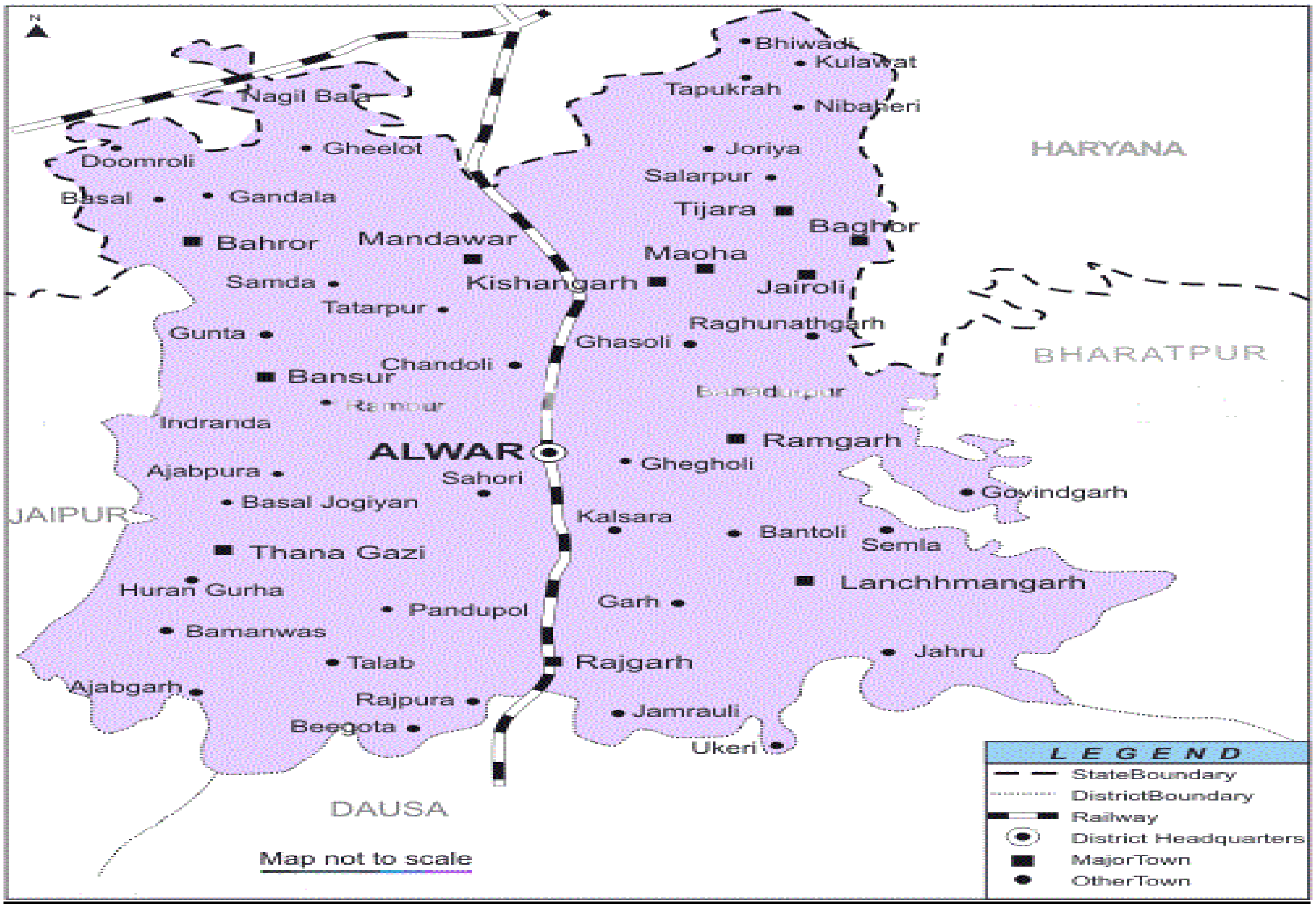
DISTRICT ENVIRONMENT PLAN

for

Alwar District



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Acknowledgement

It gives us immense pleasure to present the District Environmental Plan for Alwar district. We acknowledge the support and constructive push of Smt. Sreya Guha, IAS, Principal Secretary, Shri Pavan Kumar Upadhyay, Secretary, Department of Forest & Environment, Govt. of Rajasthan to complete the District Environment Management Plan. We express our sincere gratitude and indebtedness towards the District Collector, Shri Nannumal Pahadia, IAS, for his invaluable guidance and encouragement throughout the process of preparation of the environment plan. The team thank the contribution and support of Shri Vikram Kesharee Pradhan, Director cum Joint Secretary, Department of Forest & Environment, Govt. of Rajasthan. The constant support of Shri Kamlesh Meena Commissioner, Alwar ULB; Shri Mukesh Kumar Sharma Commissioner, Bhiwadi ULB is also sincerely acknowledge in formulating this plan. The Forest Department (especially Shri Apoorva Krishna Srivastava, the Deputy Conservator of Forest) has been the guiding light for us in this humongous task of collecting data, analyzing it and drawing inferences from it. This work would not have been possible without their support.

We also express our gratitude to all the Executive officers of ULBs in the district. Some officers that we interacted directly with are Mr. Ankit Shrivatsav, and Mr. Surender Yadav Assistant Engineer, Bhiwadi ULB; Mr. Rajesh Verma, Water Resources, Alwar; Mr. Vivek Goel, RO, Bhiwadi (Pollution Control Board); Sh. Sharad Saksena, RO Alwar (Pollution Control Board); Mrs. Sonali, Excecutive Engineer, (Pollution Control Board).

We express our sincere thanks to various departments: Regional Office Rajasthan State Pollution Control Board, District Transport Office, Police Department, Zila Parishad, Nagar Palika /Nagar Parishad, Department of Water Resources, Public Health Engineering Department, District Industrial Centre, Factories and Boilers office, RIICO, Education Department, Health Department, SPCB, Public works Deptt, Agriculture Department, Mining Department; in the district for their whole-hearted support in this work.

We also thank Prof. Uday Kumar Yaragatti, Director, MNIT Jaipur, Prof. Gunwant Sharma, Dean R&C, MNIT Jaipur for their constant support and help in timely executing the work. We also thank Shri Surjeet Singh, Secretary-General, ISPER, Panchkula for providing his valuable suggestion for the improvement of the work. The team also thank M. Plan and M. Tech. students, who have contributed a lot to the exercise.

Preface

Our biosphere is rigidly limited with finite resources. Humankind, regardless of its technological advancements till date and far in future, remains in a state of obligate dependence on the productivity and life support services of the ecosphere. It is necessary to examine environmental burdens arising from development choices and prepare an environmental management plan to enhance preparedness in mitigating the adverse environmental impacts of development.

The District Environment Plan for Alwar district has been prepared in pursuance of the directions issued by the Honorable National Green Tribunal (NGT) and is based on Model template for District Environment Plan proposed by Central Pollution Control Board (CPCB), New Delhi. The plan presents the current status of various environmental attributes, identifies probable environmental issues and proposes an action plan. I am confident it will be a useful reference in planning and executing various development schemes of the district for maintaining the environmental quality and will prove to be an invaluable asset for concerned departments.

The active participation, invaluable contributions and team effort of all the concerned district officials is highly appreciated with a request to forge similar synergies in their respective domains to make this plan a success.

Special thanks are extended to Dr. Nand Kumar, Associate Professor and Head, Department of Architecture and Planning; Dr. Virendra Kumar Saharan, Department of Chemical Engineering; Dr. Vivekanand Vivekanand, Associate Professor, Centre for Energy & Environment; Dr. Ashwani Kumar, Assistant Professor, Department of Architecture and Planning; MNIT Jaipur and their team for accepting the task of preparing the district environment plan for Alwar district. Thier relentless efforts throughout the preparation of this report are highly appreciated. The plan shall surely prove fruitful to the region and the people of Alwar.

Alwar — Shri Nannumal Pahadia, IAS

October 2021 — District Collector and District Magistrate

Prologue

Nature is indispensable to our lives; we are solely dependent on natural processes for the bulk of our waste disposal; for most of the cycling of chemical nutrients that sustain our food production; and for maintaining a library of genetic information. In the backdrop of the fact that biosphere is rigidly limited with finite resources and humankind regardless of its technological advancements till date and far in future remains in a state of 'obligate dependence' on the productivity and life support services of the ecosphere, it is necessary that development choices are made in cognizance of the environmental carrying capacity.

There is a complex set of relationships, arising firstly from our place in nature, secondly coloured by our system of values, thirdly leading us to specific kinds of conduct, and fourthly leading us to attempt modifications of nature. This modification of nature may take many physical forms; varying with our varied needs. Notwithstanding the varied physical forms arising from our differentiated activities, in fact we are simply a part of a large and exceedingly complex system and are continuously adjusting our relationship with nature. The overall aim of environmentally sound development, therefore, is to minimize the negative impact of development on the environment.

Vision

The Government of Rajasthan intends to adopt 7R approach (Reduce, Reuse, Recycle, Refurbished, Recover, Refill, and Remove) by imparting thrust on collection, segregation, improving data and analytics, minimizing environmental impacts, creating market for recyclable products and aiming towards sustainable development. The principle of 7R is essential strategy for achieving the sustainability. It reduces the load and over exploitation on the natural resources and is a key for resource efficiency. It envisions sustainable use of natural resources like cultivable land, forests and water bodies and also aims at reversing environmental degradation by restoring the degraded ecosystems thus ensuring their availability for future generations.

Mission

Environmental concerns in India have been attended significantly in the past few decades marked by notable increase in citizen awareness, proactive approach by governments and landmark judgments by the judiciary and evolution in jurisprudence. At this juncture, it is pertinent to evolve context specific strategies to attend the environmental concerns. The district environment plan is one such attempt to examine environmental burdens arising from development choices and prepare an environmental management plan to enhance preparedness in mitigating the adverse environmental impacts of development at the district level. Subsequently, information from all district environment plans shall serve as basis for preparing the State Environment Plans and finally, the National Environment Plan.

Central Pollution Control Board (CPCB), New Delhi, in pursuance of the directions issued by Honorable National Green Tribunal (NGT) has placed the model template of the District Environment Plan on its website, which specifies the scope, data requirements and structure of the report. Typically, District environment plan should outline the present status and gaps in implementation and also identify agencies responsible, requirement of infrastructure facilities for sewage treatment, waste management, monitoring environmental quality etc. District environment plan should also provide timelines for implementation; identify local issues, constraints in implementation, priority action areas and issues requiring more attention. Accordingly, the report on 'District Environment Plan for Alwar District' is being organized in sixteen chapters and the chapter outline is presented below, in sequel.

Chapter 1 Introduction: The Chapter deals with background information for preparation of the District Environment Plan along with its objectives, scope, and the details of the District Environment Committee for Alwar district of Rajasthan state.

Chapter 2 Profile of the Alwar District: A brief profile of the aspects that define the development context of Alwar district such as: Administrative System, Geographic Location and regional connectivity, Topography and Climatic Conditions,

Chapter 3 Demography of Alwar District: A brief profile of the aspects that define the development context of Alwar district such as: Demographic profile, Economy and Workforce Profile, Industrial Profile, Social and Physical Infrastructure; etc. is presented in this chapter.

Chapter 4 Waste Management: duly filled and verified dataset of the CPCB prescribed waste management parameters i.e., Solid Waste Management, Plastic Waste Management, Construction and Demolition Waste, Bio Medical Waste Management, Hazardous Waste Management, and E- Waste Management, ULB wise analysis of existing scenario and future projections, present status of implementation, identification of gaps, the details of action plan, actionable points along with proposed timeline and estimate of financial cost is presented in the chapter.

Chapter 5 Water Quality Management Plan: duly filled and verified dataset of the CPCB prescribed water quality and Domestic Sewage parameters, an analysis of existing scenario, present status of implementation, identification of gaps, the details of action plan, actionable points along with proposed timeline is presented in the chapter. The chapter also has description for Rainwater Harvesting provisions in the district.

Chapter 6 Air Quality Management Plan: deals with the Status and Inventory of Air Quality Management in the Alwar District along with a brief insight on each of the air pollutants. 'Noise Management Plan' deals with the Status and Inventory of noise pollution in Alwar District. Duly filled and verified dataset of the CPCB prescribed water quality and Domestic Sewage parameters, an analysis of existing scenario, present status of implementation, identification of gaps, the details of action plan, actionable points along with proposed timeline is presented in the chapter.

Chapter 7 Industrial Waste Management Plan: duly filled and verified dataset of the CPCB prescribed Industrial Waste Management parameters, an analysis of existing scenario, present status of implementation, identification of gaps, the details of action plan, actionable points along with proposed timeline is presented in the chapter.

Chapter 8 discusses the ‘Mining Activity Management Plan'. Alwar district is rich in mineral resources. Alwar is fairly endowed with various minerals whose industrial use has immensely contributed to the economy of the district.

Chapter 9 on Rural Environment Management Plan is a comprehensive account of different aspects of the environment in the rural areas of the district.

Chapter 10 on ‘Forest Conservation Practices’ covers the general information regarding types of forest found in Alwar district, forest land, the current management practices being adopted. The threats to forest/forest land in context to this district have also been identified and discussed. Finally, different afforestation activities proposed in forest land, as well as city/town area, are listed along with brief action plans.

1. Introduction

1.1 District Environment Plan: Background

On July 15, 2019, the Honble National Green Tribunal in New Delhi issued an order in O.A. No. 710/2017 titled Shailesh Singh Versus Sheela Hospital and Trauma Centre Shahjahanpur that it is necessary to have a District Environment Plan to be operated by the District Committee, and on September 26, 2019, the Honble National Green Tribunal in New Delhi issued an order in O.A. No. 360 of 2018 filed by Shree Nath Sharma Vs Union of India and others that it is necessary that CPCB is directed to assist the District Magistrates in the creation of the District Environmental Plan by putting a model plan on its website. All districts, under the supervision of the District Magistrate, may adopt this model plan as needed to meet local needs.

In the above-said order, it is stated that among others

"Chief Secretaries may personally monitor compliance of environmental norms (including BMW Rules) with the District Magistrate once every month. The District Magistrates may conduct such monitoring twice every month."

"We find it necessary to add that in view of Constitutional provisions under Articles 243 G, 243 W, 243 ZD read with Schedules 11 and 12 and Rule 15 of the Solid Waste Management Rules, 2016, it is necessary to have a District Environment Plan to be operated by a District Committee (as a part of District Planning Committee under Article 243 ZD) with representatives from Panchayats, Local Bodies, Regional Officers, State PCB and a suitable officer representing the administration, which may, in turn, be chaired and monitored by the District Magistrate. Such District Environment Plans and Constitution of District Committee may be placed on the website of Districts concerned. The monthly report of monitoring by the District Magistrate may be furnished to the Chief Secretary and may be placed on the website of the district and kept on such websites for a period of one year. This may be made operative from 1.08.2019. Compliance of this direction may also be seen by the Chief Secretaries of the States/UTs. This may not only comply with the mandate of law but provide an institutional mechanism for effective monitoring of environment norms."

In light of the above discussion, it has been proposed that the Alwar District Environment Development Plan be prepared in such a way that it not only outlines the current status and gaps in implementation, but also identifies the agencies responsible, as well as the need for infrastructure facilities for sewage treatment, waste management, and environmental quality monitoring, among other things. It also includes implementation timelines, local issues, implementation constraints, priority action areas, and issues that require additional attention.

State and national environmental plans will be developed based on the District Environment Plans. It is necessary to ensure that information from all District Environmental Plans is incorporated into State and National Environment Plans.

1.2 Constitution of District Environment Committee

The District Collector of Alwar, vide letter no. F-Misc./2020-21, issued the directives. For the purpose of preparing the District Environment Plan, Rajasthan State Pollution Control Board, Department of Environment, and an officer representing the administration formed a District Committee with representatives from Village Panchayats, Municipal Councils, Regional Offices, Rajasthan State Pollution Control Board, Department of Environment, and an officer representing the administration. In collaboration with Shri, Head of District Environment Committee and District Collector, Alwar, MNIT Jaipur has been tasked with preparing the District Environment Plan.

This plan was created in accordance with the CPCB's model District Environment Plan (DEP) and covers the following topics:

- Waste Management Plan
- Solid Waste Management Plan
- Plastic Waste Management
- C&D Waste Management
- Biomedical Waste Management
- Hazardous Waste Management
- E-Waste Waste Management
- Water Quality Management Plan
- Domestic Sewage Management Plan
- Industrial Wastewater Management Plan
- Air Quality Management Plan
- Mining Activity Management plan

- Noise Pollution Management Plan

The awareness about the preparation of District Environment Plans among the stakeholders of each department were created in a time-bound manner and action plans were formulated to implement it.

1.3 National Green Tribunal Directions

A. According to the NGT's order dated 15.07.2019 in O. A. No 710-713/2017, O.A. No. 606/2018, numerous stakeholders are responsible for making the solid waste management plan a successful and implementable action. National Green Tribunal has issued several directions in various matters which have been based on status brought out by the CPCB on their website and status reports filed before the Tribunal.

B. In the present case, it was stated in an order dated September 26, 2019: - I While dealing with the compliance of the Municipal Solid Waste Management Rules, 2016, this Tribunal raised various issues and necessitated monitoring at the level of the Chief Secretaries and District Magistrates in O.A. No. 606/2018. The Chief Secretaries of all the States/UTs, including the Chief Secretary of State of Rajasthan, have appeared before this Tribunal, and orders have been made for continued surveillance and the filing of additional reports. (ii) The direction has been issued by order dated 12.09.2019, while assigning a timetable for the future appearance of the Chief Secretaries of all the States/UTs to compile information with reference to the following specific thematic areas viz.:

- Compliance with Solid Waste Rules including Legacy Waste.
- Compliance to Bio-medical Waste Rules.
- Compliance with Construction & Demolition Waste.
- Compliance with Hazardous Waste Rules.
- Compliance with E-waste Rules.
- 351 Polluter Stretches in the country.
- 122 non-attainment cities.
- 100 industrial clusters.
- Status of STPs and re-use of treated water.
- Status of CETPs/ETPs including performance.

- Ground water extraction/contamination and re-charge.
- Air pollution including noise pollution.
- Illegal sand mining.
- Forest Conservation Practices and Management Plan
- Rejuvenation of water bodies

C. The National Green Tribunal (NGT) has issued Pan-India Directions on a variety of environmental matters, which must be carried out by the Central and State Governments, as well as other relevant institutions. Furthermore, the Directions must be carried out at the district level, encompassing all cities, towns, and villages.

District Collectors/Magistrates, Pollution Control Boards, Municipal Bodies, Public Health Engineering Departments, and others are responsible for enforcement.

Chief Ministers/Chief Secretaries with DMs/DCs supervise the current state-level execution and monitoring framework for several State and Central Government Schemes.

The District Environment Management Plan will include NGT's various directions (DEMP).

Any District-specific cases (if any) and the Committee/Task Force that has been formed have also been discussed.

1.4 Objectives of the District Environment Plan

The objectives of this District Environment Plan (DEP) are set as given below:

- To ensure the conservation of the environment and natural resources at the district level.
- Restore ecological balance.
- To achieve the Sustainable Development Goals (SDGs) and district level targets within the prescribed timeline.
- To ensure sustainability at the district level following the principles of resource efficiency.
- To ensure decentralized micro-level planning, execution and monitoring regarding environment conservation.

- To incorporate all facets of environmental conservation in micro-level planning
- To harness the active participation of all stakeholders in planned environment conservation actions.
- Assess, mitigate and monitor adverse impacts of various pollution sources at the district level.
- Capacity building of stakeholders, departments, agencies, organizations and individuals at the district level to understand and implement micro-level environmental conservation actions.
- To harness inter-departmental coordination for the implementation of action plans.
- To develop local knowledge centres and expertise for developing environmental conservation strategies at the district level.

2. Profile of Alwar District

2.1 Introduction

In 1775, Rao Pratap Singh established the study area of Alwar. Salwapur, afterwards known as Salwar, Halwar, and finally Alwar, was the original name of Alwar, which was derived from the Salwar tribe. It is one of Rajasthan's 33 districts, and it is located in the state's north-east corner. North-east, south-east, north-west, and south-west were the four zones that Alwar was divided into.

The National Capital Area (NCR) is the country's first experimental territory, consisting of an inter-state region centred on the capital core of NCR. Rajasthan Sub-Region is a section of the National Capital Region that is located in the south-western region of the city. The Rajasthan Sub-Region (Alwar) is 8290 square kilometres in size. Alwar is located 150 kilometres west of Jaipur and 170 kilometres north of Delhi. Within the NCR, NH-8 (Delhi–Jaipur Road) runs through RSR, connecting Gurgaon, Maneswar, Bawal, and Rewari (Map-1) The Alwar district is crossed by the NH-11A, while the NH 71B connects Rewari to Palwal in the north. The railway lines connecting Delhi and Ahmadabad were built with broad gauge rail line, which passes through the Jaipur, the state capital (GoR, 2021c).

2.2 Geographic Profile

Figure 2.1 Location of Alwar district in Rajasthan (Coordinates: 27°34′12″N 76°36′00″E)

The city of Alwar is located in Rajasthan's north-eastern area. The city is situated between two metropolises: Jaipur and New Delhi, on the Delhi-Ahmedabad railway line, and stands at the foothills of the Aravalli range. Alwar city is 48.14 square kilometres in size and has a population of 315,330 people (Census, 2011). The city is divided into 50 wards. Alwar is a city in Rajasthan, India, and the administrative centre of the Alwar District. It's roughly 150 kilometres south of Delhi and 150 kilometres north of Jaipur, Rajasthan's capital. The city of Alwar is located in the National Capital Region (NCR). The Ahirwal regional includes Alwar.

Alwar, Bansur, Behror, Govindgarh, Kathumar, Kishangarhbas, Kotkasim, Laxmangarh, Malakhera, Mundawar, Neemrana, Rajgarh, Ramgarh, Reni, Thanagazi, Tijara are the 16 tehsils that constitute the district.

2.2.1 Location and Extent

The District is located between 27°34' and 28°4' north latitudes and 76°7' and 77°13' east longitudes, with a population of 36,74,179 people living in 2021 inhabited communities. The district covers an area of 8380 square kilometres. The primary rivers that pass through the district are the Ruparel and Sabi

Table 2.1 Alwar District Profile

Alwar: District	
No. of Tehsil	16
No. of towns	16
No. of statutory towns	7
No. of census towns	9
No. of villages	2054
Total area (sq.km)	8380
No. of ULBs	12

2.2.2 Land-Use Pattern

People sought security from external threats such as repeated wars and the dread of wild animals, thus the city did not expand and remained limited within the border wall until 1940. As a result, the pattern of urban land use and its structure were likewise achieved in this manner. Along tight zigzag lanes and streets, the houses were built side by side. Commercial structures with three independent chambers were built on the ground levels of residential dwellings. People's requirements altered dramatically after independence.

Though the pattern of roads in the city's center was already established under Vinay Singh's tenure, the rise of urban land use and structure could not occur until after Independence, when growing immigration necessitated the accommodation of immigrants. As a result, a number of planned and semi-planned colonies were established. These developments are distinct from those of the old walled town. House sizes shrank dramatically as the number of nuclear households grew. The expansion of many functions occurred to meet the needs of the rural population as well.

To help rural people, commercial areas providing agricultural implements and machines, as well as grain and vegetable markets, have sprung along key external routes. Furthermore, it is due to the need for industrial labourers that urban land use and structure grew near industrial sites, resulting in urban sprawl (GOR, 2013).

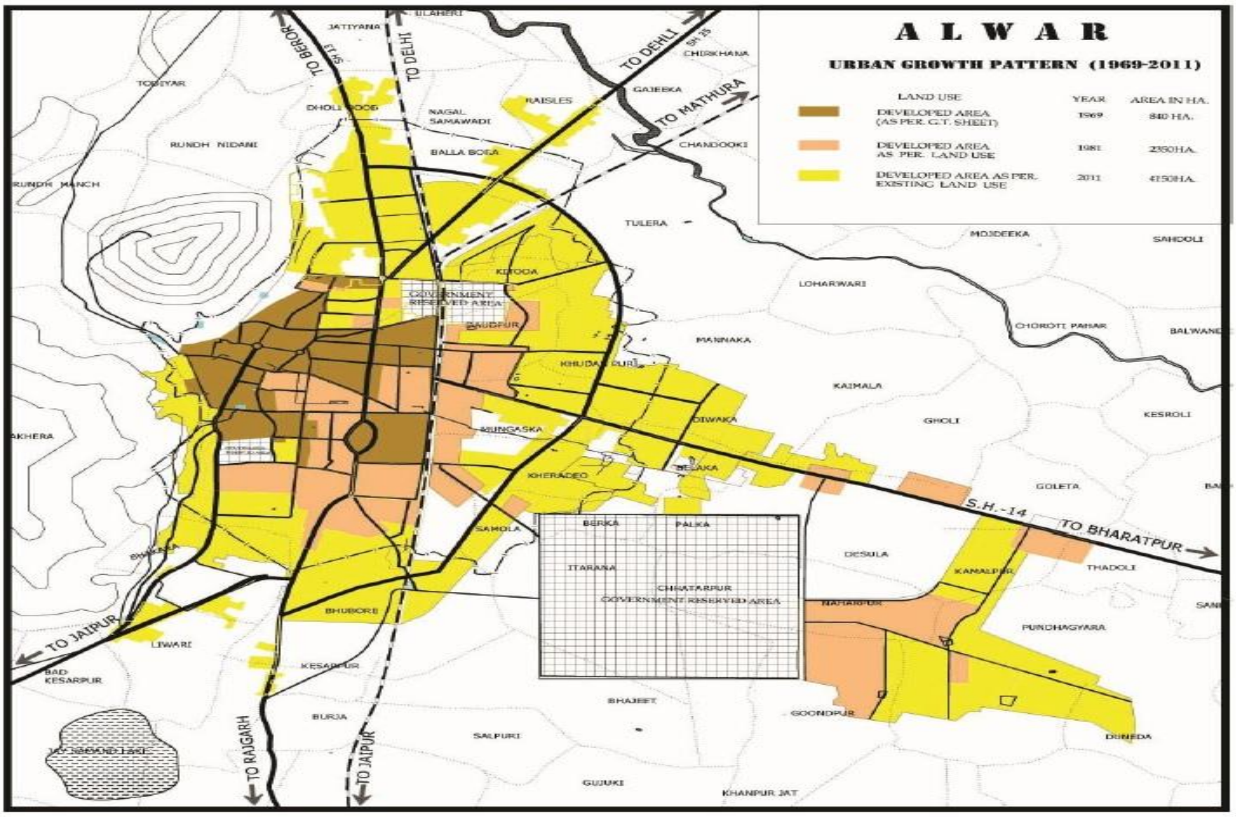


Figure 2.2 Urban Growth pattern for Alwar

2.3 Administrative Set-up

Alwar district is one of the five districts, those come under Jaipur Division.

District Collector & District Magistrate is head of the district for revenue and law and order matters. District Collector & District Magistrate is the head of District Administration. For admininstration and development the district is divided into Sub-Divisions and Tehsils.

The district Alwar has 15 Sub-Divisions. Malakhera is newly created Sub-division. There are 15 Sub Divisional Officers (SDOs) working at the sub-division level.

There are 16 Tehsil headquarters in Alwar district and each one has a Tehsildar as an administrative officer who work in accordance with the Land Record System to serve for the rural farmers and land holders

For the purpose of the implementation of rural deveopment projects/schemes under Panchayat Raj system, the district is divided into 14 Panchayat Samitis (Blocks) and each one has a BDO (Block Development Officer) to serve as the representatives of the district administration in the rural areas (GoR, 2021b).

Table 2.2 Administrative Division of Alwar District, source

S.No.	Sub-Division	Block	2Tehsil	Sub-Tehsil
1	Alwar	Bansur	Alwar	Baroda Meo (Laxmangarh)
2	Bansur	Behror	Bansur	Bahadarpur (Alwar)
3	Behror	Kathumar	Behror	Bhanokhar (Kathumar)
4	Kathumar	Kishangarh Bas	Govindgarh	Harsauli (Kotkasim)
5	Kishangarhbas	Kotkasim	Kathumar	Khairthal (Kishangarhbas)
6	Kotkasim	Laxmangarh	Kishangarh Bas	Mandhan (Neemrana)
7	Laxmangarh	Mundawar	Kotkasim	Narayanpur (Thanagazi)
8	Mundawar	Neemrana	Laxmangarh	Tapukda (Tijara)
9	Neemrana	Rajgarh	Malakhera	Tehla (Rajgarh)
10	Rajgarh	Ramgarh	Mundawar	
11	Ramgarh	Reni	Neemrana	
12	Thanagazi	Thanagazi	Rajgarh	
13	Tijara	Tijara	Ramgarh	
14	Raini	Umren	Reni	
15	Malakhera		Thanagazi	
16			Tijara	

2.4 Physical Linkages

While travelling from Delhi to Rajasthan, Alwar is considered an important city. Indira Gandhi International Airport in Delhi is 143 kilometres distant, while Jaipur International Airport is 150 kilometres away. Bhiwadi, 90 kilometres from Alwar, has also been approved for an international and cargo airport. The city is crossed by the Delhi-Jaipur railway line. Alwar is connected to Delhi, Mumbai, Jaipur, Agra, Jodhpur, Ajmer, Chandigarh, Amritsar, Katra, and other key tourist destinations in India via the railway network. Bus services are available at Alwar's old bus station, which is located 5 kilometres from the Alwar railway station (GoR, 2021b).

2.4.1 Regional Connectivity

Alwar's transportation infrastructure has not kept up with the city's rapid growth, causing lots of new commuting issues for residents. There was no city transit service supplied by the government in Alwar. For local transportation, the city operates a shared auto service that uses three-wheeled vehicles known as "Vikram" and "Ganesh." These tempos were between the ages of 20 and 25, and they were inconsistent.

2.4.2 Major Settlements in close proximity

Alwar's history and roots may be traced all the way back to 1500 BC. It is home to majestic palaces and forts from a past era, nestled within the green hills of the Aravalli range. Many kinds of birds, such as the grey partridge and white-throated kingfisher, and mammals, such as the Bengal tiger and golden jackal, thrive in the deep valleys and dense forest cover of the hills. Alwar is a traveller's dream because of its beauty and superb architecture, as well as the peaceful lakes, royal hunting lodges, lush jungles, and a socio-cultural setting unlike any other.

Bala qila

The Bala Qila (young fort) is a towering structure atop a hill that was erected on the foundations of a 10th century mud fort. The fort is made out of strong walls, beautiful marble columns, and delicate latticed balconies. Jai Pol, Suraj Pol, Laxman Pol, Chand Pol, Krishan Pol, and Andheri Gate are the six gates that lead to Bala Qila.

Alwar city palace

The City Palace, designed by Raja Bakhtawar Singh in 1793 AD, is a stunning blend of Rajputana and Islamic architecture. The beautiful marble pavilions built on lotus flower bases in the centre courtyard are the palace's feature. The Maharaja's former residence has been turned into the District Collectorate. Government offices are currently housed in its great halls and chambers.

The palace museum

The Palace Museum is a must-see for anyone interested in the Maharajas of Alwar's luxurious life and lifestyle. Rare manuscripts, such as one portraying Emperor Babur's life, Ragamala paintings and miniatures, and even historic swords originally owned by Muhammad Ghori, Emperor Akbar, and Aurangzeb can all be found here.

Moosi maharani chhatri

The Indo-Islamic style of architecture is shown in this cenotaph, which was created in commemoration of Maharaja Bakhtawar Singh and his queen, Rani Moosi. The upper section, which includes columned pavilions and domed arches, is composed of marble, while the bottom section has red sandstone pillars. The memorial is considered to be one of the best of its kind.

Fateh jung gumbad

This magnificent monument, which features a blend of domes and minarets, is a work of beauty. Its huge dome, made of high-quality sandstone, can be seen from afar and is a combination of Hindu and Muslim architecture. It is dedicated to Fateh Jung, a kind-hearted Mughal Emperor Shah Jahan's minister.

Purjan vihar

Maharaja Sheodan Singh is responsible for this lovely garden, which he designed and built in 1868. To provide relief from the hot sun, a charming spot known as Simla (the Summer House) was created in the garden.

Bhangarh

The beautiful town of Bhangarh, constructed by Raja Madho Singh in the 17th century, is 50 kilometres from Sariska Sanctuary. According to mythology, the village was cursed by an evil magician and abandoned as a result. The curse's nefarious effects are thought to be active even now. Bhangarh is one of India's most haunted cities.

Garbhaji water falls

Garbhaji Falls is a famous tourist attraction for both foreign and domestic visitors. The outstanding feature of the location is the stunning sight of water pouring from the rocks. It's popular with photographers and environment lovers, as well as those who want to go beyond the city's man-made constructions.

Hill fort kesroli

Turrets, ramparts, and arched verandas distinguish this 14th-century fort. It was constructed by the Yaduvanshi Rajputs, who are supposed to be Lord Krishna's descendants. The fort has now been turned into a heritage hotel.

Pandu pol

This temple dedicated to Lord Hanuman is reached by a trail that runs via the Sariska Sanctuary gate. A spring appears to mysteriously cascade down from the rough and solid rocks at the Pandu Pol or Pandu gate. The Pandava brothers are said to have sought refuge here during their exile, according to legend.

Neemrana fort

According to legend, the Yaduvanshis, who are thought to be Lord Krishna's descendants, built Neemrana Fort. Its history is littered with conquests and defeats, and it has moved through the hands of the Rajputs, Mughals, and Jats until returning to the Rajputs in 1775. It is now operated as a well-known heritage hotel.

Silliserh lake

This tranquil lake, 15 kilometres southwest of Alwar, is set among forested hills and displays stunning cenotaphs on its bank. Maharaja Vinay Singh built a hunting chalet for his Queen, Shila, in 1845. It is now used as a tourist bungalow.

Sariska Tiger Reserve

Sariska Tiger Reserve is only 200 kilometres from Delhi and 107 kilometres from Jaipur, making it the world's first tiger reserve to successfully move tigers. In 1955, it was designated as a sanctuary, and in 1979, it was designated as a National Park.

Tijara Jain Temple

This famous Jain pilgrimage centre is around 60 kilometres from the Alwar-Delhi road. The ornately designed ancient temple was created to honour Shri Chandra Prabha Bhagwan, the eighth Tirthankar. He ruled his kingdom for numerous years before acquiring Diksha and being initiated. He was the son of King Mahasen and Queen Sulakshana. He gained Nirvana after serving humanity for numerous years and meditating for a month.

