/reuse.
3. Obtain ballpark estimates of capital investments for having proper infrastructure for solid waste management and annualized expenditure towards capital (capex) and sustainable operation and maintenance (opex) of such infrastructure in all Class I and Class II towns of GRB.
4. Assess financial implications of provisioning sustainable solid waste management infrastructure on individuals residing in the urban agglomerations of GRB.
5. Approach towards the goal of “Minimum Landfill” and encourage sorting of waste at source.

The scope of the study is limited to availability of secondary information in DPRs and other such reports on Strategies for Solid waste management.

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4. Methodology

4.1 General

Solid Waste Management system includes (i) Waste Collection, (ii) Waste Conveyance and (iii) Waste Treatment. Estimation of capital (Capex) and operation and maintenance (Opex) costs for these three components has been worked out separately for all Class I and Class II towns in Ganga River Basin (GRB). Following sections briefly describe the methodology adopted.

4.2 Estimation of Capex and Opex of Waste Collection

This involved deciding the layout of the whole collection process, adopting an appropriate strategy which facilitates proper hygiene of the streets and open spaces besides ensuring people's satisfaction and ease to dispose of the waste. Keeping in mind the above issues 'door to door collection' strategy has been proposed which involves collection of waste from the households itself by sweepers and push cart workers, transferring it from push carts into mini waste collectors which carry it to some distance and then eventually transferring the waste into Compactors.

The costs for the required components mentioned above were worked out based on Manual on Municipal Solid Waste Management - CPHEEO - Ministry of Urban Development (2000) and Detailed Project Reports (DPRs) of several cities like Ghaziabad, Kanpur, Vadodara, etc. which were made available by officials of MoEF (Ministry of Environment and Forests). Population and area of each town of GRB was taken from a recent study (Shukla, 2013).Waste generation is assumed to be 0.5 kg per capita per day.

The criterion used in estimating the quantities of various items of waste collection are given in Table 4.01.

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Table 4.01: Criterion/Assumptions for Different Items in Waste Collection

S No	Item	Criterion /Assumptions
1	Number of sweepers	1 for 200 households + 15% extra
2	Push cart workers	1 for 2 sweepers
3	Push carts	1 for each worker + 25 % extra
4	Storage bins (4.5 cum)/Dumper placers	1 for 2000 persons+ 25 % extra
5	Mini Waste Collectors	1 for 7 MT/d + 25% extra
6	Manpower (Drivers, etc.)	2 for all the carriers + 25% extra

* cum – cubic meter; * MT/d – Metric Tons/day

The quantities, thus calculated, were multiplied by rates of each to calculate capex and opex of the process. To estimate the annual expenditure on waste collection 'Annualized capex' was also calculated for equipment for a loan period of 5 years at an interest rate of 12 %. This was done by multiplying the total capex of all equipment with a Capital Recovery Factor (CRF) of 0.28.

To determine the expenditure on energy, fuel demand was calculated for the vehicles. For this purpose, the town area is assumed to be a square and the distance to be travelled per day by all vehicles is related to the diagonal of this square. For the mini waste collectors, cost of fuel per day is calculated considering mileage of 8 km per liter (market research) and taking the distance travelled by each as one-tenth of the length of the diagonal.

4.3 Estimation of Capex and Opex for Waste Conveyance

Waste conveyance involves vehicles for transporting the collected waste to the sorting-cum-treatment plant and transfer station(s).

The conveyance cost is estimated by summing up the annualized capital cost and operation and maintenance cost in terms of manpower and energy expenditure on vehicles to be used in waste conveyance. The vehicles include compactors, hook lifters and dumper placer carriers. The cost also includes the cost of establishment of transfer station, which empirically has a relation with the capital expenditure and hence is taken as 10 % of the total capex and then this cost is added

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to calculate the final capex. Transfer stations will serve as sites for transferring waste from compactors to hook lifters so as to further transport it to the sorting-cum-treatment site.

The criterion used in estimating the quantities of various items of waste collection is given in Table 4.02.

Table 4.02: Criterion/Assumptions for different items in Waste Conveyance

S No	Item	Criterion /Assumptions
1	Compactors	1 for 35 MT/d + 25 % extra
2	Hook lifters of 20 cum capacity	8 trips a day, each of 15 MT capacity + 25 % extra
3	Dumper placer carriers	1 for 15 containers + 25% extra
4	Bins of 20 cum capacity	1 for each lifter + 50 % extra
5	Manpower (Drivers, etc.)	2 for all the carriers + 25% extra

* cum – Cubic Meter; * MT/d – Metric Tons/day

Annualized capex was computed the same way as described in Section 4.2. Energy expenditure in this case is the sum of fuel consumption by vehicles and electricity consumption at Transfer station. The town area has been assumed as square as was done in estimating cost of collection. The details of vehicles used are given in Table 4.03.

Table 4.03: Details/Assumptions used for vehicles used in Waste Conveyance

S No	Vehicle	Mileage (kmpl)	Distance travelled per day
1	Compactors	4	Half the length of diagonal
2	Hook Lifters	4	Half the length of diagonal
3	Dumper Placer Carriers	4	Half the length of diagonal

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4.4 Estimation of Capex and Opex of Solid Waste Processing Plant

Estimation of cost of solid waste treatment has been done considering that the waste is properly segregated and suitable end point solution is provided to each type of waste. Maximum recycling and minimization of landfill were the twin objectives while deciding upon the layout of the processing plan.

The total waste collected from a city is conveyed to the sorting-cum-treatment plant as described in the previous sections. This waste consists of (i) Organic or biodegradable waste (60 %), (ii) Recyclable waste (11 %), (iii) Construction waste and drain silt (29 %). While organic matter (leaves, food waste, etc.) needs treatment such as composting, recyclable waste which includes plastic, metals, glass and rubber can be sold and construction waste can be converted into other usable forms like bricks, tiles, etc. Segregation of the waste is thus an essential step and needs to be properly planned out. There are a number of segregation techniques which are being used across the world such as Induction sorting, Manual sorting, Magnetic separation, Trommel separators, etc. But in India to make it practical/feasible for all towns manual sorting, along-with few mechanized equipment, is recommended.

The complete layout of sorting station is shown in Figure 4.01.

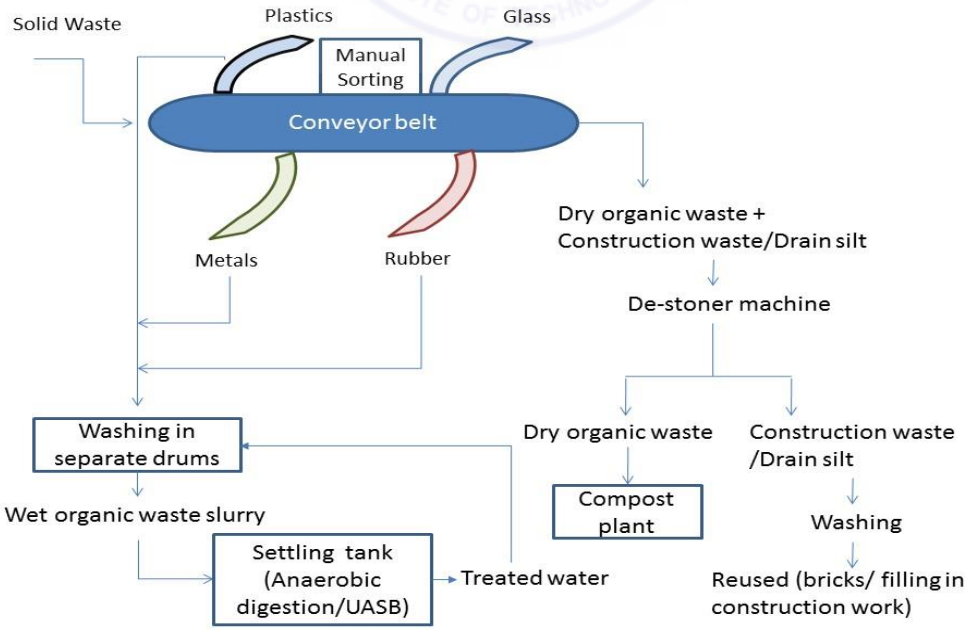

Figure 4.01: Layout Showing Unit Operations of Sorting Station

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The waste coming to the sorting station is put on conveyor belt with workers standing on either side of the belt. As the waste moves on the belt workers pick up the recyclable waste which includes plastic, metal, glass and rubber. One worker collects only one type of waste. Quantity of waste that can be picked is worked out as 5 tons per person per day (White *et al*., 1995). Sorting station is assumed to be working for 24 hours a day with the total work being done in 3 shifts per day. Paper is excluded from hand-picked waste. Percentage distribution of hand-picked materials was worked out from the data available in a study by Central Pollution Control Board (CPCB, 2000) and the details are given in Table 4.04.

Table 4.04: Estimate of Recyclable (hand-picked) Waste

Item	Content, Percent
Metals	3
Glass	2
Plastics	4
Rubber/Leather	2
Total	**11**

The speed of the belt is controllable and maintained in such a way that each worker gets sufficient time to recognize and separate out the target material. The details of the conveyor belt are given in Table 4.05.

Table 4.05: Specifications of Conveyor Belt

S No	Particulars	Specification
1	Length of conveyor belt, m	30
2	Speed of conveyor belt, m/h	600

The recyclable portions of the waste are then washed separately in different drums, to remove the organic matter, after which they are recycled. The specifications of drums for washing are given in the Table 4.06. The waste from the conveyor belt contains dry organic waste, construction waste and drain silt. This waste is passed through De-stoner machines with a capacity of 4 TPH which separates out organic waste from the sand, silt and stones which are a part of construction waste.

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Table 4.06: Equipment Requirement for Washing of Recyclables

Wooden Drums (5 ton capacity, 2 ton/hour)	Quantity	Running Hours per day
Metals	1	15
Glass	1	10
Plastics	1	20
Rubber	1	10

The details of manpower required at sorting station are given in Table 4.07.

Table 4.07: Manpower Requirement

Manpower	Criterion
Labour required for manual picking of recyclable waste	(1 worker/5 ton)*3 shifts/day + 25 % extra
Skilled Technicians (Device Operators, Drivers etc.,)	25 % of total labour + 25 % extra

Water consumption in washing the waste was calculated based on the assumption that 5 KL water per ton per day is required for this purpose. Waste water generated is taken as 95 % of the water consumed which will be treated up to tertiary treatment so that the treated water may be recycled and used for washing purpose again. The cost of treating wastewater containing organics is worked out as INR 17.20 per ton per day (Shukla, 2013).

The organic waste is then taken to the Compost plant where it undergoes decomposition to form compost which can then be used as fertilizer or manure for agricultural purposes. The cost of Compost plant is computed by summing up the cost of equipment, manpower, infrastructure and other miscellaneous expenses which include fuel and energy expenditure. The criteria used in estimating the cost of Compost plant are given in Table 4.08.

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Table 4.08: Details/Specifications of Composting Plant

S No	Item	Criterion /Assumptions	Fuel Consumption (liters per hour)
1	Loader cum excavator	1 for 160 Mt of waste	12
2	Tipper (8 cum)	1 for 80 Mt of waste	8
3	Tractor tipper	1 for 160 Mt of waste	4
4	Water Tanker (3000 cum)	1 for 160 Mt of waste	--
5	Computerized Weigh bridge	1 for 30 Mt of waste	--
6	Plant machinery	1 Crore per ton	--
7	Infrastructure	1 Crore per ton	--
8	Manpower	22 skilled technicians + drivers, 20 workers + 25% extra	--

The construction waste and drain silt is washed in separate tanks and then it can be reused in various forms for construction work e.g. making bricks, tiles or can be used as material for filling of low lying areas.

Some amount of construction waste, if left unused, and the residue from the compost plant is sent to sanitary landfill site which is designed for 10 % of the total waste in addition to the residue from compost plant. The relevant information for cost estimation of sanitary landfill site is given in Table 4.09.

Table 4.09: Details/Specifications of Sanitary Landfill Site

S No	Item	Criterion /Assumptions	Fuel consumption (liters per hour)
1	Loader Backhoe	1 for 120 MT/d	12
2	Tipper	1 for 60 MT/d	8
3	Bulldozer	1 for 120 MT/d	60

Table continued to next page … … … …

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4	Landfill Compactor	1 for 120 MT/d	50
5	Manpower	4 skilled technicians, 15 workers +25% extra	--

Thus the total cost of treatment was calculated by adding the cost incurred on all three components of treatment i.e. Sorting station, Compost plant and Sanitary Landfill. Annualized capex was computed by multiplying CRF with the total capex. CRF values is taken to be 0.28 for equipment at an interest rate of 12 % with a loan period of 5 years and 0.134 for infrastructure at an interest rate of 12 % for a period of 20 years. Cost of electricity consumption was added in the opex. Annual expenditure was determined and thus cost of total treatment per ton per day was estimated.

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5. Results and Discussion

5.1 General

An appropriate frame work is a prerequisite to provide solutions for solid waste management in urban centers. The first and foremost step towards it is to have an assessment of having the management plan in economic sense. Dumping the solid waste as landfills may appear to be a very low cost solution and may have certain advantages in low lying areas, but it has very serious effects on land, agriculture, underground water and surface water bodies as well. So having a plan for complete treatment of solid waste with an approach towards zero landfill and more recycling/reuse is the need of the hour. On the other hand achieving 100% collection efficiency and encouraging more recycling/reuse of solid waste with use of advanced treatment technologies may lead to resource recovery and also help in energy regeneration.

The present study aims at estimating the per capita expenditure on solid waste management with provision of segregation of the total solid waste generated, proper collection and conveyance of waste and subsequent recycling and treatment of different types of wastes. It is also important to note that energy consumption and footprint are also important along with expenditure incurred and hence are also estimated separately. The study also aims at estimating the financial layout for provisioning infrastructure for solid waste management in all Class I and Class II towns of the Ganga River Basin (GRB) with the objective of recycling and reuse of non-biodegradable waste and minimizing landfill sites.

Solid waste management includes (i) Waste Collection, (ii) Waste Conveyance and (iii) Waste Treatment. An attempt has been made to arrive at ballpark estimations of capital (Capex) and operation and maintenance (Opex) costs for these three components separately for all Class I and Class II towns in Ganga River Basin (GRB). Following sections describe and discuss the outcome of such an attempt based on the approach and methods described in the previous chapter.

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5.2 Collection of Solid Waste

With door to door collection in our strategy to achieve the 100% collection, estimation of cost of collection of municipal solid waste calls for calculating the required amount of manpower and identifying vehicles to transport the waste collected from households to larger vehicles which convey the waste to the transfer station.

The number of sweepers, push carts, push cart workers and storage bins required were calculated after studying Detailed Project Reports (DPRs) of cities available and using the criteria described in Manual on Municipal Solid Waste Management - CPHEEO - Ministry of Urban Development (2000). In an attempt to mechanize the collection process mini waste collectors containing bins are proposed to collect waste from residential and commercial areas.

The collection costs have been estimated by identifying the number of equipment (push carts, mini waste collectors) and manpower required and multiplying it with rates of individual component. The estimated cost comes out to be INR 1224.53 per ton per day. This includes the cost of equipment, manpower, fuel and maintenance cost. The costs were calculated by thoroughly studying available DPRs of cities like Kanpur, Ghaziabad and Vadodara as well as discussions with representatives of several consulting firms.

The estimated fuel consumption in Class I towns is in the range of 0.03 to 0.05 liters/ton/day with an average of 0.04 liters/ton/day and standard deviation of 0.01 which amounts to an average cost of INR 2.05 per ton per day and for Class II towns the range is 0.001 to 0.04 liters/ton/day with an average of 0.02 liters/ton/day and standard deviation of 0.008, amounting to an average cost of INR 1.22 per ton per day. There is no other energy requirement in the collection process.

A typical pattern of distribution of estimated expenditure on waste collection adopting the methodology described in Section 4.2 is presented in Figures 5.01 to 5.03.

