



# SOLID WASTE MANAGEMENT STRATEGY AND ACTION PLAN FOR LEH TOWN



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## ACKNOWLEDGEMENTS

Sincere gratitude to Mr. A.K. Sahu (Joint Secretary, Administration of UT Ladakh), Dr. Zaida Bano (Director ULB), Mr. Moses Kunzang (Director Industries), Ladakh Autonomous Hill Development Council (LAHDC), Municipal Committee, Leh (MCL) for all their kind support and cooperation.

**Special thanks for their valuable contributions and cooperation:** Dr. Ishey Namgyal (President MCL), Mr. Stanzin Rabgais (Executive officer, MCL), Mr. Tundup Dorje (MCL) and Wards members of Municipal Committee, Leh.

**Authors:** This report is a collaborative effort by Municipal Committee Leh, Saurabh Agnihotri and Ladakh Ecological Development Group (LEDeG).

**LEDeG:** Phunsok Angmo, Thinles Dorjay, Deachen Spalzes and Anub Tsetan Paljor.

## Cooperation Partners:

Ladakh Autonomous Hill Development Council (LAHDC)

LEDeG (Ladakh Ecological Development Group) works on promoting ecological and sustainable development that harmonises with and builds upon local traditions and culture of Ladakh.

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**The contract number is CSO-LA/2017/393-560**



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# ABBREVIATIONS

<b>3RM</b>	3R Management Private Ltd.
<b>AD</b>	Anaerobic Digestion
<b>AEN</b>	Assistant Engineer
<b>AH</b>	Alkaline Hydrolysis
<b>BWG</b>	Bulk Waste Generators
<b>C&amp;D</b>	Construction and Demolition Waste
<b>CCTV</b>	Closed Circuit Television
<b>CPHEEO</b>	Central Public Health and Environmental Engineering Organisation
<b>D2D</b>	Door to Door
<b>DG</b>	Diesel Generator
<b>EO</b>	Executive Officer
<b>EPR</b>	Extended Producer Responsibility
<b>GI</b>	Galvanised Iron
<b>GIS</b>	Geographic Information System
<b>GPS</b>	Global Positioning System
<b>GVP</b>	Garbage Vulnerable Point
<b>HD</b>	High Density
<b>HDEP</b>	High-density polyethylene
<b>HDF</b>	High Density Fibrebaord
<b>ICT</b>	Information and Communication Tool
<b>IEC</b>	Information Education and Communication
<b>IVC</b>	In-Vessel Compost
<b>JEN</b>	Junior Engineer
<b>kVA</b>	Kilo Voltage
<b>kW</b>	Kilo Watt
<b>LD</b>	Low Density
<b>LDEP</b>	Low-density polyethylene
<b>LEDeG</b>	Ladakh Ecological Development Group
<b>MCL</b>	Municipal Committee Leh
<b>MIS</b>	Management Information System
<b>MoEF&amp;CC</b>	Ministry of Environment, Forest and Climate Change
<b>MoU</b>	Memorandum of Understanding
<b>MRF</b>	Material Recovery Facility
<b>MSW</b>	Municipal Solid Waste
<b>MT</b>	Metric Tonne
<b>NFC</b>	Near Field Communication
<b>NGO</b>	Non-Governmental Organization
<b>NGT</b>	National Green Tribunal
<b>PAYT</b>	Pay as you throw
<b>PE</b>	Polyethylene
<b>PET</b>	Polyethylene Terephthalate
<b>PP</b>	Poly Propylene
<b>PWD</b>	Public Works Department
<b>RCC</b>	Reinforced Cement
<b>RDF</b>	Refuse Derived Fuel
<b>RFID</b>	Radio Frequency Identification
<b>SWM</b>	Solid Waste Management
<b>SWW</b>	Slaughterhouse Waste Water
<b>TIFAC</b>	Technology Information, Forecasting and Assessment Council
<b>TPD</b>	Tonnes per Day
<b>ULB</b>	Urban Local Body
<b>UT</b>	Union Territory

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SOLID WASTE MANAGEMENT IN LEH TOWN

# 01. EXECUTIVE SUMMARY



# 1. EXECUTIVE SUMMARY

## Objective

This report addresses the key planning, monitoring and sustainability-related aspects of solid waste management practices prevalent in Leh town. These are being prepared for the Municipal Committee, Leh under the overall guiding principles of SWM rules, 2016, Amendments in 2018 and NGT guidelines. This document will serve as a contextualized handbook for Leh town and other practitioners. This will help prioritize focus areas for town planners and town officials.

## Synopsis

The report highlights the key focus areas for Leh town's municipal waste management system that includes collection, transportation and processing. The recommendations are the result of primary and secondary data. The recommendations are linked with various guidelines, successful models and best practices used in similar situations. It also links with planning tools that are widely available, which are discussed in subsequent chapters of this document.

Leh faces a peculiar situation as it has a relatively small population of permanent residents but a fairly large floating population during the peak tourist season between April and October. There are very few towns in the country that are so ecologically fragile while still generating a high quantum of seasonal waste.

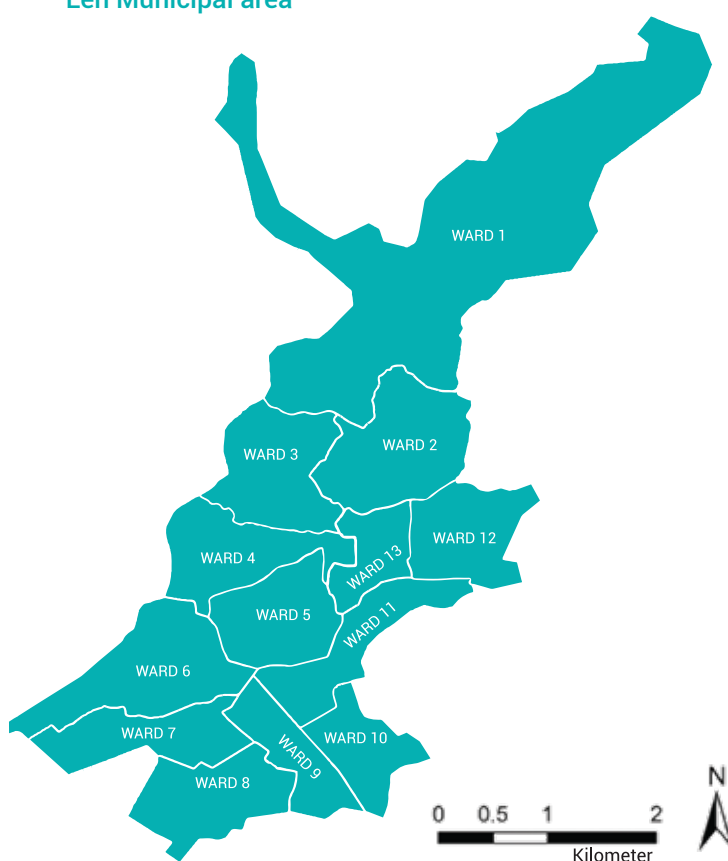
Hotels, restaurants and public places in town need to adopt more proactive solid waste systems beyond dustbins and sweeping. The frequency of cleaning and emptying of generation points along narrow road require private and public funding sources.

In this report, the collection of waste is analysed from the point of view of recycling opportunities where involvement of waste workers/rag pickers is also explored. Route maps, vehicle designs, and tracking system features are also explored in the context of distances of the new waste management facility from the town centre.

Institutional framework and present resource constraints are also analyzed with recommendations to address the possible idle time between peak and non-peak tourist season. Citizen involvement is also explored at length with an emphasis on institutionalising public participation and representation of waste generators.

Finally, waste composition is analysed to develop recommendations for best possible actions that municipalities can adopt to address low-value plastic and other packaging items. Since Leh town is not located close to any recycling hub (the nearest ones are in Srinagar and Manali) it is important to develop a strategy to address the challenges of remoteness and low quantum.

Leh Municipal area







## 2. STUDY AREA

### Location and extent

Leh town is located at 34.16°N 77.58°E at an altitude of 11,562 ft (3,524 meters) above mean sea level. It is connected by National Highway 1 to Srinagar in the southwest and to Manali in the south via the Leh-Manali Highway. Leh has been an important and historic market center that supplied goods to the Silk Route trade. It is located at a height of approximately 11,000 ft. above mean sea level. It is home a diversity of different religious communities including Buddhists, Muslims, Christians and a few Sikh and Hindu families that live in harmony with each other and with their environment.

The town area under the Municipal Committee's jurisdiction is roughly 17.2 sq km in which the highest population density is recorded in the town center while other areas are more scarcely populated. Previously, the municipal administration of Leh was known as Notified Area Committee, which was established in the 1960s by the government of Jammu & Kashmir to look after the headquarters of Leh district. It was headed by Chairperson. In 2003m the municipal administration was upgraded as Municipal Committee, Leh through SRO 423 dated 16/12/2003 with the inclusion of the Gangles, Horzey and Gonpa mohallahs. Now, the jurisdiction of Municipal Committee, Leh stretches from Gangles to Dambuchan from north to south Kartse Bagho to Teri-rong from west to east.

### Population

In the decade (2010 to 2020), the overall population of 30,850 (according to 2011 census) has grown marginally. The estimated local population for 2021 is 43440. Most of the inhabitants belong to Schedule Tribe groups and are engaged in a diversity of sectors including agriculture and tourism.

The population mix of the town and neighbouring areas have changed significantly in the last decade with the influx of tourists and migrant workers, especially tourism and allied sectors. Tourism has emerged as the dominant economic sector in Leh town. Over the last few years, Leh district has witnessed an average of 300,000 tourists and 100,000 migrant workers each year. This influx exerts a major stress on the town's resources and infrastructure.

Interestingly, the female population stands at 30% as per census data of 2011 and is continuing to decline by 15.4% annually. This suggests that a growing influx of migrants rather than a change in the demography of the settled population.

Apart from this, Leh town also houses institutions such as army, air force and Indo-Tibetan Border Police, which exerts additional pressure on the limited resources of the town. Being very close to the international border, there is

frequent collaboration between the local administration and security forces with planes being used to ferry necessary supplies to the town when the roads get blocked in the winter.

### Climate

Leh has a cold desert climate with long, cold winters from late October to early April, with minimum temperatures going as low as -25 degree Celsius. The summer months are pleasant with temperatures ranging between 15-25 degree Celsius. The city gets occasional snowfall during the winter months and low rainfall during the month of July and August with an annual rainfall of only 102 mm (4.02 inches). The city experiences high radiation due to high altitude and low humidity.



Until recently, Ladakh was a part of Jammu and Kashmir state and was declared a Union Territory in 2019. The first elections for public representations in municipalities took place where 13 ward Councillors and a Chairperson were elected to form the new Governing Body for Municipal Committee, Leh. This has resulted in increased focus on local planning and the need for solutions to old issues such as indiscriminate dumping, increasing population of stray animals such as dogs, pollution, construction and demolition waste and contamination of underground water. Indiscriminate dumping of mixed waste in Bombgarh, burning of waste littering in open spaces, and increase rate of glacial melting are some of the common issues faced by the town and its surroundings.

Since Leh is an entry gate to Ladakh region, it is more important to address its waste-related challenges to make it a model for other upcoming tourist areas such as Changthang and Nubra.