Moti Doongri

The original structure of Moti Doongri was constructed in 1882. It served as the residence for royal family of Alwar until 1928. Maharaja Jai Singh chose to demolish the old palace in 1928 and replace it with a more spectacular structure.

Talvrakash

This fascinating spot, where pilgrims bathe in hot sulphur springs, is reached through the Sariska-Alwar road. It has a distinct atmosphere, with dispersed temple bells and strolling langurs. It is well-known for being the location where Mandav Rishi sought penance.

Bhartrihari Temple

Bhartrihari Temple is a popular pilgrimage destination that draws visitors from all across the country. It is based on the mythology of King Bhartrihari, who is claimed to have spent his final years in this ancient hilltop fortress.

Naraini Mata

This lovely site, located 80 kilometres southwest of Alwar, is home to hot springs and a temple devoted to Naraini Mata. The annual Baisakh Sudi fair attracts individuals from all castes, with the largest gathering of ‘nais' (barbers).

Neelkanth

Neelkanth is truly hidden deep within the Sariska Tiger Reserve and in the centre of the mountainous Aravalli range. Rough roads, steep curves, and little evidence of human presence line the path to the shrine, adding to the mystique surrounding it.

Naldeshwar Shrine

This shrine is located 24 kilometres south of Alwar, amidst rocky hills. Two natural ponds in the historic Shiva temple draw water from the surrounding hills. This region is exceptionally beautiful and serene during the monsoon season.

Neemrana Baori

The Neemrana Baori is located in Neemrana, not far from the fort palace. The first glance alone gives an indication of how magnificent the location may have been in the past. Neemrana Baori is an architectural masterpiece that resembles a fortress rather than a step well.

Lal Masjid, Tijara

Lal Masjid is the name of the mosque located to the east of Tijara Town. Alwar city is about 55 kilometres away (GoR, 2021e).

2.5 Physical Setting

2.5.1 Topography

Alwar city, the district headquarters of Alwar district, is situated at 27° 34' north latitude and 76° 35' east longitude, at a height of 270 metres above sea level. The district covers an area of 8380 square kilometres. It is encircled on all sides by the Aravali hills, which shield it from the sand and heat of the Thar desert. River Ruparail is the district's main river, and it supports a diverse diversity of flora and fauna (GoR, 2021a).

2.5.2 Climate

The district's climate is classified as semi-arid. Summers are scorching hot, while winters are bitterly cold, with plenty of rain during the south-west monsoon season. Summer temperatures can reach up to 47°C, while winter temperatures can plummet below freezing. The average annual rainfall is 61.2 cm (GoR, 2021a).

2.5.3 Geological and Mineralogical profile

The district is shaped like a quadrilateral. In most places, the Aravalli mountains feature rocky hill ridges and are generally parallel. These appear in the district from the north east in the Tijara subdivision and extend southwards for about 24 kilometres, terminating near Naugaon, establishing the district's northern boundary. Mandawar is another significant hill range in the district, passing through Jindoli and Alwar on its way to the district's extreme south west corner, which borders Jaipur.

A mature topography of more or less flat topped hills comprising the northern continuation of the main Aravalli range characterises the region. The territory is dominated by a folded hill range that is densely forested and home to the well-known Sariska Game Sanctuary. While the flood plains in the east and north support intensive agriculture production, Alwar is an agriculturally successful area in Rajasthan.

2.5.4 Hydrology

The rocks of the Delhi Super Group are primarily underlain in Alwar, with minor outcrops of Bhilwara Super Group and Post Delhi Intrusives at sites overlain by Quaternary alluvium. The presence of ground water in the district is primarily influenced by geographic factors, physical traits, and structural features found in geological formations. Ground water in the area is restricted in phreatic zones, semi-confined in deeper zones, and found in worn and cracked areas of the hard rocks (GOI, 2017).

3. Demography of Alwar District

3.1 Population Assessment

The purpose of population assessment is to gather the information needed to understand the type and distribution of services required for a population to gain the maximum benefit. This requires an understanding of the health and wellbeing needs of the population in order to support improvement through health and care services and other initiatives including self-care. The approach outlined here involves three stages: i) assess the level of need for health and social care services ii) describe the current pattern and level of supply of services iii) identify the extent of the gap between need and supply.

Alwar had a population of 3,674,179 people in 2011, with male and female populations of 1,939,026 and 1,735,153, respectively. Alwar had a population of 2,992,592 people in the 2001 census, with 1,586,752 males and 1,405,840 females. The population of Alwar District was 5.36 percent of Maharashtra's total population. In comparison to the population in 2001, there was a 22.78 percent increase in the population. Alwar District's population increased by 27.22 percent between 1991 and 2001, according to India's last census (GoR, 2011).

Table 3.1 Population of Alwar District

Description	2011	2001
Population	36.74 Lakhs	29.93 Lakhs
Actual Population	36,74,179	29,92,592
Male	19,39,026	15,86,752
Female	17,35,153	14,05,840
Population Growth	22.78%	27.22%

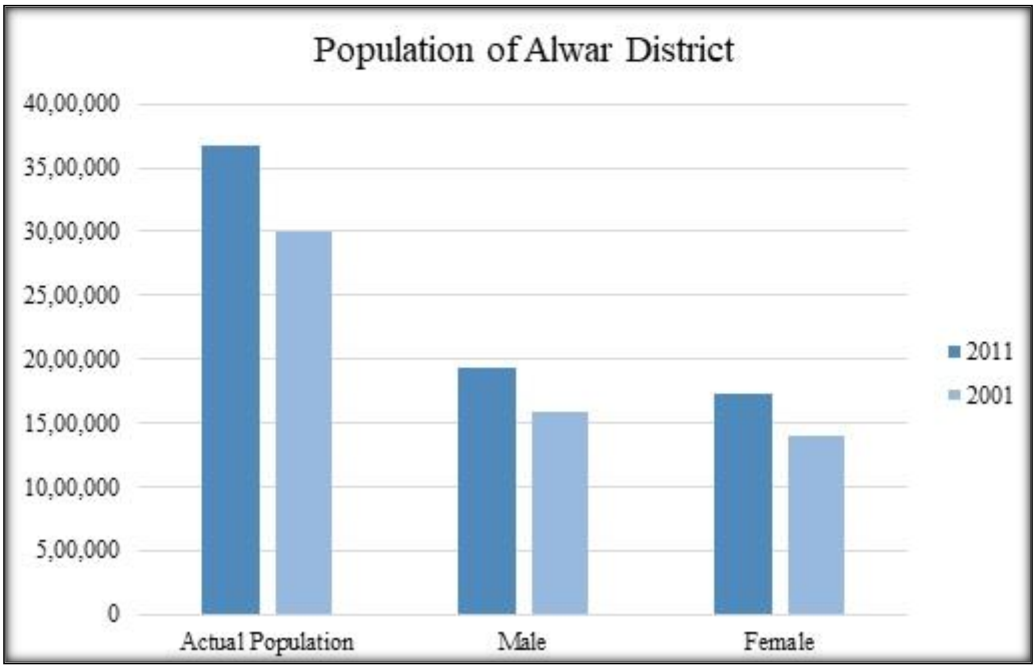


Figure 3.1 Population of Alwar District

3.2 Urban Profile of Alwar District

In the 2011 census, 17.81 percent of the people of Alwar lived in the district's urban areas. In total, 654,451 people live in urban areas, with 349,518 men and 304,933 females. According to 2011 census data, the sex ratio in Alwar district's urban area is 872. In the 2011 census, the child sex ratio in Alwar district was 851. In the urban region, there were 85,433 children aged 0 to 6, with 46,165 males and 39,268 females. Alwar district's child population is 13.21 percent of the total urban population. According to the 2011 census, the average literacy rate in Alwar district is 83.39 percent, with males and females literate at 91.02 percent and 74.67 percent, respectively.

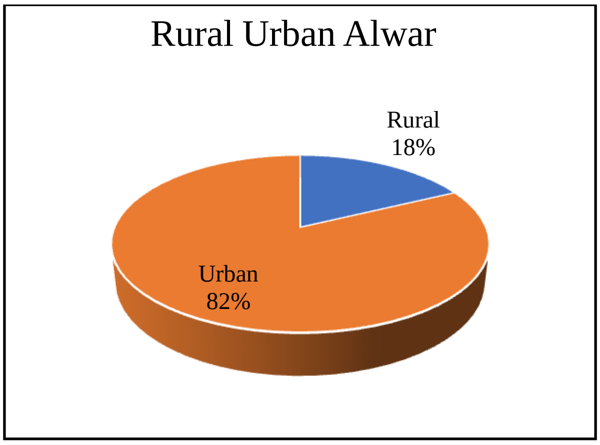


Figure 3.2 Rural Urban Alwar Population Distribution

3.3 Economy

Alwar is a transportation hub as well as an agricultural market. Cloth weaving, oilseed and grain milling, and the manufacture of paint, varnish, and pottery are among its significant industries.

Agriculture:

Alwar district has total geographical area 8380 Sqkm. The area under irrigation is 3744.94 sq km which is about 44.68 percent of the total geographical area of the District. Prominent five rivers of the District are Ruparel and Sabi. Important watershed/drainage are Sabi, Ruparel and Banganga. There are 129 tanks and dams having capacity to irrigate more than 50 acres of the land in the District.The list of important bandhs is as enclosed out of which 22 tanks are in the jurisdiction of Water resources Department and 107 tanks are in jurisdiction of Panchayti Raj Deptt.The details of 107 dams can be obtained from Zila Parishad, Alwar office (GoR, 2019).

Resources and power:

The district is a fairly regular quadrilateral in shape with its central northern portion consisting of tehsil Mandawar on the north, tehsil Behror on the west tehsil Tijeras on east and Laxmangarh tehsil on its south eastern corner. The rocks belonging to pre aravalli and consisting of schists and quartizites with intrusions of granite occur in the southernmost pene plained part of the district. The pre Aravalli is succeeded by 700 m. which sequence of metasediments belonging to Delhi super group for the study of which the district offers the type area. The rocks of Raialo Group consists of dolomite marble and felspathic quartizities with subordinate schist's and marbles whereas Ajabgarh group is dominated by phylites, marble and quartzite (GoR, 2019).

Infrastructure

The infrastructure such as Communication, transport, industrial training facilities are sufficiently developed to cater to the needs of the district. The only constraint is power supply. Similarly, the social amenities like education medical, housing, banking, etc. also seem to be sufficient for the present needs. But with the suggested industrialization program me, these facilities would have to be augmented in tune of the requirements from time to time (GoR, 2019).

Colleges & Institutes

The district has registered 86.1% the literacy rate in year 2011 of 861 in which 71.68 percent is registered for male and 85.08 for female. However, the literacy rate registered for the State as a whole in the 2011 stood at 88.3% (GoR, 2019).

4. Waste Management

4.1 Literature Review

4.1.1 Municipal Solid Waste

Any garbage or refuse, as well as sludge from a wastewater treatment plant, a water supply treatment plant, or an air pollution control facility, and other discarded material resulting from industrial, commercial, mining, and agricultural operations, as well as community activities, is considered waste. Almost everything we do produces garbage in some form.

MSW, often known as trash or rubbish, is made up of ordinary goods such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries that we use and then discard. This is found in our homes, schools, hospitals, and workplaces.

Infectious infections, land and water pollution, drain blockage, and biodiversity loss are all possible repercussion of an ineffectual municipal solid waste management system. If towns continue to dump waste without treatment at current rate, 1240 hectares of land would be needed every one year, with an estimated waste generation of 165 million tonnes bythe end of 2031, the requirement of setting up of land fill for 20 years of 10-meter height will necessary 66,000 hectares of land.

Meeting incremental infrastructural needs of an expanding urban population in India is getting increasingly difficult (CPHEEO, 2016b). As the country's population rises, municipal solid waste management has become more composite, not only because of environmental and aesthetic concerns, but also because of the huge amounts of municipal solid waste (MSW) generated every day. In 2014–2015, India generated 1,43,449 tonnes per day (TPD) of MSW, with an average waste of generation 0.11 kg per person per day, according to the Central Pollution Control Board (CPCB). Only 32,871 TPD (22%) of the total MSW was processed or handled, despite the fact that 1,17,644 TPD (80%) was collected. The amount of garbage generated per capita in India ranges from 0.2 kg to 0.6 kg, depending on the number of person at home and the economy. Isolation at source, assortment, transportation, treatment, and logical removal of waste were all inadmissible, bringing about ecological debasement and a lower expectation for everyday comforts (CPHEEO, 2016b). MSW age is irrefutably ascending over the world because of quick populace and monetary development, just as changes in living practices and buyer patterns (Al-Ghouti et al., 2021). The rising volumes of trash created would not be an issue in case trash was treated as an asset and appropriately dealt with (S. Kumar, 2016). It's important that waste be seen as a for the most part undiscovered asset for recuperating assets, acknowledging ecological, financial, and social benefits, and moving toward a more reasonable future (Ferronato and Torretta, 2019).

Municipal strong waste (MSW) dumps in Indian urban areas are in critical state (Datta and Kumar, 2016). Statures and base spaces of 62 dumps sites in 26 urban areas range from 2 to 29 m (i.e., 6 to 95 ft) and 2 to 53 hectares (i.e., 5 to 130 sections of land) separately. These dump sites have potential for ecological effect since 62% of the destinations are under 500 meter from the networks, 85% of the locales have groundwater at under 25-meter profundity and 40 % of the destinations have surface water bodies inside 2 km distance.

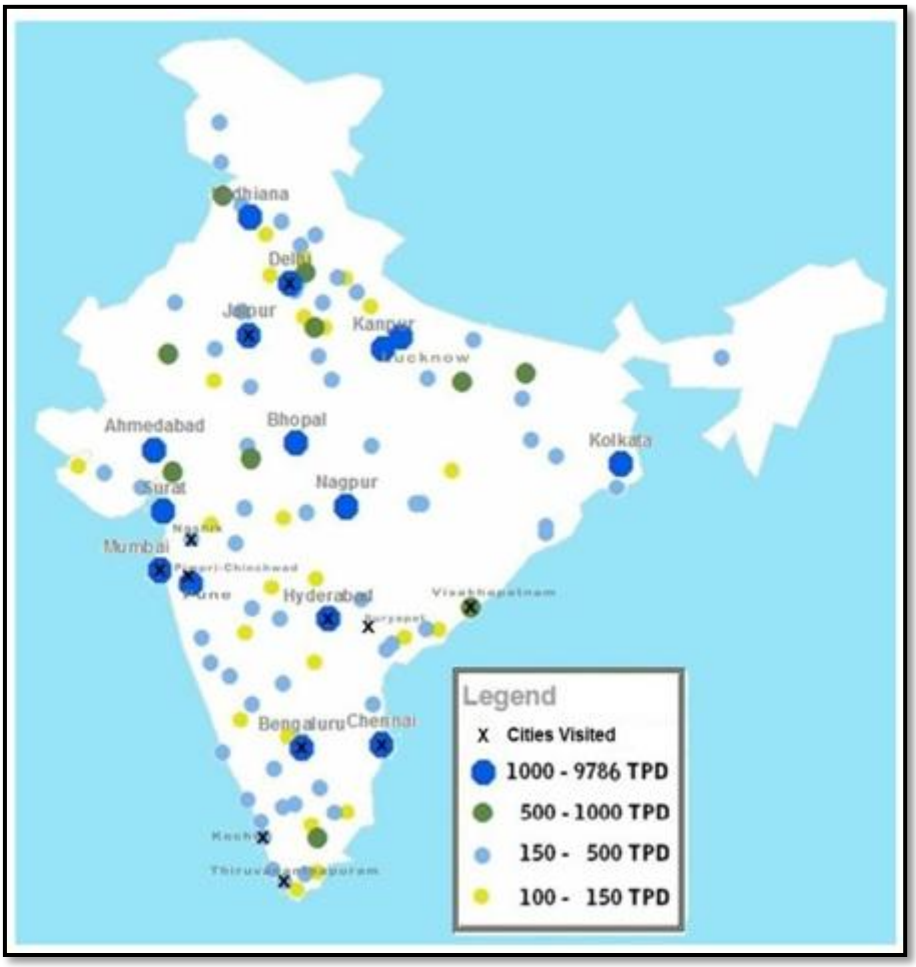


Figure 4.1 Map of Cities Generating distinct Quantities of MSW

As displayed in figure 4.2 the organization of metropolitan MSW in India is consist of 51 % organics, 17.5 % recyclables (paper, plastic, metal, and glass) and 31 % of dormant. The dampness content of metropolitan MSW is 47 % and the normal calorific worth is 7.3 MJ/kg (1745 kcal/kg). The organization of MSW in the North, East, South and Western areas of the nation differed between 50-57 % of organics, 16-19 % of recyclables, 28-31 % of inactive and 45-51 % of dampness. The calorific worth of the waste shifted between 6.8-9.8 MJ/kg (1,620-2,340 kcal/kg).

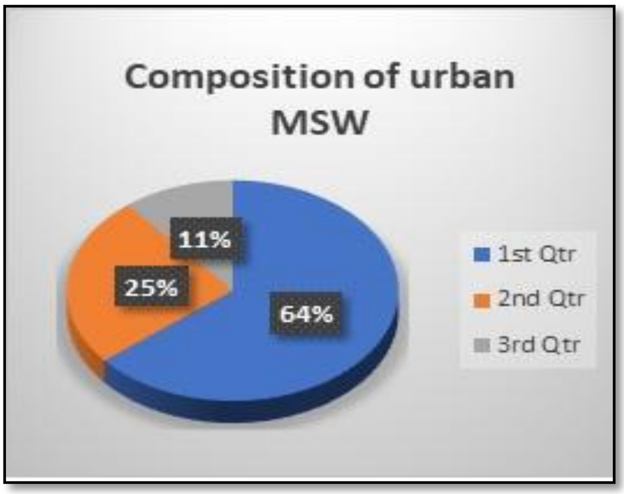


Figure 4.2 Composition of Urban MSW

The Ministry of Urban Development started the Swachh Bharat Mission (SBM) in year 2014 to advance metropolitan strong waste administration in urban areas (CPHEEO-Part I, 2016). SBM plans to advance urban communities as motors of financial development by further developing metropolitan framework quality, guaranteeing administration norms, and guaranteeing proficient administration. SBM additionally plans to determine city strong waste administration concerns and help urban areas in making present day and proper arrangements as per (CPHEEO, 2016b). Strong waste administration can be imagined as a progression of interconnected advances that start with squander age by individual families, foundations, and organizations and progress by means of Collection, Segregation, Processing, and Disposal. The cutting edge coordinated civil strong waste administration depends on the waste administration chain of command displayed in Figure 4.3 the point of which is to lessen the measure of waste being arranged while amplifying asset recuperation and productivity (CPHEEO-Part I, 2016).

All out 193 ULBs are answerable for MSW the board in the territory of Rajasthan. The all out strong waste age in the State is 6625.56 TPD out of which 6475.39 TPD is being gathered through Door-to-entryway assortment framework from 5350 wards out of 5399 wards of Urban Local bodies. Presently 780.18 TPD squander is being prepared by ULBs out of 6625.56 TPD in 4 strong waste handling offices working in the State (GOR, 2019)

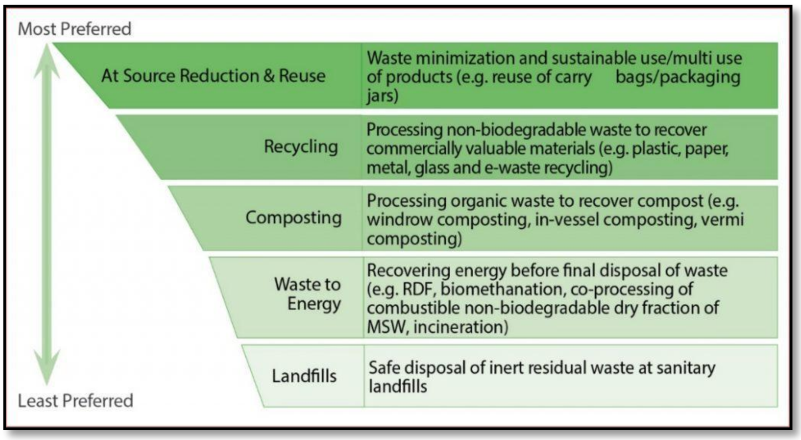


Figure 4.3 Waste Generation Techniques

Decentralized waste management v/s Centralized waste management

Now and again, decentralized waste administration techniques at the local area level are desirable over incorporated waste administration strategies (CPHEEO, 2016c) e.g., as the size of city increments or populace builds the waste produced additionally increments so to diminish the weight on a unified waste administration office decentralized waste administration frameworks are liked.

Decentralized waste administration frameworks, otherwise called local area squander the board frameworks, lighten the strain of overseeing immense volumes of MSW at a focal area, bringing down transportation and transitional stockpiling costs (CPHEEO, 2016c) Potential downsides of decentralized waste administration according to (CPHEEO, 2016c) are: I) In numerous metropolitan areas, land is hard to get. ii) Inadequate space, preparing, and limit of laborers make it difficult to keep up with logical and clean conditions. iii) Unreliable final result quality.

Integrated solid waste management and role of informal sector

Coordinated strong waste administration is a thorough way to deal with strong waste counteraction, reusing, and the board. As per (Datta and Kumar, 2016) eventually, this complete methodology will support the insurance of human wellbeing and the climate. ISWM analyzes nearby requests and conditions prior to delineating the best waste administration system for every circumstance. Complete waste administration, including treating the soil, consuming, and removal at an all around developed and oversaw landfill site, are the fundamental activities. Indeed, even a little expansion in pay in urban areas can lead individuals' utilization examples to move, bringing about waste kinds and volumes that are more hard for regions to oversee. e.g., the inconvenience of lockdowns and the conclusion of eating foundations (bistros and eateries) has brought about a flood in the transportation of food proportions and food, bringing about the development of different plastic squanders like polyethylene high-density (HDPE), Low-Density Polyethylene (LDPE), Polypropylene (PP), Polyethylene Terephthalate (PET), and so forth (S. Kumar, 2016).

ULBs should address an assortment of concerns while arranging a Municipal Solid Waste administration framework, for example, garbage stream portion and waste stock (Al-Ghouti et al., 2021). Viable methodologies that can resolve these issues in an all encompassing way are significantly expected to help MSW the executives arranging. As indicated by (Batista et al., 2021)11 basic achievement factors which whenever executed accurately can address a reasonable method to conquer the current problem that encompasses the administration of Integrated Municipal Solid Waste Management they ought to be lined up with public approaches (Digital public meeting, verbalized activities, improved coordinations), removal procedures (draining, cremation), lawful viewpoints (adaptable agreements, incorporated enactment), Public Private Partnerships (current and significant practices, upgraded models for framework) and Energy recuperation (burned strong waste, impetuses and ventures).

Three administration qualities are vital for economical strong waste administration, as per the UN-Habitat system: inclusivity (which incorporates the two clients and suppliers of administrations), monetary manageability, and successful establishments and proactive arrangements (United Nations, 2009). A very much planned and painstakingly executed waste administration strategy will assist with accomplishing every one of the three "columns" of supportable turn of events (ecological, monetary, and social): working on financial productivity, especially in asset extraction and use; diminishing or disposing of adverse consequences on wellbeing and the nearby and general climate; and giving more appealing and charming human repayments (Le Blanc and UN Environment Program, 2017).

The casual area (which incorporates cloth pickers and unlawful or unapproved recyclers) should likewise be coordinated into the standard waste administration measure since they handle a lot of junk without the vital natural protections (S. Kumar, 2016). Recyclables ought to be gathered at the local area level, ideally with the help of the casual area, and natural waste ought to be overseen through family treating the soil frameworks and local area treating the soil frameworks (CPHEEO, 2016c). The casual area, which incorporates the kabaadi framework and waste pickers, is basic to the SWM esteem chain since it recuperates significant materials from trash. According to (CPHEEO, 2016c) in India the casual area, which incorporates the kabaadi framework and waste pickers, assumes an indispensable part in reusing material assortment and preparing. Squander unloaded in unapproved places, empty parcels, and so forth, trash recuperated by kabaadi framework, trash gathered by casual waste authorities or waste pickers are totally rejected from squander estimation at depots, handling or removal destinations, which doesn't sufficiently reflect squander age rates, since these estimations do exclude: squander arranged at unapproved places, empty parts, and so on, squander recuperated by kabaadi framework, squander recuperated by casual waste authorities or waste pickers from the road, canisters, and halfway exchange focuses, and so on (CPHEEO, 2016c). Cloth pickers save more than 14 % of the civil financial plan every year, yet their work goes practically unseen, and they are regularly denied the option to work (Joshi and Ahmed, 2016). As indicated by gauges expressed by (Joshi and Ahmed, 2016) cloth pickers bring down the heap on transportation and landfills by up to 20 %. This further poses a case in the blessing of consideration of casual area in city strong waste administration framework with the goal that the waste gathered by them can likewise be represented in the waste age rates. The advantages of coordinating the casual area as indicated by (CPHEEO, 2016c) incorporate the formation of vocations, social acknowledgment, and security for casual area laborers, just as the regularization of the reusing market. This can be refined by shaping self improvement gatherings (SHGs) or cooperatives to empower individuals to function as business visionaries in a business association (CPHEEO, 2016c). So they may claim unobtrusive reusing offices that are experimentally and cleanly oversaw later on. The casual area has made a huge commitment to the reusing of auxiliary materials, with the proportion of all out recyclable materials bought by scrap purchasers surpassing the normal measure of homegrown strong waste created and gathered in the Mekong Delta, Vietnam, by 7.9 % and 17.8 %, individually, permitting the economy to work and develop effectively. Subsequently, the economy can progress to a round economy model (He and Mai, 2021).

Roles and Responsibilities of concerned Institutions

Role of Urban Local body

Due to the large number of institutions and stakeholders engaged in MSWM, it is critical that the MSWM plan, which attempts to close breach or upgrade service quality, is produced collaboratively. The ULB, specifically the SWM division, is primarily responsible for developing an MSWM plan. As per (CPHEEO, 2016a) for the purpose of designing the MSWM plan, a dedicated team or advisory team, often known as internal collaborator, may be formed. This team should be cross-functional, with representatives from all departments connected with, influenced by, or influencing SWM services in a city. The internal collaborator team should be pilot by the ULB's commissioner or chief executive (CPHEEO, 2016a)

If capacity within the ULB is insufficient, municipal officials may seek advice from subject-matter experts, academicians, environmental planners, and engineers, according to (CPHEEO, 2016a). The community (external stakeholders) must be informed and involved, as well as avenues for all stakeholders to participate in decision-making, for the MSWM approach to be successful. (CPHEEO, 2016a)

Homes, businesses, industries, the informal sector, local government, non-governmental organisations (NGOs), community-based organisations (CBOs), self-help groups (SHGs), women groups, secondary school and college students, and members of other institutions that may play a role in ensuring community participation are examples of typical MSWM system shareholders. (CPHEEO, 2016a). According to (CPHEEO, 2016a) these paticipant would have to act for the interests of men, women, youth, and other marginalized or at-risk groups of persons involved in the MSWM process. Women's groups, in particular, must be involved in the planning phase (CPHEEO, 2016a).

Action points and stakeholder responsible as per SWM rules, 2016 (District Collector and District Magistrate)

- Collection, segregation and treatment of solid waste, strengthening the capacities at ULB's – ULB's
- Notification and implementation of by-laws – ULBs and District Information and Public Relations Office (DIPRO)
- Awareness – ULB's, NGO's, SHG's, Insp. Of schools, DIPRO
- Monitoring and Review – EO of ULB's and District level committee

Role of State and local authorities

MSW management duties are not only responsibility of ULBs but also State government also. These are:

- The Secretary-in-Charge of the Department of Urban Development Department (UDD) of the state or union territory has the complete liability for MSWM system installation in cities and municipalities in accordance with the SWM Rules 2016.
- UDD is responsible for developing an MSWM state policy and action plan inside the state.
- UDD is needed to report on SLBs in order to provide SWM services in ULBs to the Ministry of Housing and Urban Development (MoUD).
- UDD is in charge of approving land transfers from the state to ULBs (for all projects).
- The establishment of staff posts is regulated by the states in the ULBs (both technical and nontechnical).
- The State Pollution Control Board (SPCB) is in charge of regulating pollution at state level. Ensuring that the MSWM and SWM rules are being followed. It also has the authority to provide environmental permits.
- The authority to provide local authorities or contractor permission to establish treatment and disposal facilities is duty of SPCB.

State governments are also required to keep check on the following:

- The separation of trash at the source has been enforced in order to channel waste into wealth through recovery, reuse, and recycling.
- No one should discard, burn, or bury his or her solid waste on roadways, open public places outside his or her premises, or in drains or water bodies.
- Hotels and restaurants should separate biodegradable garbage and establish a collection mechanism to ensure that such food waste is composted or converted to biomethane.
- Residents' welfare groups and gated communities with an area of more than 5,000 square metres should segregate rubbish and send it over to approved waste pickers or recyclers, or to the local government.
- Every street vendor should keep appropriate containers for storing waste generated during the course of his business, such as food waste, disposable plates, cups, cans, wrappers, coconut shells,

leftover food, vegetables, fruits, and so on, and deposit such waste at a waste storage depot, container, or vehicle designated by the local authority.

Best practices for solid waste management

According to Kochi Municipal Corporation, source segregation of garbage is a smart practise. The case study shows how the segregation of sources, compost, strict legislation combined with the cooperation of multi-stakeholders results in efficient waste management of urban sites without appropriate waste sites. (GIZ, 2018).

The Panaji module explains how the Panaji City Company has effectively implemented the vision of a city for achieving zero landfilling. The entire town is split into at least 6 parts of waste. The dry trash is further divided into 18-20 recycling parts, composted organic waste and rejected dry waste sent, among other things, for co-processing. Panaji was supported by a vision, solid leadership, frequent campaigns and ongoing innovation for various users groups to address the issues of new waste streams (GIZ, 2018).

The Gorai module explains how the Municipal Corporation of Mumbai needs the scientific closing of a garbage site. It briefly captures the technological process involving a specific attention on the standpoint of the community. The module shows a general improvement in living standards, local economy, ecology and the region's biodiversity both before and after the scientific closure (GIZ, 2018).

The Municipal Corporation of Vijayawada has demonstrated the simple and efficient treatment of organic waste via decentralised vermicomposting systems. The module provides information of the vermicomposting technology step-by-step guidance on its operation, maintenance, pre and postal care. It also displays the great results of vermicomposting by other urban local organisations for replication (GIZ, 2018).

Hierarchy of Solid Waste Management Approach

A solid waste management hierarchy explains the best actions to take before waste is disposed of at a waste dump or site. The first and preferable stage in hierarchy, reducing source and reuse is the prevention of waste. In reducing or reusing waste at the source, fewer raw materials are required and fewer rubbish must be collected, transported and disposed. This decrease in extractive processes leads to environmental advantages as well as financial savings over time. Recycling or composting is the next best alternative for garbage which cannot be reduced or utilised at source. Recycling/composting results in environmental advantages and economic savings comparable to reduction and reuse of sources, but requires early investment expenses to implement an efficient programme of recycling/composting. Reduction of sources and strategy of recycling both limit the amount of waste, including waterbodies and sea litter, which could ultimately reach the environment. For garbage that is not recyclable or compostable, energy recovery can be explored. The recovery of energy minimises the waste which ends in sites and dumps and compensates for the consumption of fossil fuel. However, the recovery of energy from trash can lead to emissions of air pollution and demand large investment and operating costs (EPA, 2020b).

Best practices at collection and transportation stage

A synchronised primary and secondary collection/transportation system is needed to avoid overflowing containers and garbage on the roads (CPHEEO-Part I, 2016a).

Primary collection: The process of waste collection is called primary collection from households, markets, institutions and other businesses (CPHEEO-Part I, 2016a)

Secondary collection is the procedure for collecting and transporting waste from community bins, storage and/or stations to waste treatment plants or final disposal facilities (CPHEEO-Part I, 2016a).

The collection of waste segregating from residential, business and institutional areas (wet wastes, dry recyclables and household hazardous wastes), sanitary, horticultural and construction and demolition scrap (CPHEEO-Part I, 2016a). The waste generated by each of these groups and the amount of waste separated determine the frequency of waste collection. While daily domestic waste should be collected, the waste collected twice daily may be collected at market areas, at business enterprises and institutions. In addition, the type of waste collection is decided by the quantity of waste generated and collected Separate containers are necessary for various fractions; ULBs must gather at least damp and dry trash separately. The waste that can be collected from doors can be stored in a secondary collector's station or transfered directly to secondary collector's vehicles, depending on whether secondary storage or transfer is more practicable. The availability of secondary car collectors, area size and collecting time all affect the sustainability of secondary or direct transfers to secondary car collectors. It is best to synchronise primary and secondary collections whenever possible to avoid secondary storage containers or depots (CPHEEO, 2016b)

Some of the additional points that may be followed for collection of municipal solid waste are:

- The collection of daily wet waste is advisable. Dry waste and hazardous rubbish can be collected weekly and home. The local ULB shall collect and disposal separate sanitary waste in an incinerator daily.

- The collection of doors to doors of rubbles utilising ICT and IOT (Internet of Things) technologies will be monitored by all ULBs. In order to assure 100% garbage collections, this should be used in all ULBs. The consumption charges can be evaluated using intelligent home cards against the end user. The smart card can also be used to update the waste pickup status for all users.
- Additionally, compactor bins can be geo-tagged and equipped with a smart card to enable monitoring of the bin lifting operation.

The amount of money earned is related to the amount of waste that is processed at treatment facilities. As a result, treatment facilities rather than disposal centres must transport an increasing share of garbage. The waste is also collected from treatment facilities, lowering the former's maximum trash holding capacity. As a result, in order to maximise waste allocations, the quantities moved from distribution centres to treatment facilities must be greater than those sent to disposal sites (Jalil et al., 2018).Regardless of the way that the expense of keeping trash per ton at Distribution Centers is less expensive than the expense of transportation from Distribution Centers to treatment offices and removal focuses, more trash is dispatched than is kept up with as stock this is because of the inflow limits of Distribution Centers, which restricts the amount of trash that could be held as stock to not exactly or equivalent to the appropriation communities' most extreme stock holding limit. The stock holding limits of Distribution Centers are diminished to limit stock levels and increment waste shipment from Distribution Centers to treatment and removal offices. Nonetheless, that the chief, then again, may extend these limits as per the determinations to address the issues of Distribution Centers and the issue (Jalil et al., 2018).