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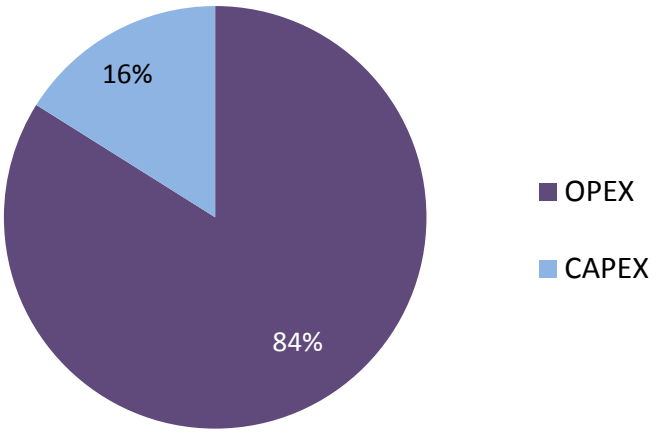

Figure 5.01: **Typical Distribution of Estimated Annualized Capital (Capex) and Operation and Maintenance (Opex) Expenditure on Collection of Solid Waste**

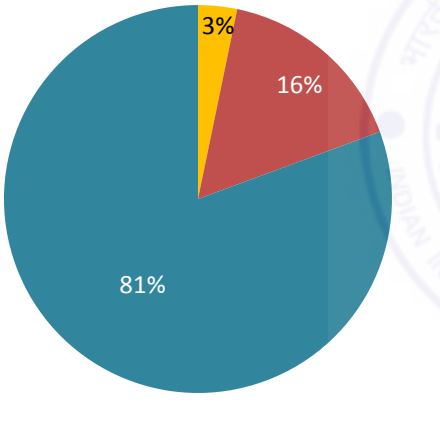

Figure 5.02: Typical Breakup of Estimated Capital Expenditure on Collection of Solid Waste

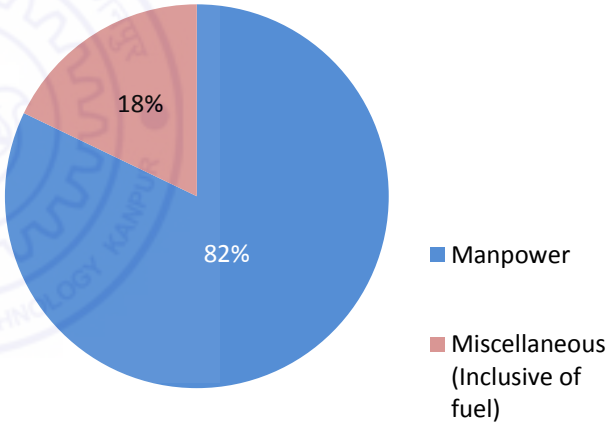

Figure 5.03: Typical Breakup of Estimated Operational Expenditure on Collection of Solid Waste

It may be noted that in waste collection the major expenditure is on Operation and maintenance (84 %) which is on account of the high cost incurred on manpower (82 % of opex).

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5.3 Conveyance of solid waste

Cost estimation for waste conveyance requires identification of equipment for transfer station and vehicles for transporting waste to the sorting-cum-treatment plant. The estimated Cost for conveyance comes out to be INR 541.96 per ton per day. This includes the cost of transfer station, equipment, vehicles, manpower, fuel and maintenance cost.

The transportation of waste exerts a fuel requirement in the range of 0.28 to 0.61 liters per ton per day with an average value of 0.43 liters per ton per day and standard deviation of 0.12, which amounts to an average cost of INR 23.71 per ton per day for Class I towns. While for Class II towns the fuel requirement is in the range of 0.11 to 0.49 liters per ton per day with an average value of 0.26 liters per ton per day and standard deviation of 0.12 and subsequent average cost is INR 14.11 per ton per day. The higher values correspond to towns with low population density and the lower values correspond to high population densities.

A typical pattern of distribution of estimated expenditure on waste conveyance adopting the methodology described in Section 4.3 is presented in Figures 5.04 to 5.06.

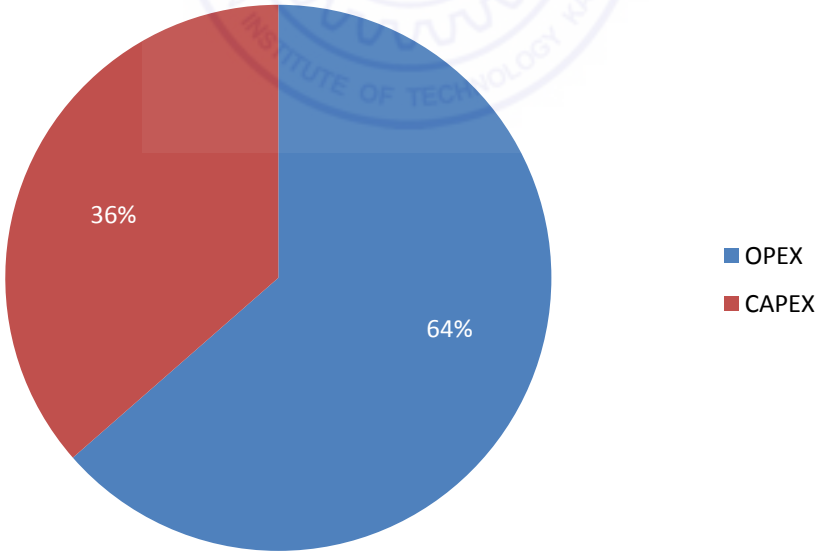

Figure 5.04: Typical Distribution of Estimated Annualized Capital (Capex) and Operation and Maintenance (Opex) Expenditure on waste conveyance

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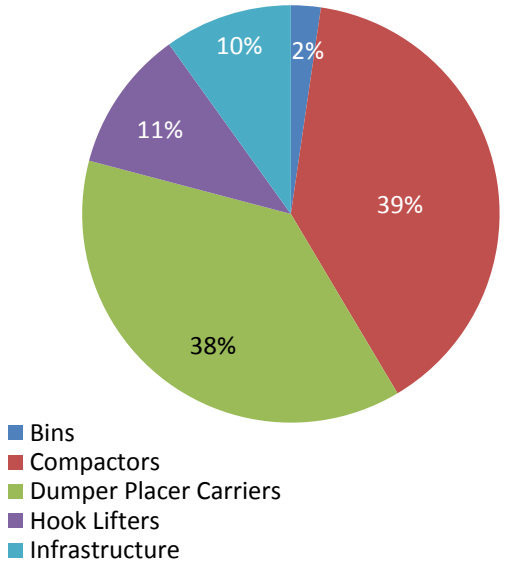

Figure 5.05: Typical Breakup of Estimated Capital Expenditure on Waste Conveyance

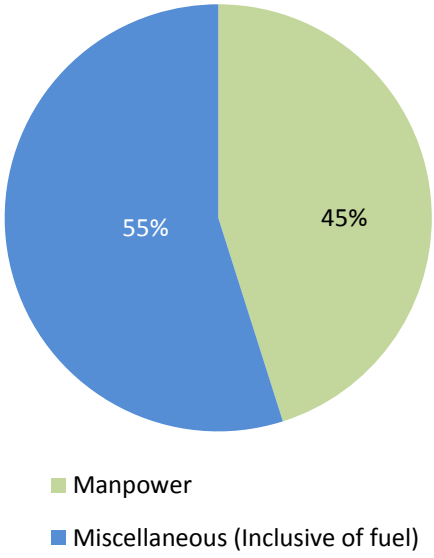

Figure 5.06: Typical Breakup of Operation and Maintenance Expenditure on Waste Conveyance

It may be noted here that in waste conveyance the opex (64 %) is very high as compared to capex (36 %). This is due to the high amount of energy expenditure in the form of fuel consumed in conveyance of the waste.

5.4 Treatment of Solid Waste

The cost of treatment of solid waste is estimated with the consideration that maximum amount of waste is recycled and reused, landfill sites are minimized and efficient treatment options are adopted.

The municipal solid waste in India mainly contains organic or biodegradable waste (60 %), recyclable waste i.e. plastics, metals, glass, rubber (11 %), drain silt and construction debris (29 %). Prior to the treatment, segregation of the total waste needs to be done so as to separate out recyclable waste from the rest and then provide different types of treatment to different types of waste. Segregation must be done at source which is not the case in India as people are not aware and unwilling to manage the waste at household level. Therefore a sorting-cum-treatment plant

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is proposed. The whole treatment process can thus be divided into three components as per the municipal solid waste distribution in India (i) Segregation, (ii) Composting, (iii) Landfill.

Estimation of the costs of these three components calls for preparing the flow sheet, determining manpower requirement and equipment costs and energy expenditure.

The total cost including capital investment (Capex) and annual operation and maintenance expenditure (Opex) for such treatment has been worked out as INR 540 per ton per day. A typical breakup on expenditure made on solid waste treatment along with breakup of capex and opex on waste treatment are presented in Figures 5.07 to 5.09.

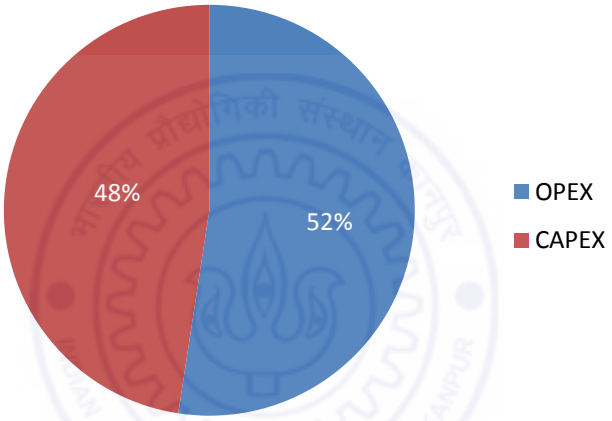

Figure 5.07: Typical Breakup of Capital (Capex) and Operation and Maintenance (Opex) Expenditure on Waste treatment

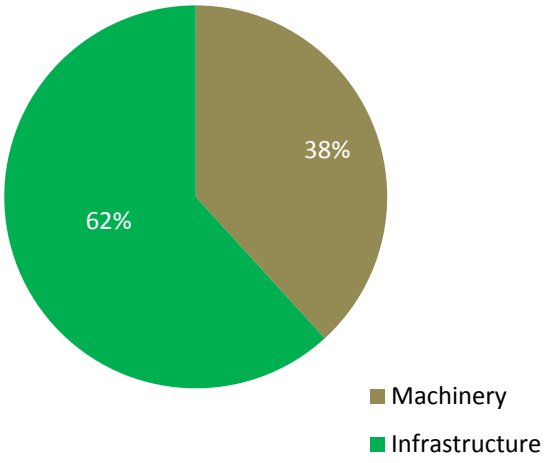

Figure 5.08: Typical Breakup of Estimated Capital Expenditure on Waste Treatment

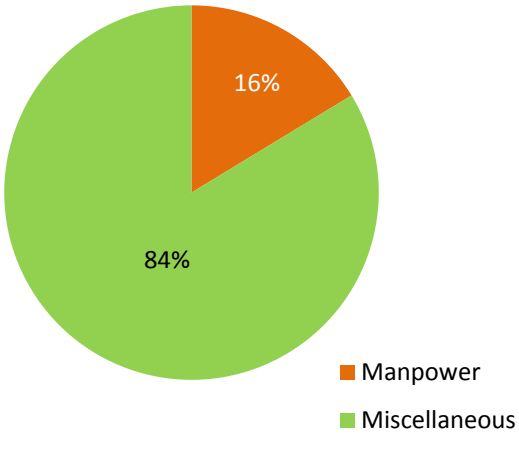

Figure 5.09: Typical Breakup of Estimated Operational Expenditure on Waste Treatment

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It may be noted from the above figures that the infrastructure cost has a major share (62 %) in the total capital expenditure on waste treatment owing to the construction of stations for sorting, composting and landfill. Also, on account of the mechanization of the sorting and treatment processes less amount of manpower is required while fuel consumption is high.

The energy expenditure comes out to be INR 172.94 per ton per day of which INR 160.16 is the cost of fuel per ton per day. A breakup of electricity and fuel on energy expenditure is presented in Figure 5.10.

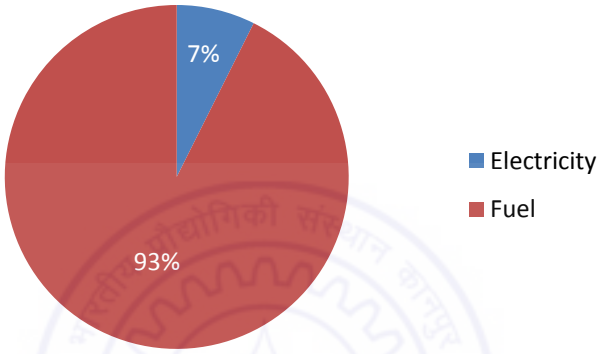

Figure 5.10: Typical Breakup of Electricity and Fuel on Energy expenditure in Waste treatment

5.5 Solid Waste Management

The entire solid waste management system costs can be arrived at by adding the cost of its three components, namely Waste Collection, Waste Conveyance and Waste Treatment. The results are presented in Figures 5.11 and 5.12.

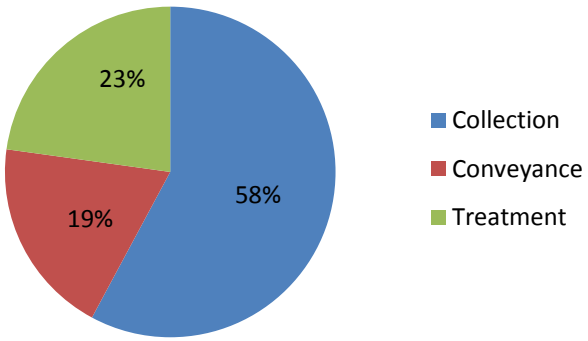

Figure 5.11: Typical Breakup of Estimated Total Annual Expenditure Amongst Three Components of Solid Waste Management

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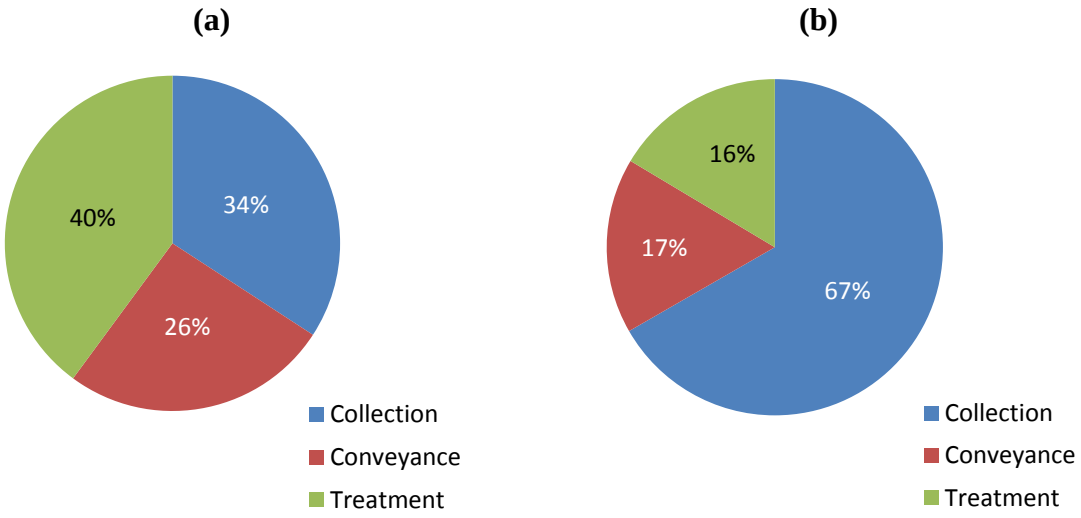

Figure 5.12: Typical Breakup of Estimated (a) Capex and (b) Opex Amongst Three Components of Solid Waste Management

It is important to note that Waste Collection has the major contribution in the total annual expenditure. This is due to high opex in waste collection which results from the heavy expenditure on manpower. Door to door collection and street sweeping demands a good number of workers. Though waste sorting at source may improve the collection efficiency and also increase the quantity of recyclable/reusable waste. Analysis of the distribution of energy expenditure, which is mainly in the form of fuel (diesel), depicts that waste treatment is the major contributor with 87 and 92 % share in Class I and Class II towns respectively. The heavy equipment and machinery such as Loader Backhoe, Tractors, Tippers, Bulldozers and Compactors used in Composting and Landfill consume high amount of fuel.

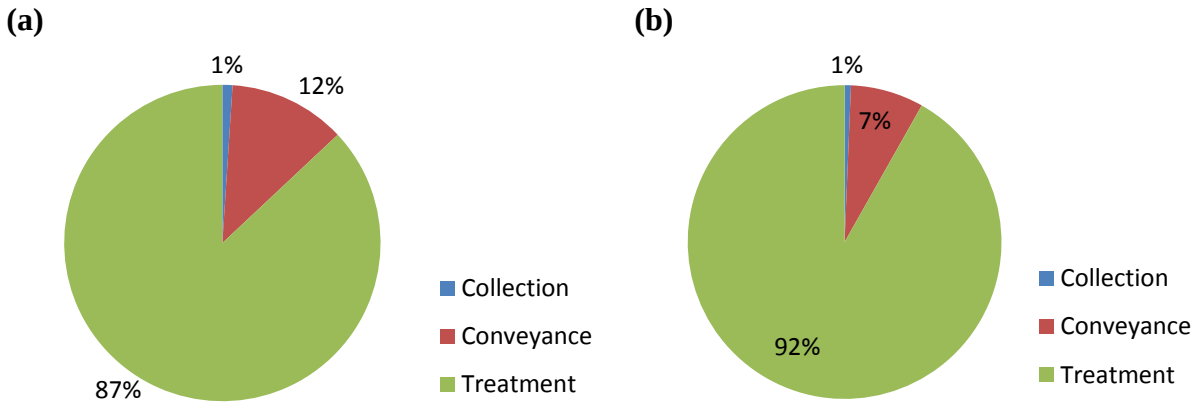

Figure 5.13: Typical Distribution of Energy Consumption in Waste Collection, Conveyance and Treatment (a) Class I and (b) Class II towns

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5.6 Estimated Costs of Provisioning Solid Waste Management in Major Urban Agglomerations in Ganga River Basin

An attempt has been made to arrive at ballpark estimates for providing an appropriate and complete infrastructure for solid waste management which is based on (i) the methodology developed and results reported in the preceding sections of this chapter, and (ii) the information collated for urban agglomerations in Ganga River Basin (GRB). Significant urban agglomerations are considered as Class I and Class II towns defined on the basis of population (Class I Towns: Population ≥ 100,000; Class II Towns: Population exceeding 50,000 and less than 100,000). Tables A1.01 to A1.22 in Appendix I present (i) population as per Indian Census 2011, (ii) estimated waste generation (taken as 0.5kg per capita per day), (iii) approximate town area, (iv) capital expenditure on all three components of solid waste management system, and (vi) the total estimated capital expenditure on provisioning complete infrastructure for solid waste management for all Class I and Class II towns of GRB spread over 11 different Indian states. A summary of the total ballpark estimates of capital expenditures on provisioning solid waste management for Class I and Class II towns of each of the GRB states is presented in Tables 5.01 to 5.03 based on information given in aforementioned tables of Appendix I.