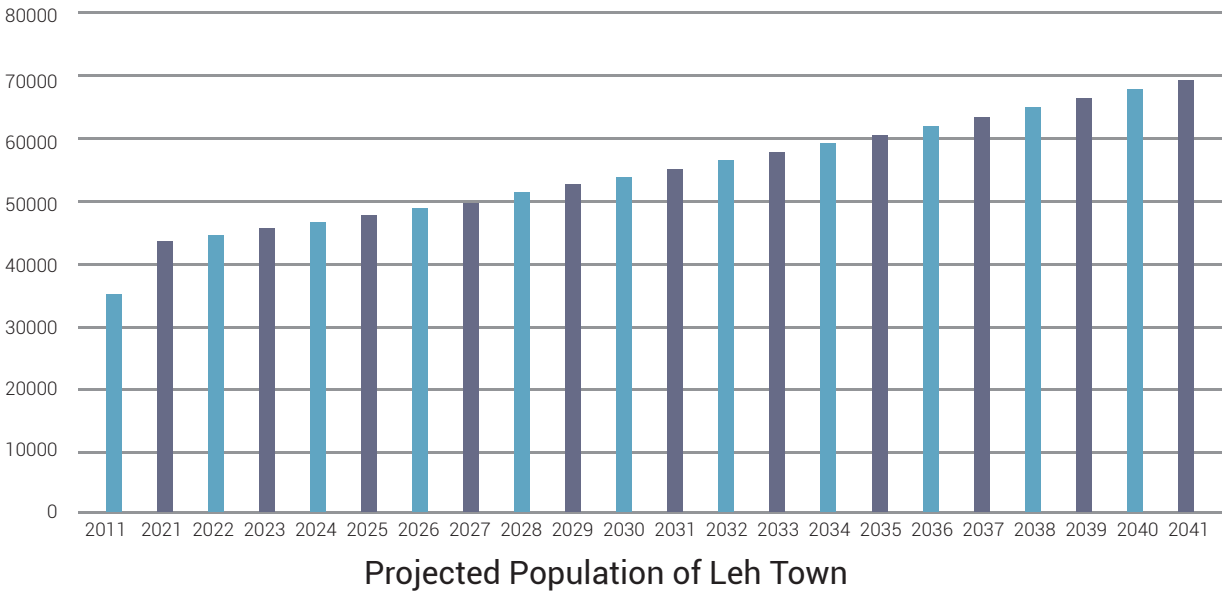
# **03. SOLID WASTE MANAGEMENT CURRENT STATUS**

# 3. SOLID WASTE GENERATION & COMPOSITION IN LEH TOWN

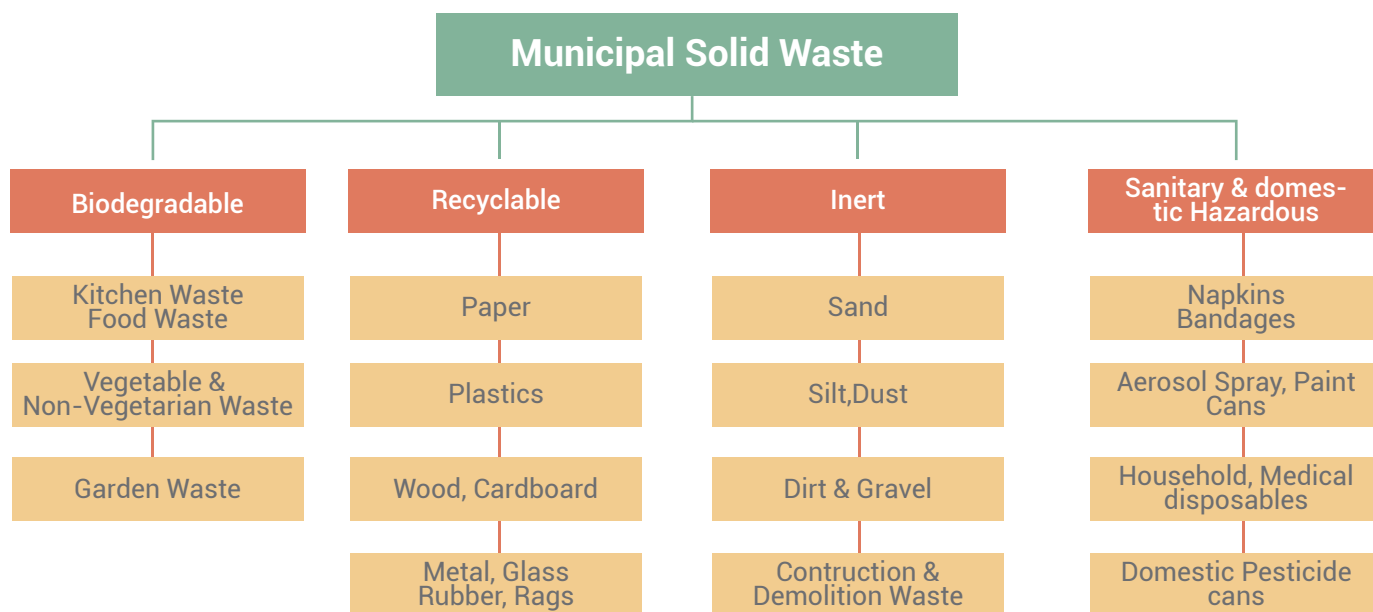
## 3.1 Solid Waste Generation

Solid waste generated is the estimated waste created by the residents, businesses and institutions of a specific region in a given period of time. It includes all waste generated that is collected by local authorities as well as the waste that is not collected and is disposed on site or in any other unauthorised place. This can include the volume of total waste generated along with its characteristics. The Municipal Solid Waste generated in Leh town is estimated to be 38.8 tonnes in the summer tourist months and 9.2 tonnes in the winter months. The average per capita waste generated in Leh town is 0.47 kg.

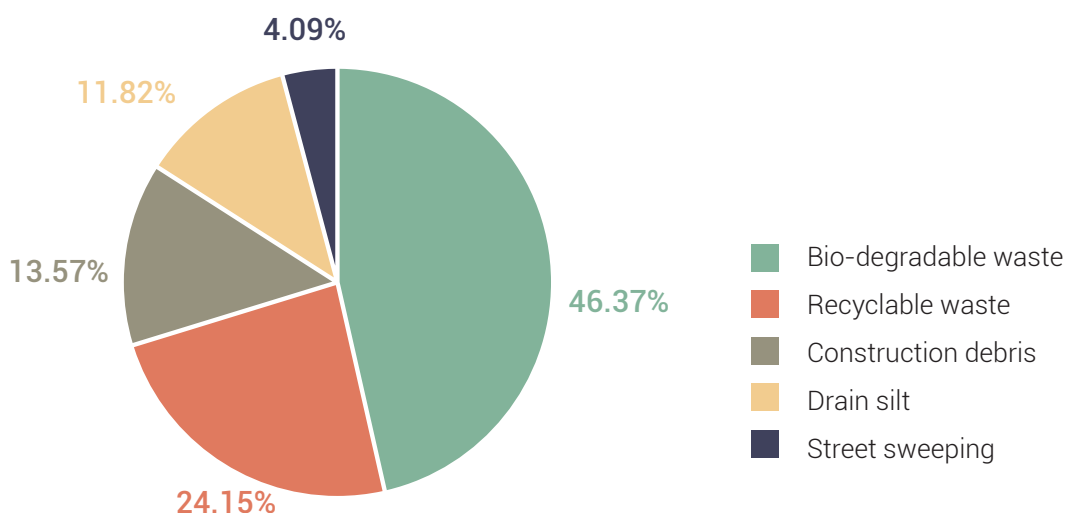
Summer Months: April to October				
S.No.	Category	Population	Waste Generated per Capita per Day (kg)	Waste Generated per Day (kg)
1	Local Population	35,190	0.45	15,836
2	Tourist	9140	0.6	5484
3	Migrant Labourers	50,000	0.35	17,500
	TOTAL	94,330	0.47	38,820
Winter Months: November to March				
S.No.	Category	Population	Waste Generated per Capita per Day	Waste Generated per Day
1	Local Population	29,912	0.3	8,973
2	Tourist	300	0.4	120
3	Migrant Labourers	500	0.2	100
	TOTAL	30,712	0.3	9,193



Looking at the population projection, the quantum of waste generated is likely to more than double by 2041.



**Composition of Waste**

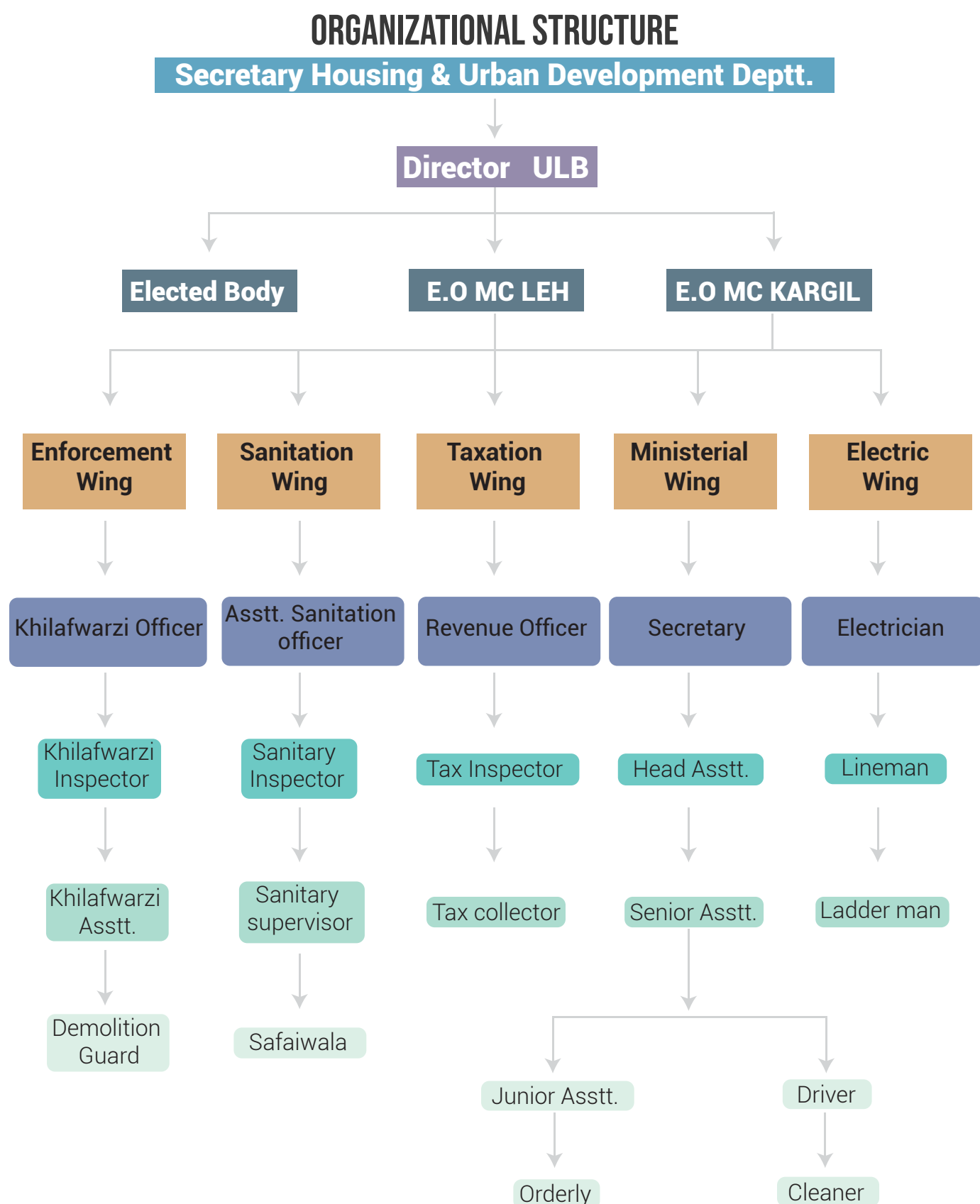


*Source: Tetra Tech India Ltd.*

According to survey conducted by Tetra Tech India Ltd. the composition of waste for Leh town consists of 46.37% bio-degradable waste, 24.15% recyclable waste, 13.57% construction debris and 11.82% drain silt. Considering the dry terrain of Leh town dust/silt constitutes a high percentage of waste compared to other towns in India.

## 3.2 PRESENT SOLID WASTE MANAGEMENT PRACTICES

### ORGANIZATIONAL STRUCTURE OF URBAN DEVELOPMENT DEPARTMENT LADAKH



For ease of reference, waste management is evaluated in three sub-sections or components, which are collection, transportation and processing.

## a) Collection

Municipal Committee, Leh has four tippers, one wet compactor, one dry compactor and three small vehicles that are deployed for collection of waste with a load-carrying capacity that ranges from 0.5MT to 5MT. There are a lot of steep roads in Leh town and these vehicles are often forced to carry less load than their actual capacity. The staff of Municipal Committee, Leh operates these vehicles under the supervision of the Assistant Sanitation Officer. The four tipper vehicles have a single compartment to carry different categories of waste while the three smaller vehicles have different compartments for dry and wet waste.

S.No.	Vehicle type	Capacity of Load	Approximate Load During one Trip
1	Tipper 1	2MT	1.5MT
2	Tipper 2	2MT	1.5MT
3	Tipper 1	2MT	1.5MT
4	Tipper 2	2MT	1.5MT
5	Wet compactor	5MT	4MT
6	Dry compactor	5MT	4MT
7	Mahindra Supro 1	0.5MT	0.5MT
8	Mahindra Supro 2	0.5MT	0.5MT
9	Mahindra Bolero 1	1 MT	1MT

The collection timing is generally in the morning (8 to 11 AM) in winters and summers. Some of the vehicles do multiple rounds when required. The vehicle halts at Leh's main market for approximately an hour twice a day to collect the bulk waste generated in public places and -including hospitals, restaurants, hotels, schools and households in every locality.