Best practices at segregation stage

Individuals should be aware of the importance of waste separation at the source. Source reduction and reuse are two terms that refer to operations that help reduce trash output. NGOs, SHGs, and RWAs should raise awareness regarding trash separation at the source. School students may be the ideal target group for instilling the source segregation culture in private houses.

For all ULBs, 100 percent source segregation should be implemented. At the moment, no ULB has a facility for source segregation. Segregation can be achieved manually or mechanically.

- Efforts should be made to implement decentralized waste management strategies.

- Given the low cost of labor in India, manual classification of recyclable fractions into distinct components such as paper, plastic, and so on may be more appropriate (Malaviya National Institute of Technology Jaipur, n.d.)
- All ULBs should provide a waste transfer point.

● Distances between the collection places and the finalisation place of treatments and disposal should govern the location of the intermediate transmission station. Transfer stations may be established if a distance exceeds 15 kilometres between the competent municipality and the last treatment and disposal areas or where land is available and needed.

A study found that, unless there is an incentive for townspeople to take part in sources-seperated collection schemes to a much higher degree than usual in the sector, applying source-separated materials for the production of paper, plastic, glass and metals would not result in higher material recuperation rate than or above 35 percent. This could boost the possible recycle rate (Fabbricino, 2001).

Best practices at processing and treatment stage

Inefficient municipal solid waste management can have major negative environmental result such as infectious diseases, water and soil pollution, drain blockage, and biodiversity loss, but on the other hand if done efficiently results have showed that plastic recycling contributed significantly to the economy among plastic, metal, glass, paper, and non-recyclable garbage, and recycling being the most economical waste management method.

Gasification and incineration are the most efficient ways to generate energy while also lowering trash volume, according to findings from a model prepared for the city of Tehran, Iran. Recycling and composting, he added, are the greatest answers and should be prioritised. Overall, recycling is a non-negotiable alternative that can be a significant source of money and help with cost coverage (Ahmadi et al., 2020). Recycling and burning are the most prevalent treatment alternatives, according to a survey done in a Greek region, with landfilling being the least acceptable management option (Minoglou & Komilis, 2013).

The volume and mix of garbage created determine how quickly processing technology is adopted. It is necessary to quantify and characterise the waste generated by the local body prior to adopting any processing or treatment system. Table 4 lists the key components of waste and the techniques required to treat them (TERI, 2014).

Table 4.1 Components & treatment for municipal solid waste (TERI, 2014)

Type	Composition of Waste	Traetment Operation	
Biodegradable	Kitchen, garden and food waste	Biological Treatment	Aerobic processes, anaerobic processes
		Thermal treatment	Incineration, pyrolysis systems, gasification systems
		Transformation	Mechanical transformation, thermal transformation
Recyclable	Plastic	Plasma Pyrolysis Technology (PPT), Alternate fuel as Refuse Derived Fuel (RDF)	
	Paper	Dissolution, Screening, De-inking, Sterilization and bleaching process	
	Glass	Vitrification technology	
Inert	Sand, pebbles & gravels	Landfilling: Jaw and Pulse Crusher	

A landfill without engineered measures may result into a number of hazards e.g. groundwater contamination (Kumar et al., 2019) surface water contamination (Kumar et al., 2016) air contamination and landfill gas explosion (Kumar et al., 2018) So it is highly recommended to develop a sanitary/engineered landfill. To provide a sanitary landfill, a cluster of ULBs may be constructed and a suitable piece of land designated for the cluster's waste disposal (Kumar et al., 2016) (Kumar et al., 2018) (Kumar et al., 2019).

The location of the waste disposal must be sufficiently large to last 20-25 years and be built up in stages to avoid water logging and abuse. Dumping site must be at least 100 metres far from a river, 200 metres away from a pond, 20 kilometres from airports and air bases, and 200 metres away from motorways, habitats, public parks and wells (CPHEEO, 2016b). Deposit sites may be created in rare cases within a 10- to 20-kilometer airport/airbase radius, after receipt from the civil aviation authority/air force of a certificate of no objection, if applicable. This site should not be positioned within flood basins, coastal control areas, wetland areas, major habitat areas or sensitive eco-fragile regions, as historical records specify (CPHEEO, 2016b).

The non-development area surrounding solid waste processing and disposals facilities, having installed capacity greater than five tonnes per day, shall be preserved within the framework of the entire footprint of the solid waste treatment and disposal plant. The local authority shall prescribe the buffer zone in conjunction with the competent State Pollution Control Board (CPHEEO, 2016b).

The use of closed landfill sites for human habitation or other purposes can be considered only after confirming that gas emission and leachate quality evaluations fulfil required standards and soil stability is maintained after fifteen years of post-closure monitoring. Figure 4.4 shows a typical section of a scientific landfill.

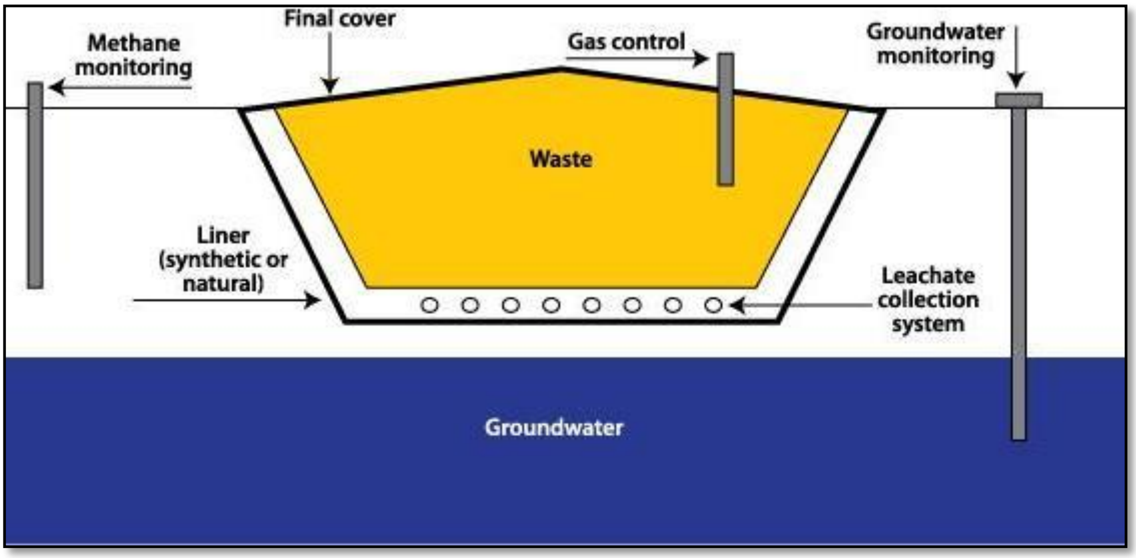


Figure 4.4 Typical section of sanitary landfill.

4.1.2 Plastic Waste Management

In today's world, plastic products have become an inextricable aspect of human life. Its application can be seen in everyday activities all throughout the world, from small communities to developed metropolises. However, their large-scale production and use result in a large amount of plastic garbage generation and production.

When a piece of plastic has outlived its usefulness, it is referred to as discarded plastic. Because this trash is non-biodegradable, it accumulates in the adjacent eco system for an extended period of time, causing harm to animals, marine life, and humans. Only because the material deteriorates under thermal pressure, limiting its life duration, virgin plastic can be recycled for reuse up to 2-3 times. However, these secondary and tertiary versions contain chemicals and colours that are damaging to the environment. As a result, recycling is not a safe nor a long-term strategy for disposing of plastic garbage.

The negative consequences of incorrect plastic waste management are not only distasteful to look at, but they also have an impact on a country's overall economy. Furthermore, as a result of swallowing plastic waste and water contamination, animals that rely on the environment are at risk. The burning of trash and plastic objects pollutes the air and harms the ecosystem. Microplastics are produced as a result of faulty plastic waste management, and they are hazardous to both humans and animals.

Thermoplastics or Recyclable Plastics (do not undergo chemical changes when exposed to heat and hence can be moulded repeatedly) and Thermosetting Plastics or Non-Recyclable Plastics (do not undergo chemical changes when exposed to heat and thus cannot be moulded repeatedly) (can melt and only be shaped once and very hard to be moulded again using the existing technologies).

Thermoplastics	Thermosetting
Polyethylene Terephthalate (PET)	Bakelite
Polypropylene (PP)	Epoxy resins
Polyvinyl Acetate (PVA)	Melamine resins
Polyvinyl Chloride (PVC)	Polyesters
Polystyrene (PS)	Polyurethane
Low density polyethelene (LDPE)	Urea – Formaldehyde
High density polyethylene (HDPE)	Alkyd resins

Figure 4.5 Types of Plastics

If left unchecked, plastic garbage can be toxic and dangerous to humans, animals, and the environment, posing major risks. They quickly mix with land and water to generate microplastics, and their macro forms operate as physical barriers, degrading soil quality and causing livestock and other animals to consume them. Plastic debris clogs sewers and streams, causing catastrophic flooding and runoff obstructions (CPCB, 2013). (Sharma & Mallubhotla, 2019).

Furthermore, plastic trash poses a greater threat to marine ecosystems. According to data conducted by "The Energy and Resource Institute," 8 million tons of plastic waste enter the waters every year all around the world. To date, the total amount of plastic garbage in the oceans has reached 150 million tonnes. Even in efforts to clean up the coast, plastic packing trash makes up roughly 62 percent of the total proportion (Bhattacharya et al., 2018).

Furthermore, plastic trash poses a greater risk to marine ecosystems. According to data conducted by "The Energy and Resource Institute," 8 million tons of plastic waste enter the waters each year throughout the world. And, as of now, the total amount of plastic waste in the oceans is 150 million tonnes. Even in efforts to clean up the coast, plastic packing materials account for almost 62 percent of the total proportion (Bhattacharya et al., 2018)

According to a survey by "The Energy and Resource Institute," around 60% of plastic manufactured is recycled, and approximately 9400 tons of plastic is left abandoned in the environment, creating pollution of land, air, and water. In a short period of time, 70% of plastic packaging products are turned into plastic garbage (Bhattacharya et al., 2018).

Lack of segregation of plastic trash, lack of structured collection and efficient aggregation systems, low economic value in low-grade (thin) plastics, and livelihoods related with plastic manufacture are main obstacles in the process of Plastic Waste Management.

There is an immediate need for a framework to deal with plastic garbage to prevent the above-mentioned adverse impacts on the environment and solve the problems. This can be accomplished by utilising a variety of technologies and processes at each stage of the process, from generation through collection to final disposal. Plastic Waste Management is the name given to the entire procedure. Furthermore, it is critical to raise public knowledge about their involvement in the Plastic Waste Management process and to advocate the use of alternative materials in order to limit the use of plastics in all forms.

Scenario in Country

Every year, the global manufacturing of plastic exceeds 150 million tonnes (Sharma & Mallubhotla, 2019). Packaging films, wrapping items, shopping and rubbish bags, fluid vessels, apparel, toys, domestic and industrial products, and building materials are all part of this diverse range of manufacture. Approximately 70% of the total amount of plastic generated is turned into plastic waste in a little period of time (Sharma & Mallubhotla, 2019).

Around 9.4 million tons per day of plastic garbage is produced in India, which equates around 26,000 TPD. About 60% of this gets recycled, with the informal sector accounting for the majority of it (Sharma & Mallubhotla, 2019). In contrast, India's recycling rate is significantly greater, roughly 20% more than the global average. Even so, around 9,400 tonnes of plastic garbage are either disposed of in landfills or pollute streams and groundwater supplies. A few plastics do not disintegrate, and even if they do, it can take up to 450 years for them to decompose entirely (Sharma & Mallubhotla, 2019). (GOI, 2019).

Traditionally, Indian laws concentrated primarily at improving and managing plastic waste in the country's metropolitan areas, with an emphasis on segregation, collecting, and even banning the use of some types of plastics. For the first time in 2016, rules were extended to rural areas, with Gram Panchayats given particular responsibilities.

Scenario in State

There are 193 Urban Local Bodies (ULBs), 295 Panchayat Samitis, and 9,892 Gram Panchayats throughout Rajasthan's 33 districts (GPs). According to the 2011 Census, the state's population is 6.86 crores, with 24.78 percent living in urban areas and 75.13 percent in rural areas. Plastic garbage accounts for around 4% of total solid waste created in the state, with ULBs, Industrial Units, RIICO, and other main sources of generation (GOR, 2019).

Roles and Responsibilities

Central Pollution Control Board

Responsible for regulating and controlling noise producing sources aiming to maintain the ambient air quality standards (CPCB, 2013)

State Level Monitoring Committee

Responsible for planning, facilitating, problem-solving and monitoring overall implementation of the programme in the state. The Rajasthan Pollution Control Board (SPCB) has issues their instruction for the management of plastic waste so as to control the pollution levels in the entire state(GOR, 2019).

Department Of Environment, Science and Technology

Responsible for environmental planning, co - ordination, advertising and monitoring of science and technology, prevention of pollution, reduction of pollution, monitoring and environmental protection activities and programmes, regulation, policy formulation, monitoring and surveillance by means of technological advances (S. Sharma & Mallubhotla, 2019)

Ministry of Environment, Forest and Climate Change (MoEF&CC)

Responsible for efficient enforcement of laws, focusing on waste reduction, segregation of source materials, recycling, involvement of waste pickers, recyclers and waste processors for household or other production sources in the plastic waste collection system (MoEFCC, 2020).

The Energy and Resource Institute (TERI)

It focused on developing technologies and solutions that minimise the production of trash and turn all wastes into usable goods. They include promoting the cycle economy by means of effective resource and clean industrial production and optimising resource recovery and recycling for waste-free towns. (Bhattacharya et al., 2018)

Ministry of Housing and Urban Affairs (MoHUA)

Responsible for the capacity-building of the Urban Local Organizations (urban local authorities) focuses on certain components of solidified waste management and holistic sanitation (MoEF&CC, 2016).

Duties of Various Stakeholders as per Plastic Waste Management Rules 2011 (Amendment 2016 & 2018), MoEF&CC:

Responsibility of Local Body

i. The development and construction of infrastructure to segregate, collect, store, transport, process and waste disposal by each local government body, by themselves or through the involvement of agencies or producers is the task for every local government body. ii. The local authority shall establish, operate, and coordinate the waste management system and fulfil the associated functionalities, which include: a) ensuring that the separation, storage, transport, processing and disposal is done in plastic waste, b) ensuring the process does not cause environmental damage and c) ensuring that no environmental damage is caused during this process and d) ensuring the processing and disposal, in accordance with the Central Pollution Control Board, of the non-recyclable fraction of plastic waste.; and g) Preventing plastic garbage from open burning. iii.The local organisation shall seek cooperation of manufacturers with the objective of developing a plastic waste management system and such a system shall be set up within one year after the final publication in the Indian Official Gazette of these Regulations. iv. It is the local authority that is accountable for drawing up ordinances incorporating those rules (MoEF&CC, 2016).

Responsibility of Gram Panchayat

Every gramme panchayat, either by itself or through an agency, must develop, operate, coordinate and perform the following functions in rural regions, as well as in the following: I ensure that recyclable waste fractions are segregated, collected, stored, transported, and channelled into recyclers with valid registration; (MoEF&CC, 2016)

Responsibility of Waste Generators

i. The waste generator shall: a. Do not litters plastic waste and ensures the segregation of waste from the source and transfer separated waste to the urban body, to local gramme panchayat or organisations designated by them or to register it; b. do not take measures to minimise waste generation and to segregate plastic at the source in accordance with the 2016 Solid Waste Management Rules or, as amended, from time to time.

ii. ii. Wastes produced in accordance with the Municipal Solid Waste shall be split and kept under compliance with all institutional generators. (Management and Handling) Rules of 2016 or amending and delivering segregated waste on its own or by the approved agency for waste collection, to allowed waste processing or disposal or repository centres.

iii. All waste generators shall pay the user fees or charges that are set by the local authorities for the management of plastic waste, such as the collection or operation of garbage collection facilities etc.

iv. Every person who is responsible for organising an open-air event that involves serving of plastic or multi-layered foodstuffs shall, in accordance with the Municipal Solid Waste Management and Handling Regulations of 2016 or amendments, segregate and manage waste produced during such events (MoEF&CC, 2016).

Responsibility of Producers, Importers and Brand Owners:

i. Within six months from the publication of the Rules, the producers shall develop, individually or collectively, through their own distribution channel or through the local authority concerned, modalities for waste collection systems that are based on Extender Producers' Responsibility and involving State Urban Development Departments.

ii. Producers, importers, and Brand Owners who advertise the items are primarily responsible for the collection of multi-layered plastic sachets or sleeves or packaging. They need to develop a mechanism for the recovery of plastic waste produced by their products. The collection plan is to be presented in the application for consent to be established or operated by the State Pollution Control Boards. Within a year of notification of these rules, the Brand Owners whose consent is renewed before notification of these rules shall produce such a Plan and implement it for a period of two years.

iii. Manufacture and usage, in a two years' time period, of plastic multilayer, that can be non-recovered or non-energy recycled or without alternative use of plastic.

iv. For granting registration a producer shall apply to the Pollution Control Board or, if applicable, a Pollution Control Committee of the States or of the Union Territories Administration concerned within a period of three months from the date of their final publication in the Official Gazette.

v. No producer shall manufacture or use any plastic or multi-layered packaging for packaging commodity products without registration of the State Pollution Control Board concerned, on or after an expiration period of six months from the date of final publication of those rules in the Official Gazette.

vi. Each manufacturer must keep a record of the details of a person supplying plastic that is used as a raw material to create bags, plastic sheets or similar or coated in plastic sheets or in multi-layered packaging (MoEF&CC, 2016).

Responsibility of State Pollution Control Board (As Per Rule 12):

i. For the purpose of enforcing the provisions of the present regulations concerning the registration, manufacture, multi-layered packaging, transforming and disposal of plastic trash, the State Pollution Control Board is responsible for the territories of the Union.

ii. The secretary-in-charge responsible for the waste management of LSG, usage of plastic bags, plastic sheets and the like, covers made of plastic sheets and packaging of various layers, must be the authority for compliance with the provisions of the present rules on waste management by generator.

iii. The gramme panchayat concerned shall have the power to enforce the provisions of those rules on waste generator management, the use of plastic transmission bags, plastic sheets etc. and on the covers of plastic sheets and multi-lader packages made in the countryside of the State or territory of the Union.

iv. Within the territorial limitations of the competence of the District concerned to implement the provisions of these rules, the authorities referred to in sub-rules (1) to (3) shall assist the Regional Magistrate or Deputy Commissioner (MoEFCC, 2016).

Responsibility of Retailers and Street Vendors

i. Retailers or road vendors may not market or give consumers with commodities that are not made, labellated or marked in carry or plastic sheet or multilayered packaging as stipulated by this Rules. ii. Any dealer or road seller selling or supplying products in, plastic bags or multifaceted packaging or sheets of plastic or similar products or coverings made from sheets of plastics not made, labelled or marked under the above rules shall be liable for paying the penalties set out in local bodies' by-laws (MoEFCC, 2016).

Rules and Regulations

Rules and Regulation to be followed for Plastic Production as per Plastic Waste Management Rules 2011 (Amendment 2016 & 2018), MoE&CC

i. The plastic carrying bags used for the transport or supply of goods, which are an intrinsic part of the packaged products, are not included. The bag thickness is not <40μ. ii. Compostable plastics compliant IS/ISO:17088:2008 can also be created with carrier bags. iii. State Pollution Control Board (SPCB) or Pollution Control Committee shall be the prescribed registration, manufacturing and recycling authority (PCC). And the municipal authority is tasked with the implementation of rules for the application, collection, segregation, transport and disposal of plastic trash. iv. Not plastic material in any form shall be utilised in multi-layered pouches or sachets used in gutkha, etc. packaging v. The labelling or mark "recycled" in accordance with IS: 14534:1998 shall apply to each plastic bag. Every bag manufactured of "Compostable" has the "Compostable" mark and complies with IS/ISO: 17088:2008. Each bag is supported. vi. The retailers shall not make a carry bag available for consumers free of charge. The municipal authorities involved may notify the transport bag to promote re-use to decrease the development of plastic garbage. vii. In order to oversee implementation, each State Government shall form a State Level Advisory (SLA) body. This organisation shall convene once a year and may invite specialists, if necessary. viii. The Plastic Waste Management shall be as under; a) plastic waste shall be recycled, recovered or disposed of in accordance with rules, regulations and standards from time to time established by the Central Government; b) Plastic recycling shall take place as part of guiding the recycling of plastics, as updated sometimes, in conformity with Indian Standard IS 14534:1998; c) In order to ensure safe waste collection, stockpiling, separation, transport, processing and deposition, no environmental damage is caused throughout that process the Municipal Authorité is responsible for the setting up, operation and coordination of the waste management system and for carrying out the related functions; d) The Municipal Authority may, collectively or individually, request the manufacturers to provide for the establishment of such a collecting centre, in accordance with the Principle of Extended Producer Responsibility (EPR); e) Recyclers shall ensure that recycling plants comply with the Indian Standard: IS 14534:194 titled "Plast Recycling Guidelines" and "Precycling Rules" Ad 1986 amended from time to time; the Municipal Authority concerned shall ensure the disposal, in compliance with the Sche Recycles Processes, of residuals created through recycle processes; f) In the Municipal Bye-laws of all urban local authorities, the Municipal Authority shall incorporate the rules; g) By adopting appropriate technology such as road construction, co-incineration, etc. the Municipal Authority will stimulate the utilisation of plastic trash. The municipal authority or the operator wishing to apply such technology must ensure that the prescribed standards, including pollution standards, are complied with in that respect by the competent authority. ix. By 30 days of September each year, each SPCB and PCC must draught and submit annual reports to the CPCB. In its report on the usage of plastic transport bags, sachets / bags and the management of plastic trash, the Central Pollution Control Board (CPCB) consolidates the report. The consolidated report and suggestions for implementing the 2011 (amendment) Plastic Waste Rules are submitted to the MoEF by 30th December (CPCB, 2013), (MoEFCC, 2016)

Conditions for Production of Plastic

The following conditions apply to the fabrication, importation, distribution, sale and usage of carrying bags, plastic sheets or the like, or cover made of plastic sheet and multi-layered packages, namely: i) Carrying bags and plastic containers shall either be in natural shade without additional colours, or be created using pigments and colourants in accordance with the Indian Standard only:: IS 9833:1981 entitled 'List of pigments and colourants used for plastic products in contact with foodstuffs, pharmaceuticals and drinking water; ii) Carry bags made of plastic recycled or items made of plastic recycled shall not be used in the storage, transport, delivery and packaging of food ready for consumption or drinking; iii) of virgin or recycled plastic, shall not be less than fifty microns in thickness; iv) The wrapping of the product shall not be less than fifty microns in thickness unless the thickness of these plastic sheets impairs the function of the product, or similar, that is not a part of the multi-layered packaging or plastic sheets used for packaging; v) The manufacturer should not, after obtaining valid registration with its State Pollution Control Boards or Pollution Control Committee, sell or arrange plastic to be used as raw material to a producer the manufacturer; vi) Plastic material sachets shall not be utilised for the storage, packaging or sale of gutkha, tobacco, and pan masala; vii) Plastic waste recycling shall be in accordance with the Indian Standard: IS 14534:1998 entitled Plastic recycling guiding principles, as modified occasionally; viii) The thickness of the bags consisting of biodegradable plastic must not be applied. Compounding plastic containers must be conducted in accordance with Indian Standard: IS 17088:2008, named Compostable Plastics Specifications as updated from time to time. Manufacturers or sellers of plastic compost carry bags shall, before selling and before commercialisation, obtain a certificate from the Central Pollution Control Board, and ix. plastic material shall not be used in any product packaging for gutkha, panmasala and tobacco in all forms including vinyl acetate – Malic acid – vinyl chloride copolymer in any form (CPCB, 2013).

Producers, recyclers and manufacturers registration

i. Unless you got registration from a national Pollution Control Board before the beginning of the production, no individual shall produce bags or recycle plastic bags or packaging that is multi layered. ii. An application in Form-I shall be made to each manufacturer or brand-owner for registration or registration renewal, a) “The State Control Board concerned, if one or two States or territories of the Union are running”; or b) “If functioning in more than two states or Union Territories, the Central Pollution control board”. iii. Application to the State PCB to grant registration or renewal of a registration in the recycling unit in Form II3 must be made by any person who recycles or processes wastes or proposes to recycle or process wastes. iv. An application shall be made to the State Pollution Control Board or the Pollution Control Committee of the territories of the Union in question, to grant a licence or to renew a registration in the form III4 of each manufacturer involved in a production of plastic to be used as a raw material by the producer. v. Unless the unit has a valid consent under the Water (Preservation and Control of Pollution) Act of 1974 (6 of 1974) and Air (Pollution Prevention and Control) Act of 1981 (14 of 1981) along with a registration certification issued by a District Industry Centre or any o-Registration, it shall not issue or renegotiate the register of plastic waste recycling and processing units. vi. Unless the producer has a plan and action plan certified by the Secretary responsible for Urban Development of the state or the territory of the Union concerned for plastics waste disposal system, the State Pollution Control Board may not reinstate the registération of a producer.vii. Upon receiving the full application, the State Pollution Control Board may, after the inquiry which it sees fit and with the satisfaction that the applicant possesses adequate installations and technical capacity and facilities for handling plastic waste in a safe manner, grant registration in all respects for the recycling and processing of plastic wastes under sub-Rule (3), (a) viii. The decision to grant registration shall be reached within 90 days of receipt of an application that is complete in all respects by each State Pollution Control Board or Pollution Control Committee. ix. Initially, registration granted in accordance with this rule is valid for one year, without revoking, suspending or cancelling and afterwards for three years. x. State Pollution Control Board or the Pollution Control Committees may not revoke, suspend or terminate the registration without giving a hearing to the manufacturer or those involved in plastic waste recycling or processing. xi. Each application for renewal shall be made at least 100 days prior to the end of the validity of the certificate of registration. (CPCB, 2013), (MoEFCC, 2016).

Recommendations from CPCB

In India the disposal of plastic waste is a major concern, however various experiments with the objective of reusing plastic trash in road building or co-processing plastic waste in cement ovens, etc. are done due to lack of technology and inadequate implementation. The most commonly utilised method is now the combustion of plastic trash, however as a result of low grade ovens and their poor maintenance, they emit dangerous gases, including dioxins and furans that burn chlorinated and brominated plastic waste (CPCB, 2013)

The fundamental problems with the failure to follow the PWM Rules of 2011 were mainly the indiscriminate use of plastic bags and litter in towns and villages, as well as the use of pan-masala, tobacco and tobacco plastic packets. In order for the Rule to be amended appropriately and/or for an Office Memorandum for improved PWM Rules 2011, a listing of critical points based on contact with representatives of SPCBs and other agencies may be considered.: i. The definition of petro-based plastic and compostable plastic or renewable material can be examined in the current PWM Rules. ii. The monitoring method must be reinforced in order to prevent the market from offering substandard carry bags (< 40μ). iii. The existing PWM Rules 2011 may include a prescribed enforcement agency for the use of plastic carrying bags and bags & pouches. iv. MoEFs can be analysed in the light of the thickness and use of biodegradable plastics or material for food packaging by means of the recommendations of the Biodegradable Committee (under Director General CIPET). Municipal authorities may submit an annual report on the execution of the PWM rules to SPCBs/PCCs, 2011., as the same is not given in the Rules. Accordingly, suitable amendments be made in the Rules. v. It is possible for SPCBs/PCCs to use plastic waste in highway construction, plastic waste co-processing in cement ovens, plastic waste conversion into liquid fuel etc. vi. SPCBs/PCCs should create laboratory facilities for analysing plastic bags and plastic material in bags/pouche thicknesss.vii. The bags of plastic must be consistent in thickness because some States still allow bags of <40 μ, such as Madhya Pradesh, Kerala etc. (CPCB, 2013), (S. Sharma & Mallubhotla, 2019)*)*.

Sustainable Development Goal (SDG 12_UNDP): Ensure Sustainable Consumption and Production Patterns

According to UNDP's SDG 12, regular monitoring of the life cycle of plastic products should be carried out in order to use the fewest resources possible to produce the greatest output (Figure 4.6). To limit energy consumption and garbage output, recycling and disposal processes should be enhanced (Le Blanc & UN Environment Programme, 2017)

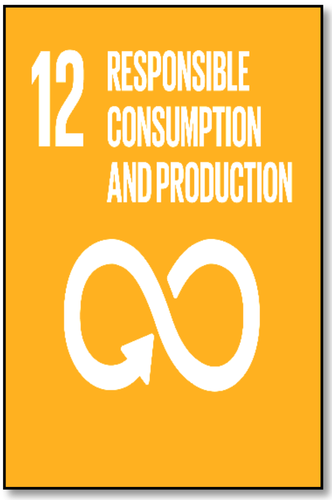


Fig (a). 17 SDGs **Fig. (b). SDG 12**

Figure 4.6 Sustainable Development Goal 12

Governance and Management Structure

Among the institutions involved in plastic waste administration are the Central Committee for Pollution Control, the National Monitoring Committee for the Environment, the Environmental Sciences and Technology Department and the Ministry of Environment, Forest and Climate Change.

Best Practices

Road construction in Bengaluru: use of plastic wastes (Bruhat Bengaluru MahanagaraPalika)

In addition to KK Plastic Waste Management Ltd (the Bangalore-based company), Bruhat Bangaluru Mahanagara Palika (BBMP) discussed developing solutions for the use of non-recyclable plastic in street improvements. The Center of Transport Engineering (CTE) and Central Road Research Institute have protected and guaranteed innovation (CRRI). Since 2002, the road is around 3000 kilometres long, using approximately 12,000 tonnes of plastic garbage from the city trash of the area. In 2004-05, KK Poly Blend in Bitumen, used for street development in the company, signed a memorandum of understanding to collect and engage with city trash. Yelchenahalli, Kanakpura Road and Anjanapur, Kanakpura Road, provide its two huge materials suitable for delivering 20 tonnes of material each day.

The first stretch of road was laid 500m long as a trial run for Karnataka under World Bank Funding.

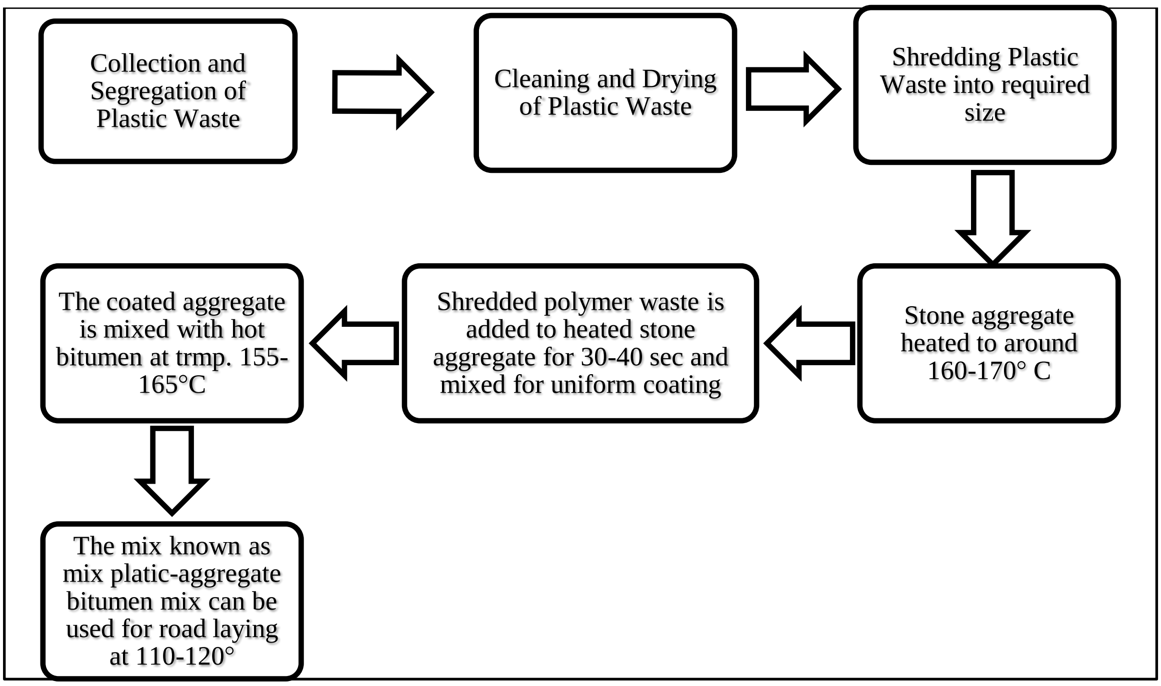


Figure 4.7 Process of making Recycled Road (S. Sharma & Mallubhotla, 2019)

This innovative innovation has resulted in a more efficient procedure for reusing and recycling plastic trash for road and transportation corridor building (Figure 4.7). Other binding elements are used with plastic composites. Polystyrene (PS) (hard packaging, cartons, plates, vending cups, etc.); Polypropylene (PP) (ketchup bottles, yoghurt cups, etc.); Polyethylene (PE) (both low and high density) are some of the plastics that are favoured for this procedure (plastic bags, water bottle, shampoo bottle etc.). (Sharma & Mallubhotla, 2019) Polyvinyl Chloride (PVC) or Flux sheets should not be allowed (GOI, 2019).

Use of Plastic Pavement Block - Hyderabad

The first Dog park situated at Hyderabad; India is a wonderful instance of reusing plastic waste. Around 400 sq. ft asphalt region outside the recreation center is comprised of 1,500 reused plastic tiles. It was started and finished by GHMC and Bamboo House India (Hyderabad based beginning up). The tiles are an eco-accommodating other option and a keen expense saving venture choice for the administrations as they are solid, enduring and have nearly less expensive assembling cost. Each tile weight upto 300 grams and is comprised of 600 polybags. They are exceptionally intended for permeation of water to guarantee better ground water re-energize and are flame resistant and harm free. Presently a days, these tiles are getting in market and are being utilized for making a few more common pathways across the city.

Aside from that, the Miyapur Metro Station parking lot was renovated with a one-of-a-kind dwelling made entirely of recovered plastic garbage. A single housing costs only Rs.1.5 lakhs, which is nearly half the price of conventional steel shelters. The resultant construction is heat, water, fire-proof, and damage-free because the raw materials employed were ‘trash' such as tetra packs, bottle caps, and poly bags. Other plastic debris, such as pet bottles, bags, shampoo bottles, and toothpaste packets, was also used to create public recycling bins. Each dumpster held 30 kilogrammes of plastic (Sharma & Mallubhotla, 2019)

Tetra Park's Go Green Initiative

The "Go Green" campaign for the promotion of carton retraining was launched by Tetra Pak India. It participated with McCann Health India's "Boxes le aao, banao school" campaign, promoting consumer adoption of green practises by depositing Tetra Pak cartons in collecting centres. These cartons can be transformed into desks, note pads, examination pads and even clothes for those less fortunate. In order to increase awareness and promote the recycling of discarded boxes, Tetra Pak's continuing flagship initiative "Go green with Tetra Pak."