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Table 5.01: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Millions) of NRGB

S No	State	Population in Millions	Estimated Waste Generation, MT/d	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
				Waste Collection	Waste Conveyance	Waste Treatment	
01	Uttarakhand	2.121	1061	158.39	315.22	579.40	1053.01
02	Uttar Pradesh	29.613	14807	2211.36	4400.87	8089.11	14701.34
03	Himachal Pradesh	**No Class I Town**					
04	Haryana	5.317	2659	397.04	790.16	1452.38	2639.58
05	Delhi	13.482	6741	1006.76	2003.57	3682.70	6693.03
06	Rajasthan	7.689	3844	574.17	1142.67	2100.30	3817.14
07	Madhya Pradesh	11.934	5967	891.14	1773.48	3259.79	5924.41
08	Bihar	6.929	3464	517.39	1029.67	1892.61	3439.67
09	Chhattisgarh	3.138	1569	234.32	466.33	857.14	1557.79
10	Jharkhand	4.801	2401	358.53	713.51	1311.48	2383.52
11	West Bengal	17.124	8562	1278.70	2544.78	4677.48	8500.96
Total		**102.148**	**51075**	**7627.80**	**15180.26**	**27902.39**	**50710.45**

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Table 5.02: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of NRGB

S No	State	Population in Millions	Estimated Waste Generation, MT/d	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
				Waste Collection	Waste Conveyance	Waste Treatment	
01	Uttarakhand	0.212	106	15.86	31.57	58.02	105.45
02	Uttar Pradesh	3.109	1554	232.15	462.01	849.21	1543.37
03	Himachal Pradesh	**No Class II Town**					
04	Haryana	0.164	82	12.22	24.31	44.69	81.22
05	Delhi	0.862	431	64.35	128.07	235.41	427.83
06	Rajasthan	0.287	143	21.42	42.63	78.35	142.40
07	Madhya Pradesh	0.654	327	48.83	97.19	178.64	324.66
08	Bihar	1.462	731	109.17	217.26	399.34	725.77
09	Chhattisgarh	0.448	224	33.43	66.53	122.30	222.26
10	Jharkhand	1.236	618	92.27	183.64	337.54	613.45
11	West Bengal	1.000	500	74.68	148.62	273.18	496.48
Total		**9.433**	**4716**	**704.38**	**1401.83**	**2576.68**	**4682.89**

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Table 5.03: Estimated Capital Expenditure on Solid Waste Management in Class I (Population > 0.1 Millions) and Class II (Population between 0.05 and 0.1 Million) Towns of NRGB

S No	State	Population in Millions	Estimated Waste Generation, MT/d	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
				Waste Collection	Waste Conveyance	Waste Treatment	
01	Uttarakhand	2.333	1167	174.25	346.79	637.42	1158.46
02	Uttar Pradesh	32.722	16361	2443.51	4862.88	8938.32	16244.71
03	Himachal Pradesh	**No Class I or II Towns**					
04	Haryana	5.481	2741	409.26	814.47	1497.07	2720.80
05	Delhi	14.344	7172	1071.11	2131.64	3918.11	7120.86
06	Rajasthan	7.976	3987	595.59	1185.30	2178.65	3959.54
07	Madhya Pradesh	12.588	6294	939.97	1870.67	3438.43	6249.07
08	Bihar	8.391	4195	626.56	1246.93	2291.95	4165.44
09	Chhattisgarh	3.586	1793	267.75	532.86	979.44	1780.05
10	Jharkhand	6.037	3019	450.80	897.15	1649.02	2996.97
11	West Bengal	18.124	9062	1353.38	2693.40	4950.66	8997.44
Total		**111.582**	**55791**	**8332.18**	**16582.09**	**30479.07**	**55393.34**

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For each Class I and Class II towns of GRB, annual expenditure on the capital investment (Capex) for all three components of solid waste management systems has been worked out by multiplying capital expenditure with capital recovery factor (CRF). The CRF has been calculated as (i) 0.28 using 12 % interest over 5 years period for equipment and machinery, and, (ii) 0.134 using 12 % interest over 20 years period for infrastructure and construction work . Operation and Maintenance (Opex) has also been estimated for each of these towns for all three components separately using methodology presented in Chapter 4 and results described in previous section of this chapter. Results are presented in Tables A2.01 to A2.22 of Appendix II. These tables also include (i) ballpark estimates of total annual expenditure on entire solid waste management, (ii) land footprint, (iii) land required per capita, (iv) fuel demand, and (v) energy consumption. A summary of these results for each of the GRB states is presented in Tables 5.04 to 5.08 for Class I and Class II towns.

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Table 5.04: Estimated Annual Capital (Capex) and Operation and Maintenance (Opex) Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Millions) of NRGB

S No	State	Population in Millions	Estimated Waste Generation, MT/d	Estimated Annual Expenditure, Millions of INR						Estimated Total Expenditure, Millions of INR
				Waste Collection		Waste Conveyance		Waste Treatment		
				Capex	Opex	Capex	Opex	Capex	Opex	
01	Uttarakhand	2.121	1061	44.35	429.67	88.26	121.54	97.51	111.62	892.95
02	Uttar Pradesh	29.613	14807	619.18	5998.72	1232.24	1696.78	1361.31	1558.38	12466.61
03	Himachal Pradesh	**No Class I Town**								
04	Haryana	5.317	2659	111.17	1077.05	221.24	304.65	244.42	279.80	2238.33
05	Delhi	13.482	6741	281.89	2731.01	240.75	772.49	619.76	709.48	5355.38
06	Rajasthan	7.689	3844	160.77	1557.54	319.95	440.56	353.46	404.63	3236.91
07	Madhya Pradesh	11.934	5967	249.52	2417.39	496.58	683.78	548.59	628.00	5023.86
08	Bihar	6.929	3464	144.87	1403.52	288.31	397.00	318.51	364.61	2916.82
09	Chhattisgarh	3.138	1569	65.61	635.64	130.57	179.79	144.25	165.13	1320.99
10	Jharkhand	4.801	2401	100.39	972.57	199.78	275.10	220.71	252.66	2021.21
11	West Bengal	17.124	8562	358.04	3468.72	712.54	981.15	787.17	901.12	7208.74
Total		**102.148**	**51075**	**2135.79**	**20691.83**	**3930.22**	**5852.84**	**4695.69**	**5375.43**	**42681.8**

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Table 5.05: Estimated Annual Capital (Capex) and Operation and Maintenance (Opex) Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of NRGB

S No	State	Population in Millions	Estimated Waste Generation, MT/d	Estimated annual Expenditure, Millions of INR						Estimated Total Expenditure, Millions of INR
				Waste Collection		Waste Conveyance		Waste Treatment		
				Capex	Opex	Capex	Opex	Capex	Opex	
01	Uttarakhand	0.212	106	4.44	43.03	8.84	12.17	9.76	11.18	89.42
02	Uttar Pradesh	3.109	1554	65.00	629.75	129.36	178.13	142.91	163.60	1308.75
03	Himachal Pradesh	**No Class II Town**								
04	Haryana	0.164	82	3.42	33.14	6.81	9.37	7.52	8.61	68.87
05	Delhi	0.862	431	18.02	174.57	35.86	49.38	39.62	45.35	362.80
06	Rajasthan	0.287	143	6.00	58.11	11.94	16.44	13.19	15.10	120.78
07	Madhya Pradesh	0.654	327	13.67	132.47	27.21	37.47	30.06	34.41	275.29
08	Bihar	1.462	731	30.57	296.14	60.83	83.77	67.21	76.93	615.45
09	Chhattisgarh	0.448	224	9.36	90.69	18.63	25.65	20.58	23.56	188.47
10	Jharkhand	1.236	618	25.84	250.31	51.42	70.80	56.80	65.03	520.20
11	West Bengal	1.000	500	20.91	202.58	41.61	57.30	45.97	52.63	421.00
Total		**9.433**	**4716**	**197.23**	**1910.79**	**392.51**	**540.48**	**433.62**	**496.40**	**3971.03**

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Table 5.06: Estimated Annual Expenditure on Solid Waste Management in Class I (Population > 0.1 Millions) and Class II (Population between 0.05 and 0.1 Million) Towns of NRGB

S No	State	Population in Millions	Estimated Waste Generation, MT/d	Estimated Annual Expenditure, Millions of INR							
				Waste Collection		Waste Conveyance		Waste Treatment		Total	
				Capex	Opex	Capex	Opex	Capex	Opex	Capex	Opex
01	Uttarakhand	1223.2	1167	48.79	472.70	97.10	133.71	107.27	122.80	253.16	729.21
02	Uttar Pradesh	19206.5	16361	684.18	6628.47	1361.60	1874.91	1504.22	1721.98	3550.00	10225.36
03	Himachal Pradesh	**No Class I or II Towns**									
04	Haryana	5.481	2741	114.59	1110.19	228.05	314.02	251.94	288.41	594.58	1712.62
05	Delhi	14.344	7172	299.91	2905.58	276.61	821.87	659.38	754.83	1235.90	4482.28
06	Rajasthan	7.976	3987	166.77	1615.65	331.89	457.00	366.65	419.73	865.31	2492.38
07	Madhya Pradesh	12.588	6294	263.19	2549.86	523.79	721.25	578.65	662.41	1365.63	3933.52
08	Bihar	8.391	4195	175.44	1699.66	349.14	480.77	385.72	441.54	910.30	2621.97
09	Chhattisgarh	3.586	1793	74.97	726.33	149.20	205.44	164.83	188.69	389.00	1120.46
10	Jharkhand	6.037	3019	126.23	1222.88	251.20	345.90	277.51	317.69	654.94	1886.47
11	West Bengal	18.124	9062	378.95	3671.30	754.15	1038.45	833.14	953.75	1966.24	5663.50
Total		**111.582**	**55791**	**2333.02**	**22602.62**	**4322.73**	**6393.32**	**5129.31**	**5871.83**	**11785.06**	**34867.77**

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Estimated per capita footprint, daily energy consumption and daily expenditure on availing appropriate solid waste management system for each of the Class I and Class II towns in GRB are included in the tables given in Appendix II. Tables 5.07 and 5.08 present summary of such results for all Class I and Class II towns belonging to eleven different Indian states, and are part of the GRB.

It is interesting to note that footprint for waste treatment is approximately 0.7 m^2 per person. The electrical energy consumption in complete solid waste management comes out to be 0.001 KW-h per person per day while the equivalent energy in the form of fuel consumption is 0.017 KW-h per person per day for Class I towns and the corresponding value for Class II towns is 0.016 KW-h per person per day. The fuel cost in waste collection and conveyance increase with decrease in population densities. The total per capita expenditure for having complete solid waste management system is estimated to be INR 1.15 per capita per day.

5.7 Benefits of Provisioning Solid Waste Management System

Having proper solid waste management system in Indian Cities has many tangible and intangible benefits. Some of the intangible benefits include improved aesthetics of towns, lesser exposure to infectious diseases thereby substantial savings in expenditure on health, lesser suffering and higher quality time available for meaningful activities, etc. Whereas some of the tangible benefits include increased amount of recyclable/reusable waste which in turn generates revenue, helps in conserving resources and reduces the amount of waste for treatment thereby decreasing treatment cost considerably. Compost from the composting plant can be sold as manure to be used in agriculture thus generating revenue and enhancing crop yield. Further, construction debris and drain silt can be used for filling in construction work or they can be washed and made into bricks to be used for construction purposes again. Slowly progressing towards the goal of "Minimum Landfill" concept ensures good quality of agricultural land availability, no groundwater or surface water hazards.

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Table 5.07: Estimated Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Millions) of NRGB

S No	State	Population in Millions	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
					Equivalent Energy (Fuel) Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Uttarakhand	2.121	5.6	3509.2	12808.6	828.8	892.95
02	Uttar Pradesh	29.613	43.4	54503.8	198939.0	11570.9	12466.61
03	Himachal Pradesh	**No Class I town**					
04	Haryana	5.317	11.2	9496.2	34661.0	2077.5	2238.33
05	Delhi	13.482	10.5	29001.0	105853.5	5267.9	5355.38
06	Rajasthan	7.689	13.3	15806.1	57692.1	3004.3	3236.91
07	Madhya Pradesh	11.934	18.9	22173.8	80934.5	4662.9	5023.86
08	Bihar	6.929	19.6	11750.2	42888.1	2707.3	2916.82
09	Chhattisgarh	3.138	6.3	5779.1	21093.9	1226.1	1320.99
10	Jharkhand	4.801	10.5	8456.3	30865.4	1876.0	2021.21
11	West Bengal	17.124	43.4	29710.4	108443.0	6690.8	7208.74
Total		**102.148**	**182.7**	**190186.1**	**694179.1**	**39912.5**	**42681.80**

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Table 5.08: Estimated Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of NRGB

S No	State	Population in Millions	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
					Equivalent Energy (Fuel) Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Uttarakhand	0.212	2.8	332.1	1212.3	83.0	89.42
02	Uttar Pradesh	3.109	30.1	4888.5	17843.0	1214.7	1308.75
03	Himachal Pradesh	**No Class II town**					
04	Haryana	0.164	2.1	255.1	931.2	63.9	68.87
05	Delhi	0.862	9.8	1307.8	4773.4	336.7	362.80
06	Rajasthan	0.287	2.8	471.9	1722.3	112.1	120.76
07	Madhya Pradesh	0.654	7.0	1040.4	3797.6	255.5	275.31
08	Bihar	1.462	16.1	2316.5	8455.2	571.2	615.45
09	Chhattisgarh	0.448	4.2	779.6	2845.4	174.9	188.48
10	Jharkhand	1.236	11.9	1994.8	7281.2	482.8	520.20
11	West Bengal	1.000	10.5	1601.7	5846.4	390.8	421.01
Total		**9.433**	**97.3**	**14988.4**	**54708**	**3685.6**	**3971.05**

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6. Conclusions and Recommendations

6.1 Conclusions

Following conclusions may be drawn based on the synthesis of the information available in the literature and the results presented in this thesis.

- Typical breakup of total annual expenditure on solid waste collection between capex and opex is 16% and 84 % respectively.
- Manpower alone contributes to about 82 % of the total opex incurred in solid waste collection.
- Typical breakup of total annual expenditure on solid waste conveyance between capex and opex is 36% and 64 % respectively.
- Approximately 10 % of total capital expenditure on solid waste conveyance is the cost incurred on transfer station.
- The total share of miscellaneous cost inclusive of fuel and maintenance cost comes out to be 55 % in case of waste conveyance which is very high as compared to 18 % as was in the case of waste collection.
- Typical breakup of total annual expenditure on waste treatment between capex and opex is 48 % and 52 % respectively.
- Infrastructure cost contributes to 62 % of the total capital expenditure in waste treatment while the cost of machinery is 38 % of the total capex.
- Approximately 84 % of the total opex is incurred on manpower while the miscellaneous cost has a share of 16 % in the total opex.
- Approximately 58, 19 and 23 % of the total annual expenditure on solid waste management is incurred on waste collection, conveyance and treatment respectively in a typical Indian town.
- About 34, 26 and 40 % of the total capital expenditure on solid waste management is towards waste collection, conveyance and treatment respectively while about 67,

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17 and 16 % of the total operational expenditure is incurred in waste collection, conveyance and treatment respectively.

- Approximately 87 % of the energy bill is towards waste treatment, 12 % is due to waste conveyance while only 1 % of energy expenditure is incurred on waste collection for Class I towns.
- For Class II towns 92 % of the energy bill is towards waste treatment, 7 % is due to waste conveyance while only 1 % of energy expenditure is incurred on waste collection
- Total annual capex and opex for provisioning solid waste management in all Class I and Class II towns of GRB is expected to be INR 11785.06 and 34867.77 million respectively. This amounts to average per capita per day expenditure of INR 1.15.
- The average per capita per day energy consumption in availing solid waste management comes out to be 20 Watt hour for Class I towns and 17 Watt hour for Class II towns.
- The expenditure on solid waste may be justified in GRB based on tangible and intangible benefits.

6.2 Recommendations

Following recommendations are made for reasonable continuation of the work described in this thesis based on the knowledge gained in conducting the present study.