S. No.	Tipper No.	Approx capacity	No. of trips per day winter/summer	Route
1	JKE 313	3 tonnes	3/3	Gangles: Twice a month; Sankar-Chubi : Twice a week; Zangsti: Daily, evening one round of the entire main roads
2	JK10-0887	3 tonnes	3/3	Balkhang to Petrol Pump, Old Road: Daily; Changspa : Thrice a week; Skampari, Malpak, Tukcha: Twice a week
3	JK10-0973	3 tonnes	2/3	Zorawar Fort, Skara Market, Skalzangling, Airport: Daily; Industrial Area, FRL, Murtse, Ibex: Once a week, Tukcha, New Sheynam Road: Twice a week
4	JK10-4266	3 tonnes	2/3	Fort Road, DC Office area, BJP Office, Maney Tselding: Daily; Skampari, Housing Colony, Snemoling, Nubra road till Tsemo : Twice a week, Agling: Twice a month
<b>TOTAL</b>	<b>4 tippers</b>	<b>12 tonnes</b>	<b>10/12</b>	





Earlier, the town had 44 waste containers at various Garbage Vulnerable Points (GVPs). Due to enhanced focus on waste management and in an attempt to clear the GVPs, all 44 containers have been removed from public places and residential areas. In addition to this, CCTV cameras have been installed at the GVPs to prevent littering.

The vehicles are deployed with a helper from the municipality to pick waste containers being collected. Helpers travel on the back of the truck. The height of the waste compartment used to force the helper to climb down to pick up waste from the road. The vehicles also collect road sweeping waste while completing its circuit.

***"Currently Leh town is a dustbin free city with no Garbage Vulnerable points"***

Also, at present a user fee for collection of municipal solid waste is only being paid by commercial institutions as given below :

S. No.	Waste generator	Number	User fee (Rs.)
1	Commercial establishments (shops, cafes, restaurants)		12,000
2	Hotels (Category A)	92	12,000
3	Hotels (Category B)	55	6,000
4	Hotels (Category C)	37	6,000
5	Hotels (Category D)	12	6,000
6	Deluxe hotels	21	12,000
7	Guest house (0-5 rooms)	116	2,000
8	Guest house (6-10 rooms)	255	3,000
9	Guest house (> 10 rooms)	23	6,000

***Door-to-door collection service has to be provided to all households. In case, where door-to-door collection is not possible, MCL can set up collection gates. The road side waste collected during street sweeping must be collected in separate containers.***

## b) Transportation

Municipality vehicles are being used to transport the town's waste to a Material Recovery Facility, which is approximately 15 kms from the town center and 5 kms from the nearest habitation. Vehicles are not fully-covered during transportation, which results in spillage of waste from trucks since the road to the yard is bumpy as it is not paved. At times, these vehicles drive over sharp objects like broken glass, which result in maintenance stops. The loading and unloading of wastes in trucks is done manually and at most times the trucks are over loaded.

***The vehicles must not be loaded above the capacity of the vehicles and the waste must be covered at all times during transportation***



## c) Processing

The waste collected from the town is taken to a Material Recovery Facility, which is operated and maintained by 3R Management Private Ltd. Collection and transportation of waste is done by Municipal Committee, Leh while the operation and maintenance of the MRF is done by 3RM. Currently, 15 green workers, one site supervisor and one engineer work at the facility.

The current capacity of the plant is 30TPD and consists of:

1. Segregation Unit
2. In-vessel compost plant: for processing biodegradable waste
3. Sanitary landfill: for final disposal of inert waste and rejects after processing at the facility

Recycling options will be considered once the plant is in operation and the composition of waste is gathered.

The facility consists of a weighing bridge where all the waste gets weighed as it enters the site. After getting weighed and recorded, the waste gets dumped at a designated site. The facility processes waste only if it is segregated into dry and wet waste. The unsegregated waste is sent for dumping at Bombarh. Large pieces of waste like furniture, trees, large construction waste, bottles etc. are segregated manually by the green workers. The remaining waste that cannot be segregated manually put on a conveyor belt to a funnel by a hopper. The workers pick up any large pieces of waste that remains unsegregated from this conveyor belt.



Weighing bridge



Conveyor belt sorting platform

The waste after being sorted manually is sent to a tromble machine (rotating screening machine) by the conveyor belt for screening treatment. According to the requirement of this process, the sieve plate aperture of the screening machine is set as 50mm. The rotating screen machine divides the MSW into two parts, materials larger than 50mm on the sieve and materials smaller than 50mm under the sieve.



: Rotating screening machine





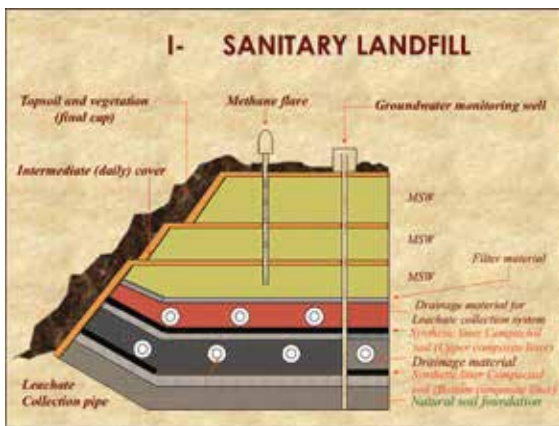
In-vessel composting machine



Magnetic separator

The materials larger than 50mm go through the magnetic separator to remove iron materials (mainly beverage and iron cans). Other waste such as plastic, glass etc. are separated and stored in containers. The waste material that are smaller than 50mm are mainly organic matter that go through the hanging magnetic separator to separate iron materials (such as caps, batteries, coins, etc.). The remaining waste is mainly organic waste that is piled up and kept for four to five days before being sent for composting. The in-vessel compost plant installed in the facility has a capacity of 10TPD with a shredder and heating vessel. The compost is then left in a warm chamber where the remaining composting process takes place.

The inert waste left behind will be dumped in the landfill that is under construction. There are two landfills being made with a capacity of five years each.



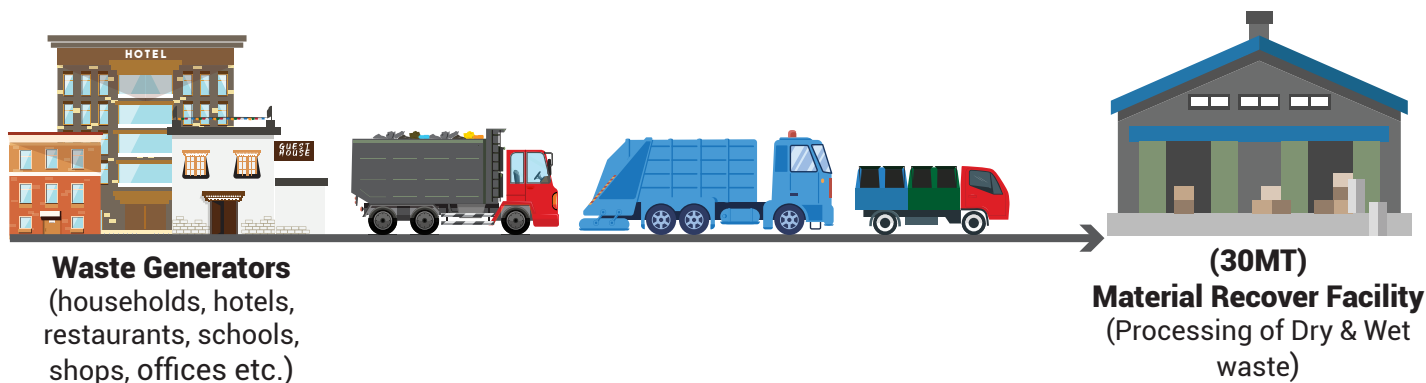
(Image source - <https://epochbrennan.wordpress.com/2013/10/29/environment-course-8-102813>)

The installed plant is operated by a 100kW solar power and has a 62.5 KVA capacity DG set as back up.

There are approximately 100 waste pickers who are present in bombgarh and Leh town. However, there is a tendency to pick high valuable waste like cardboards, PET bottles, tin cans at source and at bombgarh. Some waste generators like hotels/restaurants often store such high value waste on the premises and disposed/sold at a later stage.

However, indiscriminate dumping means valuable items are not being picked up by rag pickers as fresh waste often gets tipped over old waste at the landfill. There are many stray animals like dogs, who create chaos by picking up animal waste, hospital waste and human waste. This makes the work of waste pickers more challenging and results in low recycling of high value waste as compared to other towns and municipalities.





### 3.3 EXISTING POLICY AND REGULATION

According to World Bank, India is the largest producer of municipal solid waste owing to its population. According to a 2016 estimate India produced 277 million tonnes of MSW. It is projected that the waste generated in 2030 and 2050 will be 388 tonnes and 543 tonnes respectively. There is also a significant disparity in the per capita waste generation per day between small towns and cities. While in small towns the per capita waste generation is 0.17 kg per day, in large cities that per capita waste generation is about 0.62 kg per day.

When it comes to waste management policy, India is lagging far behind in infrastructure and management of Municipal solid waste. Up until 2000, there was no law in India dealing with Municipal solid waste. Rules like Hazardous Wastes (Management and Handling) Rules, 1989 and Biomedical Waste (Management and handling)

Rules, 1998 dealt with the subject only indirectly.

In 2000, Central government notified Municipal Solid Wastes (Management and Handling) Rules, 2000[8]rules under Section 5 of Environment Protection Act, 1986. The 2000 rules were applicable on “every municipal authority responsible for the collection, segregation, storage, transportation, processing, and disposal of municipal solid wastes”. Then under a major overhaul of environmental rules in 2016, Municipal Solid Waste Management Rules, 2016 were introduced. In this, the scope of application of MSW rules was expanded to include places of pilgrims, airports, special economic zones, ports and harbors, defence establishments and every domestic, institutional, commercial and any other non-residential solid waste generator under its ambit.

While the 2000 and 2016 rules deal with municipal solid waste, the following rules cover specific categories of waste that overlap with MSW:

1. Hazardous Wastes (Management and Handling) Rules, 1989 (amended in 2000 and 2003) (superseded)
2. Biomedical Waste (Management and handling) Rules, 1998 (superseded)
3. Recycled Plastics Manufacture and Usage Rules, 1999
4. Batteries (Management and Handling) Rules, 2001 (amended in 2010)
5. Hazardous Wastes (Management, Handling, and Transboundary Movement) Rules, 2008 (amended on 21st July 2009, 23rd September 2009, 30th March 2010 and 13th August 2010) (superseded)
6. E-waste (Management and Handling) Rules, 2011 (superseded)
7. Plastic Waste (Management and Handling) Rules, 2011 (superseded)
8. E-Waste (Management) Rules, 2016
9. Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
10. Construction & Demolition Waste Management Rules, 2016
11. Bio-medical Waste Management Rules, 2016
12. Plastic Waste Management Rules, 2016

The Jammu and Kashmir Model Solid waste management bye-laws 2018 was notified on 31/07/2019 and was being followed by Ladakh.

### 3.4 Institutional and Financial Framework

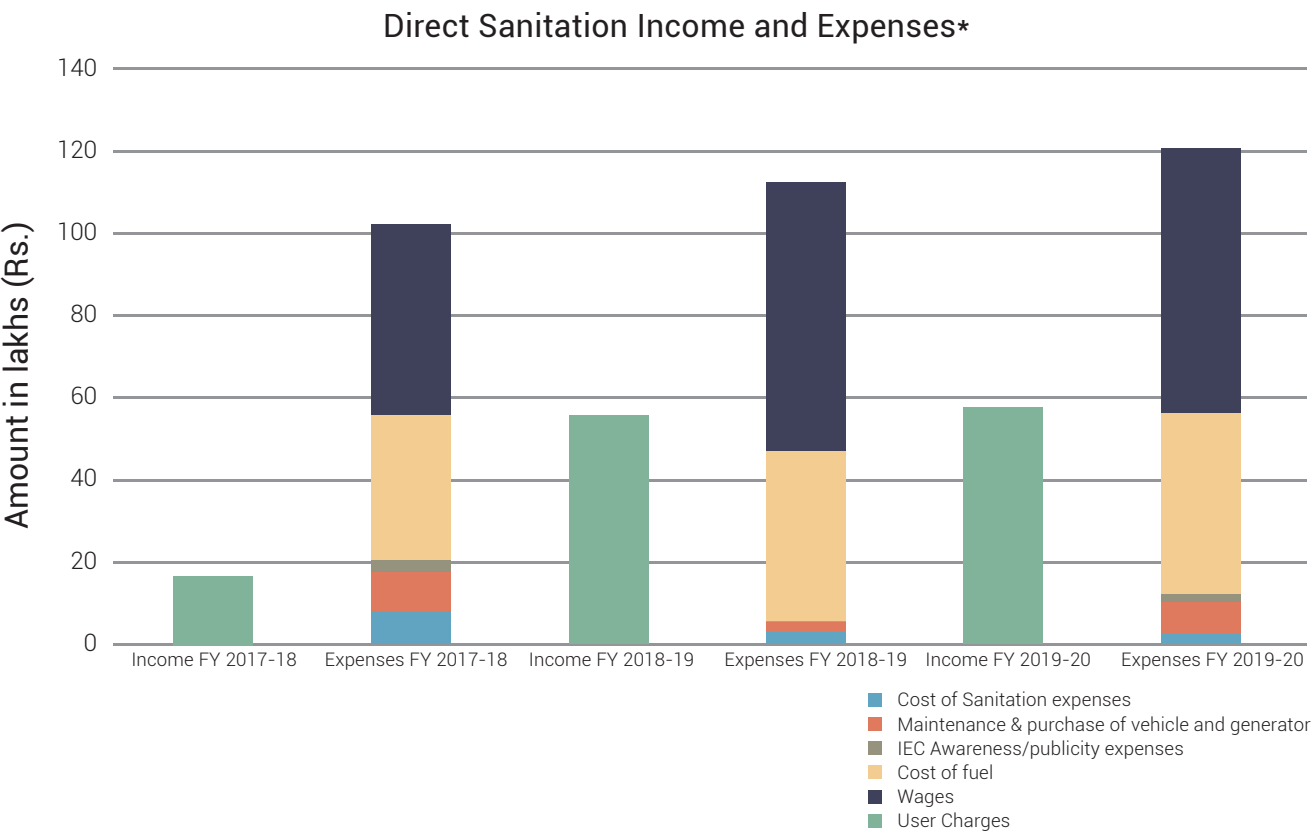
Municipal Committee Leh was established through SRO 423 dated 16/12/2003 with the jurisdiction of Municipal Committee Leh stretching from Gangles to Dambuchan from north to south Kartse Bagho to Teri-rong from west to east. It falls under the jurisdiction of Secretary Housing and Urban Development Department and is headed by Director Urban Local Body.