Since the “Go Green” campaign began in year 2010, 1.8 million cartons have been collected and recycled, and 250 school desks have been donated to underprivileged schools. This initiative is multi-city, with the initial phase taking place in Mumbai in partnership with retail chains “Reliance Fresh, Reliance Smart, and SahakariBhandar,” as well as the Mumbai-based environmental NGO RUR Greenlife (Sharma & Mallubhotla, 2019). (GOI, 2019).

Conversion into textile products of pet bottle waste

A petrochemical organization has started a project to collect PET bottle waste from all over countery and turn it into textiles. The company is installing RVMs (Reverse Vending Machines) in a variety of locations, including malls, exposition centres, schools/colleges, and temples/pilgrimage sites, to collect PET bottle waste and create public acknowledgement about how to safely use PET bottles. These bottles are collected, repurposed, and used to make fabrics for bags, and clothing made of natural fibres like cotton and wool (Figure 4.8).

The company has used 4R model instead of 3R model which added “Replace” along with “Reduce, Reuse and Recycle”.

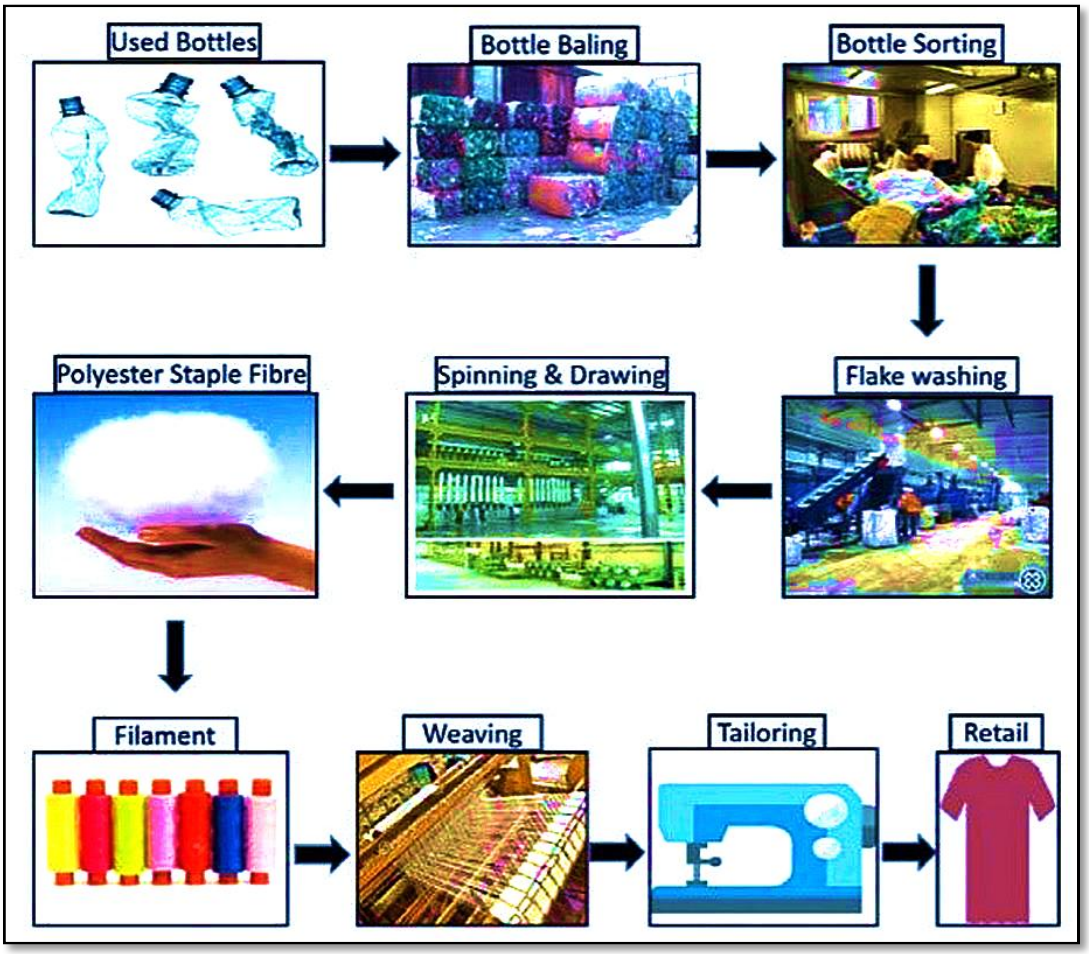


Figure 4.8 Process of making Bags and T-shirts

They replaced old PET bottles with natural raw materials in this way, saving one barrel of oil for every 8000 PET bottles recycled. Furthermore, wet dyeing changes polyester staple fibre into a dry one without polluting the environment, and removing wet dyeing from this process eliminated associated pollutants. As a result, dry dyeing has shown to be environmentally friendly. 1400 litres of watervsaved on every bag or T-shirt created from PET bottles saved, saved 8 waste PET bottles from landfill, cut pesticide use by more than 50%, and lowered carbon footprint by 32%.

Therefore, the environmentally friendly PET bottle conversion method is based on the zero waste idea, renewable energies, sewer pollution prevention, reduction in bag use and the green environment (GOI, 2019).

"Green Recycling Industry," Guwahati Plastic Bottle Recycling (Assam)

"Green Recycling Industry" at Bongshar, Kamrup district is the lone Plastic Bottle reusing unit of where 3MT waste Polyethylene terephthalate (PET) bottles are reused, creating 'Hot Washed PET Flakes'. Mr. Ranendra Baishya is the owner of the unit. The Flakes and PET powders goes about as the element of various polyester pieces of clothing and 2nd grade PET containers The waste plastic jugs are gathered by the waste authorities and packed into parcels. The bundles are then transferred to the plant. Subsequent to arriving at the plant, arranging measure is done, and pet jugs are isolated from different materials. The new reused structure is known as PET chips. Later these drops are shipped to various offices where it is changed into various completed items.

Collection and treatment unit for plastic waste- Indore

Indore Municipal Corporation (IMC) has set up a Plastic Collection Center (PCC) to reuse and reuse the city's PW. Alongside setting up a PCC, IMC has additionally introduced a plastic purifying machine known as a *'Phatka Machine'*. Waste pickers isolate and sell the plastic waste that can be reused. The excess plastic waste is then taken to the PCC where it goes through the most common way of cleaning and destroying. Around 10 Tons of the destroyed and sanitized plastic is shipped off the plastic waste fuel converter unit while the remainder of the plastic is shipped off Madhya Pradesh Rural Road Development Authority for development of streets. Plastic waste fuel convertor unit: IMC was confronting trouble in removal of scrap plastic like chocolate coverings, tobacco and dish masala pockets. Along these lines, IMC thought of a plastic waste fuel converter unit. This office chips away at switch polymerization measure and is fit for creating something like 3000 liter of fuel each day with 10 tons of scrap plastic waste. The whole interaction requires something like 16 hours. As of now, the unit is creating around 2400 liter fuel including diesel, petroleum just as unrefined petroleum. The fuel created is of acceptable quality. This plastic waste fuel change unit has tackled the issue of removal of scrap plastic waste gathered on regular schedule from the city. Roughly three crores have been spent as the expense of the plant.

Reduce

Plastic, obviously, is especially tricky since it is non-biodegradable and henceforth, perseveres for far longer than different sorts of waste. A couple of minor changes in day to day existence could assist with keeping plastics out of the waste stream. A few drives that can be embraced: I) Discourage the utilization of removal plastics. Observe how frequently we depend on items and supplant them with reusable forms. ii) Minimize Buying Water and make a propensity for utilizing reusable jug clinched. iii) Reduce the use of plastic cutlery and use metal utensils. Utilized as more current objects, the purchase of bundling materials rather attempts to use the materials used until it is very essential iv) Tax or ban package support Supporting legislation and legislation that charges the boycott of plastics for single use (CPHEEO, 2016b).

Reuse

The next best thing to recycling. It reduces the amount of plastic in landfills and relieves the load on recycling systems. Reuse, in reality, acts as a link between reduce and recycle. The reuse of plastic may help to minimise demand for new plastics, the demand for throwaway plastic and the utilisation of energy resources (CPHEEO, 2016b).

Recycle

Recycling and repurposing waste plastics has a number of positive profit. It result to a decrease in the use of virgin product and energy, as well as a decrease in CO2 emissions. (CPHEEO, 2016b); (CPHEEO, 2016a); (CPHEEO, 2016b); (CPHEEO, 2016a); (CPHEEO (Ruj et al., 2015).

Mechanical Recycling:

The Zig Zag Separator (Air Classifier):

Technique for removing fine dust from recycled materials, such as plastic flake, other granular materials, light films, or paper/foil contaminants. It is most often used after granulation or dry washing and is quite effective.

Air tabling: A technique of concentrating densities by differential settlement in regulated upward airflow under the influence of vibrants, which separate particles of different sizes, shapes and densities from one other. Ballistic Separator: designed to separate solid waste from the inlet in accordance with its dimensions, density and shape.

Sink Float Tank (or Dry and Wet Gravity Separation): This density-based technique separates the many forms of plastics. The heavier plastic fractions sink to the bottom of the tank and the lighter ones to the top. It is a substance for recycling plastic bottles and their caps. The lids and caps of these bottles are usually made of coloured HDPE plastic, while the bottles themselves are made of PET plastic. HDPE floats in the Sink-Float Tank, while PET sinks.

Froth Flotation: It is a thorough rinsing technique that uses either fluid or steam to recover huge amounts of fluid, making it a viable option for recycling. Friction Separation uses a high level of rotation and friction to dissolve impurities and separate them. This is often used to clean very dirty and mixed plastics. This strategy is helpful in the process of recycling of filthy plastics.

Electrostatic Separation (or Triboelectric Separation): The electrostatically charged particles pass through a tribocyclone in which negative charged particles migrate to the positively charged plate and vice-versa, which allows for the classification of three or more resins.

Plastic Color Sorting: Ultraviolet light used with good digital camera technology to recognize components as small as 0.04 mm in this technique. Material throughputs of 300-1800 kg/hr are covered by this series of plastics colour sorting machines. The machine throughput is affected by the type of material and the amount of contaminants. Sorting accuracy can reach 99.99 percent in most cases.

Near Infrared (NIR):

Materials when burned, they mainly reflect light with a wavelength in the near NIR. The NIR sensor can tell the difference between different materials based on how light is reflected. Optical sorting is used to positively identify various resins. It's mainly utilised for full bottles and jugs, and a particle size of 50mm is required.

Plastic to Road Construction

New potential for postconsumer plastic recycling are opened up through the usage of materials on highways. Plastic roads are either completely built of plastic or consist of a plastic blend with other materials. Polystyrene (PS) (hard packaging, cartons, plates, selling cups, and so on) (PP) (such as high- and low-density bottles, yoghurt cups, etc.) and polyethylene (PE) (such as low density) are all plastics that can serve for road building (plastic bags, water bottle, shampoo bottle etc.).

Plastic to Pavement Blocks

In contrast to toilet blocks, Plastone Block technology may also be used for making Pavement Blocks. Plastone block created from a combination of discarded plastics and stones were proven to be significantly more powerful than concrete blocks by 5 times with greater pressure and water percolation resistance. It has several advantages over ordinary cement bricks. Each plastone block requires 300 plastic bags and between 4 and 6 PET bottles. Its weight is modest and its transverse strength is outstanding. These blocks can be used for a multitude of uses such as floors, walls and channel furnishings.

Recycling of Multi-Layered Plastic

According to the 2016 rules on plastic waste management (CPCB) "diverse bundling means all materials used, or to be used in bundling and having no less than a single plastic layer as the principle fixing element, combined as overlays or co-expelled structures with at least one layer of material, such as paper, paper board, polymeric materials, metal layers or aluminium film (CPCB, 2013).

Natural product squeezes and wines can be put away at room temperature for extended timeframes in compartments made of paper, aluminum foil, and polyethylene film. Tea and desserts are bundled in covered foil with paper within. Indeed, even in hot conditions, this foil is multiple times as watertight as expected foil: the paper retains dampness while the foil shields the substance from other negative components. Most organizations incline toward complex bundling since it is light, decreases delivering volume, doesn't occupy a lot of room on a rack, and is illustrations agreeable.

Until the business finds a solution as opposed to multi-layered bundling, tertiary recicling is the preferred choice, since the isolation of the individual layers is problematic and expensive. Two essential cycles for tertiary reuse of different bundling wastes are pyrolysis and gasification. If tertiary replenishment is unpracticable, quaternary recycling can also be taken into consideration when reusing complex materials for the recovery of energy from squandering plastics by burning (Sharma and Mallubhotla, 2019).

Concept of Circular Economy

A circular economy is a restorative or regenerative industrial system. It substitutes the concept of the end of life with restoration, moves towards renewable energy, eliminates the use of dangerous chemicals that restrict reuse and re-enter the biosphere and seeks to reduce waste by means of superior material, product, system and business model development. The process of sustainable production, sustainable consumption and upgrading is crucial. This is important.

Sustainable consumption and production means less. The aim is also to divorce economic progress from environmental degradation, enhance resource efficiency and promote ecological lifestyles. It can also contribute substantially to alleviating poverty and transitioning to low carbon and green economies.

The activity of upcycling is the preparation of a useable product from waste or unwanted material or the modification of the existing product to add value. The objective of upcycling is to eliminate waste and increase the efficiency of resources.

There are 2-fold benefits of a circular economy approach, that is, economic and environmental benefits. The economic benefits include Substantial resource savings; Economic growth; Growth of employment; Innovation stimulus and Changing demand. The environmental benefits include: Less greenhouse gas emissions; Conserving vital soil; Water bodies; Bio reserves etc.

Circular economy relates to 4 loops, namely: Repair, Maintenance & Upgrade; Reuse; Remanufacturing; Re-Upcycling. The transition process from the linear economy to circular economy involves 4 different approaches, namely: Circular Economy Design; Reverse Cycle; New Innovative Business Model; Enabler System Conditions.

The new plastic economy has a few transition strategies like: Re-Design, Recycle and Reuse Plastics (Design packaging so as to make it a less harmful on the environment); Having economical attractive alternatives so as to reduce the generation of waste; Recycling Pay (Improving packaging at the palnning stage would make recycling simple and more profitable than sending plastic to the landfill sites).

Emerging Concept of 8R

The term 8R's refers to an expanded version of the 3R's waste hierarchy, which stands for reduce – reuse – recycle. The 8Rs require a rethinking of the consumer products purchasing process. The 8 R’s include: “Rethink, Regift, Recover, Recycle, Refuse, Reduce, Reuse and Repair” (Figure 4.9).

Figure 4.9 Eight R's waste hierarchy extended diagram

4.1.3 Construction and Demolition Waste Management

Safe and practical administration of strong squanders (SW) is quite difficult for current culture. Fast urbanization is switching the idea of strong waste administration from a low need, confined issue to an unavoidable ecological and social issue with dangers to general wellbeing and climate.

"Developments and destruction wastefulness" is a squander conveyed by the development, demonstration, repair, and destruction of all considerable design. It contains construction materials, floats, jetsam and scrap. Waste for development and destruction is generated at all levels, for example building streets, bridges, fly over, tram, reconstruction, etc (Figure 4.10). It usually consists of non-biodegradable materials such as cement, morter, metal, wood etc. (CPCB), 2017).

Due to the rapid expansion, India's development area is scheduled to develop at 7-8% in the next 10 years and is expected to become the world's third largest in the centre of the next decade. It is estimated that over 70 percent of planned structures will still remain in existence before 2030 (Mckinsey, 2010). It is estimated that around 70% of the structures predicted to exist by 2030 have still to be built together. A portion of these materials, particularly sand, are as of now confronting supply imperatives, subsequently influencing the area (Sakshi Gupta & Malik, 2018).

Figure 4.10 Construction and Demolition Waste

There ought to be a typical reusing office for the entire locale. The greater part of C&D squander is non-unsafe. Be that as it may, there are ecological issues during destruction and removal stages. Certain hazardous problems detected in more established structures include asbestos removal, polychlorinated biphenyl (PCBs), cables and linkages (brominated fire retardants and copper metals), lighting mercury and plume paint (Duan et al., 2015). So, C&D waste facility can be managed in time duration of 10 years.

C&D garbage generation activities in cities and cities are mostly based on: (i) Destroying existing, old structures; (ii) Existing buildings renovation (residential or commercial); (iii) Construction of new structure (residential or commercial or hotel etc.); (iv) Excavation or reconstruction of asphalt/concrete roads; (v) New bridge/bridge/subway construction, etc. New fly; and (vi) Present collection and disposal system (CPCB), 2017).

In the revised C&D Waste Management Rules 2016, a cradle-to-grave approach must be taken to properly manage C&D waste. The system should include proper collection, transportation, storage or collection of the waste from the generator, followed by correct treatment for the waste in recycled or repurpose items of market value that produce minimum trash disposed of in approved sites. A well-deployed management system must also include a good C&D waste quantification and classification system at various processing stages and a well-implemented surveillance system with a clear documentation procedure.

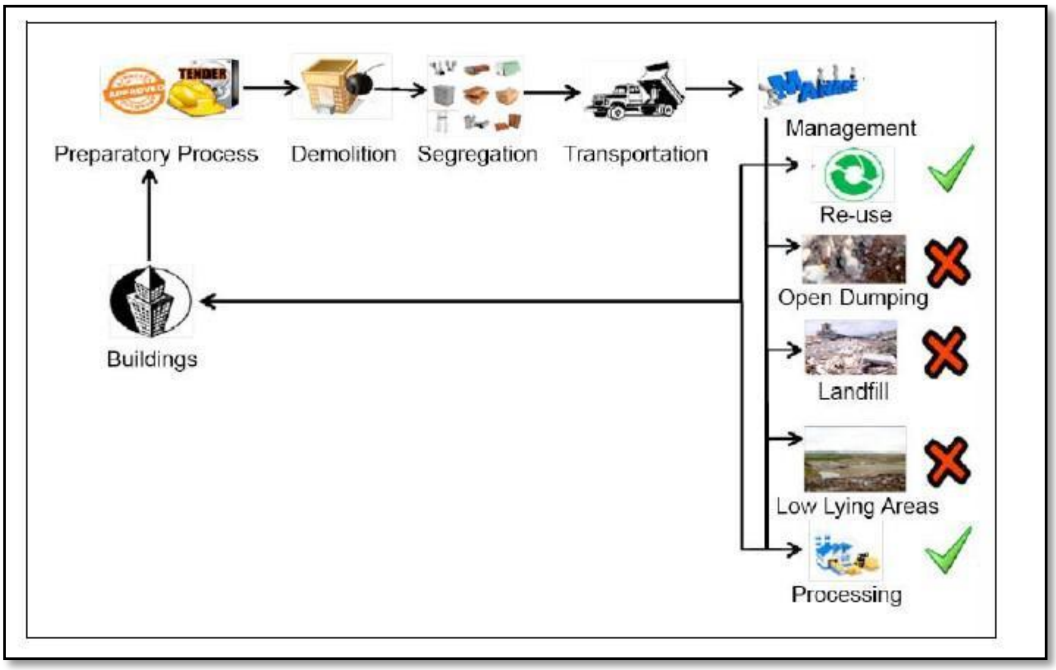


Figure 4.11 Schematic of Current vs. Ideal C&D Waste Management Processes in India

C&D waste generation and utilisation scenario

Huge heaps of C&D garbage are frequently seen alongside major roads in India, causing traffic jams, congestion, and disturbance, as well as clogging drains. C&D garbage accounts for almost 30% of all MSW generated in the country. TIFAC regulated a techno-market study on the 'Utilization of Waste from the Construction Industry,' which focused on the housing/building and road segments. The entire amount of garbage generated by the construction sector is estimated to be 12 to 15 million tonnes per year, with concrete and brick debris accounting for 7-8 million tonnes (Shrivastava & Chini, 2005).

According to the CPHEEO, the Indian Real Estate Industry alone is experiencing a 55,000 million total aggregate deficit. Furthermore, 750 million cum of aggregates would be required to meet the road building sector's ambitions, putting great strain on natural resources (Jay, 2019).

The resulting C&D waste would have various characteristics based on each city's growth trend and lifestyles. While recyclable materials such as bricks, wood, metal, and tiles are recycled, concrete and masonry waste, which accounts for more than half of the trash generated by construction and demolition activities in India, is not.

The contents of C&D waste created, as well as their respective quantities, vary by region and even within regions. Soil, sand, and gravel (26 percent), bricks & masonry (32 percent), Concrete (28 percent), metal (6 percent), wood (3 percent), and others (5 percent) make up the typical C&D trash in

Northern Plains cities (Figure 4.12). Bricks, tiles, wood and iron metal are sold for reuse or recycling. The rest of the materials are normally removed in sites (Vani & Shah, 2020).

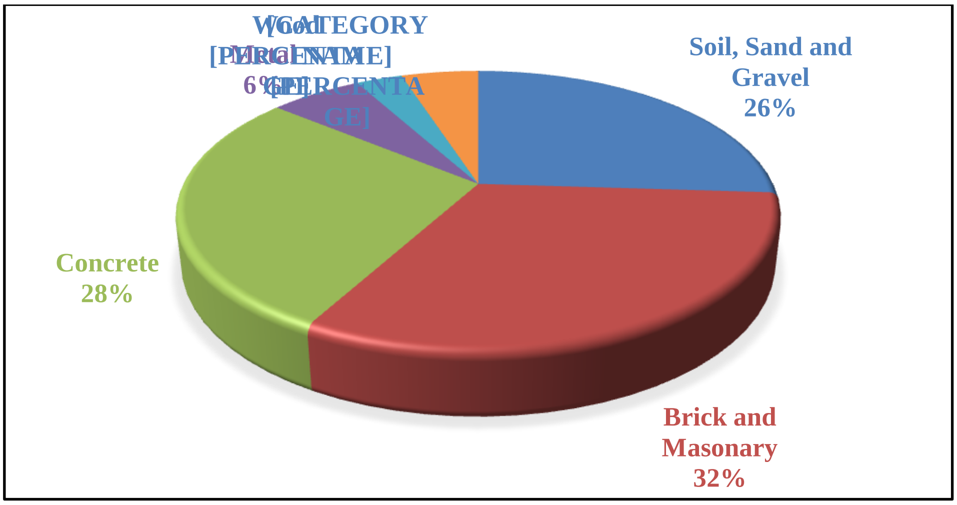


Figure 4.12 C&D Waste Composition: Indian Urban Areas

C&D waste management is currently very alert and active in the Government, the civil authorities and industry. More than 10 municipal companies have begun the process of establishing C&D waste processing facilities (Building Materials and Technology Promotion Council, 2018). In addition, Delhi is planning to set up four more plants for processing of C&D waste, including one by Delhi Metro Corporation (DMRC, 2018).

Rationale/Justification for C&D Waste Strategy

To develop an effective implementation strategy, it is vital to comprehend the importance of good C&D waste management as well as identify the problems and roadblocks.

Economic and Social Benefits

i. For communities, transporting bulky C&D garbage for disposal is an important cost to which a good, structured C&D waste management system may be lowered (or prevented) with generators paying for dispose as provided for by Rules of 2016.

ii. The mixture of C&D waste with solid waste compounds the municipal solid waste system and generates imbalances in the MSW tipping rate.

iii. As can be shown in Delhi and Ahmedabad, C&D waste treatment into recovered items can create jobs through new companies.

iv. Unregulated disposal of C&D trash produces considerable nuisance, safety and aesthetic hazards that can be improved by effective management of C&D waste.

Environmental Benefits

i. Unauthorized dumping of C&D waste through drainage and hydrological channels prevents and aggravates floods.

ii. Piles of C&D waste come up with to particulate air pollution when carried by wind.

iii. Unauthorised dumping of C&D waste in wetlands or stream/river channels disrupts local hydrology and related ecosystems.

iv. Hazardous materials associated with C&D waste may leach out and contaminate soil and groundwater from unofficial dumps.

v. Utilisation of recycled products from processed C&D waste helps reduce pressure on natural resources by decreasing extraction of virgin materials like sand.

Compatibility with current government policies and priorities

i. Swachh Bharat Mission-India: The Indian flagship waste management programme and resource recovery programme; C&D waste management is a vital part of its objectives. In comprehensive yearly surveys, towns must demonstrate advances in cleanliness and trash management, which should act as an incentive to local organisations.

ii. AMRUT: Urban infrastructure mission focusing on pedestrian areas of 500 ULBs. C&D waste recycled products (e.g., paver blocks) can be used beneficially for pedestrian zones (MoHUA & NITI Aayog, 2018).

iii. Smart Cities Mission: Mission proposes transformative projects in cities with an significance on innovation. C&D waste processing as well as utilisation of recycled products can be included in such projects.

iv. Housing for All (Pradhan Mantri Awas Yojana): A courageous objective is to create 1,2 million cheap homes by 2022 to address acute housing shortages. The Mission encourages the use of 'sustainable green resources' and allows the reuse of recovered items from C&D waste.

Governance and Management

Duties and Responsibilities of Stakeholders

In 2016, the Indian government issued the “Construction and Demolition Waste Management Rules” in response to the challenges caused by C&D waste. These regulations are fairly detailed and handle several stakeholders' obligations, among others generators, municipal authorities, state pollution control boards and urban development departments.

Table 4.2 Duties and Responsibilities of Stakeholders (Central Pollution Control Board, 2017)

Shareholders	Responsibilities and duties
Waste generator	● Collect and store garbage in your facility so that MSW is not spread or mixed. ● Dispose garbage at identified areas as local authorities have notified. ● Submit waste management plan before construction work / demolition activity begins and receive approval. ● Payment by the local authorities of the appropriate collection and disposal charges;.
Utility service providers and their contractors	● Preparation of a comprehensive waste planning. ● Preparation of a comprehensive waste planning
Local authority	● C&D waste management by-laws and appropriate levies and penalties are established. ● ● designate, in cooperation with government agencies, intermediate collecting places and sites for processing facilities. ● Examine and approve the generator waste management plan and collect applicable charges. ● Make agreements with private parties to collect, transport and process. ● Create C&D waste generating database through the connections and compliance monitoring of waste management permits. ● Sustainable IEC activities for all parties involved.
State Pollution Control Board/ Committee	● Monitor local authorities' enforcement of the Regulations. ● Calculate and monitor environmental compliance by criteria for the C&D waste processing facility. ● Prepare yearly reports for CPCB.
State government	● Prepare policy document for C&D waste management. ● Help towns identify land for waste management where necessary. ● Facilitate special procurement to recycled materials by all state agencies.
CPCB	● Prepare guidelines/regulation for C&D waste management. ● Analyse/compile data collected by SPCBs and prepare annual compliance report for central government.
BIS/Indian Roads Congress	● Prepare standards for appropriate utilisation of recycled products from C&D waste in construction and inroads.
Central	● Compliance facilitation by Ministry of Housing and Urban Affairs,

government		Ministry of Rural Developmen.
	●	Review of implementation by MoEFCC.

The local authority is responsible to establish/ get established the C&D waste processing plant functional within 18 months from the date of notification of C&D Waste Management Rules, 2016 for 1 million and above population cities, within 24 months for cities with population of 0.5 -1 million and 36 months for the cities with population less than 0.5 million (MoEFCC, 2017).

Guidelines and Advisories

The Ministry of Urban Development (MoUD) In 2012 all states required the establishment, in all cities/towns, of ecologically friendly CDW recyclers with a population of more than 1 million. CDW management was recognised and emphasised by the Swachh Bharat Mission (MoHUA & NITI Aayog, 2018)

Central Public Works Department's (CPWD) 2014 'Guidelines for Sustainable' A set of recommendations on recovered C&D wastes was included Habitats' (Department, 2014). The suggestions offer strategies and safeguards for CDW recycling, and emphasise the necessity for a deconstruction plan to re-use beneficial goods without a lot of processing.

Building Materials and Technology Promotion Council (BMTPC) In 2016, Guidelines were published to address a large shortage in Indian traditionals and traditional building materials due to the high demand for building materials in 2016, and the Guidelines for the Uses of Construction & Demolition Waste for Construction of Housing Units and Related Infrastructuring for Government Housing Schemes.

The Ministry of Housing and Urban Affairs (MoHUA) has circulated the notification, if available within 100 kilometres of the building site, to the CPWD on the necessary use of recycled parts of C&D trash in construction activities. It has further detailed the use of Lean Concrete, Plain Concrete (PCC) and Reinforced Concrete Cement (RCC) for construction in coarser and fine types of recyclic concrete aggregates (RCC) from C&D waste (MoHUA & NITI Aayog, 2018).

In 2015, Delhi PWD released a 2-10 percent use of recycled C&D waste products in construction and road development guideline for all Delhi Government Departments. In 2018, the Delhi PWD reissued the consultation. The amended consultation also demands the use of C&D waste products and promotes the establishment of C&D waste recycling plants, including at least one for each major government stakeholder, in various places in the city. The advise further mentions that North Delhi

Municipal Corporation has made seven C&D dumping sites from single homes available (CPCB, 2017).

Processing and Utilisation of C&D Waste

Material streams in C&D garbage with immediate market value, such as metals and wood frames, are currently salvaged for the secondary market (typically the informal sector) in India, while the remainder of the debris is left behind. Some of the debris are utilised to replenish and cover every day, but the majority of it is not (DGFIZ, 2017). C&D waste treatment plants that produce a large range of goods have been successfully established in Delhi and Ahmedabad. These processing units must be set all throughout India as needed by the new Regulations (Vani & Shah, 2020).

Technologies for C&D Waste Processing

Because Indian C&D waste mainly consists of concrete, mortar, bricks and cylinders, processing generally comprises crushing, shrinking, washing and screening into uniform sizes the material into aggregated particles which can be used in the construction market as substitutes for primary aggregates. The processing process is relatively similar to the preparation of stone and uses the same technology. The key phases and a simplified flow chart for C&D waste processing are shown in figures 4.13 and 4.14.

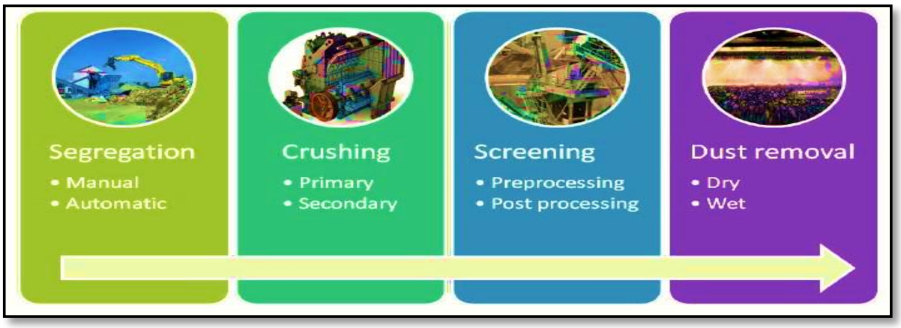


Figure 4.13 Major Steps in Processing of C&D Waste

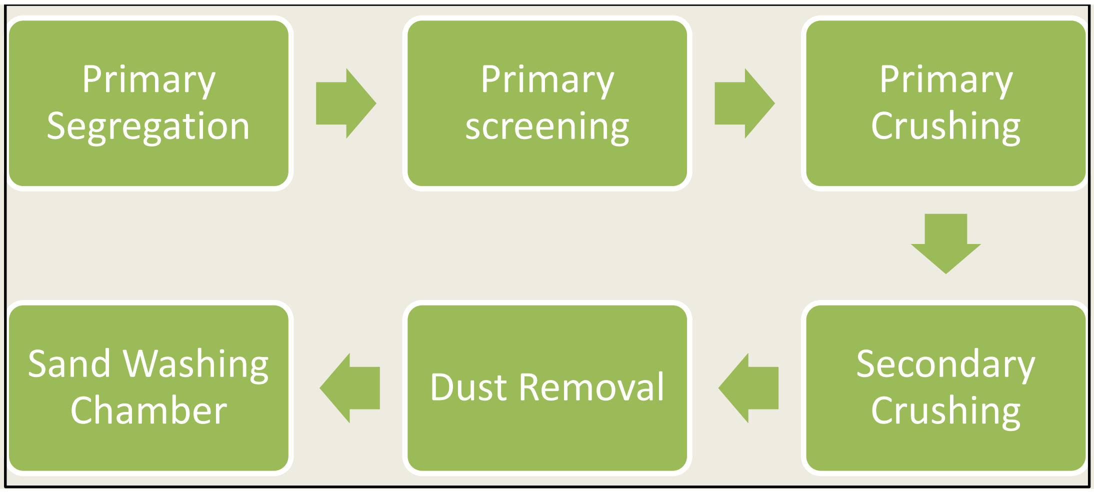


Figure 4.14 Process Outlay for Processing of C&D Waste into Secondary Raw Materials

Technology options for small towns and cities

Different measures may be required for tiny cities and communities that generate far less waste. In India, C&D waste recycling is relatively new; experience from the first few recycling units has revealed that a centralised stationary processing facility is only economically viable for trash generation above 100 TPD). Stationary processing facilities, on the other hand, may be viable for lesser capacity as the market and business models evolve (DGFIZ, 2017).

Although mobile crushers are the viable form of decentralisation that small towns can embrace, for towns that generate C&D trash less than 20-30 TPD, such a facility is not suggested. Mini mobile crusher can be a solution for such cities. The use of tiny mobile crushers is a convenient solution for ULBs to generate less than 1 or 2 C&D waste truck loads each day. Mini crushers can be maintained by ULB for processing waste into finer secondary raw material with processing capacity of approximately 5 TPD. Alternatively, selected concrete construction material manufacturers can maintain the small crushers, to which C&D waste can be sent as an enterprise model. The Foundation for MSME Clusters is now testing such a model (DGFIZ, 2017).

If ULBs can run a common C&D waste treatment facility close to borders, a cluster strategy is also conceivable for processing C&D waste. The fixed facility can be accessed or equidistant from a number of ULBs within a common region. Other ULBs can supply C&D waste on a prorated basis, and this can be operated by a single ULB, on the basis of the signed agreement. In addition, urban development agencies responsible for the management of different ULBs can coordinate the application of this technique (e.g., Chennai Metropolitan Development Authority, Mumbai Metropolitan Region Development Authority)

The cluster can optionally run a mobile crushing system, which, depending upon the documented contract, can be relocated between ULBs for a given number of days. Each ULB can store the material till the machine is able to include C&D waste and treat it for a certain amount of time. For ULBs with a tight boundaries of 20-30 km which can make large transport costs financially unviable, both of the above-mentioned methods are advisable.