- Detailed study for different categories of towns and making different plan for these classes.
- Study of reports of SWM plants of foreign countries for better understanding.
- A detailed study on waste sorting, manual as well as mechanical.

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Appendix I

Estimated Capital Expenditure on Solid Waste Management in Class I and Class II Towns of GRB

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Table A1.01: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Uttarakhand in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Dehradun	870.519	435	52.29	65.01	129.37	237.79	432.17
02	Haldwani	169.147	85	10.62	12.63	25.14	46.20	83.97
03	Hardwar	487.923	244	13.00	36.44	72.51	133.28	242.23
04	Kashipur	121.610	61	5.46	9.08	18.07	33.22	60.37
05	Nainital	110.726	55	11.06	8.27	16.46	30.25	54.98
06	Rishikesh	102.138	51	10.00	7.63	15.18	27.90	50.71
07	Roorkee	118.188	59	20.20	8.83	17.56	32.28	58.67
08	Rudrapur	140.884	70	12.43	10.52	20.94	38.48	69.94
Total		**2121.135**	**1061**	**135.06**	**158.41**	**315.23**	**579.40**	**1053.04**

Table A1.02: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Uttarakhand in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	BHEL Ranipur	51.910	26	26.94	3.88	7.71	14.18	25.77
02	Manglaur	51.101	26	1.32	3.82	7.59	13.96	25.37
03	Pithoragarh	53.957	27	9.00	4.03	8.02	14.74	26.79
04	Ramnagar	55.446	28	2.42	4.14	8.24	15.15	27.53
Total		**212.414**	**106**	**39.68**	**15.87**	**31.56**	**58.03**	**105.46**

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Table A1.03: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Uttar Pradesh in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Agra	1746.467	873	141.00	130.42	259.54	477.06	867.02
02	Aligarh	909.559	455	36.70	67.92	135.17	248.45	451.54
03	Allahabad	1216.719	608	63.07	90.86	180.82	332.35	604.03
04	Amroha	197.135	99	12.00	14.72	29.30	53.85	97.87
05	Azamgarh	116.165	58	12.60	8.67	17.26	31.73	57.66
06	Badaun	159.221	80	4.39	11.89	23.66	43.49	79.04
07	Ballia	111.287	56	16.00	8.31	16.54	30.40	55.25
08	Banda	154.388	77	11.05	11.53	22.94	42.17	76.64
09	Barabanki	154.692	77	3.87	11.55	22.99	42.26	76.80
10	Baraut	101.241	51	25.00	7.56	15.05	27.65	50.26
11	Bareilly	979.933	490	106.43	73.18	145.63	267.68	486.49
12	Basti	114.651	57	19.43	8.56	17.04	31.32	56.92
13	Bijnour	115.381	58	3.65	8.62	17.15	31.52	57.29
14	Bulandsahar	222.826	111	32.50	16.64	33.11	60.87	110.62
15	Chandausi	114.254	57	8.80	8.53	16.98	31.21	56.72
16	Deoria	129.570	65	16.19	9.68	19.26	35.39	64.33
17	Etah	131.023	66	13.49	9.78	19.47	35.79	65.04
18	Etawah	256.790	128	48.00	19.18	38.16	70.14	127.48
19	Faizabad	259.160	130	16.60	19.35	38.51	70.79	128.65
20	Farrukhabad	318.540	159	16.80	23.79	47.34	87.01	158.14
21	Fatehpur	193.801	97	56.98	14.47	28.80	52.94	96.21
22	Firozabad	603.797	302	21.35	45.09	89.73	164.93	299.75
23	Gazipur	121.136	61	13.45	9.05	18.00	33.09	60.14
24	Ghaziabad	2358.525	1179	215.00	176.12	350.50	644.25	1170.87

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
25	Gonda	138.929	69	24.62	10.37	20.65	37.95	68.97
26	Gorakhpur	692.519	346	147.00	51.71	102.92	189.17	343.80
27	Greater Noida	642.381	321	27.93	47.97	95.46	175.47	318.90
28	Hapur	262.801	131	42.00	19.62	39.05	71.79	130.46
29	Hardoi	197.046	99	11.05	14.71	29.28	53.82	97.81
30	Hathras	161.289	81	8.40	12.04	23.97	44.06	80.07
31	Jaunpur	168.128	84	20.00	12.55	24.99	45.93	83.47
32	Jhansi	549.391	275	169.50	41.03	81.65	150.07	272.75
33	Kanpur	2920.067	1460	261.50	218.05	433.95	797.64	1449.64
34	Kasganj	101.241	51	7.10	7.56	15.05	27.65	50.26
35	Lakhimpur	164.925	82	10.20	12.32	24.51	45.05	81.88
36	Lalitpur	133.041	67	18.00	9.93	19.77	36.34	66.04
37	Loni	512.296	256	34.48	38.26	76.13	139.94	254.33
38	Lucknow	2901.474	1451	330.00	216.66	431.19	792.56	1440.41
39	Mainpuri	133.078	67	7.50	9.94	19.78	36.35	66.07
40	Mathura	454.937	227	32.80	33.97	67.61	124.27	225.85
41	Mau	279.060	140	39.00	20.84	41.47	76.23	138.54
42	Meerut	1424.908	712	41.94	106.40	211.76	389.22	707.38
43	Mirzapur	233.691	117	40.00	17.45	34.73	63.83	116.01
44	Modinagar	182.811	91	14.00	13.65	27.17	49.94	90.76
45	Moradabad	889.810	445	80.00	66.45	132.24	243.06	441.75
46	Mugalsarai	154.692	77	14.43	11.55	22.99	42.26	76.80
47	Muradanagar	100.080	50	12.00	7.47	14.87	27.34	49.68
48	Muzaffar Nagar	316.729	158	12.04	23.65	47.07	86.52	157.24
49	Noida	642.381	321	203.16	47.97	95.46	175.47	318.90

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
50	Orai	190.625	95	16.00	14.23	28.33	52.07	94.63
51	Pililbhit	160.146	80	9.50	11.96	23.80	43.74	79.50
52	Raibareliy	191.625	96	34.00	14.31	28.48	52.34	95.13
53	Rampur	359.062	180	20.20	26.81	53.36	98.08	178.25
54	Saharanpur	703.345	352	73.72	52.52	104.52	192.12	349.16
55	Sahaswann	178.000	89	7.50	13.29	26.45	48.62	88.36
56	Sahjahanpur	356.103	178	11.37	26.59	52.92	97.27	176.78
57	Shambhal	221.334	111	15.65	16.53	32.89	60.46	109.88
58	Sitapur	188.230	94	35.00	14.06	27.97	51.42	93.45
59	Sultanpur	116.211	58	16.00	8.68	17.27	31.74	57.69
60	Ujhani	191.000	96	6.50	14.26	28.38	52.17	94.81
61	Unnao	178.681	89	21.50	13.34	26.55	48.81	88.70
62	Varansi	1435.113	718	79.79	107.17	213.27	392.01	712.45
Total		**29613.440**	**14807**	**2869.73**	**2211.34**	**4400.86**	**8089.12**	**14701.32**

Table A1.04: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Uttar Pradesh in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Auraiya	70.515	35	4.00	5.27	10.48	19.26	35.01
02	Baghpat	50.380	25	2.83	3.76	7.49	13.76	25.01

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
03	Baheri	74.869	37	15.00	5.59	11.13	20.45	37.17
04	Balrampur	90.000	45	36.28	6.72	13.37	24.58	44.67
05	Bhadohi	94.563	47	8.00	7.06	14.05	25.83	46.94
06	Bisalpur	83.347	42	4.58	6.22	12.39	22.77	41.38
07	Chandpur	83.456	42	23.40	6.23	12.40	22.80	41.43
08	Chibramau	55.296	28	11.10	4.13	8.22	15.10	27.45
09	Chitrakoot	57.452	29	7.77	4.29	8.54	15.69	28.52
10	Dadri	91.345	46	6.50	6.82	13.57	24.95	45.34
11	Deoband	97.068	49	7.90	7.25	14.43	26.51	48.19
12	Faredpur	76.422	38	9.43	5.71	11.36	20.88	37.95
13	Gangaghat	84.301	42	4.91	6.30	12.53	23.03	41.86
14	Gangoh	59.463	30	6.00	4.44	8.84	16.24	29.52
15	Gola	53.842	27	10.08	4.02	8.00	14.71	26.73
16	Hasanpur	64.536	32	5.72	4.82	9.59	17.63	32.04
17	Jahangerabad	59.873	30	14.30	4.47	8.90	16.35	29.72
18	Jalaun	56.871	28	5.00	4.25	8.45	15.53	28.23
19	Kaimur	51.469	26	7.12	3.84	7.65	14.06	25.55
20	Kairana	95.092	48	7.11	7.10	14.13	25.97	47.20
21	Kannauj	71.727	36	70.70	5.36	10.66	19.59	35.61
22	Khatauli	72.478	36	3.76	5.41	10.77	19.80	35.98
23	Kiratpur	61.801	31	4.45	4.61	9.18	16.88	30.67
24	Konch	53.426	27	2.95	3.99	7.94	14.59	26.52
25	Laharpur	61.280	31	8.00	4.58	9.11	16.74	30.43
26	Mahoba	95.454	48	12.15	7.13	14.19	26.07	47.39

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
27	Mau Ranipur	58.456	29	5.53	4.37	8.69	15.97	29.03
28	Mawana	81.126	41	7.50	6.06	12.06	22.16	40.28
29	Mubarakpur	71.365	36	9.00	5.33	10.61	19.49	35.43
30	Nagina	71.350	36	10.30	5.33	10.60	19.49	35.42
31	Nazibabad	88.638	44	5.06	6.62	13.17	24.21	44.00
32	Obra	56.116	28	4.50	4.19	8.34	15.33	27.86
33	Pilkhuwa	81.651	41	5.80	6.10	12.13	22.30	40.53
34	Pratapgarh	76.750	38	12.00	5.73	11.41	20.96	38.10
35	Ramnagar	54.800	27	3.60	4.09	8.14	14.97	27.20
36	Rath	65.092	33	6.10	4.86	9.67	17.78	32.31
37	S R Nagar	94.563	47	8.00	7.06	14.05	25.83	46.94
38	Shahbad	80.305	40	9.70	6.00	11.93	21.94	39.87
39	Sherkot	62.148	31	6.00	4.64	9.24	16.98	30.86
40	Sikandrabad	80.309	40	1.14	6.00	11.93	21.94	39.87
41	Tanda	96.138	48	10.45	7.18	14.29	26.26	47.73
42	Tilhar	60.803	30	3.48	4.54	9.04	16.61	30.19
43	Vrindavann	62.926	31	13.49	4.70	9.35	17.19	31.24
Total		**3108.862**	**1554**	**420.69**	**232.17**	**462.02**	**849.18**	**1543.37**

37. S R Nagar – Sant Ravidas Nagar

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Table A1.05: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Himanchal Pradesh in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
No Class I town								

Table A1.06: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Himanchal Pradesh in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
No Class II town								

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Table A1.07: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Haryana in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Bhadur Garh	170.426	85	50.00	12.73	25.33	46.55	84.61
02	Bhiwani	197.662	99	47.78	14.76	29.37	53.99	98.12
03	Faridabad	1404.653	702	207.80	104.89	208.75	383.69	697.33
04	Gurgoan	901.968	451	37.10	67.35	134.04	246.38	447.77
05	Hisar	301.249	151	48.03	22.50	44.77	82.29	149.56
06	Jagadhari	124.915	62	24.80	9.33	18.56	34.12	62.01
07	Jind	166.225	83	42.00	12.41	24.70	45.41	82.52
08	Kaithal	144.633	72	45.75	10.80	21.49	39.51	71.80
09	Karnal	286.974	143	12.00	21.43	42.65	78.39	142.47
10	Kurukhetra	154.962	77	34.50	11.57	23.03	42.33	76.93
11	Narnaul	134.067	67	41.10	10.01	19.92	36.62	66.55
12	Palwal	127.931	64	8.78	9.55	19.01	34.95	63.51
13	Panipat	294.150	147	41.40	21.97	43.71	80.35	146.03
14	Rohtak	373.133	187	47.50	27.86	55.45	101.92	185.23
15	Sonipat	292.339	146	52.80	21.83	43.44	79.85	145.12
16	Yamuna Nagar	241.723	121	34.50	18.05	35.92	66.03	120.00
Total		**5317.010**	**2659**	**775.84**	**397.04**	**790.14**	**1452.38**	**2639.56**

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Table A1.08: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Haryana in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Hodal	50.003	25	5.39	3.73	7.43	13.66	24.82
02	Narvana	61.800	31	10.00	4.61	9.18	16.88	30.67
03	Sahadab	51.786	26	5.00	3.87	7.70	14.15	25.72
Total		**163.589**	**82**	**20.39**	**12.21**	**24.31**	**44.69**	**81.21**

Table A1.09: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Delhi in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	B J	197.150	99	6.70	14.72	29.30	53.85	97.87
02	Burari	145.584	73	11.19	10.87	21.64	39.77	72.28
03	Dallo Pura	154.955	77	2.29	11.57	23.03	42.33	76.93
04	Delhi Cantt.	116.352	58	42.97	8.69	17.29	31.78	57.76
05	DMC	11007.835	5504	431.09	822.00	1635.88	3006.86	5464.74
06	Deoli	169.410	85	10.12	12.65	25.18	46.28	84.11
07	Gokalpur	121.938	61	2.32	9.11	18.12	33.31	60.54
08	Hastal	177.033	89	6.75	13.22	26.31	48.36	87.89
09	Karawal Nagar	224.666	112	4.75	16.78	33.39	61.37	111.54
10	K S N	282.598	141	4.74	21.10	42.00	77.19	140.29
11	Mandoli	120.345	60	41.77	8.99	17.88	32.87	59.74
12	Mustafabad	127.012	64	1.29	9.48	18.88	34.69	63.05

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
13	Nangloi Jat	205.497	103	6.67	15.35	30.54	56.13	102.02
14	NDMC	249.998	125	42.74	18.67	37.15	68.29	124.11
15	Sultanpur Majra	181.624	91	2.86	13.56	26.99	49.61	90.16
Total		**13482.000**	**6741**	**618.25**	**1006.76**	**2003.58**	**3682.69**	**6693.03**

01. B J – Bhalswa Jahangirpur
05. DMC – Delhi Municipal Corporation
10. K S N – Kirari Suleman Nagar
14. NDMC – New Delhi Municipal Corporation

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Table A1.10: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Delhi in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Babarpur	52.918	26	0.79	3.95	7.86	14.45	26.26
02	C S B	81.374	41	2.58	6.08	12.09	22.23	40.40
03	Gharoli	84.722	42	3.56	6.33	12.59	23.14	42.06
04	Jaffrabad	70.089	35	0.90	5.23	10.42	19.15	34.80
05	Khajoori Khas	55.006	28	0.94	4.11	8.17	15.03	27.31
06	Mithe Pur	49.583	25	1.81	3.70	7.37	13.54	24.61
07	Molar Band	49.439	25	4.12	3.69	7.35	13.50	24.54
08	Mundka	53.525	27	11.89	4.00	7.95	14.62	26.57
09	Pooth Kalan	61.727	31	6.97	4.61	9.17	16.86	30.64
10	Pulpehlad	64.484	32	2.16	4.82	9.58	17.61	32.01
11	S P G	52.730	26	1.05	3.94	7.84	14.40	26.18
12	Taj Pul	72.764	36	1.22	5.43	10.81	19.88	36.12
13	Tigri	54.774	27	1.05	4.09	8.14	14.96	27.19
14	Ziauddin Pur	58.661	29	1.80	4.38	8.72	16.02	29.12
Total		**861.796**	**431**	**40.84**	**64.36**	**128.06**	**235.39**	**427.81**

02. C S B – Chilla Saroda Bangar

11. S P G – Sadat Pur Gurjan

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Table A1.11: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Rajasthan in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Ajmer	542.580	271	87.00	40.52	80.63	148.21	269.36
02	Alwar	315.310	158	49.00	23.55	46.86	86.13	156.54
03	Bahilwara	360.009	180	69.00	26.88	53.50	98.34	178.72
04	Baran	118.157	59	72.36	8.82	17.56	32.28	58.66
05	Bharatpur	252.109	126	29.00	18.83	37.47	68.87	125.17
06	Bundi	102.823	51	22.76	7.68	15.28	28.09	51.05
07	Chittaugarh	116.409	58	30.50	8.69	17.30	31.80	57.79
08	Dhaulpur	126.142	63	32.00	9.42	18.75	34.46	62.63
09	Gangapurcity	224.773	112	17.22	16.78	33.40	61.40	111.58
10	Hindauncity	105.690	53	48.00	7.89	15.71	28.87	52.47
11	Jaipur	3073.350	1537	485.00	229.50	456.73	839.51	1525.74
12	Jhunjhunun	118.966	59	50.00	8.88	17.68	32.50	59.06
13	Kishangarh	155.019	78	100.00	11.58	23.04	42.34	76.96
14	Kota	1001.365	501	527.03	74.78	148.81	273.53	497.12
15	Nagaur	100.618	50	37.81	7.51	14.95	27.48	49.94
16	Sikar	237.579	119	39.90	17.74	35.31	64.90	117.95
17	Swaimadhavpur	120.998	60	49.00	9.04	17.98	33.05	60.07
18	Tonk	165.363	83	16.00	12.35	24.57	45.17	82.09
19	Udaipur	451.735	226	56.91	33.73	67.13	123.39	224.25
Total		**7688.995**	**3844**	**1818.49**	**574.17**	**1142.66**	**2100.32**	**3817.15**