The Municipal Committee Leh has both an administrative and elected body. The administrative wing is lead by the Executive Officer and has the sanitation wing, enforcement wing, taxation wing and ministerial wing. The elected body consists of member representative of the 13 wards of Leh town. This governing body is headed by one ward member as the President and one ward member as the Vice-President.

The sanitation wing is responsible for the management of solid waste of the city. It comprises of an assistant

sanitation officer, one sanitary inspector, four sanitary supervisors and 115 safaiwala (sanitation workers) responsible for door-to-door collection of waste, transporting the waste to the MRF and street sweeping in both commercial and residential areas.

The Municipal Committee Leh is responsible for the collection and transportation of waste while the operation and maintenance of the processing plant is outsourced to 3R Management. MCL generates an average of Rs. 58 lakhs per year through user fee from commercial establishments like hotels, guest houses, restaurants, shops etc. (residential establishments are waived off the user fee) and through fines imposed for violation of rules. While the operation and maintenance expenses incurred for collection and transportation of solid waste is Rs. 1.2 crore which is double the revenue generated from user charges.



Source : Municipal Committee Leh  
\* This does not include operation and maintenance cost of MRF

## 3.5 CHALLENGES

### Collection, Transportation and Processing

The Municipal Committee Leh faces various challenges when it comes to managing the waste generated in the city. While the waste generated in the winter months is about 10 tonnes per day, it rises to almost 40-45 tonnes per day in the summer months owing to tourist and migrant worker population. In addition, the waste generated by the army and air force population get sent to the MRF for processing since they do not have their own waste processing facility. Below are a few challenges faced by the Municipality when it comes to collection, transportation and processing of the city waste:

#### Collection:

- Households do not practice segregation of waste at source.
- Lack of infrastructure and manpower for daily collection.
- Inadequate and improper use of dustbins provided by MCL for waste storage.
- Construction and demolition waste is not being collected separately.
- Dry leaves/paper occasionally burnt at source.
- 100% Door-to-door collection not possible in few localities because of narrow lanes and alley ways



#### Transportation:

- Collection vehicles do not have segregated chambers for dry, wet and domestic hazardous waste.
- Collection vehicles do not have covered chambers hence result in being filled to overcapacity and spillage of waste.
- The height of the vehicle compartment is very high for one person to be able to dump waste properly without spillage.
- Distance and alleviation of the road leading from the town to the MRF.



#### Processing

- Disposal of waste still taking place unscientifically at the Bombgarh landfill.
- Unorganized rag pickers and unchecked burning of waste.
- Lack of adequate green workers for functioning of the plant at full capacity.



## Policies and Regulations

As stated in section 3.3 there are a number of national and state level policies, laws and rules on solid waste management and specific categories of waste management. However, there is no direct regulations and policies for addressing waste management issues at the town level. The categorization and classification of waste generated as well as geographical and climatic condition of Leh town is very different from the rest of India and

hence requires a dedicated set of policies.

Another impediment is lack of knowledge and capacity as well as the weak enforcement of existing laws and regulations in the management of Municipal solid waste. There is also a lack of knowledge as well as participation of the various stakeholders.



# 4. WAY FORWARD



## 4.1 STRATEGIC CONTEXT AND GUIDING PRINCIPLES



*Management of solid waste may be defined as the control of generation, storage, collection, transportation, processing and disposal of solid wastes based on scientific principles.*

*This includes technological, financial, institutional and legal aspects involved in solving the whole spectrum of issues related to solid wastes.*



Solid waste management is an essential and obligatory function of the Urban Local Bodies in India, clearly mentioned in Article 243W read along with 12th Schedule of the 74th constitutional amendment of India

**Waste hierarchy :** The waste hierarchy refers to concept of reduce, reuse, recycle and recover for waste minimization. The main aim is to reduce waste at source, reuse of waste materials, recycling, energy recovery and landfilling in that order.

**Polluter pays principle :** It is a principle where the waste generator pays for the impact they cause to the environment. Therefore, it is required for a waste generator to pay for appropriate processing and disposal of waste.

**Extended producer responsibility :** EPR is a strategy that seeks to shift the responsibility of waste from the government to entities producing the waste. It is designed to incorporate all costs associated with the product life cycle including disposal costs. It is meant to

make the manufacturer accountable for the entire life-cycle of the product including product and packaging disposal

**Proximity Principle :**

This principle states that any waste generated should be processed and disposed as close to the source of waste generation as possible. This reduces transportation costs, and risks of environmental contamination during transportation of waste.

**Consultation principle :** All levels of Government should consult and work with people and organisations throughout the development and implementation of waste management strategies and action plans.

**Shared responsibility :** Waste reduction and management is a shared responsibility. It requires partnerships and collaborations between all stakeholders i.e., the government, commercial institutions, NGO's, and the community.

## 4.2 MUNICIPAL SOLID WASTE MANAGEMENT RULES 2016

The Ministry of Environment and Forests notified the new Solid Waste Management Rules, 2016 to manage the growing problem of municipal solid waste. Below is a summary of the Municipal Solid Waste Management Rules 2016

### Segregation at source

The new rules have mandated the source segregation of waste into three streams- Biodegradables, Dry waste (Plastic, Paper, metal, Wood, etc.) and Domestic Hazardous waste (diapers, napkins, mosquito repellents, cleaning agents etc.) before handing it over to the collector to promote waste to wealth by recovery, reuse and recycle.

Bulk waste generators like institutions, market associations, event organisers, hotels and restaurants have been directly made responsible for segregation and sorting the waste and manage in partnership with local bodies.

### Collection and disposal of sanitary waste

The manufacturers or brand owners of sanitary napkins are responsible for awareness for proper disposal of such waste by the generator and shall provide a pouch or wrapper for disposal of each napkin or diapers along with the packet of their sanitary products.

### **Collect Back scheme for packaging waste**

As per the rules, brand owners who sale or market their products in packaging material which are non-biodegradable, should put in place a system to collect back the packaging waste generated due to their production.

### **User fees for collection**

Municipal authorities will levy user fees for collection, disposal and processing from bulk generators. As per the rules, the generator will have to pay "User Fee" to the waste collector and a "Spot Fine" for littering and non-segregation, the quantum of which will be decided by the local bodies.

The new rules have mentioned the integration of informal waste picker sector into the formal sector by the state/UT government. The rules also demand zero tolerance for littering, burning or burying the solid waste generated in open public spaces or water bodies.

### **Waste processing and treatment**

As per the new rules, it has been advised that the bio-degradable waste should be processed, treated and disposed of through composting or bio-methanation within the premises as far as possible and the residual waste shall be given to the waste collectors or agency as directed by the local authority.

Waste processing facilities will have to be set up by all local bodies according to the population of the town. Also, the rules have mandated bio-remediation/ biomining of old and abandoned dump sites.

### **Promoting use of compost**

As per the rules, the Department of Fertilisers, Ministry of Chemicals and Fertilizers should provide market development assistance on city compost and ensure promotion of co-marketing of compost with chemical fertilisers in the ratio of 3-4 bags is to 6-7 bags by the fertiliser companies to the extent compost is made available for marketing to the companies.

### **Revision of parameters and existing standards**

As per the new rules, the landfill site shall be 100 metres away from a river, 200 metres from a pond, 500, 200 metres away from highways, habitations, public parks and water supply wells and 20 km away from airports/airbase. Emission standards have reduced limits for particulate matters from 150 to 50. The compost standards have been amended to align with Fertiliser Control Order.

### **Management of waste in hilly areas**

As per the new rules, construction of landfills on hills shall be avoided. Land for construction of sanitary landfills in hilly areas will be identified in the plain areas, within 25 kilometers. However, transfer stations and processing facilities shall be operational in the hilly areas.

### **Constitution of a Central Monitoring Committee**

The government has also constituted a Central Monitoring Committee under the chairmanship of Secretary, MoEF&CC to monitor the overall implementation of the rules. The Committee comprising of various stakeholders from the Central and state governments will meet once a year to monitor the implementation of these rules.







# 5. STRATEGIC GOALS, OBJECTIVES AND TARGETS

## 5.1 STRATEGIC GOAL A : IMPROVE COLLECTION, TRANSPORTATION AND PROCESSING OF WASTE

S. No.	Recommended benchmark	Proposed action	Critical aspects
1	Door-to-door collection	Ensure 100% collection from all types of waste generators including households, institutions, commercial establishment in a covered compartment	Vehicle timings, route plans, IEC
2	Source segregation	Segregation of waste-by-waste generators in three categories: Non-biodegradable, biodegradable and domestic hazardous.	IEC (communication and training and capacity building)
3	Litter bins/waste storage bins	Installation of bins in commercial and public areas at every 50-100m unless the town is bin free.	IEC, awareness, and engagement with commercial waste generators. municipality planning.
4	Separate transportation	Compartmentalization of vehicles. GPS mandatory for town having population above 5 lakhs	Vehicle retrofitting, Involvement of green workers
5	Public sweeping	Twice daily sweeping for commercial and public areas/daily once for residential areas.	Municipality planning and decision-making.
6	Waste processing	Ensuring operation space for storage, segregation and processing for various categories of waste, promotion of both centralized and de-centralized processing of waste having dedicated MRF facility.	Trained manpower, know how on waste streams, equipment and machinery, storage place, forward linkages.
7	Scientific landfill	System of treatment of legacy waste and disposing of permitted quantity and quality of waste.	Information of non-recyclables, Prediction calculation for 20 years of waste generation. equipment and machinery
8	Construction and demolition waste	Ensuring separate collection, transportation and processing of C&D waste.	Assessment of C&D waste, Provision for dedicated collection, In-house or outsourced facility for same. Awareness around By-laws on C&D waste.
9	Plastic waste	Implementing ban on plastics that are thinner than 50 microns	By-laws, awareness and dialogues
10	Bulk waste generators	Decentralized waste processing facility for BWG	Bylaws, awareness and dialogues
11	RDF	Mandatory provisions with cement plant for non-recyclables	MoU and Agreement for particular types of waste/tie up with road contractors or civil construction authorities like PWD.

12	Preventing solid waste from entering water	Installation of mesh to prevent solid waste from entering drains/water bodies/rivers	Assessment of drainages/awareness of the public at large.
13	User fee	Waste generator paying fee regularly	Bylaws, awareness and IEC
14	Penalty provisions	Fines/spot penalty for violations/offenders	Bylaws, awareness and IEC
15	Notification of bylaws	Framing of bylaws based on MSW Rules 2016	Meetings, dialogues and resolutions
16	Citizen grievance redressal	Resolutions and tracking of complaints	Process guidelines, monitoring and evaluation
17	Monitoring mechanism	Local mechanism for tracking the progress of SWM rules adherence and status.	Reviews, meetings and workshops on periodical time frame.