Best Practices of C&D Waste Management in India

In India, scientific processing and utilisation of C&D waste has seen some success. In 2010, Delhi became the first city to implement a C&D waste management plan with the establishment of a pilot processing facility through a public-private partnership (PPP). After the pilot plant's initial success processing garbage at 500 TPD, the plant's capacity has been extended to 2,000 TPD (MoHUA & NITI Aayog, 2018). Delhi planned to establish a scattered network of processing plants in different zones of the city to save transportation distances and expenses. As a result, two more smaller plants (500 TPD and 150 TPD, respectively) have recently come online (2017-18), with more planned (MoHUA & NITI Aayog, 2018)

Ahmedabad was the second Indian town to utilise a PPP-like strategy to C&D waste processing in Delhi. A 300 TPD processing plant was opened in 2014 and the capacity was upgraded to 600 TPD in 2016 and to 1,000 TPD in 2018, following a successful year of operation (DMRC, 2018).

Both Delhi and Ahmedabad are followed by the DBOFT model of Design Build Operate Finance and Transfer. The Municipal Corporation contracts with a private company which is responsible, with its own funding, for the transportation and treatment of C&D waste and for the development of the necessary infrastructure. It provides the contracting party with property for the establishment of the processing plant and also identifies a number of interim collecting points at favoured places across the city. The authorised agency collects and transports C&D trash from these collection sites and unauthorised dumping sites, as instructed by the urban authorities, to the plant. The municipal company shall pay an agreed charge per tonne of rubbish collected and transported to the authorised agency. The authorised agency may also charge waste collection directly from major generators for recycling (such as Metro Rail), although the company receives waste at its own expense if waste generators bring the processing facilities. Thus, two sources of income for your private partner are ULB "tapping fee" and the sale of C&D waste recycled products. This guarantees the company's viability. But the use of recycled products derived from C&D trash on the market remains a continuing challenge in Delhi and Ahmedabad both (DMRC, 2018).

Proposed C&D Waste Management Model

Collection

***Existing Practices*– **Most ULBs do not collect or transport C&D waste in regular manner. Typically, the waste is collected by a local contractor and utilised for restocking elsewhere, or it is dumped illegally. Some towns have designated landfills/dumpsites for trash disposal, and waste generators must make their own arrangements to dump waste there. In most situations, however, this does not occur since the dumpsite is either located on the outskirts of town or the designated region is unknown to the waste generator due to poor communication by the ULB. Only a few of the ULBs with defined collection points have a proper tracking system using weigh bridges.

***Changes to be adopted* -** C&D waste should be adequately segregated in the producers's complex and subsequently shifted to specified disposal sites stipulated by the concerned authorities, according to the new Rules. The local government will formalise a collecting mechanism that includes proper tracking and monitoring, and will make this information available to all generators.

Transportation

Generators should transport C&D waste to the authorised location/s on their own or through other ULB-provided means, whichever is specified in the ULB's by-laws. In any event, both the generator and the transportation organisation must monitor the quantity of waste they transfer at the specified dumping location. Intermediate collecting points/transfer stations are useful to reduce transit distances before being removed to the final disposal and processing facility.

C&D vehicles should be covered in order to prevent dust, air pollution and the spill of waste on highways. These trucks can also be used to follow garbage flow from collection stations or generation sites to waste treatment plants with GPS sensors. Waste shall be quantified by weighing of trucks at the disposal or treatment location.

Disposal

***Existing practices* –** C&D trash is commonly disposed of in MSW dumpyards or landfills, where it takes up a large amount of space and limits the landfill's capacity. In MSW landfills, it's also employed as a daily cover. However, only a small percentage of C&D trash generated in most cities makes it to the ULB landfills. Unauthorized garbage disposal occurs in low-lying places, open spaces, roadside areas, and other locations.

Changes to be adopted – Before extracting usable elements from the waste stream, C&D trash shouldn't be permitted to be placed in landfills. The little amount of C&D waste that is rendered unusable after processing must be appropriately disposed of in a sanitary landfill and should not be mixed with other MSW. C&D garbage that is dangerous must be disposed of in a hazardous waste landfill. More than 90% of the C&D garbage can be processed/recycled in Indian cities and recycled as secondary raw materials. C&D waste material can also be used, to a certain degree, for approved public works construction projects when possible in cities without specific recycling facilities and the rest at designated dumping sites for recycling in future.

A processing unit may not be feasible in smaller towns with trash generation of less than 100 TPD. It may be conceivable in some rare cases for neighbouring towns to share a plant if they are close enough to each other. In most circumstances, a mobile crusher is a viable alternative, and the recycled aggregates produced can be used by the town's civil works department, other government agencies such as the PWD, or local construction material producers. City adopts preferential procurement policy to use recycled products made from C&D waste in municipal civil works and encourages other private and public entities to do the same. This standardized management model with a processing unit is depicted in a simplified way (MoHUA, 2018).

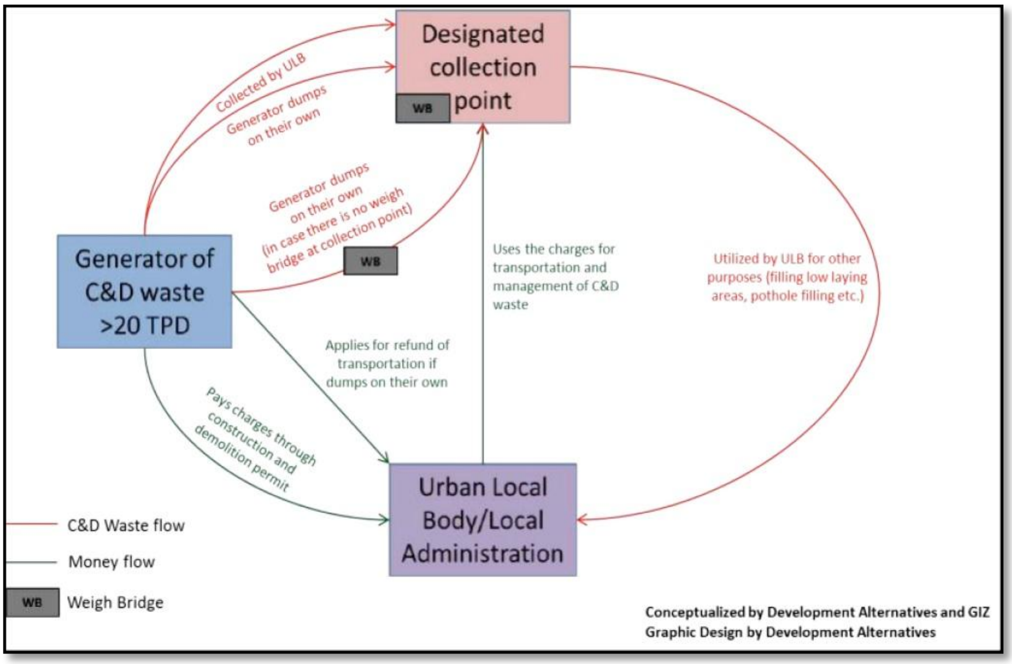


Figure 4.15 Standardised C&D Waste Management in a City without a Central Processing Unit

A processing facility may not be important for smaller communities with low C&D Waste generating rates. If many cities are close enough, a cluster approach may be used, in which a common C&D waste treatment facility is operated collaboratively.

This system can be accessible to or equidistant from a number of ULBs in a common area. On the other hand, smaller towns might run a mobile crusher plant that can be moved to places where waste from C&D is generated. End-users can then take crushed and sorted C&D trash (recycled aggregates) to a distant, depending on the type of utilization (e.g., backfilling/landfill use/road repair or construction/etc.). A standardized model C&D waste management model without a processing unit is shown below (DGFIZ, 2017).

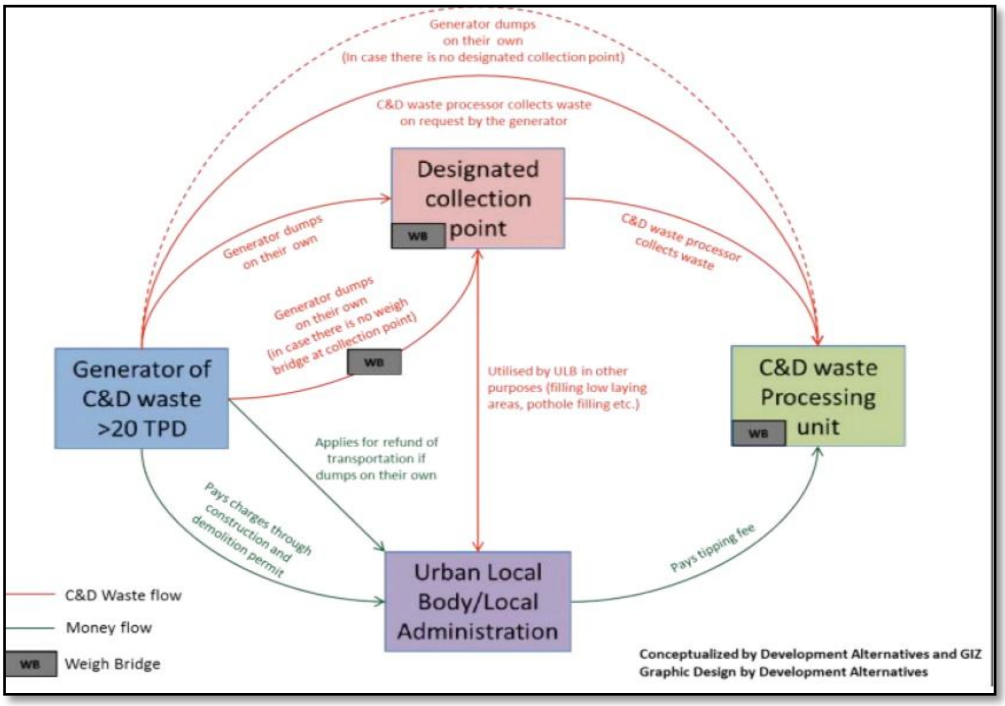


Figure 4.16 Standardised C&D Waste Management Model with a Central Processing Unit

4.1.4 Bio Medical Waste Management

Human exercises make a lot of rubbish. Such rubbish might be unsafe, requiring appropriate removal. Contingent upon their source, strong waste might be isolated into a few classifications. It comprises of (a) homegrown rubbish (b) modern waste (c) biomedical waste, medical clinic squander, or irresistible waste (Sachan and Chaurasia, 2006). Medical clinic squander is viewed as risky because of the presence of harmful substances. Bio-Medical Waste (BMW) contains creature squander, research center garbage, human physical waste, blood liquids and sharps made at medical clinics, nursing homes, facilities, dispensaries, veterinary establishments, creature houses, pathology labs, and blood donation centers during determination or Medical therapy. BMW takes on an all encompassing way to deal with squander the executives, including arrangement, evaluation, isolation, stockpiling, transportation, and treatment (Babu et al., 2009).

After 1980, the Bio Medical Waste was considered as the basic issue, as the illnesses like HIV and Hepatitis B contaminated materials can prompt a development of microorganism lead sicknesses in different patients (Patil and Pokhrel, 2005). The Bio-Medical Waste Administration Idea is new in India and gain spotlight after the warnings of Bio Medical Waste (The executives and Taking care of) Rules, 1998.The issue can be correspondingly decline with a severe source isolation approach. Essentially, with further developed arranging and organization, not exclusively can squander creation be diminished, yet in addition squander the board expenses might be monitored. Nowadays, institutional/hierarchical construction, preparing, and inspiration are totally given a ton of weight. Legitimate preparing of medical services laborers at all levels, alongside continuous inspiration, may essentially advance the circumstance. In contrast to other trash, the Bio-Medical waste is biohazardous, irresistible, and obsessive in character, which animates the development of various infections and vectors while likewise tainting non-risky and non-harmful material. This waste has high capability of transmission of illnesses for cloth pickers and waste gatherers as well as for overall population and patients too. Thus, its treatment and removal become a significant concern.

Figure 4.17 3R's Concept

Therefore, biomedical waste is sorted at the source and disposed of in accordance with best urban practices and guidelines. The ideal management strategy (BMWM) for BMW is not to waste disposal, but as much as possible to avoid waste generation or recycling. In the order that is convenient for you, prevention, reduction, reuse, recycling, recycling, treatment and final disposal BMW is BMW's many disposal options.

Therefore, instead of adopting the "tailpipe" approach, it is better to solve the waste problem from the source. All parties involved in funding and supporting healthcare operations have a moral and legal obligation to protect the safety of others, and therefore must provide expenses for the proper management of BMW. Manufacturers are responsible for providing environmentally friendly medical products to ensure proper disposal.

Bio-medical waste is waste formed during human or animal diagnosis or treatment or immunisation and during related research and biological testing.

Hospital waste refers to any discarded and not intended biological or non-biological waste.

Infectious waste: Wastes that contain germs in high enough concentrations or quantities to cause illness. It is dangerous, for example, infectious agent culture and stocks from laboratories, surgical waste, and trash from infected patients.

Sources of Bio-Medical Waste

Biomedical waste generation sources include hospitals, health care facilities, clinics, medical laboratories, blood banks, mortar shelters, medical research & training centres, biotechnology institutions, animals houses etc. Such waste can also be produced at home if a patient receives healthcare (e.g., injection, dressing material etc.)

Components of Bio Medical Waste

Discarded Medicines, Tubing, Gloves, Intravenous sets, Urine Bags, Plastic Bottles, Syringe, Plaster, Human Tissues, Cotton, Untidy Bandages, Blood Bags, Placenta, Body Part carcass, Blades, Vials and ampoule of medicines and glass bottles etc. are the prime components of Bio Medical Waste.

Only between ten percent to twenty-five percent of BMWs are harmful, with the remaining seventy-five percent to ninety percent being non-hazardous. As a result of waste processing, treatment, and disposal, hazardous waste poses a chemical, physical, and/or microbiological risk to the general public and health-care employees (CPHEEO, 2000).

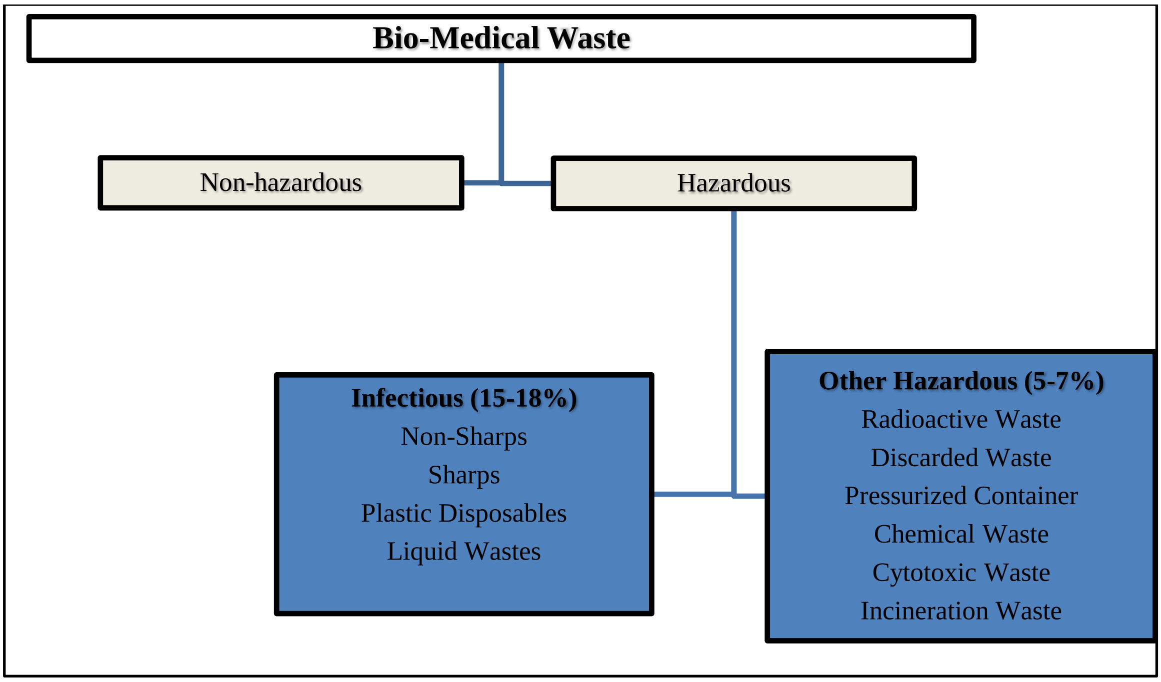


Figure 4.18 Different Categories of Bio-Medical Waste (Babu et al., 2009)

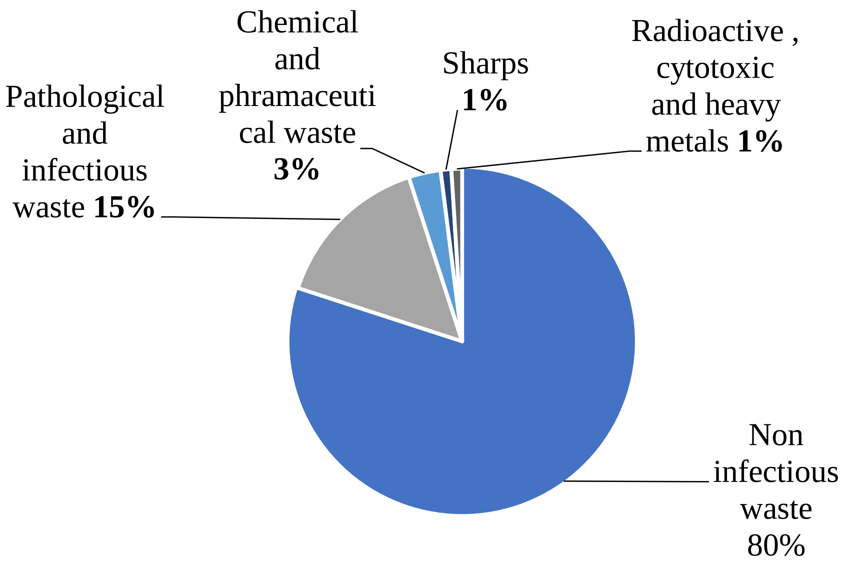


Figure 4.19 Composition of Bio-Medical Waste (Babu et al., 2009)

Categories of Bio Medical Waste

The most recent developments in healthcare facilities are aimed primarily at preventing and protecting community health. Sophisticated gadgets have become available in a number of procedures for treatment of illnesses. Waste generation in health-care facilities has increased per capita per patient as a result of these advances in scientific understanding.

During the healthcare procedure are manufactured hypodermic needles, squirrels, blades, operative cottons, gloves, bandages, clothing, medicines and fluids, human tissue and organ, chemicals and other wastes. Radioactive wastes, devices with mercury-containt, PVC plastics, and other wastes created in healthcare facilities are examples. These are the most ecologically sensitive healthcare goods, and they require a higher level of attention and monitoring (Babu et al., 2009).

Handling, segregation, mutilation, disinfection, storage, transportation, and final disposal are all important processes in ensuring the safe and scientific management of biological waste in any setting (Chatterjee, 2018).

Segregation (separate) and identification of biological waste are essential for its reduction and appropriate management. Sorting biomedical waste by colour is the most effective means of recognising the different types of trash.

All critical processes for the safe and scientific management of biological wastes in all environments include handling, sorting, mutilation, disinfection, storage, transportation and final disposal. Segregation (separate) and identification of biological waste are essential for its reduction and appropriate management.

Sorting biomedical waste into color-coded plastic bags or containers is the best approach to distinguish the different types of trash. According to Schedule II of the Biomedical Waste (Management and Handling) Rules 1998, biomedical wastes shall be divided into containers or bags at the site of production (Ibrahim Dincer Pouria Ahmadi, 2019).

Table 4.3 Categories of Bio-Medical Waste (BMWM Rules, 1998) (CPCB, 2016)

Option	Waste Category	Treatment and Disposal
Category No. I	**Human Anatomical Waste** (human tissues, organs, body parts)	incineration/ deep burial
Category No. 2	**Animal Waste** (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals colleges, discharge from hospitals, animal houses)	incineration/ deep burial
Category No. 3	**Microbiology & Biotechnology Waste** (wastes from laboratory cultures, stocks or specimens of micro organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures)	Local autoclaving/ microwaving/ incineration
Category No. 4	**Waste sharps** (needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	disinfection (chemical treatment/ autoclaving / microwaving and mutilation/ shredding
Category No. 5	**Discarded Medicines and Cytotoxic drugs** (wastes comprising of outdated, contaminated and discarded medicines)	incineration/ destruction and drugs disposal in secured landfills
Category No. 6	**Solid Waste** (Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood)	Incineration/ autoclaving/ microwaving
Category No. 7	**Solid Waste** (wastes generated from disposable items other than the waste sharps such as tubings, catheters, intravenous sets etc).	disinfection by chemical treatment/ autoclaving/ microwaving and mutilation/ shredding
Category No. 8	**Liquid Waste** (waste generated from laboratory and washing, cleaning, house keeping and disinfecting activities).	disinfection by chemical treatment and discharge into drains

Category No. 9	**Incineration Ash** (ash from incineration of any bio-medical waste)	disposal in municipal landfill
Category No. 10	**Chemical Waste** (chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.)	Chemical discharge into drains for liquids and secured landfill for solids

Effects of Bio-Medical Waste

Improper biomedical waste management has serious environmental consequences, including pollution of the air, water, and land. Biological, chemical, and radioactive pollutants are the three types of pollutants that cause harm. In India, there are a number of laws and policies that can be used to address environmental issues. It is investigated how radioactive waste created as part of biomedical waste is classified. Pollution's impacts on air, radioactivity, land, health, and risks are studied (Patil & Pokhrel, 2005).

Air Pollution: Buildings may pollute the air both inside and outdoors. The three types of biomedical waste created as a result of air pollution are biological, chemical, and radioactive waste (Patil & Pokhrel, 2005).

In-door Air Pollution: Diseases identified in garbage can infiltrate and persist in the air as spores or infections for a long period. Waste separation, source pretreatment, and other measures can all help to alleviate the situation to some extent. Sterilization of rooms will help minimise indoor biological pollution and indoor biological pollution (Babu et al., 2009) Indoor air pollution caused by the aforementioned contaminants, along with inadequate ventilation, causes Sick Building Syndrome (SBS). SBS may be reduced with the suitable construction design and well-kept air conditioners. Chemicals must be used in accordance with the regulations. It is necessary to prevent excessive use of chemical products (Saurabh Gupta & Boojh, 2006).

Out-door Air Pollution: Pathogens can contaminate the air we breathe outside. Pathogens can enter the environment when biomedical waste is moved outside of the facility without being prepared or put in open locations. Open burning and incinerators are the two main sources of chemical pollutants in outdoor air pollution. The most hazardous way is to openly burn biological waste. When inhaled, it can lead to respiratory problems. Dioxins and furans, for example, are carcinogenic organic gases (Patil & Pokhrel, 2005). The design specifications and maintenance of such technologies should comply with the rules laid down (Saurabh Gupta & Boojh, 2006).

Radioactive Emissions: Small amounts of radioactive gas can be generated during research and radioimmunoassay procedures. Gasses should be eliminated from the outside as early as feasible. Trap maintenance and off-gas monitoring are required while using such a device. (Chatterjee, 2018).

Water Pollution: If liquid waste is dumped into sewers without being adequately handled, it can pollute the water supply. Water contamination can change pH, BOD, DO, COD, and other parameters. Dioxins have been found in water bodies around incineration factories in the past. Airborne dioxins infiltrate the water body (Babu et al., 2009), (Saurabh Gupta & Boojh, 2006)

Radioactive Effluent: Chemical or biological research, bodily organ imaging, radioactive spill cleanup, patient's urine, and radioimmunoassay scintillation liquids can all produce radioactive waste in liquid form. In most circumstances, urine and faeces can be treated as non-radioactive waste if the patient's room is checked for radioactive contamination on a regular basis (Chatterjee, 2018)*;* (Mandal & Dutta, 2009).

Land Pollution: Bio-medical waste soil contamination is caused by infectious waste, abandoned medications, treatment chemicals, and ash, other trash generated during treatment operations. Heavy metals such as cadmium, plum and mercury in the waste, which can eventually enter the food chain, are absorbed by plants. Pollutants such as nitrates and phosphates can be identified in waste dumping leachates. Excessive levels of trace nutritional elements, as well as other elements like heavy metals, are harmful to agriculture, animals, and humans (Babu et al., 2009).

Waste Management Practices

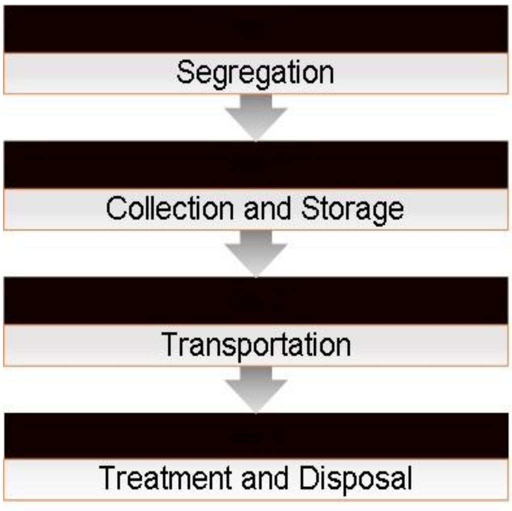


Figure 4.20 Waste Management Process

Step 1: Segregation

Bio Medical waste is separated firstly in Healthcare Institutions. For the segregation, a colour coding process is adopted for this separation process. Each type of waste must be maintained segregated in a designated container or bag, depending on the treatment choices specified in the guidelines. According to the CPCB and the Bio-medical Waste Management Rules of 2016, bio-medical waste must be separated into four color-coded waste types.

Figure 4.21 Waste Segregation at Source in Correct Liners (CPCB, 2019a)

The container/bag must have the following characteristics: 1. The maximum volume and weight of the waste must be robust enough without causing harm. It must have no perforations or leaks. 3. If possible, the container should have a foot cover. If plastic bags are to be used, they should be firmly fixed in the container so that they remain in place when the lid is opened and closed, and can be easily removed. Four. Sharps should be stored in a sharp container that is puncture-resistant. They must however be cut with a cuff and placed in the apartment/room before they are placed in the container.

Table 4.4 Color Coding of BM Waste Dustbins (BMWM Rules, 1998) (CPCB, 2019a)

Color Coding	Different type of Container	Waste Categories	Items Includes
Yellow	Plastic Bags	Cat. 1 Human Anatomical Waste Cat. 2 Animal Waste Cal. 3 Microbiological Waste Cat. 6 Solid Waste	Human Tissues, Plaster, Cotton, Untidy Bandages, Blood Bags, Placenta, Amputated Parts of Human Beings
Red	Disinfected Container, Plastic Bags	Cat. 3 Microbiological Cat. 6 Soiled Dressing	Tubing, Catheters, Gloves, Intravenous Sets, Urine Bags, Plastic Bottles, Syringes
Blue/White	Plastic Bags, Puncture Proof Containers	Cat. 4 Waste sharp Cat.7 Plastic disposable	Blades & Sharp Waste, Vials & Ampoules, Broken Glass & Bottles
Black	Plastic Bags, Puncture Proof Containers	Cat. 5 Discarded medicines Cat. 9 Incineration ash Cat 10 Chemical Waste	Discarded Medicine Incineration Ash Chemical Waste

Step 2: Collection and Storage

Figure 4.22 BMW Collection Bins

Depending on the volume of trash, it may be temporarily held at the hospital's central storage facility before being delivered in bulk to the final disposal location once or two times a day. Before disposal, HCF should double-check that waste bags/containers are sealed and marked appropriately with information regarding point of production. The disposal color coded bags should not be totally filled, allowing them to be taken up by the neck for additional handling. Hence the bags should be sealed when they are three- quarters full. Manual handling of waste bags should be avoided to prevent the risk of needle prick injury and infection. After removal of the bag, clean the container, even the lid, with an appropriate disinfectant. Waste bags and containers should be collected every day or more frequently, when appropriate, from wards and ambulatory departments (OPDs) (as in Operation Theatres, ICUs, labour rooms). Waste bags should be transported in covered wheeled containers or covered trolleys with big bins. Untreated biomedical waste must not be stored for more than 48 hours as per the guidelines. Within the health care institution or research centre, a storage place for medical waste should be specified. The waste should be stored in bags or containers in a different location, room or building which is large enough for the volume of waste produced and the regularity in which the rubbish is collected (Ibrahim Dincer Pouria Ahmadi, 2019).

Step 3: Transportation

Biomedical waste should be transported in or from a hospital with wheelchairs, containers or carts which are not used for anything and meet the specifications below.: It must be simple to load and unload; they should have no sharp edges that might harm trash bags or containers during loading and unloading; and it must be easy to disinfect. The cars must be cleansed and cleaned regularly with an appropriate disinfectant. All trash bags or containers should be labelled with basic composition and waste producer information. Vehicles used for BMW transportation must display the International Infectious Substance Symbol as shown in figure and should not be utilized for any other purpose.

Vehicles or containers used to carry health-care waste should not be utilized to transport any other type of trash.

Figure 4.23 (International Infectious Substance Symbol) Biohazard sign

Parking Lot for Collection Vehicles: Carts, trolleys, covered vehicles, and other waste collecting and transportation vehicles should be stored in a shed with fencing. To prevent cross contamination, separate sheds for hazardous and non-hazardous waste should be provided. A wash area with ample water jets, drainage, an elevated platform, and good drainage should be included in both sheds.

Step 4: Treatment and Disposal

Due to improper treatment and disposal, infections such as TB, hepatitis, enteric fever, HIV infection, and even AIDS can spread. The 'Bio-Medical Waste (Management and Handling) Rules, 1998' are having the detailed categorization and disposal methods of 10 different categories of trash produced in health-care institutions. The essential concept of biological waste treatment is that mutilation or shredding must be capable of preventing illegal reuse. Chemical treatment begins with a one-percent hypochlorite solution. Incineration, on the other hand, does not require any kind of pre-treatment. Only towns with a population of fewer than 5 lakhs are obliged to follow the deep burial procedure (MoEFCC, 2016).

The Detailed Methods for Treatment of Bio Medical Waste with technological interventions are:

Incineration: It's a very much directed burning interaction where garbage is completely oxidized and any perilous microorganisms are killed or denatured at a high temperature to change squander into latent materials and gases. Three sorts of incinerators are being used for clinic squander: numerous hearth type, revolving furnace, and air types (Wahid, 2013).

Plasma Pyrolysis: The waste is used directly as a combustion fuel or indirectly processed into different fuel to help use the energy it contains. In this case, pyrolysis is identified as a similar heat treatment in which high temperatures are used to treat waste materials with limited oxygen supply. It is an environmentally friendly technology that converts organic waste into by-products of economic value(WHO, 2014)

Autoclaving: Autoclaving is a low-heat thermal technology that disinfects waste by steam directly into regulated and long-term contact with it. The system should be designed horizontally and especially for the handling of bio-medical waste for operational comfort and safety (Babu et al., 2009).

Hydroclaving: This is the same as autoclaving, except that the waste is indirectly heated by steam from the outer jacket. During the operation, garbage kept falling inside.

Landfills*:* Infectious medical waste becomes safe waste after disinfection or combustion, which can then be disposed of in a landfill. However, after disinfection, many forms of medical waste, such as anatomical waste, can produce unpleasant visual effects, which are culturally unacceptable in many countries. Therefore, such wastes should not be identified prior to disposal, for example by incineration. If this is not an option, these wastes should be placed in containers prior to disposal (WHO, 2014).

Shredding: Sharps (needles, blades, glass, etc.) and plastic (I.V. bottles, I.V. sets, syringes, catheters, etc.) should be shredded following chemical treatment/microwaving/autoclaving. Needle destroyers can be used to dispose of needles without having to treat them chemically.

Scenario outside Country

In 2012, the World Health Organization (WHO) performed a survey on the status of BMWM in 24 West Pacific nations, including New Zealand, Japan, China, Australia, the Philippines, Malaysia, Vietnam, Cambodia, the Republic of Korea, Micronesia, Nauru, and Kiribati. A research, study of publications, newspaper stories, and other sources of information were all used in the study. Management, training, policy and regulatory framework, technology utilised, and economic resources were all considered in determining each country's standing. All Western Pacific countries, with the exception of Micronesia, Nauru and Kiribati, were good in terms of administration, training and BMWM policies. Only Japan and the Republic of Korea employ BAT (best available technology) for BMW logistics and treatment, and these systems are well-maintained and tested on a regular basis. The majority of countries lacked or had insufficient financial resources to support BMWM. Therefore, the HCWM of most Western Pacific countries is still far from ideal, and more funds to expand the HCWM system in several countries are essential to ensure the implementation of a secure HCWM system in the next ten years. In Canada, different jurisdictions have different methods of managing medical waste. The management and disposal of medical waste has not been regulated by all provinces. However, it seems that Canadian hospitals are migrating to BMW's national central disinfectant from incinerators in place (Mishra et al., 2016).

Scenario in Country

In India BMW has problems with the absence, and second, of re-use syringes with correct disinfection, of gloves, masks, shoes and open and un-protected medical waste for reuse. The International Medical Epidemiology Network investigated the current BMW practices, settings and structures in basic, intermediate and tertiary healthcare facilities (HCF) in 20 states of India from 2002 to 2004. They found that 82% of primary care does not have a reliable BMWM system center. In India there are 60% of secondary school CS and 54% of higher education. In 2009 approximately 240 persons, who had used non-sterile needles in Gujarat, India, contracted hepatitis B. Different studies show that although India is one of the first countries to take measures to safely dispose of BMWs, there is an urgent need to expand existing system capacity, increase funding, and increase BMW’s commitment to disposal safety. For healthy humans and a cleaner environment, effective biomedical waste management is highly needed. Safe and sustainable biological waste management is the duty of managers and owners of sanitary systems.

CPCB published an Annual Report on Biomedical Waste Management for 2019 based on data compiled and reported by all SPCBs. The country generates a total of BMW of 614 TPD (tonnes a day) from 2,70,416 HCFs, according to the data. Sadly, 447 TPDs are only treated, which leaves 37 untreated. 200 CBMWTF and 28 under construction are in operating (Mishra et al., 2016).