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Table A1.12: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Rajasthan in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Jhalawara	66.500	33	12.95	4.97	9.88	18.16	33.01
02	Makrana	94.447	47	36.00	7.05	14.04	25.80	46.89
03	Nawalgarh	64.903	32	27.91	4.85	9.65	17.73	32.23
04	Nimbahera	61.000	31	12.74	4.56	9.07	16.66	30.29
Total		**286.85**	**143**	**89.6**	**21.43**	**42.64**	**78.35**	**142.42**

Table A1.13: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Madhya Pradesh in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Bhind	197.332	99	17.79	14.74	29.33	53.90	97.97
02	Bopal	1883.381	942	285.00	140.64	279.89	514.46	934.99
03	Chatarpur	147.688	74	54.00	11.03	21.95	40.34	73.32
04	Damoh	147.515	74	16.00	11.02	21.92	40.29	73.23
05	Datia	100.466	50	6.85	7.50	14.93	27.44	49.87
06	Dewas	289.438	145	102.00	21.61	43.01	79.06	143.68
07	Guna	180.978	90	45.75	13.51	26.90	49.44	89.85
08	Gwalior	1101.981	551	173.88	82.29	163.77	301.01	547.07
09	Indore	2167.447	1084	131.17	161.85	322.11	592.05	1076.01
10	Jabalpur	1267.564	634	135.00	94.65	188.37	346.24	629.26
11	Katni	221.875	111	68.60	16.57	32.97	60.61	110.15

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
12	Mandsour	141.468	71	36.00	10.56	21.02	38.64	70.22
13	Morena	200.506	100	12.00	14.97	29.80	54.77	99.54
14	Neemuch	128.575	64	22.00	9.60	19.11	35.12	63.83
15	Pithampur	126.099	63	89.90	9.42	18.74	34.44	62.60
16	Ratlam	273.892	137	39.19	20.45	40.70	74.82	135.97
17	Rewa	235.422	118	102.00	17.58	34.99	64.31	116.88
18	Sagar	370.296	185	33.75	27.65	55.03	101.15	183.83
19	Satna	283.004	142	12.00	21.13	42.06	77.30	140.49
20	Sehore	1090.025	545	13.10	81.40	161.99	297.75	541.14
21	Shahdol	100.565	50	28.24	7.51	14.95	27.47	49.93
22	Shepour	105.026	53	5.00	7.84	15.61	28.69	52.14
23	Shivpuri	179.972	90	86.55	13.44	26.75	49.16	89.35
24	Singrauli	220.295	110	280.66	16.45	32.74	60.18	109.37
25	Tikamgarh	101.786	51	6.22	7.60	15.13	27.80	50.53
26	Ujjain	515.215	258	92.68	38.47	76.57	140.73	255.77
27	Vidisha	155.959	78	8.83	11.65	23.18	42.60	77.43
Total		**11933.77**	**5967**	**1904.16**	**891.13**	**1773.52**	**3259.77**	**5924.42**

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Table A1.14: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Madhya Pradesh in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Basoda	78.265	39	5.90	5.84	11.63	21.38	38.85
02	Bina	64.579	32	12.00	4.82	9.60	17.64	32.06
03	Dabra	61.260	31	12.00	4.57	9.10	16.73	30.40
04	Dhar	95.000	48	30.00	7.09	14.12	25.95	47.16
05	Jaora	65.111	33	5.54	4.86	9.68	17.79	32.33
06	Mandla	55.145	28	8.87	4.12	8.20	15.06	27.38
07	Narshimpur	59.858	30	14.71	4.47	8.90	16.35	29.72
08	Panna	50.432	25	4.50	3.77	7.49	13.78	25.04
09	Shajapur	70.000	35	11.16	5.23	10.40	19.12	34.75
10	Sidhi	54.317	27	12.31	4.06	8.07	14.84	26.97
Total		**653.967**	**327**	**116.99**	**48.83**	**97.19**	**178.64**	**324.66**

Table A1.15: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Bihar in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Arrah	261.099	131	30.97	19.50	38.80	71.32	129.62
02	Aurangabad	101.520	51	8.00	7.58	15.09	27.73	50.40
03	Bagaha	113.012	57	11.00	8.44	16.79	30.87	56.10
04	Begusarai	251.136	126	8.98	18.75	37.32	68.60	124.67

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
05	Bettiah	132.896	66	11.55	9.92	19.75	36.30	65.97
06	B M C	398.138	199	30.17	29.73	59.17	108.75	197.65
07	B M C	296.889	148	22.46	22.17	44.12	81.10	147.39
08	Buxar	102.591	51	8.00	7.66	15.25	28.02	50.93
09	Chapra (NP)	201.597	101	16.96	15.05	29.96	55.07	100.08
10	Darbhanga	294.116	147	19.18	21.96	43.71	80.34	146.01
11	Dehri	137.068	69	21.32	10.24	20.37	37.44	68.05
12	D N	182.241	91	11.63	13.61	27.08	49.78	90.47
13	Gaya	463.454	232	50.17	34.61	68.87	126.60	230.08
14	Hajipur	147.126	74	19.64	10.99	21.86	40.19	73.04
15	Jamalpur	105.221	53	10.65	7.86	15.64	28.74	52.24
16	Jehanabad	102.456	51	20.23	7.65	15.23	27.99	50.87
17	Katihar	225.982	113	24.54	16.88	33.58	61.73	112.19
18	Kishanganj	107.076	54	30.12	8.00	15.91	29.25	53.16
19	M T	105.000	53	8.50	7.84	15.60	28.68	52.12
20	Motihari	125.183	63	13.52	9.35	18.60	34.19	62.14
21	Munger	213.101	107	17.50	15.91	31.67	58.21	105.79
22	Muzaffarpur	351.838	176	26.43	26.27	52.29	96.11	174.67
23	Nawada	109.141	55	5.68	8.15	16.22	29.81	54.18
24	Patna	1683.200	842	108.34	125.69	250.14	459.78	835.61
25	Purnia	280.547	140	44.52	20.95	41.69	76.63	139.27
26	Saharsa	155.175	78	21.13	11.59	23.06	42.39	77.04

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
27	Sasaram	147.396	74	12.00	11.01	21.90	40.26	73.17
28	Siwan	134.458	67	15.68	10.04	19.98	36.73	66.75
Total		**6928.657**	**3464**	**628.87**	**517.4**	**1029.65**	**1892.61**	**3439.66**

06. B M C – Bhagalpur Municipal Corporation
07. B M C – Biharsharif Municipal Corporation
12. DN – Dinapur Nizamat
19. MT – Madhubani Town

Table A1.16: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Bihar in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Araria	80.000	40	4.50	5.97	11.89	21.85	39.71
02	Barahiya	50.230	25	26.54	3.75	7.46	13.72	24.93
03	Barh	61.037	31	4.50	4.56	9.07	16.67	30.30
04	Bhabua	52.611	26	7.12	3.93	7.82	14.37	26.12
05	D M	67.995	34	11.30	5.08	10.10	18.57	33.75
06	Dumraon	57.716	29	15.33	4.31	8.58	15.77	28.66
07	Forbesganj	52.289	26	4.98	3.90	7.77	14.28	25.95

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
08	Gopalganj	66.624	33	11.11	4.98	9.90	18.20	33.08
09	Kaimur	51.469	26	7.12	3.84	7.65	14.06	25.55
10	Khagaria	56.978	28	2.97	4.25	8.47	15.56	28.28
11	Khagaul	60.866	30	5.32	4.55	9.05	16.63	30.23
12	Lakhisarai	98.123	49	24.79	7.33	14.58	26.80	48.71
13	Madhepura	56.739	28	25.84	4.24	8.43	15.50	28.17
14	Masaurhi	57.012	29	9.43	4.26	8.47	15.57	28.30
15	Mokameh	71.335	36	14.18	5.33	10.60	19.49	35.42
16	Narkatiaganj	51.446	26	10.96	3.84	7.65	14.05	25.54
17	Phulwari Sharif	67.348	34	6.48	5.03	10.01	18.40	33.44
18	Raxaul Bazar	52.429	26	5.82	3.92	7.79	14.32	26.03
19	Samastipur	70.042	35	3.45	5.23	10.41	19.13	34.77
20	Shekhpura	54.322	27	15.58	4.06	8.07	14.84	26.97
21	Sitamarhi	87.279	44	8.00	6.52	12.97	23.84	43.33
22	Sultanganj	52.867	26	12.29	3.95	7.86	14.44	26.25
23	Supaul	85.200	43	22.37	6.36	12.66	23.27	42.29
Total		**1461.957**	**731**	**259.98**	**109.19**	**217.26**	**399.33**	**725.78**

05. D M – Digha-Mainpura

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Table A2.17: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Chhatisgarh in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Ambikapur	114.575	57	9.39	8.56	17.03	31.30	56.89
02	Bhilai Nagar	625.697	313	141.30	46.72	92.99	170.91	310.62
03	Bilaspur	330.106	165	37.56	24.65	49.06	90.17	163.88
04	Durg	268.679	134	66.09	20.06	39.93	73.39	133.38
05	Jagdalpur	125.345	63	22.49	9.36	18.63	34.24	62.23
06	Korba	363.210	182	215.02	27.12	53.98	99.21	180.31
07	Raigarh	137.097	69	20.68	10.24	20.37	37.45	68.06
08	Raipur	1010.087	505	108.66	75.43	150.11	275.91	501.45
09	Rajnandgaon	163.122	82	78.09	12.18	24.24	44.56	80.98
Total		**3137.918**	**1569**	**699.28**	**234.32**	**466.34**	**857.14**	**1557.80**

Table A1.18: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Chhatisgarh in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Bhatapara	54.846	27	30.42	4.10	8.15	14.98	27.23
02	Bhilai Charoda	95.848	48	141.30	7.16	14.24	26.18	47.58
03	Chirmiri	99.934	50	64.94	7.46	14.85	27.30	49.61
04	Dalli-Rajhara	55.684	28	37.25	4.16	8.28	15.21	27.65
05	Dhamtari	89.857	45	23.40	6.71	13.35	24.55	44.61
06	Mahasamund	51.543	26	14.68	3.85	7.66	14.08	25.59
Total		**447.712**	**224**	**311.99**	**33.44**	**66.53**	**122.30**	**222.27**

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Table A1.19: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Jharkhand in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Aditya	173.988	87	49.82	12.99	25.86	47.53	86.38
02	Bhuli	110.127	55	11.74	8.22	16.37	30.08	54.67
03	Bokaro	413.934	207	162.91	30.91	61.51	113.07	205.49
04	Chas	141.618	71	20.49	10.58	21.05	38.68	70.31
05	Deoghar	203.116	102	14.00	15.17	30.19	55.48	100.84
06	Dhanbad	1161.561	581	23.39	86.74	172.62	317.29	576.65
07	Giridih	114.447	57	9.75	8.55	17.01	31.26	56.82
08	Hazaribag	142.494	71	26.37	10.64	21.18	38.92	70.74
09	JNAC	629.659	315	59.80	47.02	93.57	172.00	312.59
10	Jharia	100.839	50	4.42	7.53	14.99	27.54	50.06
11	Jorapokhar	104.673	52	16.40	7.82	15.56	28.59	51.97
12	MNAC	224.002	112	19.45	16.73	33.29	61.19	111.21
13	Phusro	102.673	51	40.64	7.67	15.26	28.05	50.98
14	Ranchi	1073.440	537	177.19	80.16	159.52	293.22	532.90
15	Saunda	104.642	52	24.26	7.81	15.55	28.58	51.94
Total		**4801.213**	**2401**	**660.63**	**358.54**	**713.53**	**1311.48**	**2383.55**

09. JNAC – Jamshedpur Notified Area Committee
12. MNAC – Mango Notified Area Committee

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Table A1.20: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Jharkhand in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Bagbera	82.559	41	10.70	6.17	12.27	22.55	40.99
02	Bhowrah	54.483	27	15.73	4.07	8.10	14.88	27.05
03	Bhuli	99.999	50	8.60	7.47	14.86	27.32	49.65
04	Chaibasa	78.287	39	11.11	5.85	11.63	21.38	38.86
05	Chatra	51.685	26	3.45	3.86	7.68	14.12	25.66
06	Daltonganj	87.849	44	14.00	6.56	13.06	24.00	43.62
07	Dumka	55.336	28	6.12	4.13	8.22	15.12	27.47
08	Gumia	56.024	28	26.11	4.18	8.33	15.30	27.81
09	Jhumri Tilaiya	85.489	43	51.14	6.38	12.70	23.35	42.43
10	Jugsalai	56.720	28	3.69	4.24	8.43	15.49	28.16
11	Katras	63.017	32	5.00	4.71	9.36	17.21	31.28
12	Lohardaga	56.821	28	14.57	4.24	8.44	15.52	28.20
13	Madhupur	58.211	29	18.36	4.35	8.65	15.90	28.90
14	Ramgarh Cantt.	90.324	45	34.46	6.74	13.42	24.67	44.83
15	Sahibganj	98.589	49	8.98	7.36	14.65	26.93	48.94
16	Sindri	94.398	47	46.65	7.05	14.03	25.79	46.87
17	Tisra	65.894	33	14.02	4.92	9.79	18.00	32.71
Total		**1235.685**	**618**	**292.69**	**92.28**	**183.62**	**337.53**	**613.43**

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Table A1.21: Estimated Capital Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of West Bengal in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Alipurduar	127.342	64	9.80	9.51	18.92	34.78	63.21
02	Asansol	564.491	282	127.87	42.15	83.89	154.19	280.23
03	A-K	123.906	62	18.44	9.25	18.41	33.85	61.51
04	Baidyabati	121.081	61	7.89	9.04	17.99	33.07	60.10
05	Bally	115.715	58	11.68	8.64	17.20	31.61	57.45
06	Balurghat	151.183	76	10.46	11.29	22.47	41.30	75.06
07	Bangaon	110.668	55	24.70	8.26	16.45	30.23	54.94
08	Bankura	138.036	69	19.06	10.31	20.51	37.71	68.53
09	Bansberia	103.799	52	9.07	7.75	15.43	28.35	51.53
10	Bara Nagar	248.466	124	7.12	18.55	36.92	67.87	123.34
11	Barasat	283.443	142	34.50	21.17	42.12	77.42	140.71
12	Bardhaman	314.638	157	26.30	23.50	46.76	85.95	156.21
13	Barrackpore	154.475	77	11.65	11.54	22.96	42.20	76.70
14	Basirhat	127.135	64	22.50	9.49	18.89	34.73	63.11
15	Beharampore	195.363	98	31.43	14.59	29.03	53.36	96.98
16	Bhadreswar	101.334	51	8.28	7.57	15.06	27.68	50.31
17	Bhatpara	390.467	195	30.42	29.16	58.03	106.66	193.85
18	Bidhannagar	218.323	109	30.00	16.30	32.45	59.64	108.39
19	Chakdaha	132.855	66	15.54	9.92	19.74	36.29	65.95
20	Champadani	110.983	55	6.47	8.29	16.49	30.32	55.10
21	Chandernagore	166.949	83	22.03	12.47	24.81	45.60	82.88
22	Chinsurah	180.502	90	17.24	13.48	26.82	49.31	89.61
23	Darjiling	120.414	60	10.57	8.99	17.89	32.89	59.77
24	Dhulian	239.022	120	10.27	17.85	35.52	65.29	118.66

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
25	Durgapur	566.937	283	1.10	42.34	84.25	154.86	281.45
26	Habra	149.675	75	21.80	11.18	22.24	40.88	74.30
27	Haldia	200.762	100	104.90	14.99	29.84	54.84	99.67
28	Halisahar	126.893	63	8.28	9.48	18.86	34.66	63.00
29	H-C	177.209	89	8.29	13.23	26.34	48.41	87.98
30	Jalpaiguri	107.351	54	12.50	8.02	15.95	29.32	53.29
31	Jamuria	144.791	72	73.23	10.81	21.52	39.55	71.88
32	Jangipore	122.875	61	7.86	9.18	18.26	33.56	61.00
33	Kalyani	100.62	50	21.91	7.51	14.95	27.49	49.95
34	Kamarhati	336.579	168	20.48	25.13	50.02	91.94	167.09
35	Kanchapara	122.181	61	29.21	9.12	18.16	33.37	60.65
36	Kharagpur	206.923	103	90.65	15.45	30.75	56.52	102.72
37	Khardaha	111.13	56	10.96	8.30	16.52	30.36	55.18
38	Kolkata	4486.689	2243	185.00	335.04	666.77	1225.57	2227.38
39	Konnagar	124.585	62	9.07	9.30	18.51	34.03	61.84
40	Krishnanagar	181.182	91	6.87	13.53	26.93	49.49	89.95
41	Madhyamgram	198.964	99	21.32	14.86	29.57	54.35	98.78
42	Mahestala	449.423	225	21.50	33.56	66.79	122.76	223.11
43	Medinipur	169.127	85	14.78	12.63	25.13	46.20	83.96
44	Nabadwip	125.528	63	11.66	9.37	18.65	34.29	62.31
45	Naihati	221.762	111	11.55	16.56	32.96	60.58	110.10
46	N B	134.825	67	17.17	10.07	20.04	36.83	66.94
47	NDD	253.625	127	26.45	18.94	37.69	69.28	125.91
48	Panihati	383.522	192	6.89	28.64	57.00	104.76	190.40
49	Puruliya	121.436	61	13.90	9.07	18.05	33.17	60.29