## 1. Collection:

Ensuring collection- The municipality must focus on coverage, cooperation of stakeholders, cost recovery or minimisation

### 1.1 100% Door-to-door collection

- (A) Redesigning the routes and deployment in such a way that there is fixed timing and plan for different waste generators. For instance, different vehicles can be used for households and other waste generators.  
Ideal timings:
  - Households - 8 to 11AM (winters) and 7 to 10 AM (summers)*
  - Commercial - (Between 12 and 4 PM & 7 to 9 PM) Winters*  
*(Between 11AM and 3 PM (6 to 8 PM) Summers)*
- (B) Route charts/points of interest must be prominently displayed in vehicles for the public
- (C) A feedback register must be kept in the vehicle for registering feedback and complaints.
- (D) Safety equipment like masks and gloves must be specially implemented and ensure adherence through monitoring and constructive follow up by Municipal Committee Leh.
- (E) Swachh Nagar App for waste collection must be introduced for municipality staff and waste collectors to ensure quality monitoring and optimum utilisation of resources
- (F) The vehicle's height should be reduced and more smaller vehicles must be deployed. Having analysed the current timings, we recommend 10 closed body auto-tippers for Leh Municipality.

Since recommendation of Swachh Nagar App – A dedicated vehicle must be deployed/re designated to cover on call service to waste generators with additional fee.

## 2. Transportation

Leh town has great variation in terms of waste generation in the summer and winter. Thus, a two -pronged recommendation is being made to address the issue of transportation. Furthermore, the following recommendations are being made since the municipality is planning to start a new facility next summer in place with a difficult approach road:

SNO	Recommendations	Applicable season	Remarks
1	Covered transportation: This is very important in the ward during collection and while transportation to the landfill site/processing centre. The waste must be covered to avoid spillage of waste from the vehicle. Generally, compartments are designed in such a manner that the flap or door can be shut while in transit. Vehicles such as tractors/big trucks are sometimes deployed to collect the garbage, which can be covered with tarpaulin or other materials that can withstand rain or snow and can save materials from moisture while amidst transportation	Winter and summer	Retrofitting designs have been summarized in the annexure of this report for vehicle modification
2	Provision of secondary sorting/storage space on the town's outskirts: There are high probabilities of breakdowns during waste collection. Also considering the availability of waste workers in and around Bomgarh, it is advisable to sort collected waste in this facility where vehicles can be emptied till, they are repaired. Storage space is being recommended also as many times in peak season waste streams may fill the vehicle completely and many households and routes may not be covered during regular routes hence multiple trips may be required during several days in the peak season.	Winter season: Sorting Summers: Only temporary storage	
3	Washing and cleaning of vehicles: It is very essential that the vehicles are cleaned and washed/sanitised properly after each day's work. Hence, while returning the vehicle from new process areas provisions of washing/sanitizing should be made at the MRF facility.	Summer and winter	





### 3. Processing

In this section we analyse various factors of existing facilities with recommendations based on long-term economic and functional viability:



Our analysis is presented in the context of organic and non-organic waste guidelines approved by NGT

#### Hardware-related provisions-

S. No.	Critical points for processing	Existing scenario	Recommendations
1	Weight of organic and non-organic waste before dumping	There is space constraint at the existing MRF where waste gets dumped. No separate dumping area for dry and wet waste.	<ol style="list-style-type: none"> <li>1. Vehicles to be weighed while entering with all the waste and then once again after unloading. This will give data and knowledge about quantum of waste streams entering the processing center each day.</li> <li>2. Weigh bridge calibration must be linked with a software that is capable of sharing this information regularly with the municipal office in Leh town.</li> <li>3. Cameras must be installed at the entrance of processing plant to capture the registration number of vehicles as well.</li> </ol>

2	Unloading place for wet and dry waste	Platforms being designed do not have separate unloading sections for wet and dry waste	<ol style="list-style-type: none"> <li>1. The designated place must have shade while unloading waste separately in two categories.</li> <li>2. A platform must be installed where vehicles can easily unload the payload without disrupting the activities in the main platform.</li> </ol>
3	Provision of day-wise waste unloading in sections of platform	As on date, there is no demarcation in the platform	Since there is possibility that due to breakdown or absence of staff on a particular day, the waste may not get processed, provisions can be made for temporary staff/maintenance schedule of machines and equipment. However, day-wise waste processing output needs to be captured and monitored that will provide critical information on resource planning and provisions.
4	Changing rooms/toilets	Provision of toilets is already there, there is no availability of changing rooms for workers	Since waste processing involves probability of contamination, separate room for male and female workers along with toilets should be provided where they can change in and out of their uniform while reporting for duty and going back.
5	Fencing of processing centre	There is no barricade around waste dump-yard and processing centre as on date	Since Bombgarh is close to the new facility, it is advisable that we keep dogs and other animals out of the premises by installing a barbed wire or other type of permanent fencing to check un-authorised entry to the premises.
6	Sorting and storage bins	There is a need for sorting bins for different categories of waste. Also the MRF facility needs storage space for the segregated waste especially because during the winter months due to closure of motor roads	Recyclable and non-recyclable waste have many categories that need to be sorted to exploit and optimise opportunities for forward linkages. These have to be sorted and stored in two-litre drums with wheels to make it easier for transportation. This also helps in moving the sorted waste stream from machines to storage facilities.
7	Storage place for waste streams	Long-term storage space is not available on site	It is essential to have sufficient provisions to store the waste till it can be sold and disposed. Leh is a relatively secluded town that is far from the recycling industry. It is essential to develop storage facilities other than the New MRF Centre. This should be located near Bombgarh or a suitable site within the municipality jurisdiction. This facility should have a capacity of around <b>5000</b> cu mtr.

## Software-related provisions-

### • DRY WASTE-

Waste processing has to be done in line with available opportunities for forward linkages. Though there are multiple waste streams in municipal solid waste, sorting all categories/sub-categories must be done in accordance to norms. Organic waste can easily be converted to compost in the local context. In contrast, dry waste has several factors such as:

- A. Cost of making sub-categories of waste at MRF Facility.
- B. Average price available for sub-category.
- C. Additional resource required for sorting/storage/and transportation.

S. No.	Factor to be analysed	Step 1	Step 2	Step 3
1	Direct cost of making any waste category	Amount of manpower deployed/cost per day	Weight of the category being achieved after sorting on any given day	Bailing, if needed and what is the maximum amount weight that can be achieved for reaching bail quantity.
2	Average prices available for sub-category	Average purchase price in Leh town	Minimum quantity necessary for highest price achievement	Minimum distance from nearest available recycling hub: Delhi/Ludhiana/Jammu
3	Additional resource requirement	Material doesn't need to be cleaned	Does it need to be bailed for transportation	Does it need to be bifurcated in terms of color.

We have the following recommendations for Municipal Committee, Leh:

Waste composition analysis: in the previous section, we recommended sampling and survey of waste as part of behaviour change strategy. Similarly, we recommend collection, sorting and weighing of different waste streams mentioned above. A weighted average of these items can be logged and filed for analysis, which is extremely critical for planning the provision for operations of MRF centre.

To begin with, we recommend sorting of waste into the following categories at the MRF:

Paper, Plastic (non PVC), Plastic (PVC), Glass, Rubber, Leather, wooden, cardboards, thermocol, jute, metal (ferrous), metal (non-ferrous), clothes, electronic waste, medical/medicine waste, aluminum coated plastic, aluminum coated paper.

Recommendations after sorting-

Municipal Committee, Leh has purchased the following machines to add value at the processing site-

S. No.	Machine description	Capacity	Recommendations for operations
1	LD/PE Granulator	1,500 kg/day	Extremely helpful in reducing the volume of particular waste type/category. In winters, it can be operated once a month. In summers, it can be operated on a weekly basis after preparing sub-categories.
2	HD/PET Shredder	1,000 kg/day	Reduces the volume of PET bottles and helps in creating space in storage house. Cleaning of PET and HDF becomes easier and fetches good price while being sold. These machines can be operated as per requirements of recyclers as at times non-shredded materials are preferred. Machine should be operated only after securing orders.

3	Card board/paper shredder and briquette maker	500 kg/day	The ban on low-value plastic has resulted in increased the demand for paper in the packaging industry and subsequent waste generation. Paper and cardboard are moisture prone and quickly loose value if not stored properly. As Leh has many requirements for insulated walls, and other construction items these machines can be used on a daily basis to convert paper and cardboard to quality briquettes.
4	Glass Sand Machine	200 kg/day	Since glass bottles are difficult to store and often break in transit, this machine can be used to convert them into sand. This powder can then be sold to recyclers as it can be transported easily and also used in local construction work.
5	Hydraulic Bailer	10 bales/day	Bailer is very important in any MRF centre; it can be used to create bales of 100 kg and can be used to reduce the volume of waste types like PET bottles, paper, cloth, rubber and other types of plastic items.

It is essential to achieve scale and volume to achieve the optimum economic value of waste streams. The availability of volume is beyond the control of the municipality, but this can be addressed by organizing each category well. Here, we summarise a few options for waste streams.

At the local level, the MRF has the following options to enhance the value of waste materials-

1. Sorting
2. Cleaning and washing.
3. Shredding/reducing size
4. Creating bales
5. Recycling/value additions through machines

S.No.	Waste Type	Sorting	Cleaning & Washing	Shredding	Bales	Re-cycling/ Value additions
1	Paper/Card Board	Yes	No	No	Yes	No
2	Glass	Yes	Yes	No	No	Yes
3	Tin/Steel	Yes	No	No	No	No
4	Cloth	Yes	No	No	Yes	No
5	PET Bottles( Transparent/Green/ Other as per Color)	Yes	Yes	Yes	Yes	No
7	LDEP( low Density plastics)( white/Green/Black)	Yes	Yes	Yes	Yes	No
8	HDEP( High Density)( o need for bifurcation as per colour)	Yes	Yes	No	Yes	No
9	PP( Poly Propylene)	Yes	Yes	No	Yes	No
10	Multilayer Plastics/Printed Plastics	Yes	No	No	Yes	No

*Note: Only glass is being recommended here for local recycling as quantum is low for each category linking/selling in market is a better option for other categories.*

**WET WASTE-**

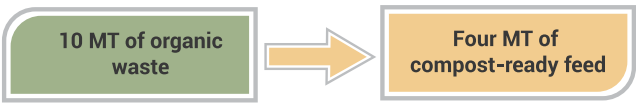
Wet waste in Leh municipality is expected to have compostable and non-compostable components.



*(Items like orange peels/onion skin must be excluded from composting if possible. If this is not possible, then bio culture must be used in sufficient quantities to ensure proper decomposition.)*

**Compostable Organic Waste-**

The municipality has installed a semi-automatic machine in the MRF plant for organic and biodegradable waste. The machine has Integrated systems including shredder, mixer and heater and is also known as **In-Vessel Compost (IVC)**. Considering the low temperatures in Leh town for most of the year, anaerobic digestion is a challenge. Machine-facilitated decomposition is essential for most organic waste.



Under IVC system, we can take a feed of 10 metric tonnes or organic waste per day according to the the capacity declared by the supplier. We expect that the volume and weight of organic waste will get reduced to 40% by single batch processing that will require eight hours of continuous working. Hence, by the second day 10 MT of organic waste will become 4 MT of ready compost.

Output of the IVC machine requires curing in open air after being packed in sacks. This can be done in an open ground by keeping bags on top of each other. Bio-culture can be spread and mixed on this partly-digested manure every five to six days. In about two weeks this should produce homogenised compost-ready to be used in the field or a kitchen garden.

## Non-compostable organic waste-

As In-Vessel Composter has an inbuilt grinder machine and most non-compostable items can be composted through the grinding and mixing process where bio-culture will play a crucial role. Items such as tender coconut shells can create operational challenges and can roughen the edges of the grinding blades. Coconut sheets have a high number of fibres and can be used for various other purposes. They are excellent sources of carbon if converted into charcoal and can be used to enhance soil fertility.

We recommend coconut shells to be stored separately and dried as much as possible in open areas/fields near the MRF Centre. After four to six weeks of drying, they can be burnt in closed drums and containers with limited air supply to convert them into carbon/charcoal. This can act as feed for furnaces and can also be crushed and applied to soil to address carbon deficiency.

## 5.2 STRATEGIC GOAL B: STOP UNCONTROLLED DUMPING AND BURNING AT BOMBGARH DUMPSITE





Bombgarh, located near Diskit Tsal has been the dump yard site for Leh town since the last 20 years. The site is spread across an area of 11 hectares or 27.2 acres. Indiscriminate dumping of mixed municipal solid waste at bombgarh took place till August 2020 till the MRF was functional. Since there was no segregation practiced, mixed waste was collected by Municipal Committee Leh and dumped in an unscientific manner without any treatment or material recovery. There are mounds of untreated waste collected over the last two decades. This has led to soil pollution, contamination of underground water and uncontrolled breeding of stray animals mainly dogs.