Annual Report Information has been submitted by every RSPCB for as per the data annual report information for the year 2019, there are 5974 no. of HCFs which generate 22502.57 kg/day bio-medical waste.

09 CBWTFs (07 under development) are in operation (RSPCB, 2019). The trash is usually collected without disinfection in open containers. Plastic or other non-specific containers hold bandages, cotton and other absorbing materials. Miscellaneous waste is collected. Some hospitals around the country have established a colour coding scheme for themselves. Sharps are dumped without disinfection or mutilation, which might lead to reuse and disease transmission. The recyclable material for sale is segregated by the garbage and transport personnel in the hospital. Likewise, any disposable plastic item is separated by garbage pickers, which are used for transit and for the municipal solid waste either within the hospital or outside the community waste bin. Since infectious waste is intermingled with municipal waste, it might cause the whole lot to become contagious under adverse environmental conditions (CPCB, 2016)

Scenario in State

There are 193 Urban Local Bodies (ULBs), 295 Panchayat Samitis, and 9,892 Gram Panchayats throughout Rajasthan's 33 districts (GPs). According to the 2011 Census, the state's population is 6.86 crores, with 24.78 percent living in urban areas and 75.13 percent in rural areas. The RSPCB provided the annual report for 2019 and has produced 8 100 No. HCFs, which provide 20685.65 kg/day of bio-medical waste. Annual reports RSPCB has submitted for 2016. There are 08 no. of CBWTFs in operation (RSPCB, 2019). The 78.9% of waste generated is treated per day. Rajasthan's government has designed and implemented a plan to handle this crucial issue, and Dept. of Medical & Health Science is responsible for it.

Hospital Waste Management Plan, Ministry of Health and Family Welfare

Hospital waste disposal is a complicated operation in which the many processes listed below are highly interrelated on both a technical and organisational level. The following are the governing principles in general terms:

A. Generation / Minimization: - Under rules hospital trash is categorised into 10 categories including human anatomical waste, animal waste, microbiological or biotechnological waste, waste cutting, abandoned pharmaceuticals and cytotoxic medicines. Dirty waste, solid waste, liquid waste, incinerator ash, and chemical waste are all examples of waste. Compliance with 3 Rs, namely reduction, recycling and reuse, encourages a significant reduction in waste generated by health institutions.

B. Segregation of Waste: - Segregation is the most important process in the category of organic waste, and each form of trash is followed by. It is done at the point of generation, for example, in all patient activity areas, diagnostic service areas, operating rooms, labour rooms, and treatment rooms. The generators of bio-medical waste, such as physicians and nurses, are responsible for segregation.

C. Collection: - Only non-chlorinated plastic collecting bags are utilised in the bins and receptacles. This prevents rag pickers from recycling or repurposing the products. Every day, waste is collected and delivered to a designated storage facility or deep burial pits. After 2/3 of the bags have been filled with biomedical waste, they are removed.

D. Transportation: - Garbage routes and transit times have been established within the hospital to minimize the amount of garbage that passes through busy and patient care areas. To transfer plastic bags to deep storage / burial places, special containers with wheels, trolleys / trolleys are used. The design of the container allows the garbage to be easily dumped into it, and the foot cover can safely close the sick waste inside.

E. Storage: - Storage, according to the Bio-Medical Waste Rules, is explained as keeping biomedical waste for a specified amount of time before it is treated and disposed of. Inside the facility, there is a specific storage site for hospital waste collection. The garbage is collected in bags or containers and stored in a designated place.

F. End Treatment and Disposal: - The Office of Local Bodies, which is part of the GoR's Local Self Government (LSG), has been tasked with establishing Common Treatment Facilities (CTFs) in a number of cities. CTFs are in charge of trash collection and transportation from hospitals, as well as treatment and destruction when needed, and ultimate disposal at the CTF site. Before installing the equipment and treatment processes, the owner of CTF obtains permission from the appropriate authority under the BMW Rules, particularly the Rajasthan Pollution Control Board (RPCB). The provision exists for the payment of CTF hiring fees by RHSDP to CTF operators at the rate of Rs. 1000/- per bed per year for project-supported installations only. The CTF recruiting fees are paid via RMRS, which is repaid on an as-needed basis. This refund of CTF connection expenses is available until the end of the project duration (September 2011), after which it becomes liable (CPHEEO-Part I, 2016b).

Monitoring of the Health Care Waste Management Activities

The Director-Hospital Administration at the Department of Medical, Health, and Family Welfare has chaired a Coordination, Monitoring, and Evaluation (CM&E) Committee for health care waste management. This committee is in charge of overseeing all actions relating to the management of medical waste. The Rajasthan government has undertaken regular cooperation between the RHSDP, DM&HS and NRHM authorities for the sustainable and convergent activities and practises of all HCWM with the Department of Medical and Health (TERI, 2014).

Governance and Management Structure

The various concerned institutions involved in the process of Bio-Medical Waste Management are: Central Pollution Control Board, Ministry of Environment, Forest and Climate Change, Central Public Health and Environmental Engineering Organisation (CPHEEO), Department of Medical, Health & Family Welfare, Rajasthan, The Energy and Resource Institute (TERI) and Ministry of Housing and Urban Affairs.

Roles and Responsibilities

Functions of the Central Board at the National Level

Advising the Government of the Central on any topic concerning the prevention and control of water and air pollution and the improvement of air quality. Developing and implementing a national water and air pollution prevention, control or reduction programme; Coordinate and resolve problems between the State Board's operations; Providing the State Boards with technical advice and guidance, and carrying out and funding research and research into the prevention of water and air pollution, control and abatement of these concerns; Planning and organising training on the prevention, control or mitigation of water and air pollution programmes; Organize a comprehensive mass sensitization effort in media prevention, control and mitigation of water and air pollution; Collect, consolidate and publicise data on water and air pollution techniques and statistics and actions to successfully prevent them, control, or abate it; Prepare wastewater treatment and disposal instructions, rules and recommendations as well as gas cleaning equipment, stacks and pipes for stacking gas, stacks and canals; disseminate information on and prevention and management of water and air pollution; Lay standards for waterways or wells and establish criteria for air quality, alter them and annul them, in consultation with the State Governments concerned; fulfil the additional function that the government of India may prescribe (CPCB, 2016);(Patidar et al., 2014)

Rules and Regulations

Their reckless disposal from hospitals, nursing homes and pathological laboratories has caused significant environmental degradation, leading to the spread of illness and exposure of people to some very infectious and disease-prone vector. This has caused considerable environmental concern.

Bio Medical Waste (Management and Handling) Rules, 2016

The Ministry of the Environment and Forestry issued in July 1998 the Government of India, pursuant to the Environment (Protection) Act (1986, the first Bio Medical Waste rules (hereafter "BMW Rules"). The BMW 1998 rules were updated in 2000, 2003 and 2011. The drawn BMW Regulations 2011 remain a draught, not announced, because of lack of consensus on classification and criteria. In March 2016, the Ministry of Environment, Forestry, and Climate Change revised the BMWM guidelines (Ibrahim Dincer Pouria Ahmadi, 2019).

To reduce pollution, these new guidelines have expanded coverage, simplified classification and authorisation, and improved segregation, transportation, and disposal techniques.

The new BMWM Rules 2016 states the guidelines, effective implementation, techniques and eco-friendly methods. These laws are suggested to improve methods of segregation, transport and disposal, by decreasing pollution in the environment. To properly dispose of BMWM, we need to have a collective team-based approach with strong government assistance on financing and infrastructure development, dedicated health-care employees and health facilities, on-going monitoring of BMW practises, strict regulations and powerful regulatory organisations. State governments have made steps to establish Common Biomedical Waste Treatment Facilities (CBWTFs) for waste treatment and disposal. Segregation at the source and waste minimization are the cornerstones of BMWM.

Furthermore, tight procedures have been established to prevent pilferage of recyclable items, secondary handling, or animal dispersal or spillage during delivery from the HCFs to the shared BMW treatment plant (CBMWTF). Waste collection, sorting, transportation, and disposal are all being improved. Simultaneously, by adopting new rules for incinerators and improving their operations, the function of incinerators in increasing environmental air pollution has been controlled (Balasubramanian, 2018; Sachan & Chaurasia, 2006)

“Any waste generated during the diagnosis, treatment, or immunization of humans or animals, or during related research, or during the production or testing of biologicals,” according to India's Biomedical Waste (Management and Handling) Rules, 1998. As a result of the Government of India promulgation, medical administrators have now been legally obliged to deal properly with and disposal this sort of waste.

Following rules have been followed for Bio-Medical Waste Management (CPHEEO, 2000)*:*

The health facilities must get authorization/renovation certificates from the State Pollution Control Board in accordance with Bio-Medical Wastes (Management and Handling) Rules, 1998. (SPCB).

Bio-medical waste must be segregated in four color-coded red (infected dressing, pop cast), yellow (body-shaped), blue (syringe), white (needles, cut glasses) waste categories as indicated by the disposal methods laid down in Schedule I of the R, as notified the Central Pollution Control Board and in line with Bio-Medical Waste Management Rulings, 2016 (CPHEEO, 2000).

The following are some of the act's most notable features:

The Act requires the approvable operator of the Common Bio-Medical Waste Treatment and Disposal Facility (CBWTF) to take reasonable action to ensure the safe and ecologically acceptable transportation, handling, storage, processing and disposal of biomedical waste collected from the worker. Local governments, like gramme panchayats, local authorities and corporations, shall provide or allocate appropriate land for the establishment in their jurisdictions of a CBWTF in accordance with CPCB Guidelines by Schedule III of the Bio-medical waste management Rules, 2016.

Solid Waste Management rules, 2016 -Requirements on Bio-Medical Waste

The treatment of biomedical waste, industrial waste, e-waste and domestic hazardous wastes shall be subject to specific rules on their administration and domestic hazardous waste may be handled in accordance with the provisions of the SWM Rules, 2016 by the State Pollution Control Board or Pollution Control Board. In line with the Bio-Medical Waste Management Rule, 2016, the biological waste shall be disposed of as reviewed from time to time based on the site selection criteria set out in Schedule I(x) of the 2016 SWM Rules. In compliance with the CPCB guidelines, local governments, such as gramme panchayats, local governments and corporations, shall provide for or allocate suitable land to establish a CBWTF within their jurisdiction under Schedule III of the Bio-medical Waste Management Rules of 2016. In compliance with the 2016 SWM regulations or as revised sometimes, collect other solid waste (no bio-medical waste) from health care establishments (CPCB, 2016).

Environmental Concern

The following are the primary environmental risks about incorrect bio-medical waste disposal:

A. Infection and diseases carried via vectors that affect the internal and external populations (fly, mosquitoes, insects etc.). B. Infection spreads to healthcare personnel and sweepers/pickers by contact and damage, notably from sharps (needles, blades). C. The infection spreads to hypodermic needles, bowls, blades and bottles by unauthorised recycling of throwaway things. Reaction caused by the usage of expired medications. D. Toxic emissions from incinerators that are malfunctioning or inefficient, as well as indiscriminate disposal of incinerator ash and leftovers (Patil & Pokhrel, 2005).

B.

Best Practices

Disposal in three stages

1. Primary Level

At this level, the factory is located in the urban area, so it is located in the urban area. Air pollution will take center stage, so we replaced the incinerator with a plasma pyrolysis system, which can destroy dioxins and furans, which are carcinogenic compounds emitted during improper combustion. To increase capacity we replaced the autoclave with Hydroclave, by using Hydroclave we can increase speed and efficiency. At this level, the focus should be on adequate insulation to avoid mixing of food waste and reducing waste from incineration. The adjustment of the GPS tracker in the vehicle is also used for a correct collection The transport vehicle will be carried out in accordance with the Motor Vehicle Law.

2. Secondary Level

The main goal is to collect and dispose of rubbish from the suburbs and villages. Since the factory is located in a non-residential area, there is no need to advance the system because it will be expensive. The plant will include an incinerator and an autoclave. For collection and transportation purposes, we are implementing collection points. The local EHR will collect your waste at the center. Transport vehicles collect the waste to the factory.

3. Tertiary Level

Prime aim is disposal of the waste Area is remote so the old burning using the Brick masonry incinerator and old container can be used to dispose the waste.

4.1.5 Hazardous Waste Management

Hazardous waste refers to any type of waste, if improperly disposed of, it will cause health problems to humans and the environment. It can take many forms, can be produced from various human activities, such as industrial projects and factory work, and can even be found in domestic waste. It is important to have a clear and concise plan that can be followed to minimize hazardous waste, and at the same time to properly separate, process and dispose of waste, to ensure that humans and the environment are protected from the dangers it poses.

"Hazardous waste" refers alone or in contact with chemicals which provide a hazard to health or the environment, and which may pose a risk to the environment, physical, chemical, biological, reagent, poisonous, flammable, explosive or corrosive qualities. Health or environment. Any Wastes or material, and must comprise a) Hazardous Waste 2016, as described in Annex I column (3) and Other

(Handling and Cross-Border Movement) Regulations; b) Class A and B of Annex II of equal or higher Class composition or any characteristic specified in Class C of Annex II of the 2016 Hazardous Waste and Other Waste (Handling and Transboundary Movement) Regulations; and c) The restrictions on imports or exports of such wastes, movements, wastes identified in Part A of Annex III which, not defined in Part A, have dangerous qualities specified in Part C of Annex III and in Part C of Hazardous Waste and Others, 2016. (Karthikeyan et al., 2018)

"Domestic hazardous wastes are defined as discarded paint drums, pesticide cans, CFL bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles and syringes, contaminated gauge, etc. generated at the household level" (CPHEEO, 2016b).

Hazard Classification

Physical Hazards

The following are classified by GHS as physical hazards or chemicals that cause physical property damage:

Table 4.5 Classification of Physical Hazards

HAZARD CLASS	NO. OF CATEGORIES	GHS SYMBOL
Explosives: Explosive substances (or mixtures) are solids or liquids (or mixtures of substances) that are in and of themselves able to produce gas at such a temperature, pressure and speed to cause damage to the environment by chemical reaction.	Unstable explosives – 1 Explosives Division 1.1-1.6	
Mixtures and self-heating compounds is a solid or liquid, other than a pyrophoric liquid or solid, which is limbic to self-heat by reaction with air and without energy source. It varies in that it ignited only when it is largely (kilogramme) and after long period, from pyrophoric liquids or solids. periods of time (hours or days).	Two Categories: 1 and 2 classified in accordance with test N.4 under GHS	
Substances and compounds that emit flammable gases in contact with water or compounds which are likely to be flammable spontaneously by interaction with water, in dangerous concentrations, and to emit inflammable gases.	Three Categories: 1, 2 and 3 classified in accordance with test N.5 under GHS	

Oxidizing liquid: A liquid which, although not always fuel in itself, can generally lead to the combustion of other materials by releasing oxygen.	Three Categories: 1, 2 and 3 classified in accordance with test O.2 under GHS	
Oxidizing solids: A liquid that, although not always fuel in itself, can usually lead or contribute to the combustion of other materials by releasing oxygen.	Three Categories: 1, 2 and 3 classified in accordance with test O.1 and O.3 under GHS	
Organic peroxides: Thermally unstable or prone to blending exothermically accelerated breakdown, fluid or solid organic molecules. They may also be responsible for explosives.	Seven categories: Types A - G divided on the basis of principles under Chapter 2.15	 
Flammable gases: A flammable gas range 20 degrees Celsius and a standard 101,3 kPa pressure. They differ from pyrophoric gases and chemical instabilities. A pyloric gas which can fire at or below 54 degrees Celsius in the air is a flammable gas. However, a chemically unstable gas is an inflammable gas that even in the absence of air or oxygen can react explosively.	Three categories - 1A, 1B and 2	
Anaerole is a non-refillable container made of metal, glass or plastic, with or without a liquid, paste or powder compressed, liquid or dissolved gas under pressure. The containers are provided with a releasing device that permits the dispersion into gas, foam, adhesive or powder or liquid or raucous conditions of solid or liquid particles in suspension. The classification of aerosols as Flammable should be evaluated where they contain any component which is designated as GHS-inflammable.	Three categories- 1, 2 and 3	
Oxidising Gases: Oxidizing gas is defined as a category and is a gas that can contribute to the combustion of other materials than air, often by giving oxygen.	One Category	

Gases under pressure: Gases that contained arc in a container at a pressure of 20 degrees Celsius not less than 200 kPa or as a cooled Liquid.	Four Categories: Compressed gases, Liquefied gases, Dissolved gases and refrigerated liquefied gases.	
Corrosive to metals: A metal-corrosive substance or mixture is a substance or mixture that substantially damages, or even destroys metals with a chemical effect.	One category	
Desensitized Explosive: They have arc solid or liquid explosive ingredients or mixtures that are made less vulnerable to their explosive properties in a way that does not explode in mass or burn too quickly and is therefore free from the dangerous class of explosives.	Four categories: 1, 2, 3 and 4 based on ‘burning rate test’	

Environment Hazards

Chemical compounds and combinations in environmental dangers are categorised by environmental components into several classes (such as the aquatic environment, the ozone layer). The GHS classifies chemicals as:

Table 4.6 Classification of Environment Hazards

HAZARD CLASS	NO. OF CATEGORIES	GHS SYMBOL
Aquatic environment dangerous The intrinsic quality of a substance which is harmful to an organism during short exposure to that substance is acute aquatic toxicity. Chronic aquatic toxicity – The potential or actual qualities of the drug in relation to the life cycle of the organism which can create detrimental effects to aquatic species during exposures.	In the three categories: the Acute 1, Acute 2 and Acute 3 short term hazard is listed. Long-term (chronic) hazards are also categorised on the basis of sufficient data available on toxicity.	
Ozone layer dangerous Ozone Depletion Potential is an integrative amount that reflects the extent of ozone depletion of the halocarbon in the stratosphere expected in relation to the mass for mass of the CFC-11 for each halocarbon source type.	One Category.	

Governance and Management Structure

Concerned Stakeholders

Solid Waste Management stakeholders are as follows:

- Government Departments
- Waste Generators (Residential and Bulk Waste Generators)
- Producers Manufacturers &Brand Owners
- Industrial Units

Roles and Responsibilities

According to Solid Waste Management Rules, 2016 the duties of various stakeholders are as follows:

Duties of Ministry of Urban Development

The Ministry of Urban Development and State Government Administrations shall conduct regular reviews of measures taken by the states and local bodies to improve the practises of solid waste management, and implement solid waste management projects financed by the Department and external agencies. (GOR, 2019).

Duties of Department of Fertilisers, Ministry of Chemicals and Fertilisers

Through appropriate procedures the Fertilizers Department must offer market development aid to city compost, ensuring the co-selling of compost with chemical fertilisers at the ratio of 3 to 4 bags: 6 to 7 bags of fertilisers provided to enterprises by compost for marketing (GOR, 2019).

Duties of Ministry of Agriculture

The Agriculture Department shall provide the Fertiliser control order flexibility for compost manufacture and sales, the propagation of compost on farmland, the development of compost quality testing laboratories produced by local authorities or their authorised authorities and the development of appropriate directives for the maintenance of compost quality and the use relation between compost and chemical fertiliser wheat and other chemical fertilisers (GOR, 2019).

Duties of the Ministry of Power

The Power Ministry shall decide tariffs or fees for energy generated from waste to power plants on the basis of solid waste by means of acceptable methods (GOR, 2019).

Duties of Ministry of New and Renewable Energy Sources

The Ministry of New and Renewable Energy shall enable waste infrastructure generation in power stations and shall provide suitable subsidies or incentives for such waste in power plants via appropriate channels. (GOR, 2019).

Duties of the Secretary-in-charge, LSG or Local Self Government Department and the Secretary-in-charge of Gram Panchayats or Rural Development Department

The Secretary of LSG shall prepare, in consultation with stakeholders including representatives of waste pickers, self-sustainers, through a Commissioner or Director of the Municipal Administration or Director of the local authorities or of the Secretary of Gram Panchayats or of the Rural Development Department of the State a State policy and strategy for solid waste management; the focus is laid on waste reduction, reuse, recycling, recovery and optimal use of various solid waste components, as well as on minimising waste disposal impacts on human health or the environment, as well as on preparing state policies and strategies for solid waste management. State policies and strategies should recognise the main role of informal waste management

It shall also ensure the compliance by all municipal governments of the terms of the Regulation and conduct regular meetings of the State Level Advisory Body (SLAB). (GOR, 2019).

Duties of District Magistrate or District Collector

The District Magistrate or District Collector shall, in closer consultation with the Minister-in-Commerce of the State Urban Development, facilitate the identification and allotment of suitable land for building solid waste processing and disposal facilities in his district and supervise the performance of local authorities (GOR, 2019).

Duties and Responsibilities or Local bodies and Gram Panchayats

In addition to the duties and responsibilities required for gramme panchayat, the key tasks are to prepare a Solid and Liquid Resource Management (SLRM), arrange door-to-door recycling of solider waste segregated in each household, set up a material recycling facility, i.e. a Resource Recovery Center (RRC) (GOR, 2019).

It is also their job, as ordered by the State Pollution Control Board or the Pollution Control Committee, to guarantee that the home hazardous waste is safely stored and transported to the disposal site or to, Direct street sweepers not to burn tree leaves collected and separately stored and transferred to local authorised collectors and agencies, train waste collectors and waste collectors to solid waste management, collect waste from vegetables, fruits, meat, poultry and fish market day-today and promote the establishment and development of decentralised poultry waste collector systems. waste collection Recycling initiatives through the informal trash recycling sector may be encouraged.

Their task is to make it possible for solid waste processing plants and associated infrastructure to be builed or maintained by themselves or by the private sector, or through any agency to make the best use of various solid waste components using appropriate technology, including the following techniques and following the guidelines issued by the Ministry of Urban Affairs. (GOR, 2019).

Duties of State Pollution Control Board

The National Pollution Control Board, in close cooperation with the Directorate for Municipal Administration or Secretary-in-Charge of LSG concerned, shall implement these rules by local authorities in their respective jurisdiction at least twice a year and shall monitor the environmental standards and compliance with the conditions set out in Schedule I of this Convention.

After providing adequate chance for the applicant to be heard and for reasons for recording in writing, the State Pollution Control Board shall refuse to grant or renovate its authorisation. In the case of new technologies where the Central Pollution Control Board has not established standards, the State Pollution Control Board shall approach Central Pollution Control Board with regard to the definition of standards.

The State Pollution Control Board shall monitor the compliance of the standards as prescribed or laid down and treatment technology as approved and the conditions stipulated in the authorisation and the standards specified in Schedules I and II under these rules as and when deemed appropriate but not less than once in a year. The State Pollution Control Board may give directions to local bodies for safe handling and disposal of domestic hazardous waste deposited by the waste generators at hazardous waste deposition facilities. It regulates inter-state waste mobility, and prepares and implements the IEC / BCC plan in different areas involving ULBs / GPs and other stakeholders State Pollution Control Commission (GOR, 2019).

Duties of Waste Generators (Residential and Bulk Waste Generators)

Every waste generator shall separate the waste produced by it in three separate streams, i.e. in appropriate bins, biodegradeable and domestic waste and transfer separate waste, as specified by the directions and notifications of local authorities, to authorised waste collectors or waste picker and collectors., wrap securely sanitary waste like diapers, sanitary pads etc. in the bags of those goods, or in the appropriate wrapping material, as directed by local authorities, in the bins intended for dry or non-bio-degradable waste, store separately the construction and demolition waste, As and when generated, they shall dispose of garden waste and garden waste, as provided by the Construction and Demolition Waste Management Rules of 2016. They shall be stored separately in their premises and disposed of, as the local body requires, from time to time in their own premises.

The solid trash generated by it, on the streets, open public areas outside of its premises or in drainage or water bodies shall not throw, bump or haste.

All waste generators are paid the same user charge as set out in the State SWM Bye-laws of 2019 for solid waste management, as revised from time to time (GOR, 2019).

Duties of Industrial Units

All fuel-fueled industrial plants situated within a century km from the rejected fuel-fired solid wastes must arrange to replace at least five per cent of their fuel requirement with the resulting refuse-derived fuel (RDF) produced within six months of notification of the Solid Waste Management Rules 2016 (GOR, 2019).

Rules and Regulations

Regulatory framework for Rajasthan's SWM Policy consists of the various legal and regulatory roles and responsibilities outlined for the various organizations, institutions and local bodies under the various waste management rules and regulations. These provide a framework for solid waste management across the state.

The duties and responsibilities to be carried out by various institutions, bodies, groups and individuals shall be in accordance with the below rules and guidelines or any other waste management rules notified from time to time: Rajasthan Municipalities Act, 2009; Hazardous and Other Wastes (Management and Trans-boundary Movement) Rules, 2016; Guidelines of CPCB; and any other waste management rules/ guidelines provided by any authorized and competent authority from time to time (GOR, 2019).

Enforcing Authorities

According to the Solid Waste Management Rules, 2016 (Rule 16. a) prescribed by Ministry of Environment, Forest and Climate Change (MoEF& CC), Rajasthan State Pollution Control Board (RSPCB) will be the enforcing authority of these rules in the State through local bodies in their respective administration and review implementation of these rules at least two times a year in close cooperation with concerned Directorate of Local Bodies or Secretary-in-charge of State Urban

Development Department. The ULBs in urban areas and Gram Panchayat in rural areas, respectively, will perform the implementation of these rules.

Guidelines

Environment Department Guidelines

The Hazardous Waste (management and handling) Rules of the Central Government were notified to govern the hazardous waste generated in 1989. The 1989 Regulations were introduced to secure the environmentally sound handling and management of hazardous waste. These Rules have nevertheless been abolished and a new set of Rules has been established. The new laws focused on dangerous trash and its cross-border trafficking. In addition to the objectives set out in the Basel Convention on the control of and disposal of transboundary movement of hazardous wastes, the 2008 Rules on the Management, Handling and Transboundary Movement of Hazardous Wastes have been specifically developed to acheve them. The Central Government subsequently created 2016 rules on hazardous and other waste, recently updated in 2019. (Management and Transboundary Movement) (GOI, 1986).

Application

According to Section 886, the Environment (Protection) Act, 1986 specifically bans anyone save for the procedure and subsequent compliance with such precautions as may be specified from the handling of dangerous substances. This clause shall be read in accordance with Rule 13 of the Environmental Rules (1986). The Central Government replaced the old Rules framed in 2008 ('2016 Rules') by the new Regulations for Hazardous and Other Waste (Management and Transboundary Movement) of the year 2016 (GOI, 1986).

Swachh Bharat Urban Guidelines

Certain waste products are dangerous to health and can contaminate and damage the environment when mixed with other garbage. These should be kept every 1-3 months for collection: Using tube lights and CFLs (since they include mercury), paint cans, cadmium etc., torch cells and button cell and batteries, which have oils and toxic substances. The following products include cosmetics, hair dyes (which include lead), cleaning oily rags, and many more: Aerosol canisters, torches and cell batteries for flashlights, blankets, household cooking and drainage agents, car batteries, oil filters and car-patients and consumer goods, chemical products and solvents, their vacuum containers, cosmetics, chemical products and syringes for both, insecticide products, vacuum containers, light bulbs, tube-light and compa-like products.

Best Practices

Waste Minimization through Co-Processing

Co-processing is based on the use of waste in industrial processes, especially in energy intensive industries like cement, lime, steel, glass and power generation as a staple, energy source or both for the exchange of natural resources and for the exchange of fossil fuels like coal, petroleum or gas (recovery of energy).

In Gujarat, the usage of hazardous waste in cement fuel and input materials climbed from 15,693 tonnes once a year to 543,569 TPA in 2013/2014 35 times between 2009/2010. In 2013/2014, the amount of cement plants used increased by 185% from 190,707 TPA in 2012/2013 (Karthikeyan et al., 2018).

Treatment, Processing, and Disposal Facilities in Gujarat

Under the HW-containing restrictions in safety areas, considerable stocks are kept near commercial locations of hazardous or partially treated HW. The garbage must be properly disposed of. Failure to handle such waste leads to pollution by groundwater, so endangering those who utilise groundwater as their source of domestic water and irrigation (Karthikeyan et al., 2018).

Role of Gujarat Government in Hazardous Waste Management

Gujarat was the main state in dealing with hazardous waste issues and created a wholly new idea of the TSDF for the industrial cluster. Gujarat is the country's leading manufacturer of TSDF sites. There are eight TSDFs in the country out of 27 TSDF sites (Karthikeyan et al., 2018).

Common Hazardous Wastes Incineration Facility (CHWIF):

It is recommended to disposal in an environmental safe manner specific non-biodegradable trash and liquid hazardous waste (toxic). The detoxification procedure is not economically possible for the treatment of non-biodegradable wastewater. At the end of 1990 a concept was adopted for the safe disposal of toxic waste by individual common incinerators. The State now has five common hazardous burning sites and 83 individual burning facilities (Karthikeyan et al., 2018).

The Clean-up of Old Waste Dump Sites in Gujarat:

Hazardous waste 34,395.40 MT was removed and transferred to the place of deposition (TSDF). The board is continuing with the clean-up of unlawful dumping sites throughout the country (Karthikeyan et al., 2018).

Public private partnership Common TSDFs have come up:

Common TSDFs have received subsidies of capital investment from the State Government and the Government of India, in some situations. State Industrial Growth Corporation land at concessional rates and the financial involvement of industrial units as well as the financial backing of institutional institutions have contributed in this development.

Green industries formation in Gujarat:

The Gujarat Pollution Control Board issued a list of 100 small and cottage industries with no pollution potential. These industries are excluded from obtaining NOCs for the establishment of such industries and converting the land into "non-agricultural" usage by the board (Karthikeyan et al., 2018).

4.1.6 E-Waste Management

Development in the field of science and technology have led to major industrial developments and revolutions. This has had a great impact on the lives of each of us and has also caused many problems, including a large amount of hazardous waste and other waste generated by electronic items. WEEE or Ewaste waste can be defined as any electrical appliance (Organization for Economic Cooperation and Development) that uses an electronic power supply that has reached the end of its useful life. The electronics sector is one of the world's largest and most rapidly developing production industries, hence e-waste is a global problem which needs to be tackled.

There are several conventions and initiatives that discuss the importance and current scenarios of waste management. The Basel Convention is one of the first global initiatives on the subject, it aims to solve problems related to the generation and transport of electronic waste and introduces the idea of reuse and recycling, as well as marketing methods. Here are some definitions of some of these initiatives:

Table 4.7 Definitions of E-waste

Conventions	Definition
EU WEEE Directive (EU, 2002a)	“Electrical or electronic equipment, which is waste including all components, subassemblies & consumables, which are part of the product at the time of discarding.” Directive 75/442/EEC Article 1(a) defines "waste" as any of the substances or objects which, pursuant to National Law provisions in force, the holder disposes of or is obliged to disposed of."
Basel Convention	“E-waste encompasses a broad and growing range of electronic devices ranging

Action Network (Puckett & Smith, 2002)	from large household devices such as refrigerators, air-conditioners, cell phones, personal stereos, and consumer electronics to computers which have been discarded by their users."
OECD (2001)	"Any appliance using an electric power supply that has reached its end of life."
Sinha (2004)	"An electrically powered appliance that no longer satisfies the current owner for its original purpose."
StEP (2005)	E-waste- "the reverse supply chain which collects products no longer desired by a given consumer and refurbishes for other consumers recycles or otherwise processes wastes."

Sources and generators

Electron waste includes residues that are not suitable for the originally expected use. Includes a computer and its accessories, a monitor, a keyboard, a printer and a central processing unit. Typewriter, mobile phone, charger, compact disc, remote control, headphones, battery, LCD / plasma TV, air conditioning, refrigerator and other appliances. Waste contain toxic substances and chemical products. This negatively affects the environment and health, directly or indirectly if it is not processed properly. India is one of the estimated annual productions of the world's annual production country of the estimated Taobao production countries.

EWASTE is generally collected from individual, small and medium business segments, unique manufacturing departments, large companies, institutions and four main sources of government agencies.

Material components in E-waste

E-waste generally contains a complex combination of materials and ingredients, and can even be microscopic. It includes about 1000 distinct compounds, many of them dangerous to the environment and human health if not disposed of in an ecologically sound way (MoEF, 2011). Printed circuit boards, CRTs, switches and flat screens, computer battery, condensers and transformers, print circuit boards, plastic shell cables, and cable insulation/sheathing are all very poisonous. They are toxic components. lead and cadmium, lead and cadmium oxide, mercury, cadmium, PCB, brominate flame retardant and PVC are all elements present. There are a number of valuable metals, rare earth metals, ferrous and non-ferrous metals, polymers, wood and glass available in electronic waste. Around 50% of the waste is derived from steel, then plastics (21%), non-ferrous metals (13%) and other elements.

Scenario in Country

It is estimated that more than 50 metric tons of E-waste is produced globally every year and it is the rapidly growing component of municipal waste across the world today. We note that emerging countries would increase as significant generators of e-waste in the years ahead due to their growing customer base and predicted sales growth in economic products due to high future demand and quick economic and industrial growth. United States of America holds the first position in E-waste generation and three Asian countries are included in the top five list including India in the fifth position.

India is the 5th largest producer of E-waste on world level but is not among top 15 E-waste generators per capita. India produces 1.8 million tons of E-waste every year that is roughly 4 per cent of E-waste generated annually. The collection of e-waste is done together with other debris in India, which means that documented information is almost nonexistent about the quantity of e-waste produced each year, which is disposed of. This indicates that the data available on the environmental and health sector is also not documented. There are only estimations based on independent studies conducted by the NGOs or government agencies. The yearly growth rate of E-waste in India is 30%.

E-Waste Sources

The prime sources of e-waste are manufacturers, consumers, and imports from other countries. In year 2005, the Central Pollution Control Board (CPCB) estimated that India's e-waste was 1.8 million tons which is 0.573 metric tons per day. According to reports, only 10 states in the country generate 70% of the total e-waste, while 65 cities in India generate more than 60% of the total e-waste. Maharashtra was top among the 10 most populated countries of E-waste, followed by Tamil Nadu, and Andhra Pradesh, and Uttar Pradesh, West Bengal and Delhi and Karnataka, and Gujarat. It was followed by Delhi, Bangalore, Chennai, Kolkata, Ahedabad, Hyderabad, Pune, Surat and Nagpur.

E-waste in India is mainly produced in the public, public and private sectors, accounting for nearly 70% of the total waste generated. At the same time, the total contribution of self-employed individuals is relatively small, about 15%; the rest is provided by manufacturers.