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S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
50	Raiganj	183.682	92	10.64	13.72	27.30	50.17	91.19
51	R G	404.991	202	28.00	30.24	60.19	110.63	201.06
52	R S	423.806	212	49.25	31.65	62.98	115.77	210.40
53	Rana Ghat	235.583	118	7.72	17.59	35.01	64.35	116.95
54	Raniganj	128.624	64	23.44	9.60	19.11	35.13	63.84
55	Rishra	124.591	62	6.48	9.30	18.52	34.03	61.85
56	Santipur	151.774	76	24.60	11.33	22.56	41.46	75.35
57	Serampore	183.339	92	14.50	13.69	27.25	50.08	91.02
58	Siliguri	509.709	255	41.90	38.06	75.75	139.23	253.04
59	S D D	410.524	205	17.39	30.66	61.01	112.14	203.81
60	Titagarh	118.426	59	3.24	8.84	17.60	32.35	58.79
61	Uluberia	221.175	111	33.72	16.52	32.87	60.42	109.81
62	Uttarpara K	162.386	81	16.34	12.13	24.13	44.36	80.62
Total		**17123.79**	**8562**	**1557.84**	**1278.71**	**2544.79**	**4677.49**	**8500.99**

03. A K – Ashokenagar-Kalyangarh
29. H C – Hooghly- Chinsurah
46. N B – New Barrackpore
47. NDD – North Dum Dum
51. R G – Rajarhat Gopalpur
52. R S – Rahjpur Sonarpur
59. S D D – South Dum Dum
62. Uttapara K – Uttapara Kotrung

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Table A1.22: Estimated Capital Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of West Bengal in NRGB

S No	Town	Population in Thousands	Estimated Solid Waste Generation, MT/d	Town Area in Km2	Estimated Capital Expenditure, Millions of INR			Estimated Total Expenditure, Millions of INR
					Waste Collection	Waste Conveyance	Waste Treatment	
01	Arambagh	67.000	34	34.75	5.00	9.96	18.30	33.26
02	Baduria	52.500	26	22.43	3.92	7.80	14.34	26.06
03	Bankra	55.229	28	3.59	4.12	8.21	15.09	27.42
04	Baruipur	53.500	27	9.50	4.00	7.95	14.61	26.56
05	Bishnupur	70.620	35	22.01	5.27	10.49	19.29	35.05
06	Bolpur	74.890	37	10.73	5.59	11.13	20.46	37.18
07	Budge Budge	76.858	38	9.06	5.74	11.42	20.99	38.15
08	Chittaranjan	52.391	26	19.65	3.91	7.79	14.31	26.01
09	Contai	88.365	44	14.25	6.60	13.13	24.14	43.87
10	Gangarampur	61.028	31	10.29	4.56	9.07	16.67	30.30
11	Garulia	91.116	46	5.38	6.80	13.54	24.89	45.23
12	Gayeshpur	65.398	33	30.00	4.88	9.72	17.86	32.46
13	Gobardanga	57.878	29	13.50	4.32	8.60	15.81	28.73
14	J-A Ganj	51.790	26	11.66	3.87	7.70	14.15	25.72
15	Katwa	81.510	41	7.93	6.09	12.11	22.26	40.46
Total		**1000.073**	**500**	**224.73**	**74.67**	**148.62**	**273.17**	**496.46**

14. J-A Ganj – Jiyaganj-Azimganj

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Appendix II

Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I and Class II Towns of GRB

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Table A2.01: Estimated Land Footprint, Energy Consumption, and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Uttarakhand in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Equivalent Energy (Fuel) Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
1	Dehradun	870.519	52.29	435	60.9	0.7	1517.2	5537.7	340.1	366.47
2	Haldwani	169.147	10.62	85	11.8	0.7	268.1	978.7	66.1	71.21
3	Hardwar	487.923	13.00	244	34.2	0.7	780.2	2847.7	190.6	205.40
4	Kashipur	121.610	5.46	61	8.5	0.7	188.3	687.4	47.5	51.20
5	Nainital	110.726	11.06	55	7.8	0.7	175.8	641.8	43.3	46.61
6	Rishikesh	102.138	10.00	51	7.1	0.7	161.5	589.6	39.9	43.00
7	Roorkee	118.188	20.20	59	8.3	0.7	193.2	705.0	46.2	49.75
8	Rudrapur	140.884	12.43	70	9.9	0.7	224.8	820.6	55.0	59.31
Total		**2121.135**	**135.06**	**1061**	**148.5**	**5.6**	**3509.2**	**12808.6**	**828.8**	**892.95**

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Table A2.02: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Uttarakhand in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	BHEL Ranipur	51.910	26.94	26	3.6	0.7	86.3	314.9	20.3	21.85
02	Manglaur	51.101	1.32	26	3.6	0.7	76.7	280.1	20.0	21.51
03	Pithoragarh	53.957	9.00	27	3.8	0.7	85.0	310.2	21.1	22.71
04	Ramnagar	55.446	2.42	28	3.9	0.7	84.2	307.2	21.7	23.34
Total		**212.414**	**39.68**	**106**	**14.9**	**2.8**	**332.1**	**1212.3**	**83.0**	**89.41**

Table A2.03: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Uttar Pradesh in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Agra	1746.467	141.00	873	122.3	0.7	3365.5	12284.2	682.4	735.22
02	Aligarh	909.559	36.70	455	63.7	0.7	1542.9	5631.6	355.4	382.90
03	Allahabad	1216.719	63.07	608	85.2	0.7	2154.9	7865.2	475.4	512.21
04	Amroha	197.135	12.00	99	13.8	0.7	314.1	1146.5	77.0	82.99

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
05	Azamgarh	116.165	12.60	58	8.1	0.7	185.5	677.1	45.4	48.90
06	Badaun	159.221	4.39	80	11.1	0.7	245.1	894.5	62.2	67.03
07	Ballia	111.287	16.00	56	7.8	0.7	179.7	655.9	43.5	46.85
08	Banda	154.388	11.05	77	10.8	0.7	245.1	894.8	60.3	64.99
09	Barabanki	154.692	3.87	77	10.8	0.7	237.3	866.2	60.4	65.12
10	Baraut	101.241	25.00	51	7.1	0.7	167.5	611.3	39.6	42.62
11	Bareilly	979.933	106.43	490	68.6	0.7	1827.8	6671.5	382.9	412.53
12	Basti	114.651	19.43	57	8.0	0.7	187.0	682.5	44.8	48.27
13	Bijnour	115.381	3.65	58	8.1	0.7	176.7	645.1	45.1	48.57
14	Bulandsahar	222.826	32.50	111	15.6	0.7	374.8	1368.1	87.1	93.80
15	Chandausi	114.254	8.80	57	8.0	0.7	179.8	656.3	44.6	48.10
16	Deoria	129.570	16.19	65	9.1	0.7	209.3	764.1	50.6	54.55
17	Etah	131.023	13.49	66	9.2	0.7	209.9	766.0	51.2	55.16
18	Etawah	256.790	48.00	128	18.0	0.7	444.5	1622.3	100.3	108.10
19	Faizabad	259.160	16.60	130	18.1	0.7	419.2	1530.2	101.3	109.10
20	Farrukhabad	318.540	16.80	159	22.3	0.7	515.6	1881.9	124.5	134.10
21	Fatehpur	193.801	56.98	97	13.6	0.7	340.2	1241.8	75.7	81.59
22	Firozabad	603.797	21.35	302	42.3	0.7	989.8	3612.8	235.9	254.19
23	Gazipur	121.136	13.45	61	8.5	0.7	194.0	708.1	47.3	51.00
24	Ghaziabad	2358.525	215.00	1179	165.1	0.7	4805.9	17541.5	921.6	992.89
25	Gonda	138.929	24.62	69	9.7	0.7	229.6	838.1	54.3	58.49
26	Gorakhpur	692.519	147.00	346	48.5	0.7	1341.4	4896.1	270.6	291.54
27	Greater Noida	642.381	27.93	321	45.0	0.7	1070.0	3905.4	251.0	270.43

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
28	Hapur	262.801	42.00	131	18.4	0.7	450.2	1643.2	102.7	110.63
29	Hardoi	197.046	11.05	99	13.8	0.7	312.9	1142.0	77.0	82.95
30	Hathras	161.289	8.40	81	11.3	0.7	253.4	924.8	63.0	67.90
31	Jaunpur	168.128	20.00	84	11.8	0.7	274.6	1002.4	65.7	70.78
32	Jhansi	549.391	169.50	275	38.5	0.7	1083.7	3955.3	214.7	231.28
33	Kanpur	2920.067	261.50	1460	204.4	0.7	6124.8	22355.6	1141.0	1229.28
34	Kasganj	101.241	7.10	51	7.1	0.7	158.1	577.1	39.6	42.62
35	Lakhimpur	164.925	10.20	82	11.5	0.7	261.0	952.7	64.4	69.43
36	Lalitpur	133.041	18.00	67	9.3	0.7	216.1	788.8	52.0	56.01
37	Loni	512.296	34.48	256	35.9	0.7	865.2	3158.1	200.2	215.67
38	Lucknow	2901.474	330.00	1451	203.1	0.7	6315.4	23051.4	1133.7	1221.46
39	Mainpuri	133.078	7.50	67	9.3	0.7	208.2	760.0	52.0	56.02
40	Mathura	454.937	32.80	227	31.8	0.7	765.7	2795.0	177.8	191.52
41	Mau	279.060	39.00	140	19.5	0.7	475.4	1735.4	109.0	117.48
42	Meerut	1424.908	41.94	712	99.7	0.7	2440.7	8908.7	556.8	599.86
43	Mirzapur	233.691	40.00	117	16.4	0.7	398.9	1455.9	91.3	98.38
44	Modinagar	182.811	14.00	91	12.8	0.7	293.3	1070.6	71.4	76.96
45	Moradabad	889.810	80.00	445	62.3	0.7	1611.3	5881.2	347.7	374.59
46	Mugalsarai	154.692	14.43	77	10.8	0.7	248.5	907.2	60.4	65.12
47	Muradanagar	100.080	12.00	50	7.0	0.7	159.5	582.1	39.1	42.13
48	Muzaffar Nagar	316.729	12.04	158	22.2	0.7	504.8	1842.4	123.8	133.34
49	Noida	642.381	203.16	321	45.0	0.7	1298.5	4739.6	251.0	270.43
50	Orai	190.625	16.00	95	13.3	0.7	307.8	1123.5	74.5	80.25
51	Pililbhit	160.146	9.50	80	11.2	0.7	252.8	922.6	62.6	67.42

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
52	Raibareliy	191.625	34.00	96	13.4	0.7	323.3	1180.2	74.9	80.67
53	Rampur	359.062	20.20	180	25.1	0.7	586.8	2141.9	140.3	151.16
54	Saharanpur	703.345	73.72	352	49.2	0.7	1263.6	4612.3	274.8	296.09
55	Sahaswann	178.000	7.50	89	12.5	0.7	278.5	1016.5	69.6	74.93
56	Sahjahanpur	356.103	11.37	178	24.9	0.7	566.1	2066.3	139.1	149.91
57	Shambhal	221.334	15.65	111	15.5	0.7	357.0	1303.0	86.5	93.18
58	Sitapur	188.230	35.00	94	13.2	0.7	318.2	1161.6	73.5	79.24
59	Sultanpur	116.211	16.00	58	8.1	0.7	187.6	684.9	45.4	48.92
60	Ujhani	191.000	6.50	96	13.4	0.7	297.4	1085.6	74.6	80.41
61	Unnao	178.681	21.50	89	12.5	0.7	293.0	1069.5	69.8	75.22
62	Varansi	1435.113	79.79	718	100.5	0.7	2598.1	9482.9	560.7	604.15
Total		**29613.440**	**2869.73**	**14807**	**2072.9**	**43.4**	**54503.8**	**198939.0**	**11570.9**	**12466.63**

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Table A2.04: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Uttar Pradesh in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Auraiya	70.515	4.00	35	4.9	0.7	108.3	395.2	27.6	29.69
02	Baghpat	50.380	2.83	25	3.5	0.7	76.7	280.0	19.7	21.21
03	Baheri	74.869	15.00	37	5.2	0.7	120.5	439.9	29.3	31.52
04	Balrampur	90.000	36.28	45	6.3	0.7	152.5	556.8	35.2	37.89
05	Bhadohi	94.563	8.00	47	6.6	0.7	148.3	541.3	36.9	39.81
06	Bisalpur	83.347	4.58	42	5.8	0.7	128.4	468.8	32.6	35.09
07	Chandpur	83.456	23.40	42	5.8	0.7	137.5	502.0	32.6	35.13
08	Chibramau	55.296	11.10	28	3.9	0.7	87.8	320.5	21.6	23.28
09	Chitrakoot	57.452	7.77	29	4.0	0.7	90.0	328.5	22.4	24.19
10	Dadri	91.345	6.50	46	6.4	0.7	142.2	519.2	35.7	38.45
11	Deoband	97.068	7.90	49	6.8	0.7	152.2	555.4	37.9	40.86
12	Faredpur	76.422	9.43	38	5.3	0.7	120.6	440.1	29.9	32.17
13	Gangaghat	84.301	4.91	42	5.9	0.7	130.2	475.1	32.9	35.49
14	Gangoh	59.463	6.00	30	4.2	0.7	92.4	337.1	23.2	25.03
15	Gola	53.842	10.08	27	3.8	0.7	85.2	310.9	21.0	22.67
16	Hasanpur	64.536	5.72	32	4.5	0.7	100.1	365.3	25.2	27.17
17	Jahangerabad	59.873	14.30	30	4.2	0.7	96.2	351.0	23.4	25.21
18	Jalaun	56.871	5.00	28	4.0	0.7	87.8	320.6	22.2	23.94
19	Kaimur	51.469	7.12	26	3.6	0.7	80.4	293.4	20.1	21.67
20	Kairana	95.092	7.11	48	6.7	0.7	148.5	542.1	37.2	40.03
21	Kannauj	71.727	70.70	36	5.0	0.7	128.4	468.5	28.0	30.20

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
22	Khatauli	72.478	3.76	36	5.1	0.7	111.1	405.5	28.3	30.51
23	Kiratpur	61.801	4.45	31	4.3	0.7	95.2	347.3	24.1	26.02
24	Konch	53.426	2.95	27	3.7	0.7	81.4	297.2	20.9	22.49
25	Laharpur	61.280	8.00	31	4.3	0.7	96.1	350.8	23.9	25.80
26	Mahoba	95.454	12.15	48	6.7	0.7	152.2	555.5	37.3	40.18
27	Mau Ranipur	58.456	5.53	29	4.1	0.7	90.6	330.6	22.8	24.61
28	Mawana	81.126	7.50	41	5.7	0.7	126.9	463.3	31.7	34.15
29	Mubarakpur	71.365	9.00	36	5.0	0.7	112.4	410.3	27.9	30.04
30	Nagina	71.350	10.30	36	5.0	0.7	113.0	412.3	27.9	30.04
31	Nazibabad	88.638	5.06	44	6.2	0.7	137.0	499.9	34.6	37.31
32	Obra	56.116	4.50	28	3.9	0.7	86.4	315.5	21.9	23.62
33	Pilkhuwa	81.651	5.80	41	5.7	0.7	126.7	462.4	31.9	34.37
34	Pratapgarh	76.750	12.00	38	5.4	0.7	122.3	446.4	30.0	32.31
35	Ramnagar	54.800	3.60	27	3.8	0.7	83.9	306.3	21.4	23.07
36	Rath	65.092	6.10	33	4.6	0.7	101.2	369.2	25.4	27.40
37	S R Nagar	94.563	8.00	47	6.6	0.7	148.3	541.3	36.9	39.81
38	Shahbad	80.305	9.70	40	5.6	0.7	126.8	463.0	31.4	33.81
39	Sherkot	62.148	6.00	31	4.4	0.7	96.5	352.3	24.3	26.16
40	Sikandrabad	80.309	1.14	40	5.6	0.7	120.3	439.2	31.4	33.81
41	Tanda	96.138	10.45	48	6.7	0.7	152.3	555.9	37.6	40.47
42	Tilhar	60.803	3.48	30	4.3	0.7	93.0	339.6	23.8	25.60
43	Vrindavann	62.926	13.49	31	4.4	0.7	100.8	367.9	24.6	26.49
Total		**3108.862**	**420.69**	**1554**	**217.6**	**30.1**	**4888.5**	**17843.0**	**1214.7**	**1308.77**