The place also attracts unorganized rag pickers in huge numbers every year who scavenge for recyclables among the mountains of waste. Although this unorganized sector is responsible for clearing the dumpyard of tonnes of recyclable waste they are also responsible for causing resentment among the settlement below the dumpyard who are direct victims of air pollution from open burning of waste. The ragpickers resort to burning of garbage in order to extract valuable metals causing air pollution. The place still sees illegal dumping by the commercial establishments and households as well as mixed municipal waste rejected by the MRF. These issues make it critical that focused action is taken by the Urban Local Body to clean up legacy waste site at Bombgarh.

Below are the key actionable plans to consider for cleaning up legacy waste:

- Estimating area of the landfill site and analysing the waste composition
- Divide the landfill site into smaller portions. Level the waste, perform sorting into different categories and recover the recyclables through bio-mining. Separate the composting materials
- Stabilization of the open land site
- Sell the recyclables or distribute to local scrap dealers
- Dispose inert waste in the incinerator and/or in the scientific landfill.

There is also an unauthorized slaughter house at Bombgarh operating since the last 10 years. The place is badly managed with unhygienic working conditions. The waste generated at such sites is a reservoir of biological pathogens both bacterial and viral in nature capable of infecting both humans and animals. The site also produces a huge amount of Slaughterhouse Waste Water (SWW) polluting the soil and underground water. The Municipal Committee Leh needs to formalise the operation of the slaughterhouse and provide necessary infrastructure.

CPHEEO has provided guidelines to manage Slaughterhouse waste and dead animals. Depending upon the type of animals slaughtered, the slaughter houses are classified into (i) large animal (cattle, buffalo etc.) slaughter house (ii) Goat and sheep slaughter house (iii) Pig slaughter house and (iv) Poultry slaughter house. In

Leh town we have the goat and sheep slaughterhouse located at the landfill site.

The current condition of the slaughter is not met with standard guidelines. Slaughtering is carried out using the halal method and blood is left to pollute the soil. The dehiding of the carcass is done on the floor thus contaminating the meat. The skin, bones and other parts of the animal are also left on the floor without immediate disposal. The visceral material generated during the evisceration process contributes to the maximum amount of toxic slaughterhouse waste.

There are various methods of management and safe disposal of slaughterhouse waste essential in order to reduce risks of spread of diseases. The Municipal Committee Leh needs to upgrade the slaughterhouse facility according to the guidelines provided by CPHEEO which is summarized below :

### Infrastructural Requirements:

1. The slaughter house shall have the following essential facilities:
  - (i) Reception area for animals;
  - (ii) Lairage;
  - (iii) Facilities for ante-mortem inspection;
  - (iv) Segregation ward for sick/diseased animals;
  - (v) Carrying out humane slaughtering;
  - (vi) Flaying, dressing and washing of carcasses;
  - (vii) Handling carcasses and edible offal;
  - (viii) Handling by-products;
  - (ix) Inspection of meat and disposal of unfit meat for human consumption;
  - (x) Refrigerated room;
  - (xi) Laboratory.
2. The floor of slaughter hall and dressing area of should be made of impervious materials like marble/stone slabs, tiles or cement with gradient for proper drainage of slaughter waste water.
3. The walls should be lined with approved quality white glazed tiles or other equivalent material upto 1.5 to 2 meters from floor.
4. The slaughterhouse should be provided with proper ventilation system
5. The slaughter house should have a separation between clean and dirty sections
6. The arrangement of process flow should be made in a continuous process; without any possibilities of reversal, inter-section or overlapping between the live animals and meat, and between meat and by-products or waste.
7. There should be rails with hooks of suitable rust proof metal for bleeding, dressing and hanging of carcasses in slaughter house.



## Operation and Maintenance Requirements:

1. Sufficient, safe, potable and constant supply of fresh water at adequate pressure throughout the premises.
2. Hot water supply in the slaughter hall during working hours.
3. Frequent sterilizing of equipment and tools.
4. Sanitary working conditions should be provided with adequate facilities should be provided for persons working in slaughter house.
5. Workers engaged in the slaughterhouse should be trained well in their respective area of operation.
6. Workers should have regular medical check-up and should be medically fit to handle meat.
7. Workers should be provided with necessary uniform and protective clothing
8. The site should be equipped with high efficiency spray nozzles for washing carcass floor and evisceration line
9. Proper drainage and treatment of slaughterhouse waste water (SWW) should be provided.
10. Proper segregation of dry waste and collection of blood should be practiced. Discharge of stomach and intestinal contents should be collected separately.

Below are a number of safe disposal methods for waste generated in the slaughterhouse.

- a. composting,
- b. anaerobic digestion (AD),
- c. alkaline hydrolysis (AH),
- d. rendering,
- e. incineration and
- f. burning.

The Municipal Committee Leh needs to identify the right disposal method to be followed by the slaughterhouses in accordance to the quantity and type of waste generated keeping in mind the climatic conditions of the town. MCL also needs to formalise the operation of the slaughterhouse and provide necessary infrastructure. They should identify illegal slaughtering places and do regular checks to monitor the conditions of the slaughterhouse and how waste is disposed. Till the activity of illegal slaughtering is not put to a halt, MCL is responsible for collection and safe disposal of such waste.



Slaughterhouse at bombgarh



## 5.3 STRATEGIC GOAL C: MAXIMIZE PROPER WASTE COLLECTION AND TREATMENT OF CONSTRUCTION & DEMOLITION WASTE

### Construction and Demolition Waste

As per the Construction and Demolition (C&D) Waste Rule 2016, 'any waste comprising building materials, debris and rubble resulting from construction, remodelling, repair and demolition of any civil structure' is classified as C&D waste. Debris recovered from desilting of drains and waterbodies are also included by some municipalities as C&D waste.

In Leh, most construction work takes place in building roads, bridges and hotels. An exponential increase in tourism over since 2010 has led to an increase in the number of hotels in Leh town. Further, with Ladakh being granted UT status in October 2019, the annual budget has seen a six-fold increase than earlier. This means that there will be a boom in construction activities in both government and private sectors.

Construction and demolition waste generated in Leh town comes into the waste stream of Municipal Committee, Leh. It consists mostly of inert and non-biodegradable material such as concrete, plaster, metal, wood, plastics, ceramics, stones etc. Such waste is generally heavy and bulky. It is common to see huge piles of such waste on the road outside big construction sites disrupting traffic as well as cleanliness of the town. Construction waste from small generators, such as individual houses, often finds its way to municipal waste collection vehicles. In Leh, small quantities of construction waste make its way to the Material Recovery Facility in the collection vehicles making it difficult and time consuming for green workers at the facility. C&D waste is also illegally dumped on the outskirts of Leh town and at the dump yard near Housing Colony.

### C&D Waste Management Rules, 2016

The Ministry of Environment, Forest and Climate Change (MoEFCC) notified the Construction and Demolition Management Rules in 2016.

As per the C&D Waste Management Rules, 2016:

- Municipal Committee, Leh to create recycling facility for C&D waste at a safe distance from habitation and maintain a database of waste collected, processed and recycled
- Municipal Committee, Leh will utilise 10 to 20% of material from C&D waste in municipal and government contracts for construction
- The price of C&D waste recycled products to be kept

about 20% lower than corresponding conventional products

- All large contractors are accountable for collection and disposal of C&D waste from their respective sites
- Municipal Committee, Leh to give appropriate incentives to waste generators for processing and reusing waste at site or other construction sites
- Municipal Committee, Leh to mandate the use of atleast 20% of recycled C&D waste at all renovation/demolition projects

### Duties of state government or UT administration

- Prepare policy document for management of C&D waste as per rules. The responsibility for policy making lies with the Secretary in-charge of development in the UT
- Provide land for storage, processing and recycling of C&D waste
- Include site in approved land-use plan by Town and Country planning department.
- Make it mandatory to procure up to 10-20% materials made with C&D waste in municipal and government contracts, subject to strict quality control.

### Duties of waste generator

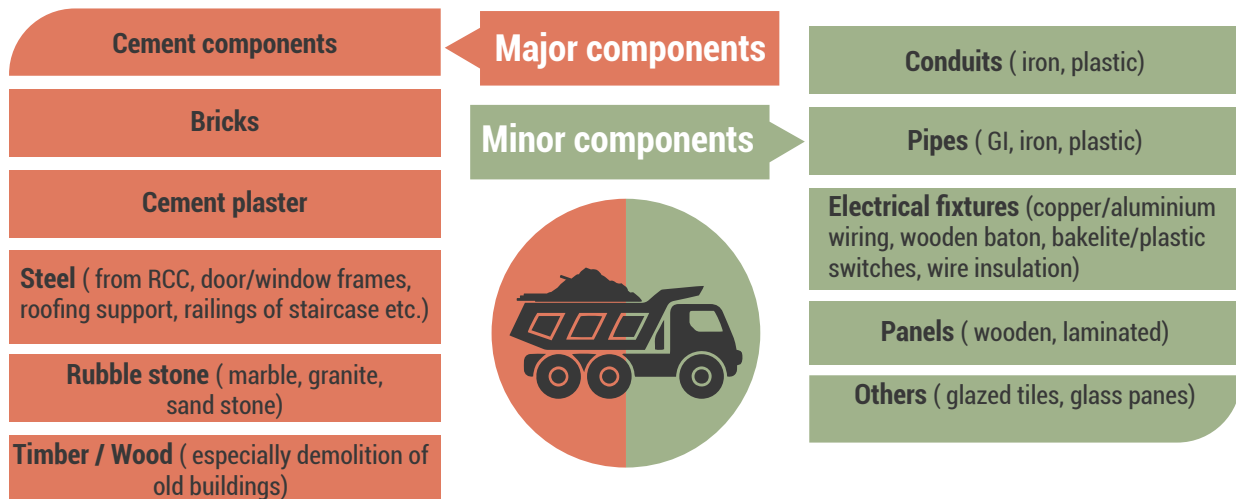
- To collect and store C&D waste generated within their premises
- To ensure that other solid waste is not mixed with C&D waste
- To deposit C&D waste to collection centers or processing facilities as authorised by Municipal Committee, Leh
- To ensure that there is no littering or deposition of waste to prevent obstruction of traffic, public and drains.
- Pay relevant charges for collection transportation, processing and disposal as notified by Municipal Committee, Leh



## CHARACTERISTICS

C&D waste is an inert waste and over 90% of the waste can be easily reused or recycled. A study by Technology Information, Forecasting and Assessment Council (TIFAC) in 2001 noted that C&D waste in India typically contains soil, sand and gravel (36%), bricks and masonry (31%), concrete (23%), metal (5%), wood (2%), and others (3%). The composition of C&D waste varies from place to place, depending on the type of architecture and materials prevalently used in the region.

This category of waste is rather complex due to the regional variation in the types of building materials used but in general it comprises of the following materials:



As part of its 2001 study, TIFAC developed the following rules of thumb to estimate C&D waste generation:

- Range 40–60 kg per sq. m of new construction,
- Range 40–50 kg per sq. m of building repair,
- Range 300–500 kg per sq. m for demolition of buildings.

Currently, Municipal Committee, Leh gives building permission for new constructions. The applicant has to deposit a fee of Rs. 3/- per square feet for residential construction and Rs.5/- per square feet for commercial construction. For demolition of an existing building, the applicant has to submit an application along with a nominal fee of Rs. 1,000. Currently, there are no regulations for demolition of existing buildings in Ladakh. Since, maximum C&D waste is generated from demolition of buildings, Municipal Committee, Leh should adopt regulations around demolition of buildings in its building bylaws. It could include the usage of a considerable part of C&D waste generated in the new construction, storage of waste at site and transportation of the waste at the processing site. This will not only reduce the quantum of waste but also reduce illegal dumping of C&D waste.

C&D waste generators should apply for a permit from Municipal Committee, Leh in writing in advance before undertaking any construction or demolition activity after paying the necessary fees. In case of violation of regulations or illegal dumping, there should be suitable penalty levied by way of moderate to heavy fines depending on the severity of the offence.

## STORAGE OF CONSTRUCTION AND DEMOLITION WASTE

- C&D waste should be stored at site/source and not dumped illegally in and around town or at Bombarh
- As far as possible, waste should be segregated into different categories to facilitate reuse and recycling
- Materials that can be reused at the same site for backfilling/levelling of foundation should be stored separately and consumed at the same site
- For large construction sites, like Leh airport, and government buildings either Municipal Committee, Leh or a private company should provide bins/containers for hire to be kept on site to store waste and plan transfer of waste depending on storage capacity
- For government related maintenance and repair work, including maintenance of roads, water pipelines, electrical cables etc., the concerned departments or contractors must coordinate with Municipal Committee, Leh for removal of debris generated
- While giving out building permissions, Municipal Committee, Leh should clearly specify the responsibility of the owner/contractor with respect to storage of C&D waste generated at the site with clear fines to be imposed in case of violations.