The 2009 Indian Market Research Bureau (IMRB) 'e-waste at source' survey indicated that TV and desktop computers, including servers, are the principal categories of total e-waste in India. Their combined revenues are about 68% and 27% respectively. Mobile and imports accounted for 2% and 1%, respectively.

Major contributors to this are computers and computer components; the field of consumer electronics is mainly television, telecommunications and changing consumer patterns.

Maharashtra leads the list with an annual e-waste generation of 20,270 tonnes. The electronic trash generated by Rajasthan annually is about 6326.9 tonnes.

E-Waste management in India

According to report from ASSOCHAM, India recycles only 1.5 per cent of the E-waste generated through an 'institutional operation'. The total E-waste produced in a year is 1.8 million and the amount undergoing E-waste treatment is 4000 tons. That gives us 1.6 million tonnes of unprocessed e-waste each year on average.

The informal sector handles the more than 90% of the E-waste management system i.e., the collection, recycling etc. and the formal sector accounts for less than 10% of the recycling business. Indian cities produce alarming rates of E-waste with no organized system available present on which Mumbai tops the list with 11000 tons of E-waste, Delhi with 9000 tons, Bangalore 8000 tons and Chennai 5000-6000 tons each year.

The Ministry of Environment and Forest of the Government of India is responsible for environmental legislation and its control. The CPCB also plays an important role as an autonomous agency under MoEF, responsible for drafting guidelines and advising MoEF on policy matters related to environmental issues. According to the Ministry of Environment and Forests, there are currently 4,444 hazardous materials in 28 processing, storage and disposal facilities (TSDF).

The project titled "Development of e-waste recycling and reuse processing technology" has been successful. It was implemented in March 2011 at the Jamshedpur National Metallurgical Laboratory in India, which is a research and development laboratory under the Council of Scientific and Industrial Research (CSIR). In this project, local technology was developed to recycle 90% of the metal content in e-waste. The process will not produce toxic gases or harmful wastewater. Thus, you will reduce environmental hazards caused by waste recycling units in unorganized sectors. The increasing quality of life and high rates of resource consumption patterns have had an adverse and involuntary environmental impact through trash generation well beyond government and agency capacity. Also, E-waste recycling is still an alien concept in India where it is practiced only in very few urban areas of the country.

Some of the Indian Enforced Agencies involved in E-waste are Ministry of Environment and Forests, Government of India, Central Pollution Control Board, State Pollution control Board, Port and Customs Authorities, The Directorate General of Foreign Trade etc.

In conjunction with industry associations since 2015, the Ministry of Electronics and Information Technology (MeitY) has launched a Digital India e-waste awareness programme to raise public awareness about e-waste recycling dangers and to educate them about alternative ways to dispose of their electronic wasted material. The program stresses the need for adopting environment friendly e-waste recycling practices. In order to provide jobs and business chances for local residents, the initiative has incorporated best practises for e-waste recycling accessible worldwide. Institutional infrastructures, such as e-waste collection, movement, processing, stockpiling, recovery and disposal, must be built for environmentally sound management of e-waste at the national and/or regional level. These facilities should be approved by the regulatory authorities and if required provided with appropriate incentives. MeitY has created cost effective technologies for the environmentally sound recycling of materials and polymers, including two exclusive PCB recyclers, with an acceptable environmental standard of 1000 kg/day (~35 MT e-waste) and 100 kg/batch (~3.5 MT e-waste) processes. The 1000kg PCB/day continuous processing plant is suited for building an eco-park in the country, while the 100kg processing plant is suitable for the informal sector. The current condition of affairs in informal sectors can be upgraded and transformed. E-waste also comprises up to almost 25% of the weight of plastic. New retrieval and conversion of plastics for the use of the e-waste has also been created successfully. A majority (76 percent) of waste plastics can be turned into appropriate materials for use in virgin plastic products by the established procedure. The technology for commercialisation has already been transferred.

Scenario in State

As per the Country level WEEE assessment study by International Resource Group Systems South Asia Pvt. Ltd, Rajasthan produces 6326.9 tons of WEEE in 2005. The Rajasthan State Pollution Control Board, pursuant to E-waste Management Regulations of 2016 established the permission to generate, handle, gather, collect, receive, store, transport, renovate, remove, recycle, process and disposal of electric waste. For this, they have developed an online system for the submission of the application. There are 26 authorized Dismantler/ Recycler located in the state with a total capacity of 90769 MTA.

There is Policy for condemnation of IT Equipment and disposal under Department of Information Technology & Communication, which describes certain rules for the disposal of IT equipment such as

Servers, PCs, Dumb Terminals, Printers, UPS, Laptop, Package Software, Mouse, LAN cabling 100 MBPS or below, Dialog Modems with less than 33 KBPS speed etc.

This policy is applicable to all government departments under Government of Rajasthan, all autonomous bodies and all PSUs under Government of Rajasthan.

The government along with the state pollution control board, Indian Oil, Instacash, and Greenspace, has started a campaign to create public awareness and improve understanding on e-waste and plastic so that a common man is made aware on about the importance of e-waste management.

In addition, in the Indian Oil pumps in Jaipur, the government established 20 collection points for electric waste and plastic bags, where you can easily go and store your plastically and electric waste bags. While money is paid in return for plastic bags for e-waste. Jute bags are supplied.

Governance and Management Structure

Some of the Indian enforced Agencies involved in E-waste are Ministry of Environment and Forests and Climate change, Central Pollution Control Board, State Pollution control Board, Port and Customs Authorities, The Directorate General of Foreign Trade, Department of Environment Science and Technology, Local Self-Governing Bodies, Department of Information Technology & Communication, NGOs etc.

Roles and Responsibilities

Central Pollution Control Board

They are responsible for regulating and controlling and overlooking the procedures done and also to identify the impacts on environment and health. Some of the responsibilities are to grant and Renewal of Extended Producer Responsibility - Control of compliance and authorisation, maintain information on Extended Producer Responsibility, Setting and review of e-waste collection targets from time to time, coordination with state pollution control boards, creation of environmental management guidelines for e-waste management, The producer should take the responsibility for conducting random sampling of the electric and electronic equipment on the market for the monitoring and monitoring of compliance with the provisions for the reduction of hazardous substance and the costs for sampling and testing, Publish sampling and analysis methodologies of hazardous substances, carry out random dismantler or recycler inspections, or revamp them, documentation, e-waste data collection, and web-based downloading by Central Pollution Control Board, infringement measures. Training programmes, submitting to the Department Annual Report on the reduction in the use of risk substances in electric and electronic equipment manufacturing, interaction with IT industries to reduce hazardous substances, setting and reviewing targets for the reduction of the use of hazardous substances in electrical or electronic equipment manufacturing (GOI, 2011).

State Pollution Control Board

They overlook the situations on state level and also divide the responsibilities among the urban local bodies. The important responsibilities are to Inventorize E-waste, grant and renewal of authorization to manufacturers, dismantlers, recyclers and refurbishes, monitoring and compliance of Extended Producer Responsibility - The approval of dismantlers, recyclers or refurbishers is controlled by CPCB, Random dismantler or recycler inspection or rehabilitation, keep the authorisation provided to manufacturers, dismantlers, recyclers, rehabilitators, implement ecologically responsible recycling programmes, fight against infringements of those regulations, and other function designated to the Ministry by the Ministry under these rules (MoEFCC, 2017).

State Government

There are a few divisions which bear liability regarding the general well-working of the framework. Some of them are the Department of Industry, which need to guarantee reserving or assignment of modern space for E-squander preparing in the current or impending mechanical park, domain and modern groups. The other one is Department if Labor which needs to guarantee acknowledgment and enlistment of laborers included, help arrangement of gatherings of laborers, embrace ability advancement exercises and lead yearly observing and guarantee wellbeing and soundness of laborers included. It ought to likewise get ready coordinated arrangement for viable execution and submit yearly report to Ministry of Environment, Forest and Climate Change

Urban Local Bodies (Municipal Committee or Corporation)

Responsible for efficient grassroots implementation. Some of the duties include to ensure that e-waste is properly separated, recovered and channelled to authorised dismantlers or recovery machines if found to be combined with municipal solid goods, and that e-waste is collected and channelled to an approved decommissioner or recycler.

Port Authority

The Port Authority plays a significant role because there are numerous levels of legal and illicit E-waste imports. The duties include verifying the Extended Producer Responsibility-Authorization, informing the Central Pollution Control Board of any illegal traffic so that appropriate action can be taken, and prosecuting importers for violations of the Indian Ports Act, 1908.

Rules and Regulations

The environmental ramifications of these materials were recognised early on, and guidelines were put in place to preserve the environment. Previously, e-waste management was lumped in with dangerous substances and categorised as environmental protection. The regulations are listed in order of their occurrence.

Factories Act 1948**:** There are several contaminants arising out from manufacturing or recycling of electronic components and are listed in this Act.

Environmental Protection Rules 1986 (amended till 2004**):** There is no direct standard to deal with contaminants in the production or recycling of electronics. However, some PCB units are categorised as electroplating units and must therefore comply with the waste disposal standards in accordance with Schedule 1 of this rule. (GOI, 1986).

Hazardous waste (management and Handling) rules 1989, amended in 2003**:** Schedule 2 of this act can be applied for the disposal of e-waste. It stated that authorization is to be obtained by the generator or collection receptor, treatment, storage and Disposal of Hazardous waste in an environmentally sound manner. Non-direct usage, but recycling electrical and electronic assemblies.

Hazardous Waste (management, Handling and Transboundary movement) rules, 2008**:** It includes the list of e-waste to be imported, and it also includes e-waste to be imported and exported and which does not require prior informed permission. The site for the collection, reception, storage and disposal to the open space shall be approved by competent authority. It also describes the regulations for the import export of hazardous waste (MoEF&CC, 2008).

Policy for Condemnation of IT Equipment and disposal

The IT equipment can be condemned when they have completed 5 years and are currently not in working condition, third party software/ books/ manuals for which the technical support or service is currently no longer available, when the cost of repair is high compared to the current rate, damage due to fire or any other similar reason.

The policy states that once the equipment is condemned it should be removed from the office and taken for alternate use if there is any or for disposal with proper bio-friendly techniques.

E-Waste Management Rules, 2016

A combined exclusive set of rules for E-waste was implemented year 2012 by the Ministry of Environment and Forest named as E-waste (Management and Handling) Rules, 2012. This was amended in the year 2016 and 2018 for further additions. The Central Pollution Control Board Swatch Bharat Abhiyan Mission keeps these guidelines as base for the waste treatment.

The Indian Government is a core agency for environmental policy, planning, promotion, coordination of the programme, including electronic waste. The e-Waste Management Rules of the year 2016 were applied to every manufacturer of electronic equipment, collection centres, e-Waste recycler and dumping centres and recycler concerned with the manufacture, sale and procurement of electrical and electronic equipment, even if it is based primarily on the principle of extended production responsibility (EPR). It excluded batteries, micro and small enterprises and radio–active wastes as they all are separately covered in their own Acts or guidelines. It defines responsibilities for each group involved from producer, collection center, bulk consumer, dismantler, recycler etc.

Responsibility of Manufacturer

The main responsibility of manufacturers is to collect and channel electrical waste created during the production of electrical or electronic recycling or disposal equipment. Furthermore, authorisations should also be obtained from the State Pollution Control Board to ensure that no environmental damages occurr during storage and transport of e-waste, to maintain, handle and disposal records for e-waste produced and made available to State Pollution Control Boards for inspection and to file the State Pollution Control Boards annual return record.

Responsibility of Producer

Extended Producer Responsibility (EPR): Authorization should include a normal scheme for collecting waste Electrical Equipment from previously placed on the market Electrical Equipment, such as through dealers, collection centres, Producer Responsibility Organizations, buy-back arrangements, trade schemes, and so on, whether directly or indirectly. It also includes collection and channelization of E-waste generated from the ‘end-of-life’ of their products or products with same electrical and electronic equipment code and historical waste available, Pre-treatment is necessary for the volume reduction of waste before the treatment, storage and disposal facility. This is necessary to immobilise mercury to ensure that the channelling of e-waste, including those from its service centres into an approved dismantler or recycler, is in conformity with Extended Productor Liability, Facilitating the return of electrical and electronic terminal equipments by providing contact details, such as the e-mail address, telephone and helpline number to the customer(s) or bulk consumer(s), Creation of awareness about dangerous components of the item, risks of inadequate handling and disposal, do-and-don't, etc. through media, publications, advertisements, posters or other media and product user information., Provide information on Deposit Refund Scheme.

The EPR can be an individual or collective system in which the producer enlists the help of other members to complete the process and ensure that only EPR-authorized producers are allowed to import electrical and electronic products.

Responsibility of Collection centres

The collection centres, including those resulting from orphaned products, collection points or bins should also be designed to collect e-waste on behalf of the manufacturer, dismantler, recycler or rehabilitator, ensure that the facilities are in line with CPCB guidelines and standards, ensure safe storation of the recovered e-waste, and ensure no damage.

Responsibility of Dealers

The dealer should collect E-waste on behalf of the producer and shall collect it by providing the customer with a box, bin, or a delimited place to dump it, or by using a take-back system and sending it to the producer's designated collection centre, dismantler, or recycler. The money will be returned according to the take-back system. They must also ensure that no harm is done to the environment during the process.

Responsibility of Refurbisher

The renovators should collect the e-waste generated during renovation and send it via their collection centre to an accredited dismantler or recycler. You must ensure that no environmental or human health damage is done during the whole refurbishment process, that e-waste is securely transported and that records are retained.

Responsibility of Consumer or Bulk Consumer

Consumer should have minimum awareness not to throw E-waste in municipal waste bins. They should ensure that the end-of-life electrical are not admixed with E-waste containing radioactive material mention under Atomic Energy Act, 1962.

Responsibility of Dismantler

The Dismantler has responsibilities to ensure that facilities comply with CPCB standards and guidelines, to obtain SPCB approvals, to ensure that no harm occurs, to ensure that decomposed E-waste is segregated and sent to permitted material recovery recycling facilities and to ensure that non-recyclable or non-recoverable materials are not covered.

The data held in the memory of end-of-life items (hard disc, telephones and mobile phones) should be destroyed or permanently deleted by hammers or by data erasers.

Responsibility of Recycler

Recyclers must ensure that their facilities meet CPCB standards/guidelines, that no harm is done to the environment, and that the residue produces during the recycling process is disposed of in a CPCB-approved treatment storage disposal facility.

Categorisation of Electronic items

Under the rule, the electrical items are categorized into two categories as shown below. This includes their components, consumables, parts and spares.

Table 4.8 Categorisation of items

Categories of Electrical and Electronic Equipment	Items
Information technology and telecommunication equipment	Centralized Data Processing, Mainframes, Minicomputers, Personal Computers, Laptop, Notebook, Notepad, Printers Including Cartridges, Copying Equipment, Electrical and Electronic Typewriters, User Terminals and Systems, Facsimile, Telex, Telephones, Pay Telephones, Cordless-Phones, Cellphones, & Answering Systems.
Consumer electrical and electronics:	Television sets, Liquid crystal display, Light emitting diode display, Refrigerator, washing machine, and Air conditioners, Fluorescent and other Mercury containing lamps.

All manuals involved in manufacturing, sales, buying and processing of electric and electronic equipment or components, producer, dealer, collectors, dismantlers, recyclers or auctioneers, customers or bulk consumers should be subject to updated guidelines.

The electrical equipment producer must channel any E-waste generated throughout the manufacturing process to recycle or eliminate it. Dealers must plan the collections of e-wastes and,

where applicable, acquire permission from the SPCB or the CPCB, as well as ensuring the safety and security of the storage, transit, disassembly and restoration of e-wastes.

Extended Producer Responsibility (EPR)

This is an environment policy approach where the obligation of manufacturers is extended to include final disposals during the post-consumer phase of their life cycle. In theory, the identical answer lies with all categories, including customer, producer and provider.

Guidelines for Collection and storage

1. A well-functioning collection mechanism should be introduced by producers which could include take-back, collection centres etc.2**.** For collection, producer can take help from Producer Responsibility Organization (PRO) or E-waste exchange**.** 3**.** It should be accessible to all citizens if a take-back system is given. 4**.** Each manufacturer, collection facility, distributor, recycler and refurbisher shall keep records of the collection, sale, transport and storage of trash for a period of no more than 180 days and shall make these documents available for examination. In case of special stocks of e trash for research development, a procedure of recycling or reuse of e-waste may be extended up to 365 days. 5. End-of-life storage may be carried out in a way not leading to the breakdown and safe handling of these products by personnel. 6**.** Fire prevention systems should be in place in the storage area and evacuation route.

Guidelines for Transportation of E-waste

The e-waste sender, who can be producer, producer, recycler, dismantler, bulk consumer, renovator and collection centre, should identify the carriers or make arrangements for transport of e-waste in a manner which minimises the environmental consequences of the hazards associated with their transport. E-waste should be transported in accordance with the regulations.

Guidelines for Dismantling Process

1. Dismantler could perform De-dusting or Manual Dismantling. 2. After opening electric and electronic equipment into the component by human operations, the procedure will consist of physical separation and segregation. 3. The dismantling of the dismantling table should be manually performed with space de-pollution equipment in order to preserve appropriate air quality in the working area. 4. The de-dusting system should consist of suction hoods over the disassembly table with a cyclone, a bag filter, and a three-meter high chimney above the roof level. 5. Boxes to collect the removable components should be positioned next to the removable table. 6. The personnel should be using adequate personal protection facilities such as goggles, masks, gloves, casks and gum boats, etc.,

throughout dismantling operations. 7. After disassembling, the volume or size shall be reduced. Noise and dust checks should be installed for volume reduction. 8. The decommissioners should have sufficient leak management facilities for compressor oils, refreshing/cooling gases such CFCs, HCFCs and end-of-life mercury, fluorescent mercury and other lamps containing, for example. 9. The premise for removal should comply with the following conditions. 10. Waterproof roofing and impermeable surfaces needed to be provided. 11. Storage space for dissembled spare parts shall be given. 12. Separate containers, condensers containing PCBs, must be provided for battery storage. `

Environmentally sound e-waste recycling guidelines

Dismantling and recovering operations are among the activities of recyclers. They should construct suitable wastewater treatment facilities and air pollution control devices for the waste water treatment process.

It is necessary to provide noise control for equipment such as the crusher, grinder, and shredder. The recovery of resources, notably valuable metals included in e-waste, should be prioritised. Recyclers should use the following processes:

a) Manual / semi- automatic / automatic dismantling operations

b) Shredding / crushing / fine grinding/wet grinding/ enrichment operations, gravity/ Magnetic /density /eddy current separation

c) Pyro metallurgical operations - Smelting furnace

d) Hydro metallurgical operations

e) Electro-metallurgical operations

f) Chemical leaching

g) CRT/LCD/Plasma processing

h) Toner cartridge recycling

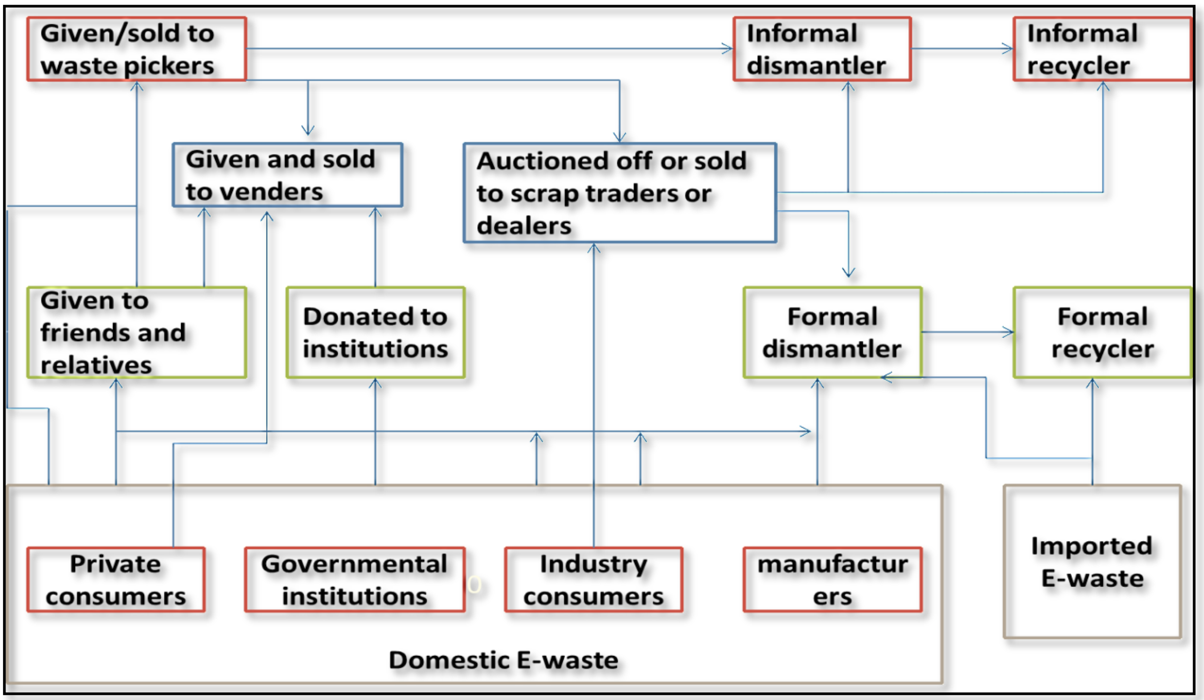
i) Melting, casting, moulding operations (for metals and plastics)

Best Practices

E-Waste flow in India

Currently, e-waste is eliminated in one of four ways: garbage disposal, incineration or recycling or exporting. Each procedure affects the environment and the health and safety of employees. Recycling is only considered one of the best means of disposing of electronic components when the recycling operation involves environmentally sound recycling. In developing nations like India, harmful e-Waste management techniques are becoming more common due to poor employment, missing consciousness, lack of technological advancement, and lack of regulatory rules. The manufacturers and governments are not able to keep pace with the electronic waste policy and practice which makes the issue quite serious.

The informal sector now handles more than 90% of India's e-waste management. The sources and numerous stakeholders form a complex system involving formal and informal sectors that is nonscientific and equally destructive to the Environment and people's health, as well as the community as a whole. The majority of e-waste is sold to scrap merchants, who then sell it to the



informal sector.

Figure 4.24 E-waste Flow in India

Eco-Assurance System

Improving the recycling rate of E-waste and following up on prohibitions on the usage of dangerous chemicals. It comprised preventative policies such as limiting the use of hazardous materials, enhancing the quality of materials and structures, providing recycling information, and reaching the highest possible rate of recycling. It also had a recycling policy, which includes enforcing facility standards, establishing recycling procedures and standards, and meeting recycling targets, among other things.

Table 4.9 Recycling Principles

Items	Recycling Principles
Common products	● Reuse and recycling of parts after processing treatment (disassembling, compression, crushing, and cutting) ● Recovery of valuable metals from the printed circuit boards
Large scale appliances	● Recovery of chlorofluorocarbons from refrigerators, air conditioners, and vending ma-chines ● Implementation of mandatory recycling rate (weight base) of over 65% for the television (except for liquid crystal displays and plasma display panels), over 70% for refrigerators and vending machines, and over 80% for washing machines and air conditioners.
Office equipment	● Recycling of personal computers ● Implementation of mandatory recycling rate (weight base) of over 65% for PCs, over 75% for printers, copiers, and fax machines, and over 70% for mobile phones
Medium scale appliances	● Recovery of chlorofluorocarbons from electric water purifiers ● Implementation-of mandatory recycling rate (weight base) of over 75%
Small scale appliances	● Recycling of electric heaters ● Implementation of mandatory recycling rate (weight base) of over 75%

International Measures

The Basel convention

Mobile Phone Partnership Initiative (MPPI): Developing and promoting ecological mobile handling for used and end-of-life devices. MPPI created standards for environmentally sustainable management of used and end-of-life mobile phones, including education, design considerations, collecting, transboundary transportation, refurbishing, and material recovery/recycling. It comprises companies including Alcatel, LG, Mitsubishi, Motorola, Nokia, Philips, Samsung, Sony Ericsson, and Vodafone, Orange, and Bell Canada, as well as telecom providers like Vodafone, Orange, and Bell Canada.

The MPPI's objectives include improving product stewardship, influxing consumer behaviour, promoting the best disposal/recycling/refurbishment options, organising political and institutional aid for environmentally sound management and establishing a replicable project to build new, public/private environmental support partnerships.

The StEP Initiative

It is the responsibility of the United Nations University. This was designed to build a worldwide information platform for stakeholders, including country representatives, producers' groups, recyclers, refurbishers, academia, NGOs and the international organisations, to share information on e-waste management systems., to enhance global efforts and coordinate sustainable handling of e-waste. The goal is to undertake research investigations, enhance public awareness, science and business understanding about optimising the electrical and electronics life cycle, improve the supply chain, close material loops, reduce pollutants and increase resource use.

UNEP DTIE

The aims of UNEP DTIE are the promotion of sustainable consumption and production; voluntary action to improve the sustainability performance of member countries; implementation in developing countries of complementary waste management programmes; and the implementation of strategies that influence informed decision making through partnerships with other international organisations, NGOs, Govgovernment authorities

Recommendations from CPCB

Due to a lack of technology and inadequate implementation, plastic waste disposal in India is a severe worry. Different experiments were nonetheless carried out to reuse plastic waste during road construction or to co-process plastic waste in concrete ovens, among other things. Incineration is now the most widely used method for disposing of plastic trash, but due to under-graded kilns and poor maintenance, they emit toxic pollutants such as dioxins and furans when burning chlorinated and brominated plastic waste, posing a number of environmental concerns.

Other interventions

Policy level

1. For economic advantages, a technique can be established for each unit of the product sold on the marché, such as advanced fee for recycling (ARF) or advanced fees for disposal (ADF). This would relieve manufacturers of physical collection responsibilities and allow the funds produced to be used to establish end-of-life products markets. 2. Subsidize consumers to place their electrical waste in approved centres. 3. Help informal employees in the education or training sector and give them with a stronger and efficient social security network. 4. In order to foster the broad use of environmentally friendly electronic waste recycling methods, indigenous technology and/or technology transfers should be promoted. 5. In the absence of suitable recycling infrastructure in the country, the prohibition or restriction of all types of imports should be considered. 6. The system should progress in addressing challenges caused by resource scarcity, a weak legal framework, no non-compliance fines and collection and recycling targets. 7. Accountability, transparency and sustainability on E-waste management should be ensured at every stage of the process.

Informal sector

1. The current social and economic situation in the informal sector is unsatisfactory and therefore has to be addressed and the sector's validity in access to garbage and trading should be recognised. 2. Review of current regulations to include faster and more organized system.3**.** Waste intervention and data generation needs to be updated frequently. 4**.** Implimentation of online systems for the ease of work and documentation has to be done. 5**.** Skill development: Programs to improve the sector's ability to dismantle and segregate e-waste of various kinds are necessary. Forming and skills to build the informal sector to grasp proper environmental, safety and health practise creates e-waste recycling techniques that are environmentally friendly.

Formal Informal partnership

As previously said, the participation of the informal sector is unavoidable, and so a collaboration between the official and informal sectors would be advantageous. The interventions can be focused on one thing: collecting and recovering valuable materials with the help of local interface agencies. 2. Establishing long-term relationships with larger collectors and aggregators helps boost collection rates. 3. Getting the necessary agreements, contracts, and procedures (including payment systems) in place as soon as possible should be a top concern. 4. Develop a comprehensive EPR strategy. Information on the formalisation of informal collectors can enhance the credibility of EPR plans during downstream stages.

Updating partnerships and provide long-term support to partnering organizations and thus encouraging them and acknowledging their contribution.

Public awareness

For proper system maintenance, the consumer should be educated during the buying process, from the manufacturers, through media channels, social media platforms, and so on. Institutions in charge should launch awareness efforts at grass-roots level on a regular basis. Producers would be given stricter guidelines/regulations regarding the frequency and style of these awareness programmes.

Consumer education: They must be made aware of their function in the system via item labelling requirements. Consumers are trained to purchase only necessary products that utilise some of the technological advancement (e.g., non-leaded, halogen-free, recycled plastics, manufacturers or retailers that will accept their products back) and are eco-labelled.

Customers who are aware of the environmental impact of their purchases are more likely to choose amongst producers for the most ecologically friendly items, according to responsible purchasing. Only by raising public awareness can this be accomplished.

Compulsory labelling: Labeling products as 'environmental hazards' to implement hazardous materials declaration content for the identification and correct management and disposal of e-wastes.

Donating electronics**:** The donation of electronics for reuse extends the life of the items and keeps them from being managed for longer periods. It helps the economically weaker sector to enjoy the benefits of these products.

Technological Advancements

Free cycle

It is built on the foundation of internet-based technology. Members post details of unwanted products on platforms like yahoo groups, blogs, e-mails, and distribution lists, and other members can respond to the offers. Similarly, Craiglist is a website where people may list unwanted electronic items to be purchased by others. This aids in the recycling and repurposing of goods.

Design for the environment (DfE)

DfE Organizations are working together in a number of actors to reduce danger for human beings and the environment by reducing pollution. It's a worldwide project. It seeks to reduce chemical risks, energy efficiency in order to promote positive and sustainable chemical evaluation tools as well as knowledge to inform firms about safe chemicals as replacement.

Sustainable Practices

Whole System Approach**:** It's a method that involves linking sub-frameworks and frameworks and applies a single solution for several challenges. It is working on cost-effective solutions to lessen the harmful effects of e-waste on the environment and human health.

Green IT: A multifaceted strategy to safeguarding and supporting long-term IT company operations. A different viewpoint is that of product service systems, which is a sustainable or environmentally friendly service. Customers are urged to rent hardware and software components so that the seller maintains ownership and product maintenance.

Eco parks: can be set up to bring the formal and informal sectors together. This aims to ensure that E-waste is treated scientifically and to eliminate unlawful E-waste processing. The material movement could be streamlined from originators to recycling centres at a few predetermined locations.

The most environmentally friendly option is to reuse and recycle, which also benefits society. The reuse and recycling of E-waste requires enough technical support and skill sets. Reuse refers to things that have been recycled informally, either immediately or after they have been discarded. The following sections highlight some of the technological interventions utilised in the E-waste recycling process.

Recycle

The E-waste process allows metals and/or scarce materials to be recovered which are used as raw materials to produce EEE. The e-waste recycling chain includes three activities: collection; categorization, disassembly and pre-processing, and processing, as well as final processing. It is shown in the figure below:

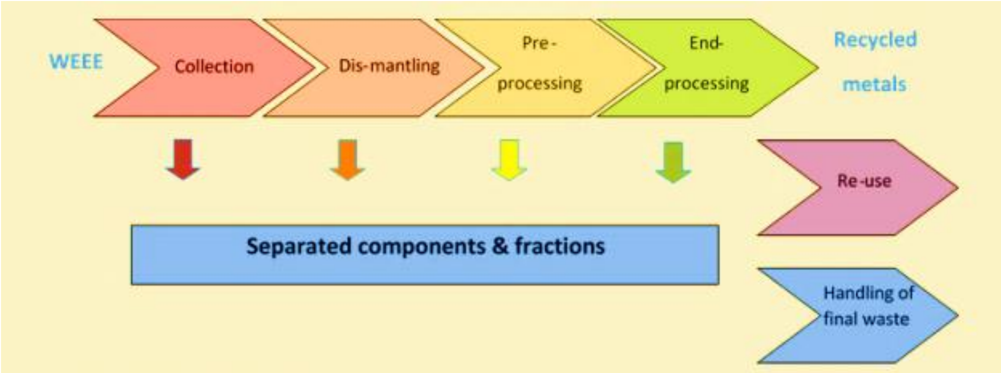


Figure 4.25 E-waste recycling chain, (Source UNEP, Step initiative, 2009)

Some of the sustainable recycling approaches are discussed below:

Cementation Technology: Cementation technology is an integrator technology that requires the use of a solidifying agent for trapping hazardous E-wastes (i.e. cement). They can also use special powder mixture, special non-metal reinforcement or chemical crystallization treatment.

Nanotechnology: It can be utilised efficiently to treat contaminants, in particular organic volatile and organic pollutants in e-waste.

Bio-Metallurgy: The biotechnological technique is one of the potential solutions for solving metals from e-waste materials. It offers a number of advantages such as:

Low operating costs, Use of less hazardous chemicals, Eco-friendliness and Low energy requirement.

Rethink product design: New and better-conceived concepts must be included. In terms of material selection, manufacturing process, product distribution, and product support system, better product design is required. It is necessary to introduce the use of non-renewable materials that are safer than those now in use. The image below depicts a sustainable recycling process:

Disposal

Integrated E-Waste Management Facility (IEWMF): Integreen E-waste management facility (IEWMF), reducing the number of actions linked to pollution prevention, reduction and control under the existing regulation institutional system. Secured Land Filling (SCF) and Incineration only for e-waste residues is permitted under the regulatory national framework for hazardous waste practiced. Land allocation: At the level of government, many incentive systems might promote allocation of land.

4.2 Present Scenario and Action Plan

4.2.1 Municipal Solid Waste Management

In Alwar district, there are total 12 ULBs of which are 10 Nagar Palika namely, and 2 Nagar Parishad namely Alwar and Bhiwadi. The population distribution for Alwar district as shown in the Table 4.10.

Table 4.10 Population of ULBs, Alwar District

Population range	Name of ULB	Population as per census 2011
1-5 Lakh	Alwar	341422
	Bhiwadi	104921
50,000-1 Lakh		-
25000- 50,000	Khairthal	38298
	Rajgarh	26631
	Behror	29531
Less than 25,000	Tijara	24734
	Kishangarh Bas	20814
	Kherli	17634

Data provided by ULBs

Inventory of Solid Waste

The total solid waste generation in the district currently stands at 285 TPD in which Alwar city contributes around 166 TPD. The solid waste generated in the ULBs comes in the form of dry waste, wet waste, construction and demolition waste, waste coming through street sweeping and drain slits, hazardous waste and sanitary waste (Table 4.11). Out of 12 ULBs in Alwar district have total 11 municipal solid waste dumping sites Khairthan and Kishangarh Bas have a common dump site which currently store huge quantity of legacy waste. Only Rajgarh had started segregating the legacy waste and -have been trying to recover useful fractions. Alwar have a huge quantity of legacy waste, segregation of this legacy waste is not yet started during the site visit.

The district has 61 bulk waste generators, which are in Alwar city alone have 49. All the ULBs should implement regulatin for bulk waste generators. Laxmangarh and Rangarh ULBs have not started provisions the 100 per cent door to door collection of solid waste in their administrative boundaries while also achieving 100 per cent sweeping in the ULBs. Only four ULBs, Kishangarh Bas, Behror, Kherli, Rajgarh, Bansur have been able to achieve partial waste segregation done at source, whereas the remaining ULBs have not initiated segregation yet.