37. S R Nagar – Sant Ravidas Nagar

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Table A2.05: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Himanchal Pradesh in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
No Class I town										

Table A2.06: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Himanchal Pradesh in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
No Class II town										

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Table A2.07: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Haryana in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Bahadur Garh	170.426	50.00	85	11.9	0.7	295.9	1080.2	66.6	71.75
02	Bhiwani	197.662	47.78	99	13.8	0.7	342.0	1248.2	77.2	83.21
03	Faridabad	1404.653	207.80	702	98.3	0.7	2848.4	10396.7	548.8	591.33
04	Gurgoan	901.968	37.10	451	63.1	0.7	1531.2	5588.9	352.4	379.71
05	Hisar	301.249	48.03	151	21.1	0.7	521.4	1903.3	117.7	126.82
06	Jagadhari	124.915	24.80	62	8.7	0.7	206.6	753.9	48.8	52.59
07	Jind	166.225	42.00	83	11.6	0.7	284.8	1039.4	64.9	69.98
08	Kaithal	144.633	45.75	72	10.1	0.7	249.4	910.3	56.5	60.89
09	Karnal	286.974	12.00	143	20.1	0.7	457.3	1669.0	112.1	120.81
10	Kurukshetra	154.962	34.50	77	10.8	0.7	261.7	955.3	60.5	65.24
11	Narnaul	134.067	41.10	67	9.4	0.7	229.3	836.9	52.4	56.44
12	Palwal	127.931	8.78	64	9.0	0.7	201.3	734.8	50.0	53.86
13	Panipat	294.15	41.40	147	20.6	0.7	503.4	1837.3	114.9	123.83
14	Rohtak	373.133	47.50	187	26.1	0.7	645.3	2355.3	145.8	157.08
15	Sonipat	292.339	52.80	146	20.5	0.7	509.9	1861.2	114.2	123.07
16	Yamuna Nagar	241.723	34.50	121	16.9	0.7	408.3	1490.2	94.4	101.76
Total		**5317.010**	**775.84**	**2659**	**372.2**	**11.2**	**9496.2**	**34661.0**	**2077.5**	**2238.37**

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Table A2.08: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Haryana in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Hodal	50.003	5.39	25	3.5	0.7	77.4	282.5	19.5	21.05
02	Narvana	61.800	10.00	31	4.3	0.7	97.7	356.7	24.1	26.02
03	Sahadab	51.786	5.00	26	3.6	0.7	80.0	292.0	20.2	21.80
Total		**163.589**	**20.39**	**82**	**11.5**	**2.1**	**255.1**	**931.2**	**63.9**	**68.87**

Table A2.09: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Delhi in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	B J	197.150	6.70	99	13.8	0.7	307.3	1121.6	77.0	83.00
02	Burari	145.584	11.19	73	10.2	0.7	231.3	844.2	56.9	61.29
03	Dallo Pura	154.955	2.29	77	10.8	0.7	234.9	857.4	60.5	65.23
04	Delhi Cantt.	116.352	42.97	58	8.1	0.7	199.7	728.8	45.5	48.98
05	DMC	11007.835	431.09	5504	770.5	0.7	25094.0	91593.0	4301.1	4634.06

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
06	Deoli	169.410	10.12	85	11.9	0.7	268.0	978.3	66.2	71.32
07	Gokalpur	121.938	2.32	61	8.5	0.7	184.9	674.9	47.6	51.33
08	Hastal	177.033	6.75	89	12.4	0.7	276.0	1007.4	69.2	74.53
09	Karawal Nagar	224.666	4.75	112	15.7	0.7	346.5	1264.9	87.8	94.58
10	K S N	282.598	4.74	141	19.8	0.7	435.9	1590.9	110.4	118.97
11	Mandoli	120.345	41.77	60	8.4	0.7	206.1	752.2	47.0	50.66
12	Mustafabad	127.012	1.29	64	8.9	0.7	190.7	695.9	49.6	53.47
13	Nangloi Jat	205.497	6.67	103	14.4	0.7	320.3	1168.9	80.3	86.51
14	NDMC	249.998	42.74	125	17.5	0.7	428.8	1565.2	97.7	105.24
15	Sultanpur Majra	181.624	2.86	91	12.7	0.7	276.6	1009.7	71.0	76.46
Total		**13482.000**	**618.25**	**6741**	**943.7**	**10.5**	**29001.0**	**105853.5**	**5267.9**	**5675.63**

01. B J- Bhalswa Jahangirpur
05. DMC (U) – Delhi Municipal Corporation
10. K S N – Kirari Suleman Nagar
14. NDMC – New Delhi Municipal Corporation

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Table A2.10: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Delhi in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Babarpur	52.918	0.79	26	3.7	0.7	78.9	288.0	20.7	22.28
02	C S B	81.374	2.58	41	5.7	0.7	123.7	451.4	31.8	34.26
03	Gharoli	84.722	3.56	42	5.9	0.7	129.7	473.4	33.1	35.67
04	Jaffrabad	70.089	0.90	35	4.9	0.7	104.7	382.1	27.4	29.51
05	Khajoori Khas	55.006	0.94	28	3.9	0.7	82.2	300.0	21.5	23.16
06	Mithe Pur	49.583	1.81	25	3.5	0.7	74.8	273.2	19.4	20.87
07	Molar Band	49.439	4.12	25	3.5	0.7	76.0	277.3	19.3	20.81
08	Mundka	53.525	11.89	27	3.7	0.7	85.3	311.2	20.9	22.53
09	Pooth Kalan	61.727	6.97	31	4.3	0.7	96.3	351.6	24.1	25.99
10	Pulpehlad	64.484	2.16	32	4.5	0.7	97.6	356.4	25.2	27.15
11	S P G	52.730	1.05	26	3.7	0.7	78.9	288.0	20.6	22.20
12	Taj Pul	72.764	1.22	36	5.1	0.7	109.1	398.3	28.4	30.63
13	Tigri	54.774	1.05	27	3.8	0.7	82.0	299.2	21.4	23.06
14	Ziauddin Pur	58.661	1.80	29	4.1	0.7	88.5	323.1	22.9	24.70
Total		**861.796**	**40.84**	**431**	**60.3**	**9.8**	**1307.8**	**4773.4**	**336.7**	**362.82**

02. C S B – Chilla Saroda Bangar
11. S P G – Sadat Pur Gurjan

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Table A2.11: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Rajasthan in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Ajmer	542.580	87.00	271	38.0	0.7	990.8	3616.3	212.0	228.41
02	Alwar	315.310	49.00	158	22.1	0.7	546.6	1995.3	123.2	132.74
03	Bahilwara	360.009	69.00	180	25.2	0.7	642.8	2346.2	140.7	151.56
04	Baran	118.157	72.36	59	8.3	0.7	211.9	773.5	46.2	49.74
05	Bharatpur	252.109	29.00	126	17.6	0.7	420.9	1536.4	98.5	106.13
06	Bundi	102.823	22.76	51	7.2	0.7	169.2	617.5	40.2	43.29
07	Chittaugarh	116.409	30.50	58	8.1	0.7	195.0	711.7	45.5	49.01
08	Dhaulpur	126.142	32.00	63	8.8	0.7	212.0	773.7	49.3	53.10
09	Gangapurcity	224.773	17.22	112	15.7	0.7	364.3	1329.6	87.8	94.62
10	Hindauncity	105.690	48.00	53	7.4	0.7	182.9	667.7	41.3	44.49
11	Jaipur	3073.350	485.00	1537	215.1	0.7	7159.8	26133.2	1200.9	1293.81
12	Jhunjhunun	118.966	50.00	59	8.3	0.7	206.6	754.0	46.5	50.08
13	Kishangarh	155.019	100.00	78	10.9	0.7	287.2	1048.3	60.6	65.26
14	Kota	1001.365	527.03	501	70.1	0.7	2369.9	8650.2	391.3	421.55
15	Nagaur	100.618	37.81	50	7.0	0.7	171.0	624.3	39.3	42.36
16	Sikar	237.579	39.90	119	16.6	0.7	405.4	1479.9	92.8	100.02
17	Swaimadhavpur	120.998	49.00	60	8.5	0.7	209.8	765.7	47.3	50.94
18	Tonk	165.363	16.00	83	11.6	0.7	267.0	974.6	64.6	69.61
19	Udaipur	451.735	56.91	226	31.6	0.7	792.9	2894.1	176.5	190.17
Total		**7688.995**	**1818.49**	**3844**	**538.2**	**13.3**	**15806.1**	**57692.1**	**3004.3**	**3236.89**

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Table A2.12: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Rajasthan in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Jhalawara	66.500	12.95	33	4.7	0.7	106.3	388.1	26.0	28.00
02	Makrana	94.447	36.00	47	6.6	0.7	160.0	584.0	36.9	39.76
03	Nawalgarh	64.903	27.91	32	4.5	0.7	108.1	394.6	25.4	27.32
04	Nimbahera	61.000	12.74	31	4.3	0.7	97.5	355.7	23.8	25.68
Total		**286.850**	**89.60**	**143**	**20.1**	**2.8**	**471.9**	**1722.3**	**112.1**	**120.76**

Table A2.13: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Madhya Pradesh in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Bhind	197.332	17.79	99	13.8	0.7	320.3	1169.2	77.1	83.07
02	Bopal	1883.381	285.00	942	131.8	0.7	4003.5	14612.8	735.9	792.86

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
03	Chatarpur	147.688	54.00	74	10.3	0.7	258.1	942.0	57.7	62.17
04	Damoh	147.515	16.00	74	10.3	0.7	238.2	869.4	57.6	62.10
05	Datia	100.466	6.85	50	7.0	0.7	156.7	572.0	39.3	42.29
06	Dewas	289.438	102.00	145	20.3	0.7	537.4	1961.4	113.1	121.85
07	Guna	180.978	45.75	90	12.7	0.7	312.1	1139.0	70.7	76.19
08	Gwalior	1101.981	173.88	551	77.1	0.7	2180.9	7960.4	430.6	463.91
09	Indore	2167.447	131.17	1084	151.7	0.7	4140.5	15113.0	846.9	912.45
10	Jabalpur	1267.564	135.00	634	88.7	0.7	2429.8	8868.8	495.3	533.62
11	Katni	221.875	68.60	111	15.5	0.7	395.9	1445.2	86.7	93.40
12	Mandsour	141.468	36.00	71	9.9	0.7	239.6	874.7	55.3	59.55
13	Morena	200.506	12.00	100	14.0	0.7	319.5	1166.1	78.3	84.41
14	Neemuch	128.575	22.00	64	9.0	0.7	211.1	770.6	50.2	54.13
15	Pithampur	126.099	89.90	63	8.8	0.7	231.0	843.3	49.3	53.08
16	Ratlam	273.892	39.19	137	19.2	0.7	466.8	1703.8	107.0	115.30
17	Rewa	235.422	102.00	118	16.5	0.7	437.1	1595.4	92.0	99.11
18	Sagar	370.296	33.75	185	25.9	0.7	624.5	2279.4	144.7	155.89
19	Satna	283.004	12.00	142	19.8	0.7	450.9	1645.9	110.6	119.14
20	Sehore	1090.025	13.10	545	76.3	0.7	1743.6	6364.1	425.9	458.88
21	Shahdol	100.565	28.24	50	7.0	0.7	167.6	611.8	39.3	42.34
22	Shepour	105.026	5.00	53	7.4	0.7	162.2	592.2	41.0	44.21
23	Shivpuri	179.972	86.55	90	12.6	0.7	328.5	1198.9	70.3	75.76
24	Singrauli	220.295	280.66	110	15.4	0.7	467.2	1705.1	86.1	92.74

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
25	Tikamgarh	101.786	6.22	51	7.1	0.7	158.3	577.7	39.8	42.85
26	Ujjain	515.215	92.68	258	36.1	0.7	946.9	3456.2	201.3	216.89
27	Vidisha	155.959	8.83	78	10.9	0.7	245.5	895.9	60.9	65.66
	Total	**11933.770**	**1904.16**	**5967**	**835.4**	**18.9**	**22173.8**	**80934.5**	**4662.9**	**5023.85**

Table A2.14: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Madhya Pradesh in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Basoda	78.265	5.90	39	5.5	0.7	121.5	443.5	30.6	32.95
02	Bina	64.579	12.00	32	4.5	0.7	102.9	375.6	25.2	27.19
03	Dabra	61.260	12.00	31	4.3	0.7	97.6	356.3	23.9	25.79
04	Dhar	95.000	30.00	48	6.7	0.7	159.0	580.2	37.1	39.99
05	Jaora	65.111	5.54	33	4.6	0.7	100.9	368.2	25.4	27.41

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
06	Mandla	55.145	8.87	28	3.9	0.7	86.8	316.8	21.5	23.21
07	Narshimpur	59.858	14.71	30	4.2	0.7	96.3	351.4	23.4	25.20
08	Panna	50.432	4.50	25	3.5	0.7	77.7	283.5	19.7	21.23
09	Shajapur	70.000	11.16	35	4.9	0.7	111.2	405.9	27.4	29.47
10	Sidhi	54.317	12.31	27	3.8	0.7	86.6	316.3	21.2	22.87
Total		**653.967**	**116.99**	**327**	**45.8**	**7.0**	**1040.4**	**3797.6**	**255.5**	**275.31**

Table A2.15: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Bihar in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Arrah	261.099	30.97	131	18.3	0.7	437.8	1598.0	102.0	109.92
02	Aurangabad	101.520	8.00	51	7.1	0.7	159.2	581.1	39.7	42.74
03	Bagaha	113.012	11.00	57	7.9	0.7	179.4	654.9	44.2	47.58

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
04	Begusarai	251.136	8.98	126	17.6	0.7	395.5	1443.6	98.1	105.72
05	Bettiah	132.896	11.55	66	9.3	0.7	211.4	771.7	51.9	55.95
06	B M C	398.138	30.17	199	27.9	0.7	666.4	2432.5	155.6	167.61
07	B M C	296.889	22.46	148	20.8	0.7	488.1	1781.5	116.0	124.98
08	Buxar	102.591	8.00	51	7.2	0.7	160.9	587.2	40.1	43.19
09	Chapra (NP)	201.597	16.96	101	14.1	0.7	326.5	1191.6	78.8	84.87
10	Darbhanga	294.116	19.18	147	20.6	0.7	479.3	1749.6	114.9	123.82
11	Dehri	137.068	21.32	69	9.6	0.7	224.7	820.1	53.6	57.70
12	D N	182.241	11.63	91	12.8	0.7	290.0	1058.5	71.2	76.72
13	Gaya	463.454	50.17	232	32.4	0.7	805.0	2938.3	181.1	195.10
14	Hajipur	147.126	19.64	74	10.3	0.7	240.1	876.3	57.5	61.94
15	Jamalpur	105.221	10.65	53	7.4	0.7	166.8	608.9	41.1	44.30
16	Jehanabad	102.456	20.23	51	7.2	0.7	167.5	611.2	40.0	43.13
17	Katihar	225.982	24.54	113	15.8	0.7	373.4	1363.1	88.3	95.13
18	Kishanganj	107.076	30.12	54	7.5	0.7	179.2	654.1	41.8	45.08
19	M T	105.000	8.50	53	7.4	0.7	165.0	602.3	41.0	44.20
20	Motihari	125.183	13.52	63	8.8	0.7	200.5	731.9	48.9	52.70
21	Munger	213.101	17.50	107	14.9	0.7	345.6	1261.6	83.3	89.71
22	Muzaffarpur	351.838	26.43	176	24.6	0.7	584.0	2131.7	137.5	148.12
23	Nawada	109.141	5.68	55	7.6	0.7	169.2	617.7	42.6	45.95
24	Patna	1683.200	108.34	842	117.8	0.7	3145.7	11482.0	657.7	708.59

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
25	Purnia	280.547	44.52	140	19.6	0.7	482.7	1762.0	109.6	118.10
26	Saharsa	155.175	21.13	78	10.9	0.7	254.2	927.9	60.6	65.33
27	Sasaram	147.396	12.00	74	10.3	0.7	234.9	857.3	57.6	62.05
28	Siwan	134.458	15.68	67	9.4	0.7	216.9	791.7	52.5	56.60
Total		**6928.657**	**628.87**	**3464**	**485.0**	**19.6**	**11750.2**	**42888.1**	**2707.3**	**2916.83**

06. B M C – Bhagalpur Municipal Corporation
07. B M C – Biharsharif Municipal Corporation
12. DN – Dinapur Nizamat
19. MT – Madhubani Town

Table A2.16: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Bihar in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Araria	80.000	4.50	40	5.6	0.7	123.2	449.7	31.3	33.68
02	Barahiya	50.230	26.54	25	3.5	0.7	83.4	304.4	19.6	21.15