## COLLECTION AND TRANSPORTATION

The processing facility for C&D waste should be located at an ideal distance from habitation. Ideally, there should be one collection point for 25,000 people. Given the local population of Leh town is around 40,000, this means there should be two collection points. Since, the area of Leh town is only 17.2 sq km and maximum distance between any two places is only 5.06 kms, the C&D waste should be transported directly to the processing facility.

For handling waste from construction/demolition sites:

- Municipal Committee, Leh can provide paid door-to-door service of C&D waste to the processing facility
- Municipal Committee, Leh can permit the contractor/builder to transport the C&D waste to the processing facility

*The fee for collection and transportation of C&D waste has been fixed by the Municipal Committee Leh at Rs. 2000/- per trip.*

## 5.4 STRATEGIC GOAL D: IEC ACTIVITIES FOR CAPACITY DEVELOPMENT AND AWARENESS

### Segregation of waste at source

#### 1. Communication and cooperation:

Collection quality necessitates that waste generators of all kinds in the municipality area must abide by the system and protocols being selected and provisioned.

Municipality needs engagement with stakeholders in broader perspective. Here we summarise key stakeholders long with key messages to engage with them

Stakeholders	Communication Message	Medium
Waste Generators (Households/Commercial Establishments/Institutions)	Waste type, segregation methods, home composting, avoiding single use plastic, kitchen/rooftop gardens	Meetings, handbills, video shows, banners and paintings
Mohalla Committee Members/ Residents committees/Market and other Associations	Waste management at small level, Budget planning and monitoring, Various schemes of govt. for dovetailing	Exposure visits, Video shows, Presentations, handouts
Green Workers/Business Players/Aggregators/Rag pickers	Waste Handling, Safety equipment, personal hygiene, Waste Recycling	Trainings, Video Shows, Presentations, Demonstrations
Municipality officials/Ward Councilors	SWM advocacy, leadership and ownership creation	Review & Share Meetings, trainings, Exposure visits,

## KEY OUTPUTS -

This section lists the output matrix that the municipality must target in a concerted manner

S.NO	Desirable outputs	Tools	Critical Points
1	Waste generators are aware of collection timings	IEC, route charts, pamphlets, meetings	Timings must be decided according to season, waste quantum, and waste generator type.
2	Waste generator is aware of financial contribution and is willing to pay.	Meetings, dialogues, participatory planning	Financial background, usage of other resources like electricity, plot size, quantum must be taken into consideration.
3	Waste generator is willing and practicing segregation of waste.	Follow ups, green worker demonstrate segregation	Wide-level awareness on waste types is essential, Distribution of twin bin system, Making rules for bulk waste generator
4	Vehicles doing collection have separate compartments for different categories of waste	Retrofitting and redesigning of vehicles as per need.	Three compartments must be designed as per volume of waste. Wet waste is heavier and must be in the back. Dry waste must be in the middle compartment. Opening of a compartment should be easy and convenient. Must be fitted with automatic tilting facility (A hydraulic system is recommended)
5	Green workers are aware and implement health and hygiene protective equipment protocols.	Training and capacity building, Monitoring of green workers	User friendly masks and gloves must be procured and should be re-usable and convenient for workers. They must not create sweat (less plastic and more cloth and other materials are desirable)
6	Waste generators should be aware of the complaint system in case of grievances and troubleshooting.	Display and dissemination of complaint numbers, Daily tracking and monitoring for redressal.	Complaint number (preferably landline) must be displayed in vehicles prominently and must be operational during working hours (8 AM to 2 PM)

## 2. Behaviour change communication and stakeholder engagement :

Waste Management is a community issue and can't be driven by the municipality alone. Overall success and sustainability depend on how effectively stakeholders are identified, engaged and institutionalised with. Collection quality necessitates that waste generators of all kinds in the municipality area abide by the system and protocols being selected and provisioned.

The municipality needs to ensure engagement with stakeholders in broader perspective. Here is a summary of key stakeholders and key messages for engagement:



“Behaviour change, unlike awareness generation is about being participative rather than instructive. It drives action by communicating specific rather than generic information. It empowers the target audience towards decentralized planning and resource mobilization. Involvement of stakeholder is enhanced.”

### Steps for engagement-



The Municipality is expected to define goals (short-term and long-term) for solid waste management. These goals/objectives will help identify key actions for each stakeholder and strategies for communication. The table below lists potential approaches for solid waste management. These are models where a cadre is created along within the official machinery by engaging an NGO/organisation or the municipality can train its own staff and create relevant functions within the department as required. Stakeholder identification will also help outline roles for each group while also identifying immediate and long-term action.

SNO	Waste Generator	Sample Size	Remarks
1	Households	10% from each ward	Households must be selected from low Income, middle income and higher income groups with equal numbers
2	Hotels/restaurants	10% of total number of hotels and restaurants	50% hotels and 50% restaurants must be selected from across town
3	Institutions like schools/offices/colleges	At least 10	At least three schools/three offices/ airport and army cantonment areas must be selected

Assessment of waste quantum and profile of generators: The municipality should conduct an assessment of the quantum of waste being generated by different generators. The assessment should be carried out by weighing total waste produced by each generator over three consecutive days. The identified generator must be briefed to ensure that they keep their waste for the day for assessment at a particular time. The waste collection vehicle being used should be equipped with a weighing scale to weigh the wet and dry waste generated.

The segregated waste should then be taken to a resource centre where it will be further sorted into categories such as recyclable/non-recyclable and inert waste. This data is very critical to plan various steps in waste management.

## Identification and formation of Institutions for behaviour change communication-

Institutions are very important for sustainability of any change. Generally, campaigns suffer the following mistakes and shortcomings:

“ Awareness and engagement around specific requirements such as celebration of events and days.  
General messages are through mediums such as pamphlets, speeches, jingles and visuals.  
Impact is for a very fie.  
No desired outputs complimenting the Main Work.



Since waste management takes place every day throughout the year, it is regarded as an 'Essential Service' and requires volunteers and stakeholder involvement,

In this regard, we recommend the following steps:

1. Conduct a workshop with support from ward councillors and representatives of sub-groups of waste generators from all the wards to explain various roles and responsibilities.
2. Tabulate the name of individual leaders/opinion leaders from each ward from the participants in the workshop
3. Prepare micro-plans for each ward on waste management by tabulating gaps, mapping garbage vulnerable points along with resources required and possible sources of problems.
4. Perform route cause analysis of the issues.
5. Formalise micro-plans/pocket plans through Institutionalisation.
6. Engage, train and deploy teams of mobilisers for

door-to-door follow-ups and through dialogues with community members.

7. Mobilisers must work close coordination with community leaders and ensure they conduct at least one to two joint visits/interactions to all households
8. Identify community leaders with the help of known opinion-makers to form a ward-level committee and jointly formalise its bylaws.
9. Institutionalise the committees in the municipal framework by passing resolutions and orders and sharing this information through public notices in newspapers and other media channels.
10. Regularise monthly/bi-monthly reviews on key issues on waste management.

(The municipality must take decisions on different subjects and issues it wants to introduce through these associations and committees in localities where they can serve as channels for faster uptake of cooperation from community members.)





## 5.5 STRATEGIC GOAL E: REVIEW, MONITORING AND INNOVATION FOR SUSTAINABLE SERVICES

### Engagement with institutions-

1. The municipality must ensure regular interactions through meetings in office or in field while ensuring maximum participation from committee members.
2. The municipality must institute contests, drives and competitions with these Institutions (Inter-institutions/Intra-institutions) on pre-defined parameters on cleanliness, Source segregation and waste recycling themes will keep the momentum high within the town while also ensuring that the issue of waste remains relevant throughout the year.
3. The municipality must organise trips to model areas/committees that perform exceptionally well so that others can learn from their best practices. This will facilitate cross-learning
4. All visits by senior officials must be accompanied by at-least few committee members to empower the newly-formed group and enhance their self-esteem.

### Institutionalisation-

By creating a culture of engagement, we can motivate community leaders while also encouraging an enabling environment. Participation must go beyond immediate need of behavior change communication.

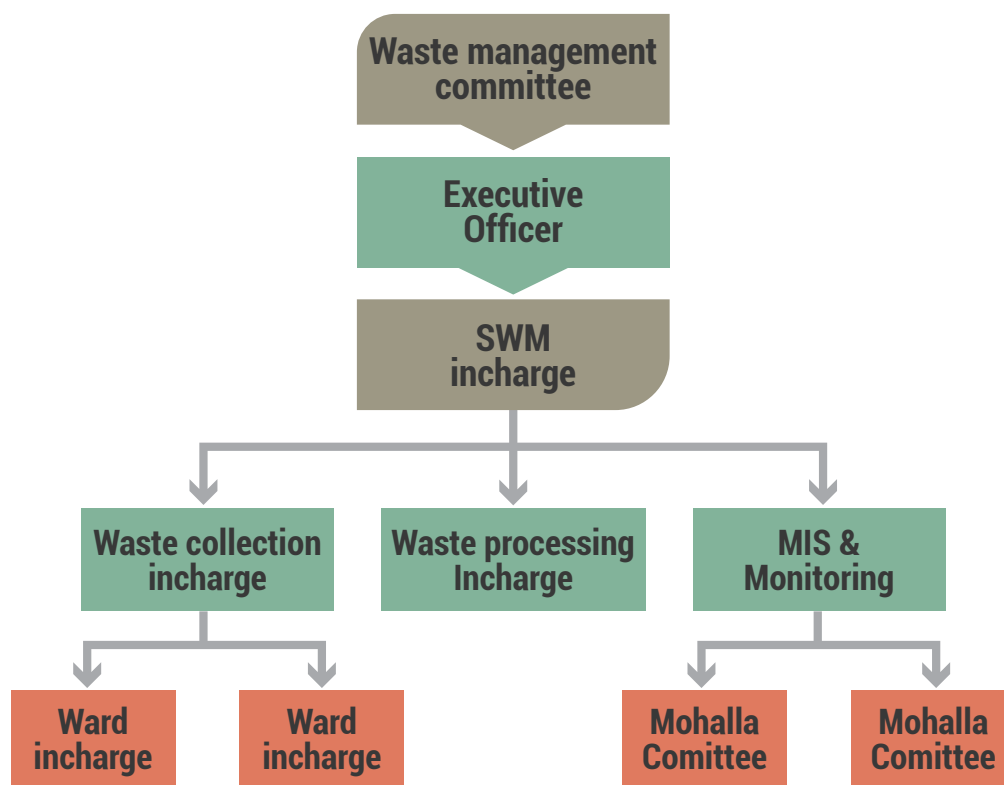
The municipality must ensure bylaws in its powers for "regularisation" of such committees around waste management. These bylaws must be passed and advertised for the public at large.

S. No.	Institutions	Roles Expected	No s Recommended
1	Mohalla Committee/Resi dent Welfare Associations	Micro-planning of sanitation and waste in pockets, conduct door-to-door contact drives, Conduct monthly review with municipal officials and their representatives, Ensure source segregation and user fee collection. Promote methods of home composting and other principles of reduce/reuse	One every 200 to 300 Households
2	Hotel Associations/Re staurant Associations	Ensure adherence to source segregation, Participate in reviews, conduct meetings internally for challenges and present the case with authorities, Cooperate for identification of bulk waste generators, Ensure adherence to NGT guidelines on commercial waste, Ensure user fee charges to municipality	One for each category such as hotels, restaurant and other institutions
3	Waste recyclers/ aggregators waste pickers	Ensure timely collection and quality services to the inhabitants of Leh. Use personal protective equipment. Follow guidelines of the municipality in terms of waste handling and storage. Share data, test trends and market opportunities	One for businesses and one for waste pickers.

## Solid Waste Management Cell-

Generally, solid waste is managed by executive officers through the Health and Sanitation Department in most of the country. In view of competing priorities in this department, the steps needed to address issues of waste management often take a backstage.

Hence, we recommend a solid waste management organo-gram where dedicated efforts will be channelised on a daily basis.