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
03	Barh	61.037	4.50	31	4.3	0.7	94.0	343.1	23.8	25.70
04	Bhabua	52.611	7.12	26	3.7	0.7	82.2	299.9	20.6	22.15
05	D M	67.995	11.30	34	4.8	0.7	108.1	394.4	26.6	28.62
06	Dumraon	57.716	15.33	29	4.0	0.7	93.0	339.4	22.6	24.30
07	Forbesganj	52.289	4.98	26	3.7	0.7	80.8	294.8	20.4	22.01
08	Gopalganj	66.624	11.11	33	4.7	0.7	105.8	386.2	26.0	28.05
09	Kaimur	51.469	7.12	26	3.6	0.7	80.4	293.4	20.1	21.67
10	Khagaria	56.978	2.97	28	4.0	0.7	86.9	317.0	22.3	23.99
11	Khagaul	60.866	5.32	30	4.3	0.7	94.2	343.8	23.8	25.62
12	Lakhisarai	98.123	24.79	49	6.9	0.7	162.2	592.2	38.3	41.31
13	Madhepura	56.739	25.84	28	4.0	0.7	94.1	343.3	22.2	23.89
14	Masaurhi	57.012	9.43	29	4.0	0.7	90.0	328.3	22.3	24.00
15	Mokameh	71.335	14.18	36	5.0	0.7	114.5	418.0	27.9	30.03
16	Narkatiaganj	51.446	10.96	26	3.6	0.7	81.7	298.1	20.1	21.66
17	Phulwari Sharif	67.348	6.48	34	4.7	0.7	104.9	382.7	26.3	28.35
18	Raxaul Bazar	52.429	5.82	26	3.7	0.7	81.4	296.9	20.5	22.07
19	Samastipur	70.042	3.45	35	4.9	0.7	107.1	391.1	27.4	29.49
20	Shekhpura	54.322	15.58	27	3.8	0.7	87.6	319.7	21.2	22.87
21	Sitamarhi	87.279	8.00	44	6.1	0.7	136.9	499.6	34.1	36.74
22	Sultanganj	52.867	12.29	26	3.7	0.7	84.3	307.8	20.7	22.26
23	Supaul	85.200	22.37	43	6.0	0.7	140.0	511.1	33.3	35.87
Total		**1461.957**	**259.98**	**731**	**102.3**	**16.1**	**2316.5**	**8455.2**	**571.2**	**615.48**

05. D M – Digha-Mainpura

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Table A2.17: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Chhatisgarh in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Ambikapur	114.575	9.39	57	8.0	0.7	180.7	659.7	44.8	48.23
02	Bhilai Nagar	625.697	141.30	313	43.8	0.7	1206.1	4402.1	244.5	263.40
03	Bilaspur	330.106	37.56	165	23.1	0.7	560.9	2047.2	129.0	138.97
04	Durg	268.679	66.09	134	18.8	0.7	477.8	1744.1	105.0	113.11
05	Jagdalpur	125.345	22.49	63	8.8	0.7	206.1	752.2	49.0	52.77
06	Korba	363.210	215.02	182	25.4	0.7	740.1	2701.4	141.9	152.90
07	Raigarh	137.097	20.68	69	9.6	0.7	224.3	818.9	53.6	57.71
08	Raipur	1010.087	108.66	505	70.7	0.7	1888.4	6892.6	394.7	425.22
09	Rajnandgaon	163.122	78.09	82	11.4	0.7	294.7	1075.6	63.7	68.67
Total		**3137.918**	**699.28**	**1569**	**219.7**	**6.3**	**5779.1**	**21093.9**	**1226.1**	**1320.98**

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Table A2.18 Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Chhatisgarh in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Bhatapara	54.846	30.42	27	3.8	0.7	91.9	335.3	21.4	23.09
02	Bhilai Charoda	95.848	141.30	48	6.7	0.7	184.8	674.3	37.5	40.35
03	Chirmiri	99.934	64.94	50	7.0	0.7	177.5	647.7	39.0	42.07
04	Dalli-Rajhara	55.684	37.25	28	3.9	0.7	94.6	345.1	21.8	23.44
05	Dhamtari	89.857	23.40	45	6.3	0.7	148.1	540.5	35.1	37.83
06	Mahasamund	51.543	14.68	26	3.6	0.7	82.9	302.5	20.1	21.70
Total		**447.712**	**311.99**	**224**	**31.3**	**4.2**	**779.6**	**2845.4**	**174.9**	**188.48**

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Table A2.19: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of Jharkhand in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Aditya	173.988	49.82	87	12.2	0.7	302.0	1102.5	68.0	73.25
02	Bhuli	110.127	11.74	55	7.7	0.7	175.3	639.9	43.0	46.36
03	Bokaro	413.934	162.91	207	29.0	0.7	812.3	2964.8	161.7	174.26
04	Chas	141.618	20.49	71	9.9	0.7	231.6	845.4	55.3	59.62
05	Deoghar	203.116	14.00	102	14.2	0.7	325.9	1189.5	79.4	85.51
06	Dhanbad	1161.561	23.39	581	81.3	0.7	1914.1	6986.4	453.9	488.99
07	Giridih	114.447	9.75	57	8.0	0.7	180.8	660.0	44.7	48.18
08	Hazaribag	142.494	26.37	71	10.0	0.7	236.5	863.2	55.7	59.99
09	JNAC	629.659	59.80	315	44.1	0.7	1109.9	4051.3	246.0	265.07
10	Jharia	100.839	4.42	50	7.1	0.7	155.2	566.6	39.4	42.45
11	Jorapokhar	104.673	16.40	52	7.3	0.7	169.2	617.7	40.9	44.07
12	MNAC	224.002	19.45	112	15.7	0.7	365.3	1333.5	87.5	94.30
13	Phusro	102.673	40.64	51	7.2	0.7	175.5	640.4	40.1	43.22
14	Ranchi	1073.440	177.19	537	75.1	0.7	2129.8	7773.6	419.4	451.89
15	Saunda	104.642	24.26	52	7.3	0.7	172.8	630.7	40.9	44.05
Total		**4801.213**	**660.63**	**2401**	**336.1**	**10.5**	**8456.3**	**30865.4**	**1876.0**	**2021.21**

09. JNAC – Jamshedpur Notified Area Committee
12. MNAC – Mango Notified Area Committee

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Table A2.20: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of Jharkhand in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Bagbera	82.559	10.70	41	5.8	0.7	130.9	477.9	32.3	34.76
02	Bhowrah	54.483	15.73	27	3.8	0.7	87.9	320.8	21.3	22.94
03	Bhuli	99.990	8.60	50	7.0	0.7	157.2	573.9	39.1	42.10
04	Chaibasa	78.287	11.11	39	5.5	0.7	124.3	453.8	30.6	32.96
05	Chatra	51.685	3.45	26	3.6	0.7	79.1	288.6	20.2	21.76
06	Daltonganj	87.849	14.00	44	6.1	0.7	140.9	514.5	34.3	36.98
07	Dumka	55.336	6.12	28	3.9	0.7	86.0	313.9	21.6	23.30
08	Gumia	56.024	26.11	28	3.9	0.7	92.9	339.2	21.9	23.58
09	Jhumri Tilaiya	85.489	51.14	43	6.0	0.7	148.7	542.8	33.4	35.99
10	Jugsalai	56.720	3.69	28	4.0	0.7	86.9	317.2	22.2	23.88
11	Katras	63.017	5.00	32	4.4	0.7	97.3	355.3	24.6	26.53
12	Lohardaga	56.821	14.57	28	4.0	0.7	91.3	333.4	22.2	23.92
13	Madhupur	58.211	18.36	29	4.1	0.7	94.6	345.5	22.7	24.51
14	Ramgarh Cantt.	90.324	34.46	45	6.3	0.7	152.5	556.8	35.3	38.02
15	Sahibganj	98.589	8.98	49	6.9	0.7	155.3	566.7	38.5	41.50
16	Sindri	94.398	46.65	47	6.6	0.7	163.0	595.0	36.9	39.74
17	Tisra	65.894	14.02	33	4.6	0.7	105.7	385.9	25.7	27.74
Total		**1235.676**	**292.69**	**618**	**86.5**	**11.9**	**1994.8**	**7281.2**	**482.8**	**520.21**

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Table A2.21: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class I Towns (Population > 0.1 Million) of West Bengal in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Alipurduar	127.342	9.80	64	8.9	0.7	201.2	734.5	49.8	53.61
02	Asansol	564.491	127.87	282	39.5	0.7	1075.1	3924.2	220.6	237.64
03	A-K	123.906	18.44	62	8.7	0.7	201.5	735.5	48.4	52.16
04	Baidyabati	121.081	7.89	61	8.5	0.7	189.8	692.7	47.3	50.97
05	Bally	115.715	11.68	58	8.1	0.7	184.2	672.2	45.2	48.71
06	Balurghat	151.183	10.46	76	10.6	0.7	239.5	874.2	59.1	63.64
07	Bangaon	110.668	24.70	55	7.7	0.7	183.0	667.8	43.2	46.59
08	Bankura	138.036	19.06	69	9.7	0.7	224.9	820.8	53.9	58.11
09	Bansberia	103.799	9.07	52	7.3	0.7	163.5	596.9	40.6	43.70
10	Bara Nagar	248.466	7.12	124	17.4	0.7	388.1	1416.4	97.1	104.60
11	Barasat	283.443	34.50	142	19.8	0.7	478.7	1747.4	110.8	119.32
12	Bardhaman	314.638	26.30	157	22.0	0.7	522.1	1905.7	122.9	132.46
13	Barrackpore	154.475	11.65	77	10.8	0.7	245.8	897.3	60.4	65.03
14	Basirhat	127.135	22.50	64	8.9	0.7	209.0	763.0	49.7	53.52
15	Beharampore	195.363	31.43	98	13.7	0.7	327.9	1196.8	76.3	82.24
16	Bhadreswar	101.334	8.28	51	7.1	0.7	159.1	580.7	39.6	42.66
17	Bhatpara	390.467	30.42	195	27.3	0.7	654.0	2386.9	152.6	164.38
18	Bidhannagar	218.323	30.00	109	15.3	0.7	365.3	1333.4	85.3	91.91
19	Chakdaha	132.855	15.54	66	9.3	0.7	214.2	781.9	51.9	55.93

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
20	Champadani	110.983	6.47	55	7.8	0.7	172.8	630.7	43.4	46.72
21	Chandernagore	166.949	22.03	83	11.7	0.7	274.2	1000.7	65.2	70.28
22	Chinsurah	180.502	17.24	90	12.6	0.7	292.5	1067.8	70.5	75.99
23	Darjiling	120.414	10.57	60	8.4	0.7	190.9	696.6	47.0	50.69
24	Dhulian	239.022	10.27	120	16.7	0.7	378.4	1381.2	93.4	100.62
25	Durgapur	566.937	1.10	283	39.7	0.7	849.0	3099.0	221.5	238.67
26	Habra	149.675	21.80	75	10.5	0.7	245.6	896.6	58.5	63.01
27	Haldia	200.762	104.90	100	14.1	0.7	373.9	1364.7	78.4	84.52
28	Halisahar	126.893	8.28	63	8.9	0.7	199.2	727.2	49.6	53.42
29	H-C	177.209	8.29	89	12.4	0.7	278.3	1015.6	69.2	74.60
30	Jalpaiguri	107.351	12.50	54	7.5	0.7	171.4	625.5	41.9	45.19
31	Jamuria	144.791	73.23	72	10.1	0.7	260.0	948.9	56.6	60.95
32	Jangipore	122.875	7.86	61	8.6	0.7	192.6	702.9	48.0	51.73
33	Kalyani	100.62	21.91	50	7.0	0.7	165.2	602.9	39.3	42.36
34	Kamarhati	336.579	20.48	168	23.6	0.7	550.5	2009.3	131.5	141.69
35	Kanchapara	122.181	29.21	61	8.6	0.7	204.1	744.9	47.7	51.44
36	Kharagpur	206.923	90.65	103	14.5	0.7	379.4	1384.9	80.9	87.11
37	Khardaha	111.13	10.96	56	7.8	0.7	176.4	643.9	43.4	46.78
38	Kolkata	4486.689	185.00	2243	314.1	0.7	8953.5	32680.2	1753.1	1888.80
39	Konnagar	124.585	9.07	62	8.7	0.7	196.3	716.4	48.7	52.45
40	Krishnanagar	181.182	6.87	91	12.7	0.7	282.6	1031.6	70.8	76.27

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
41	Madhyamgram	198.964	21.32	99	13.9	0.7	326.1	1190.4	77.7	83.76
42	Mahestala	449.423	21.50	225	31.5	0.7	737.0	2690.1	175.6	189.20
43	Medinipur	169.127	14.78	85	11.8	0.7	272.0	993.0	66.1	71.20
44	Nabadwip	125.528	11.66	63	8.8	0.7	199.8	729.2	49.0	52.84
45	Naihati	221.762	11.55	111	15.5	0.7	352.8	1287.7	86.6	93.36
46	N B	134.825	17.17	67	9.4	0.7	218.5	797.4	52.7	56.76
47	NDD	253.625	26.45	127	17.8	0.7	421.0	1536.7	99.1	106.77
48	Panihati	383.522	6.89	192	26.8	0.7	598.3	2184.0	149.9	161.45
49	Puruliya	121.436	13.90	61	8.5	0.7	194.8	710.9	47.4	51.12
50	Raiganj	183.682	10.64	92	12.9	0.7	291.2	1062.9	71.8	77.33
51	R G	404.991	28.00	202	28.3	0.7	674.7	2462.6	158.2	170.49
52	R S	423.806	49.25	212	29.7	0.7	735.0	2682.9	165.6	178.41
53	Rana Ghat	235.583	7.72	118	16.5	0.7	369.0	1346.8	92.0	99.18
54	Raniganj	128.624	23.44	64	9.0	0.7	212.0	773.7	50.3	54.15
55	Rishra	124.591	6.48	62	8.7	0.7	194.0	708.0	48.7	52.45
56	Santipur	151.774	24.60	76	10.6	0.7	250.8	915.6	59.3	63.89
57	Serampore	183.339	14.50	92	12.8	0.7	294.6	1075.4	71.6	77.18
58	Siliguri	509.709	41.90	255	35.7	0.7	873.0	3186.5	199.2	214.58
59	S D D	410.524	17.39	205	28.7	0.7	665.6	2429.6	160.4	172.82
60	Titagarh	118.426	3.24	59	8.3	0.7	180.9	660.2	46.3	49.85

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S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
61	Uluberia	221.175	33.72	111	15.5	0.7	373.0	1361.4	86.4	93.11
62	Uttarpara K	162.386	16.34	81	11.4	0.7	262.5	958.0	63.4	68.36
Total		**17123.790**	**1557.84**	**8561.9**	**1198.7**	**43.4**	**29710.4**	**108443.0**	**6690.8**	**7208.73**

03. A K – Ashokenagar-Kalyangarh
29. H C – Hooghly- Chinsurah
46. N B – New Barrackpore
47. NDD – North Dum Dum
51. R G – Rajarhat Gopalpur
52. R S – Rahjpur Sonarpur
59. S D D – South Dum Dum
62. Uttapara K – Uttapara Kotrung

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Table A2.22: Estimated Land Footprint, Energy Consumption and Expenditure on Solid Waste Management in Class II Towns (Population between 0.05 and 0.1 Million) of West Bengal in NRGB

S No	Town	Population in Thousands	Town Area in Km^2	Estimated Waste Generation in MT/d	Estimated Land Footprint in Ha	Estimated Land Required Per Capita in m^2	Estimated Daily Fuel Demand in Liters	Estimated Annual		
								Fuel Consumption in MWH	Energy Consumption in MWH	Expenditure on Solid Waste Management in Millions of INR
01	Arambagh	67.000	34.75	34	4.7	0.7	113.2	413.3	26.2	28.21
02	Baduria	52.500	22.43	26	3.7	0.7	86.3	315.0	20.5	22.10
03	Bankra	55.229	3.59	28	3.9	0.7	84.6	308.7	21.6	23.25
04	Baruipur	53.500	9.50	27	3.7	0.7	84.4	308.2	20.9	22.52
05	Bishnupur	70.620	22.01	35	4.9	0.7	116.0	423.3	27.6	29.73
06	Bolpur	74.890	10.73	37	5.2	0.7	118.8	433.5	29.3	31.53
07	Budge Budge	76.858	9.06	38	5.4	0.7	121.1	442.0	30.0	32.36
08	Chittaranjan	52.391	19.65	26	3.7	0.7	85.5	312.1	20.5	22.06
09	Contai	88.365	14.25	44	6.2	0.7	141.9	517.9	34.5	37.20
10	Gangarampur	61.028	10.29	31	4.3	0.7	96.6	352.7	23.8	25.69
11	Garulia	91.116	5.38	46	6.4	0.7	141.0	514.8	35.6	38.36
12	Gayeshpur	65.398	30.00	33	4.6	0.7	109.4	399.4	25.6	27.53
13	Gobardanga	57.878	13.50	29	4.1	0.7	92.7	338.4	22.6	24.37
14	J-A Ganj	51.790	11.66	26	3.6	0.7	82.4	300.8	20.2	21.80
15	Katwa	81.510	7.93	41	5.7	0.7	127.8	466.4	31.8	34.31
Total		**1000.073**	**224.73**	**500**	**70.0**	**10.5**	**1601.7**	**5846.4**	**390.8**	**421.02**

14. J-A Ganj – Jiyaganj-Azimganj