In the table below we list recommendations, selection criterion and main roles and responsibilities of each function from the organogram-

S. No.	Function	Background /Selection	Key roles and Responsibilities
1	Solid Waste Management Committee	Committee will be comprised of the Chairperson of the Municipality as Chairperson and selected members from ward Councillors (committee will have three to five members as per discretion of the Chairperson	<ol style="list-style-type: none"> <li>1. To make policy decisions regarding levying collection charges, guidelines.</li> <li>2. Review key indicators on a periodic basis.</li> <li>3. Provide budgetary approvals and functional approvals.</li> </ol>
2	Executive Officer	Official Executive Officer for Municipality	<ol style="list-style-type: none"> <li>1. Participate in regular reviews.</li> <li>2. Conduct joint field work with the waste management team.</li> <li>3. Analyse data of performance and report to the Waste Management Committee.</li> <li>4. Identify need for capacity/skills for staff.</li> <li>5. Reward performing staff members.</li> </ol>

3	SWM Incharge	Senior health Official or Technical officer (AEN, JEN) from technical wing of the municipality	<ol style="list-style-type: none"> <li>1. Prepare monthly and quarterly plans.</li> <li>2. Participate in review meetings and conduct field assessments of key parameters.</li> <li>3. Maintain good rapport with representative organizations and associations.</li> <li>4. Ensure motivation and involvement of the Health and other line departments on a daily basis.</li> <li>5. Share information and key circulars from state government/UT.</li> </ol>
4	Waste Collection In charge	Senior Person from Health Department	<ol style="list-style-type: none"> <li>1. Ensure coverage of waste vehicles.</li> <li>2. Ensure maintenance and retrofitting of waste collection vehicles.</li> <li>3. Ensure staff members use Personal Protection Equipment.</li> <li>4. Design job rotation chart for support staff.</li> <li>5. Ensure source segregation, emptying of bins as per time and schedule.</li> </ol>
5	Waste Processing In charge	JEN/AEN of technical Wing of Leh Municipality	<ol style="list-style-type: none"> <li>1. Ensure smooth functioning of plants.</li> <li>2. Monitor labour at the plant.</li> <li>3. Ensure proper functioning and maintenance of machines.</li> <li>4. Ensure records, book keeping of waste streams and sharing of information with municipality.</li> </ol>
6	MIS and Monitoring	Clerical staff with skills to operate a computer	<ol style="list-style-type: none"> <li>1. Collate information on waste collection and processing on a daily basis.</li> <li>2. Disseminate orders, circulars and information to all the personnel on a regular basis.</li> <li>3. Share key indicators with all stakeholders.</li> <li>4. Prepare and release rankings of various wards and areas for knowledge and Improvement.</li> <li>5. Register complaints with complaints numbers and follow up for redressal with respective ward incharge.</li> </ol>
7	Ward In charge	Sanitary inspectors	<ol style="list-style-type: none"> <li>1. Overall responsible for waste collection, road sweeping and cleaning of public places in respective wards.</li> <li>2. Field visits to address grievances/complaints.</li> <li>3. Ensure collection of feedback from waste generators and share them with SWM in charge for necessary action.</li> </ol>
8	Mohalla committees/association of hotels/institutions	Waste generators	<ol style="list-style-type: none"> <li>1. Work as a medium of communication and feedback between the community and municipality.</li> </ol>



## Monitoring and evaluation framework-

It is very critical that the Municipality introduce a mechanism to ensure waste management follows the broader guidelines under NGT and municipality bylaws and feedback received from waste generators. To measure the effectiveness of system indicators and the frequency of measurement, a mechanism of verification must be institutionalised within the waste management cell"

S.No.	Indicator	Data collection mechanism	Frequency of collection	Evaluation
1	Number of households covered during door-to-door waste collection	By extrapolating the average waste weight to number of waste generators	Daily	Random sampling by Health Department/SWM in charge/GPS route log
2	Number of households separated/source segregated waste in dry, wet and domestic hazardous waste components	Green workers report with particular vehicles.	Daily	Random sampling by Health department/SWM in charge/ Weight receipts of every vehicle.
3	number of bulk waste generators identified and practicing in house composting	Survey by health /sanitary inspector	Monthly	Tele-calling by MIS person/random visit by municipality
4	Number of waste generators paying user charges	Field report by sanitary inspector	Monthly/ quarterly	Calling on contact numbers/random visit by ward In-charge
5	Number of complaints received and resolved related to waste collection	By MIS In charge	Daily	MIS track sheet/call log register
6	Number of Health workers using protective equipment while working	SWM In charge/ WhatsApp image while on round	Daily	Photographs/random visits
7	Number of vehicles covered while transporting waste	MRF In charge	Daily	Photograph of facility while trucks are entering
8	Amount of Total Waste handled in MRF plant. (Composition of dry and wet Waste)	Weight log register	Daily	Weight receipts to be checked on a weekly basis by SWM in charge
9	Quantities of recyclables from MRF plant and weight of compost produced.	Weight receipts/outward register of material movement	Weekly/ monthly	
10	Number of workers deployed in MRF	Attendance register	Daily	
11	Value realization from waste sale/recyclables sale	Bank records/cheque receipts	Monthly	Account's personnel.

# **6. IMPLEMENTATION TOOLS AND MECHANISM**

## 6. IMPLEMENTATION TOOLS AND MECHANISM

A range of policy measures, instruments and incentives will be required to ensure effective implementation the town's Municipal solid waste management strategy and action plan. Few relevant tools and mechanisms are briefly described below :

The legislation and regulations need to be well designed but more important is the effective compliance of these rules and regulations. It will be crucial to monitor and enforce these rules and regulations for successful waste management practices in the town.

### 6.1 Legislation and regulation

Appropriate legislation and associated regulatory requirements to be set by the Urban Local Body will be essential for guiding the execution of the town's waste management strategy and action plan. The provisions should include:

- (i) Notification of solid waste management byelaws for the Union Territory of Ladakh
- (ii) Notification of policy on Promotion of City Compost in accordance with Ministry and Chemicals and Fertilizers
- (iii) Notification of policy on biomedical waste and construction and demolition waste
- (iv) Practical standards and guidelines for managing discharges to air, water and soil from waste management facilities and set standards for landfill construction and incinerator operations in accordance to Jammu and Kashmir Pollution Control Board rules and regulation;
- (v) Proper licensing of services/facilities for slaughterhouse, biomedical and army/air force waste management
- (vi) Guidelines for proper management of specific waste streams mainly slaughterhouse waste, biomedical waste,
- (vii) Detailed features of waste management system infrastructure as bin sizes, separation classifications, time and frequency of collection, etc.
- (viii) Actions to address greenhouse gas emissions that have a bearing on the management and operations of landfills and incinerators; and
- (ix) Land use policies which specify the designation of available land for landfills and other waste treatment facilities.

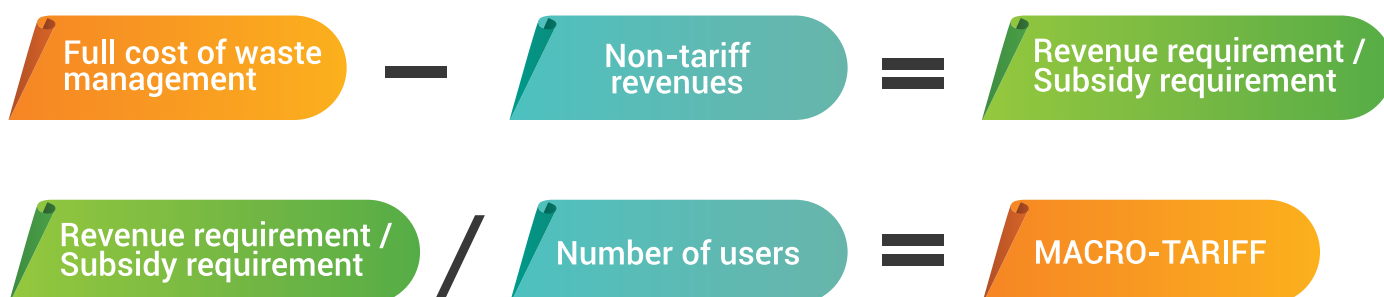
### 6.2 Financial instruments

The use of financial instruments by the Urban Local Body is crucial for an effective and efficient waste management system by meeting all operation and maintenance costs through revenue generation from user fees and other fines. It is important to transfer costs of waste management to waste producers thus easing O&M cost pressure faced by the MCL and providing supplying funding for improve the waste management system.

- Below are a few financial instruments that aid in waste reduction, transfer of processing costs to the waste producer/generator and/or contributing to financing waste management activities
- Financial instruments like 'Pay-as-you-throw (PAYT)' can serve as a strong incentive for reducing waste generation and encouraging source separation at source, in turn maximising revenue generation from re-use and recycling.
- Correct user charge/fee for both residential and commercial institutions to be set which must be agreed to by both the service provider and the public
- Extended Producer Responsibility (EPR) is a financial instrument that can transfer a great deal of the processing costs to the waste producer, in turn reducing the amount of waste generated
- Fee for use of single-use plastic: Levy taxes/fees on use of single-use plastic to deter households and manufacturers from their use and contribute to waste management activities
- Subsidies can be issued by the MCL when key business actors, such as domestic recycling firms, face barriers to market entry

Incentives for source segregation of waste into three categories

## Determining correct fees to be imposed for waste management services



### 6.3 Choice of technology

Municipal Committee Leh should adopt specific technologies that are best suited to local circumstances. Given the current quantum of waste generated and level of resources, MCL may wish to utilise technologies that are low-cost and low maintenance like mechanized sweeping machines, smaller vehicles for primary collection of waste, on-site composting, as opposed to capital-intensive equipment.

The Municipal Committee Leh should also opt for Information & Communication Technology tools that have revolutionised Solid Waste Management. It integrates all municipal waste management tools into one system with a single control room. This technology can provide visibility to urban sanitation and solid waste management, route planning for garbage collection, resource optimisation, efficient asset management, efficient maintenance, visibility of waste bins etc. Most ICT Tools contain an informative dashboard with an array of features that can be customised to the needs of MC, Leh. An informative dashboard not only allows us to track the efficiency of all the workers involved but also inculcates transparency in the system ensuring no waste being generated remains unaccounted. By employing these applications, we ensure that waste is collected, transported and treated in the most optimised way possible. This system also works as an O&M tool. Real-time data helps you anticipate various variables and plan accordingly.

Below are the features of the proposed dashboard integrated in these applications.

- GIS Data Visualisation for D2D
- NFC Tag Installation – D2D and Bins
- Driver's App – D2D Tag Reading

- Field Staff App
- Mobile Handheld NFC Reader
- RFID Tags for Vehicles (for route optimisation and scheduling)
- Citizen's App
- Informative Dashboard

Continuous research and development are necessary in identifying waste solutions and improving existing service provision in implementing the town's waste strategy and action plan in the long run.

### 6.4 Awareness raising and public education

Influencing behaviours, attitudes and practices of concerned stakeholders is also fundamental to the successful implementation of the waste management strategy and action plan of any city or town. Raising awareness and educating the public on the following:

- Minimizing waste consciously by not purchasing products that generate large quantities of waste or are products that are not environmentally friendly.
- Composting food waste at home
- Engaging in segregation of waste in dry, wet and domestic hazardous
- Early education of children about the importance of managing waste properly and responsible behaviour

## 6.5 Monitoring and performance assessment

In order to implement the city's waste strategy and action plan there should be regular monitoring, with progress and performance assessed against its specified goals and targets. Monitoring and evaluation in this way works to identify a known starting point, providing the possibility of establishing whether or not anticipated milestones have been reached as time goes on. However, locating sound waste related data and information is often difficult to access and stands as one of the most challenging aspects of carrying out a waste management strategy. Data collection and information sharing is therefore a key element of strategy implementation. Information is not only an essential element of effective policy; it also can comprise a policy tool in itself. For instance, a decree or statute may mandate that entities of various kinds—mostly but not exclusively private companies— to publicly report on their discharge of hazardous chemicals to the environment. In such a case, the law might also include a requirement that offsite transfers of hazardous wastes for treatment or disposal be registered with the appropriate authorities. This reporting process serves several purposes: informing the public of polluting activities; providing required information to governments; and imposing a discipline on reporting entities themselves. However, such programmes also rely on the nature of the reported information in order to influence specific behaviour. Likewise, public sustainability reporting undertaken by companies, often on a voluntary basis, typically provides information on a wide range of parameters, including waste generation.

## 6.6 Commitment and partnership building

Lastly, establishing a transparent and credible commitment of all involved stakeholders— members of the public, city staff, political decision makers, informal and formal business sectors, among others—is paramount for ensuring the waste management strategy and action plan is fit for purpose and implementable over time. In this way, the strategy and action plan, together with its attendant rules, standards, and regulations can help to coordinate the actions of different actors based on a level of shared expectations. Resolving future commitment-related challenges rests on designing the strategy and action plan in a consultative and participatory manner, providing all stakeholders the opportunity to contribute to the decision-making process and reflecting these inputs in the city's legal and political system, even in the face of changing circumstances and incentives. This includes ensuring the continued involvement of political authorities throughout the strategy design process, as well as launch and implementation. In much the same way, cooperation and partnership can be sustained over the long term by limiting opportunistic behaviour, including through mechanisms such as rewards or penalties.













Funded by  
The European Union

Ladakh Ecological Development Group (LEDeG)

Karzoo, Leh,  
Ladakh 194101,  
India

T : +91-1982-253221; +91-1982-252284

[mail@ledeg.org](mailto:mail@ledeg.org)

[www.ledeg.org](http://www.ledeg.org)

[www.lehvision2030.com](http://www.lehvision2030.com)