Table 4.11 presents the total quantity of solid waste generated/collected, number of dumpsites in each ULBs and number of wards present in the respective ULBs.

Table 4.11 Inventory of Solid Waste in Alwar District

	Parameters	**Units**	**Urban Local Bodies**											
			Alwar	**Bhiwadi**	**Tijara**	**Kishangarh bas**	**Behror**	**Thanagazi**	**Kherli**	**Rajgarh**	**Khairthal**	**Laxmangarh**	**Bansur**	**Ramgarh**
A	**Inventory**													
1	Total solid waste Generation	TPD	166	60	13	11.00	11.00	9	9.40	11	15	Not estimated	13.67	Not estimated
2	Qty. of Dry Waste segregated	TPD	83	16	8	8.7	8.7	4.05	5.10	8.7	6.75	Not initiated	10.37	Not initiated
3	Qty. of Wet Waste segregated	TPD	83	23	5	2.30	2.30	4.95	3.00	2.3	8.25	Not initiated	3.30	Not initiated
4	Qty. of C&D Waste segregated	TPD	3	5	0	0.0167	0.0167	1	0.50	0.0167	0.75	Not initiated	0.0178	Not initiated
5	Qty. of Street Sweeping	TPD	70	2.5	2	1.5	1.5		0.45	1.5		Not estimated	1.55	Not estimated
6	Qty. of Drain Silt	TPD	50	1	5	4.0	4.0		0.30	4		Not estimated	3.5	Not estimated
7	Qty. of Domestic Hazardous Waste(DHW) collected	TPD	0.5	0.5	2	0.5	0.5		0.05	0.5	No Facility	No Facility	0.25	No Facility
8	No of bulk waste generators	Nos	49	12	0	0	0		12		No Facility	Qty not estimated	0	Qty not estimated
9	Quantity of waste generated by BWG	TPD	1		0	0	0		0		1	None	1	None
10	Total waste processed by BWG	TPD	332100		0	2500	2500	100	1870	2500	12613	Qty not estimated	2700	Qty not estimated
11	Total waste dumped untreated by BWG	TPD	1	1	0	0	1				0	None	NONE	None

12	No of composting machines installed by BWG	Nos	65	60	25	25	35	25	25	35	35	35	35	35
13	Qty. of Other Waste (Horticulture, sanitary waste, etc.)	TPD	75	30	0	0	2	0	0	2	0		1	
14	No of Old dump sites	[Nos] or [None]	8	10	0				0		0		0	No data
15	Qty stored in dumpsites	TPD	100	50	100	40	40	0	46	100	40			
16	No of Sanitary landfills	[Nos] or [None]	0	4	5	3	3	0	2	0	4			
17	No of wards	[nos]	5	3	5	3	2	2	7	5	3			
18	No of wards covered with D2D	[nos]	1	0	0	0	0	0	0	0	0			
19	No of vehicles for D2D	[nos]	0	0	0	0	0	0	0	0	0			
20	No of vehicles covered	[nos]	166	42	13	11	11	9	9.17	11	15	Not estimated	12	Not estimated
21	No of Households	[nos]	83	17	8	2.3	2.3		5.10	2.3	6.75	Not initiated	2.3	Not initiated
22	No of wards with source segregation	[nos]	83	13	5	8.7	8.7		3.00	8.7	8.25	Not initiated	8.8	Not initiated
23	No of wards partially covered with source segregation	[nos]	3	1	0	0.0167	0.0167		0.50	0.0167	0.75	Not initiated	0.0177	Not initiated
24	No of wards not covered with source segregation	[nos]	1	1	1	100%	100%	0	100%	1	1	Not initiated	1	Not initiated

Litter Bins and Waste Bins storage

Litter bins are installed at vulnerable garbage point for waste collection. These garbage bins have twin compartment for collection of segre gated waste. Zero garbage vulnerable points exits in the whole district.

Table 4.12 Litter Bins and Waste Bins Storage

S.No.	Parameters	Units	Urban Local Bodies											
			Alwar	Bhiwadi	Tijara	Kishangarh bas	Behror	Thanagazi	Kherli	Rajgarh	Khairthal	Laxmangarh	Bansur	Ramgarh
1	No of twin bins installed in commercial and public areas	Nos	100	50	100	40	40	0	46	100	40			
2	No of garbage vulnerable points (existing)	Nos	0	4	5	3	3	0	2	0	4			
3	No of garbage vulnerable points eliminated (Damaged to be replaced)	Nos	5	3	5	3	2	2	7	5	3			

Compliance in segregated waste Collection SW Collection

Waste segregation refers to the separation of dry and wet garbage, which paves the way for other concepts of waste management like composting, recycling and incineration. Its end goal is to reduce waste from landfills and eventually, prevent land, water and air pollution. As per Table 4.13, Segregated waste collection is not initiated in ULB Laxmangarh and Ramgarh.

Table 4.13 Report on compliance in segregated solid waste management

S.No.	Parameters	Units	Urban Local Bodies											
			Alwar	Bhiwadi	Tijara	Kishangarh bas	Behror	Thanagazi	Kherli	Rajgarh	Khairthal	Laxmangarh	Bansur	Ramgarh
1	Total generation	TPD	166	42	13	11	11	9	9.17	11	15	Not estimated	12	Not estimated
2	Wet Waste	TPD	83	17	8	2.3	2.3		5.10	2.3	6.75	Not initiated	2.3	Not initiated
3	Dry Waste	TPD	83	13	5	8.7	8.7		3.00	8.7	8.25	Not initiated	8.8	Not initiated
4	C&D Waste	TPD	3	1	0	0.0167	0.0167		0.50	0.0167	0.75	Not initiated	0.0177	Not initiated

__Waste Management Operations__

Waste management (or waste disposal) includes the activities and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process and waste-related laws.

As per Table 4.14, Composting for wet waste and Material Recovery Facility (MRF) for dry waste are the commonly found processes with landfilling in the district. The ULBs have not started any reclamation of any old dumpsites except in Alwar, Kherli.

No NGOs are involved in the solid waste management process in any of the ULBs and no linkage is made with brand owners or waste generators. Few of the ULBs have initiated authorization and issuance of identity cards to the waste pickers.

Table 4.14 Waste Management operations in Alwar District

S.No.	**Parameters**	**Units**	**Urban Local Bodies**											
			Alwar	**Bhiwadi**	**Tijara**	**Kishangarh bas**	**Behror**	**Thanagazi**	**Kherli**	**Rajgarh**	**Khairthal**	**Laxmangarh**	**Bansur**	**Ramgarh**
1	Door to Door Collection	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	Not initiated	100%	Not initiated
2	Mechanical Road Sweeping	%	partial	NO	0	NO	NO		NO	NO	Not initiated	Not initiated	NO	Not initiated
3	Manual Sweeping	%	100%	80%	100%	100%	100%	100%	100%	100%	100%	100%		100%
4	Segregated Waste Transport	%	partial	0.8	[not initiated]	100%	100%		100%	100%	Not initiated	Not initiated	100%	Not initiated
5	Digesters (Bio-methanation)	% of WW	1		[not initiated]	nil	nil			NIL	Not initiated	Not initiated	nil	
6	Composting operation	% of WW	initiated	0.15	[not initiated]	0	0		10%	0	Not initiated	Not initiated	0	Not initiated
7	Reclamation of old dumpsites	[initiated] / [not initiated]	initiated		[not initiated]				60%			not initiated	0	not initiated
8	MRF Operation	[MRF used] / [not installed]	initiated	0.8	[not initiated]	0	0	No	40%	0	Not initiated	Not installed	0	Not initiated

9	Waste to energy (if applicable)	[Required] / [Nos. Available]	initiated	0.8	NO	0	0		0%		0	No SLF	0	No SLF
10	Waste to RDF	[Required] / [Nos. Available]	initiated		[not initiated]				60%			not initiated	0	not initiated
11	Linkage with Waste to Energy Boilers / Cement Plants	[initiated] / [not initiated]	Not initiated	initiated	[not initiated]	Initiated	Initiated			Initiated	Not initiated	not initiated	not initiated	not initiated
12	Linkage with Recyclers		initiated		[not initiated]						Not initiated	not initiated	not initiated	not initiated
13	Authorization of waste pickers	[initiated] / [not initiated]	Not initiated	initiated	[not initiated]	Initiated	Initiated		Initiated	Initiated	Not initiated	not initiated	not initiated	not initiated
14	Linkage with TSDF / CBMWTF	[initiated] / [not initiated]	initiated		[not initiated]						Not initiated	not initiated	not initiated	not initiated
15	Involvement of NGOs	[initiated] / [not initiated]	Not initiated		[not initiated]	Initiated	Initiated		Initiated	Initiated	Not initiated	not initiated	not initiated	not initiated
16	Linkage with Producers / Brand Owners	[initiated] / [not initiated]			[not initiated]							not initiated	not initiated	not initiated
17	Authorization of Waste Pickers													not initiated
18	Issuance of ID Cards	[initiated] / [not initiated]	not initiated	not initiated	[not initiated]	Not initiated	Not initiated		0	Not Initiated		Not initiated	Not initiated	Not initiated

Adequacy of Infrastructure

As per Table 4.15, Currently the ULBs have 174 waste collection trolleys, 23 mini-trucks and 21 bulk waste trucks to collect and transport the solid waste generated. Except for Alwar city, no other ULB has a transfer station and the collected waste is directly transported to the solid waste dumpsite. There is no requirement for a transfer station in ULBs as the population is less than 50,000. No data related to routes and fuel consumption of waste transporting vehicle has been provided.

Only Alwar ULB has Bio-methanation unit. Composting unit has been established in ULBs for treatment of wet waste, however; Tijara, Kishangarh Bas, Laxmangarh and Ramgarh have no composdting units.

Table 4.15 Report on efficacy of infrastructure

S.No.	Parameters	Units	Urban Local Bodies											
			Alwar	**Bhiwadi**	**Tijara**	**Kishangarh bas**	**Behror**	**Thanagazi**	**Kherli**	**Rajgarh**	**Khairthal**	**Laxmangarh**	**Bansur**	**Ramgarh**
1	Waste Collection Trolleys	[Nos. Required] / [Nos. Available]	2	50	0	2	2	0	60	2	50	1	5	1
2	Mini Collection Trucks	[Nos. Required] / [Nos. Available]	4		0	1	1		0	1	9	0	3	4
3	Segregated Transport	[yes] / [no] / [% area covered]	50	Yes	0	yes	yes	0	0.8	Yes	No	No	Yes/3/ 100%	No
4	GPS enabled vehicles	[Yes] / [No]												
5	No of compartmentalized vehicles	Nos												
6	No of non-compartmentalized vehicles	Nos												
7	Bulk Waste Trucks	[Nos. Required] / [Nos. Available]	21		0	no	no			no	0	no	0	no
8	Waste Transfer points	[Nos. Required] / [Nos. Available] /[Not available]	1		0	no	no			no	0	no	no	no
9	Bio-methanation units	[Nos. Required] / [Nos. Available]	1		0						0		0	
10	Composting units	[Nos. Required] / [Nos. Available]	2	2	0	NO	1		1	1	1	0	1/0	0

Material Recovery Facilities

Table 4.16 provides the details of material recovery facilities in various ULBs.

Table 4.16 Report on Material Recovery Facility

S.No.	Parameters	Units	Urban Local Bodies											
			Alwar	**Bhiwadi**	**Tijara**	**Kishangarh bas**	**Behror**	**Thanagazi**	**Kherli**	**Rajgarh**	**Khairthal**	**Laxmangarh**	**Bansur**	**Ramgarh**
1	Material Recovery Facility		installed	Installed	0	Installed	Installed			Installed	0	not available	not available	not available
2	Waste to energy (if applicable)	[Required] / [Nos. Available]	NIL		0				0		0		-	
3	Waste to RDF	[Required] / [Nos. Available]	1		0				0		0		-	

Adequacy of Financial Status of ULB

Table 4.17 shows the Capital cost and operation and maintenance cost that is being required by the respective ULBs.

Table 4.17 Report on financial adequacy of ULB

S.No.	Parameters	Units	Urban Local Bodies											
			Alwar	**Bhiwadi**	**Tijara**	**Kishangarh bas**	**Behror**	**Thanagazi**	**Kherli**	**Rajgarh**	**Khairthal**	**Laxmangarh**	**Bansur**	**Ramgarh**
1	CAPEX Required	Crore per annum												
2	OPEX	[INR per Year] / [% of requirement]												
3	Adequacy of OPEX	[Yes] / [No]						YES			YES			

Notification and Implementation of By-Laws

The by-laws have provisions, which if implemented properly, should lead to transformational changes. The by-laws emphasise the generator’s responsibility to segregate solid waste at source. All ULBs have initiated the implementation of by-laws except Nagarpalika Tijara, Thanagazi, Khairthal, Laxmangarh and Ramgarh.

Table 4.18 Report on Notification and Implementation of by-laws

S. No.	Parameters	Units	Urban Local Bodies											
			Alwar	**Bhiwadi**	**Tijara**	**Kishangarh bas**	**Behror**	**Thanagazi**	**Kherli**	**Rajgarh**	**Khairthal**	**Laxmangarh**	**Bansur**	**Ramgarh**
1	Notification of By-laws	[done] / [in progress] / [not initiated]	Done	Done		Done	Done	Not to be filled	Done	Done	Not to be filled	not initiated	done	not initiated
2	Implementation of by-laws	[done] / [in progress] / [not initiated]	Done	Done		Done	Done		Done	Done		not initiated	done	not initiated

Inferences for present scenario

The following pie charts shows the population and waste generation distribution for all ULBs of Alwar district.

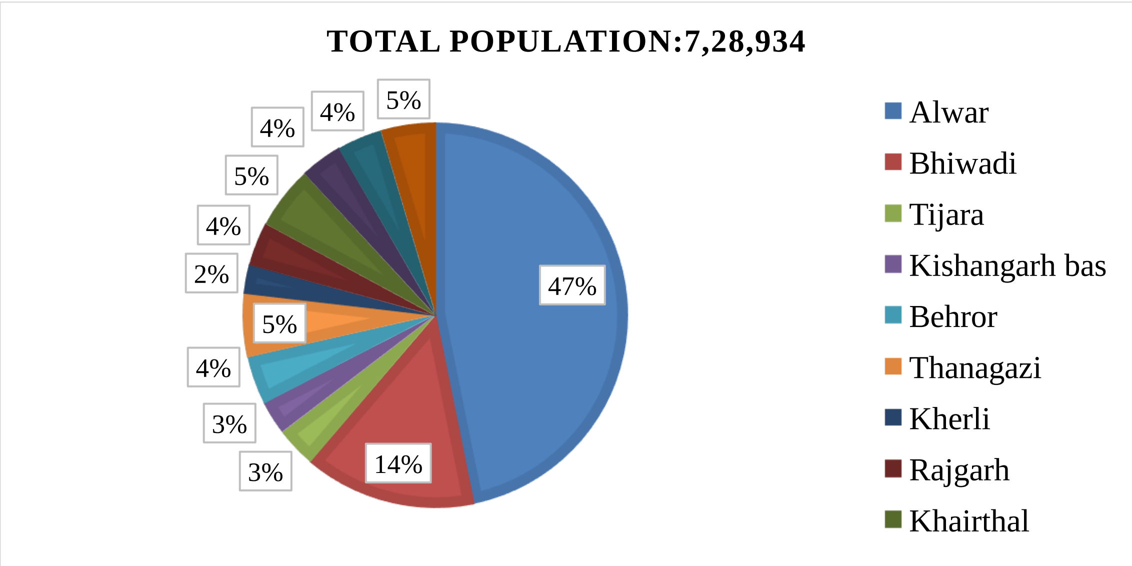


Figure 4.26 Population Distribution for all ULBs of Alwar District

Total waste generation for Alwar district is 258 TPD of 0f which morethan 50% waste is generated by the Alwar ULB. Out of total 12 ULBs only Laxmangarh and Bansur have not estimated their waste generation per day.

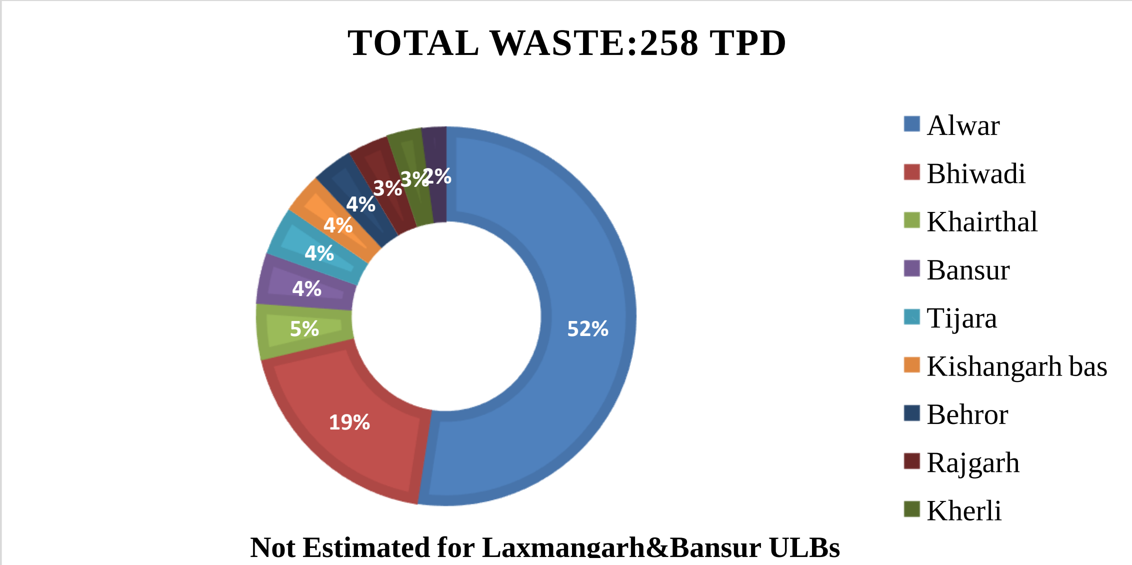


Figure 4.27 Waste Generation for 10 ULBs in Alwar District

Total dry waste generated from 10 ULBs is 160 TPD, which is more than the wet waste (127 TPD).

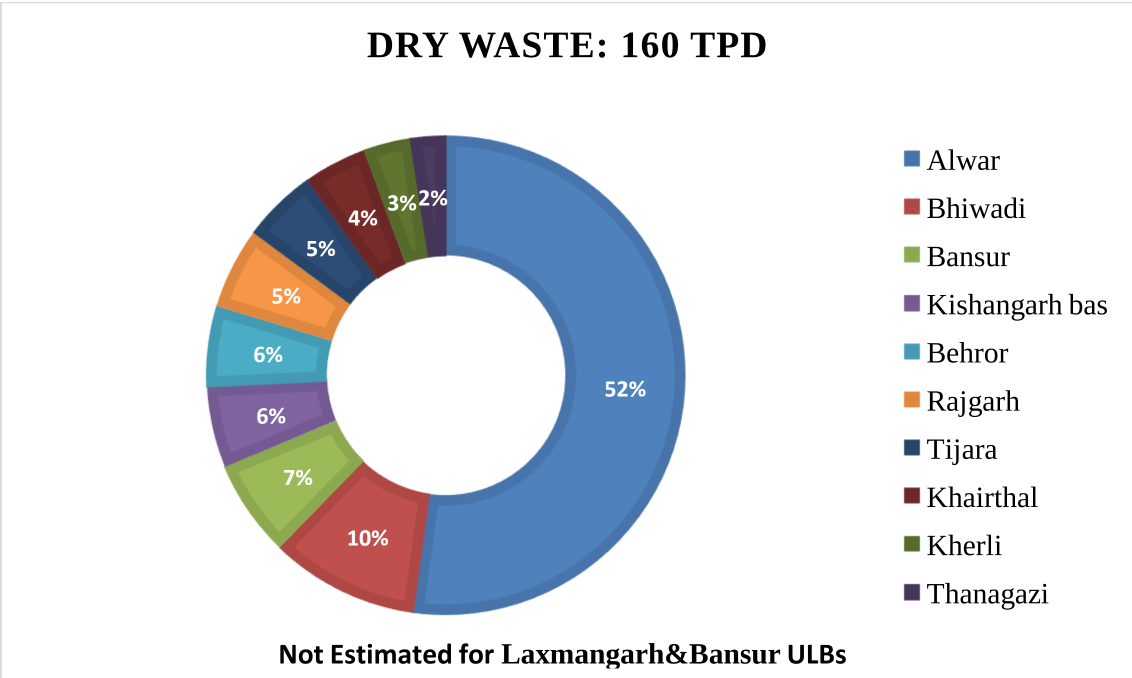


Figure 4.28 Dry Waste Generation for 10 ULBs of Alwar District

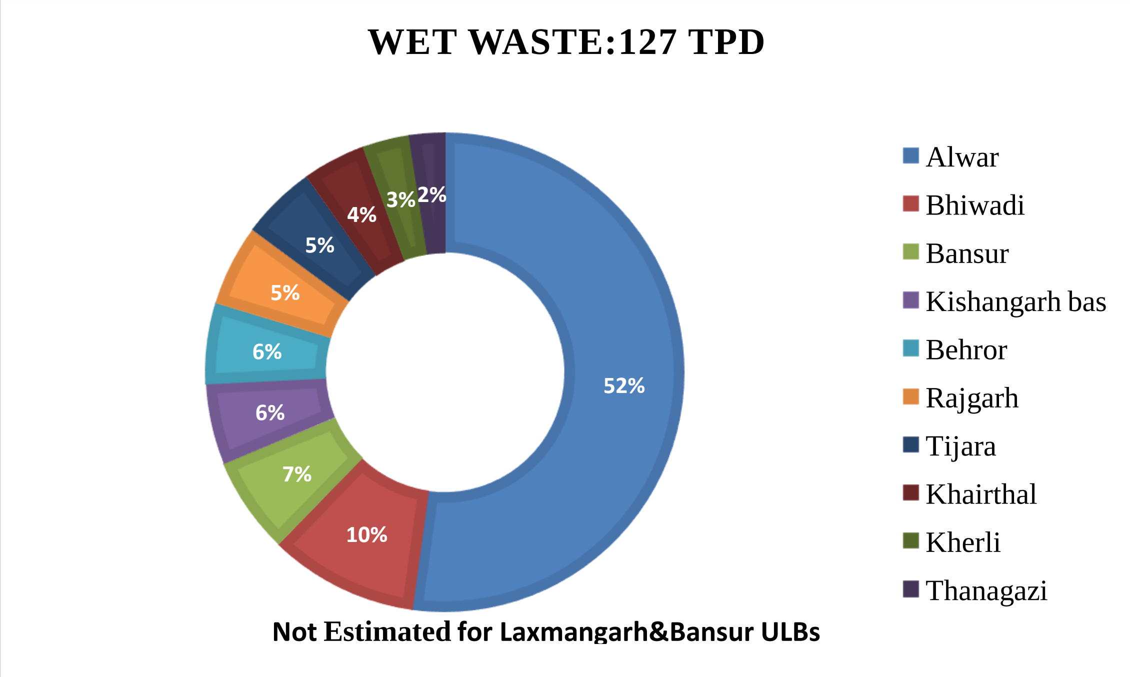


Figure 4.29 Wet Waste Generation for 10 ULBs of Alwar District

This section presents the inferences compiled from the data provided by the ULBs in Alwar district.

The total solid waste generation in the district currently stands at 258 TPD in which Alwar city contributes around 166 TPD, which is 52% of total waste. The solid waste generated in the ULBs comes in the form of dry waste, wet waste, construction and demolition waste, waste coming through street sweeping and drain slits, hazardous waste and sanitary waste. Waste collected from different ULBs also have fraction of other waste i.e C&D waste, domestic hazarodous waste. Quantity of C&D waste segreagated from this waste is 9.3 TPD. The district has 110 bulk waste generators, which are 75 in Alwar and 30 in Bhiwadi ULB.

All the ULBs have made provisions for the 100 percent door to door collection of solid waste in their administrative boundaries except newly established Laxmangarh and Bansur ULBs. Rajgarh has yet not achieved 100 percent sweeping in the administrative boundaries. Only five ULBs, Kherli, Rajgarh, Kishangarh bas, Behror have been able to achieve 100% waste segregation done at source, whereas rest of the ULBs have not initiated segregation yet.

Litter bins are installed at vulnerable garbage point for waste collection. These garbage bins have twin compartment for collection of segregated waste. Currently the ULBs have 174 waste collection trolleys, 23 mini-trucks and 21 bulk waste trucks to collect and transport the solid waste generated.

Waste Processing and Disposal

The processing of solid waste collected is important for resource recovery from the waste. There are a number of options for resource recovery e.g., composting, vermi-composting, anaerobic digestion and incineration. A number of advanced treatment methods are also available e.g., hydrothermal carbonization. These methods are yet to be employed extensively in the field.

Composting for wet waste and Material Recovery Facility (MRF) for dry waste are the commonly found processes with landfilling in the district. Bio-methanation process is only established in Alwar ULB.

Figure 4.30 Large Quantity of Legacy Waste at Closed Dump Site, Alwar ULB

Figure 4.31 Google Earth View of Closed Dump Site, Alwar (Coordinates- 27°32'36.9"N 76°41'34.8"E)

Figure 4.32 Waste Dumped near Road Side in Bhiwadi ULB

Figure 4.33 Animal at Waste dumped near Road Side

Figure 4.34 Waste bin at market area in Thanagazi ULB

Figure 4.35 Waste Dump site Thanagazi ULB

Figure 4.36 Twin Bin Tipper for Segregated Waste Collection in Ramgah ULB

Figure 4.37 Choked unlined Drainage due to Waste Dump in Ramgarh ULB

Figure 4.38 Waste dumped Near Residential Area, Ramgarh ULB

Figure 4.39 Sewage near Road due to Lack of Drainage

Figure 4.40 Tipper in Waste Collection Operation, Ramgarh ULB

Figure 4.41 ULB Wastewater Dump Site in Ramgarh ULB

Figure 4.42 Dedicated Staff of Ramgarh ULB

Figure 4.43 Municipal waste Dumped near Waste water Drain, Laxmangarh ULB

Figure 4.44 MSW with plastic Waste Dumped Near Road Side, Laxmangarh ULB

Figure 4.45 Wastewater near Residential Vicinity in Laxamangarh ULB

Figure 4.46 Dump Site, Laxmangarh ULB

Figure 4.47 Plastic Waste at Dump Site, Laxmangarh ULB

Figure 4.48 Tipper for Waste collection at Tijara ULB

Figure 4.49 Large Quantity of Legacy Waste on Dump site at Tijara ULB

Figure 4.50 Waste Collection Tipper Vehicle at Kishangarh Bas ULB

Figure 4.51 Common Dump site for Kishangarh Bas and Khairthal ULBs

Figure 4.52 Tyre Recycling Facility near Rajgarh ULB

Figure 4.53 Waste Collection Vehicle at Rajgarh ULB

Figure 4.54 Legacy Waste Tratment Facility at Rajgarh ULB Dump Site

Alwar, Bhiwadi, Behror, Kherli, Rajgarh, Khairthal ULB have a composting facility for treating the wet waste. All ULBs in Alwar district have municipal solid waste dumping sites which currently store lacs of tones of legacy waste. All the ULBs had not started segregating the legacy waste and have been trying to recover useful fractions. Only Rangarh ULBs has established a facility for legacy waste treatment, which was seen during the site visit.

Figure 4.55 Mechanical Segregator at Alwar ULB (27°30'56.8"N 76°45'08.6"E)

Fig. A- Legacy Waste

Fig. B-Waste Pickers at Dump Site

Figure 4.56 Closed Dump site with Large Volume of Legacy Waste at Alwar ULB

Figure 4.57 Manuual MRF Facility at Alwar ULB

Figure 4.58 Google Earth view of Waste Dump Site Thanagazi (27°23'25.4"N 76°19'17.9"E)

Figure 4.59 Google Earth view of Waste Dump Site Tijara (Co-ordinates 27°56'09.7"N 76°51'51.3"E)

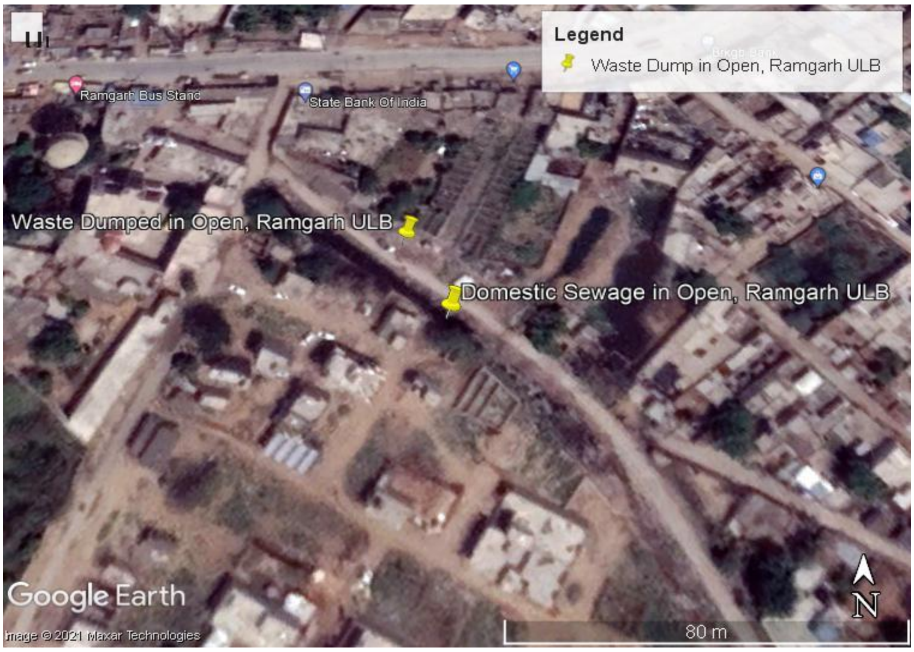


Figure 4.60 Google Earth view of Waste Dump in Open, Ramgarh ULB (27°34'59.0"N 76°48'47.4"E)

Figure 4.61 Waste Dump Site, Khairthal and Kishangarh Bas ULB (Coordinate 27°48'32.8"N 76°37'33.9"E)

4.2.2 Action Plan for Municipal Solid Waste Management

Collection and Transportation

Collection of segregated solid waste from individual households and establishments is accomplished through the use of containerized pushcarts, tricycles or small mechanized vehicles, compartmentalized vehicles, or tipping vehicles depending on the terrain of the locality, width of streets, and building density.

Considering the method of collection, 10 out of 12 ULBs are having 100 % door-to-door collection. A slight improvement of including the houses/commercial establishments present on the fringes of a ULB may be made by all the ULBs.

The most important aspect of collection is the availability of source-segregated waste for subsequent transportation, processing and disposal. Only five ULBs, Kherli, Rajgarh, Kishangarh bas, Behror have 100% waste segregation done at source, whereas Alwar has partial segregation yet. For ensuring the availability of source-segregated waste from the households, commercial establishments and institutions, a robust awareness program must be initiated in all the ULBs. The awareness program may be more fruitful if conducted in primary schools. The experts from diverse disciplines ranging from science and engineering to humanities should be consulted to plan the awareness program. The awareness program may also be combined with other missions of the state/central government e.g., Swachh Bharat Abhiyan, Unnat Bharat Abhiyan etc.

Collection frequency of the waste should be decided depending on the degradation/nuisance potential of the waste stream. For the purpose of this report, following streams may be considered for the household waste: dry waste (paper, plastic, metal, textile, rubber), wet waste (kitchen/food waste, garden/yard waste), sanitary waste (baby diapers, sanitary napkins etc), domestic hazardous waste (batteries, insecticide bottles/containers, electronic waste). While dry waste and domestic hazardous waste may be easily stored without creating any nuisance, wet waste and sanitary waste must be collected daily. Following the philosophy, dry waste and domestic hazardous waste can be arranged to be collected on a weekly basis. Although waste collection centres are generally the norm for domestic hazardous waste but collecting and transporting it separately may result into better management of domestic hazardous waste. After collection, it is of utmost importance to transport the segregated waste separately either using separable vehicle (which may be too costly) or using compartmentalized vehcles.

In terms of technological improvement, ULBs may be encouraged to introduce ICT and IoT based monitoring of Door-to-Door waste collection. This should be implemented in all the ULBs for ensuring 100% waste collection and better efficiency in operations. The user charges may be levied on the end-user using smart home cards. The smart card can also be used to update waste collection status of all users. No ULB have already initiated implementing this technology. Similarly, the compactor bins may also be geo-tagged and installed with smart card for monitoring of bin lifting process.

Transfer stations are the intermediate stops between the point of collection and the processing/disposal facilities in a city. The establishment of intermediate transfer stations is determined by the distance between secondary waste collection points and the final treatment and disposal point. If the distance from the city jurisdiction to the final treatment and disposal points exceeds 15 km, transfer stations may be established or as per availability and requirement of land (GOR, 2019). Yet another measure may be utilizing the biofuel powered vehicles for collection purposes.

Environmental pollution is a big concern today. To address the environmental pollution, it is important to evaluate the composition of our waste streams intensively. Other stakeholders e.g., higher education institutions and research institutes should be asked to participate in these exercises requiring advanced equipment and expertise. Some of the contaminants that should be regularly tested are heavy metals, pesticides and insecticides.

Last, but not the least, aspect is to maintain the records. The records should be maintained for collection and at processing/disposal facilities. At collection level, the records may start with the vehicle number and number of trips made for the collection for each day.

Processing and Disposal

For Indian conditions with cheap labour, manual segregation of recyclable fractions into different components like paper, plastic etc. may be more suited. Waste Transfer point should be established for all ULBs. Currently only for Alwar ULB waste transfer points are marked.

The adoption of processing technologies largely depends upon the quantity and characteristics of the waste generated. It is essential to quantify and characterize the waste generated in the local body before adopting any processing and treatment technology. Ragpicker may be employed for separating the recyclables into different categories. So, the processing should concentrate on recyclables first for processing (up to 50% in first 3 years). On the other hand, a smaller fraction of 25% of wet waste should be used for composting for the next 3 years. In the subsequent three years, the amount of recyclables and wet waste being processed, can be doubled.

The informal sector, comprising of kabadi system and waste pickers, plays an important role in the SWM value chain by recovering valuable material from waste. Home composting presents some potential environmental benefits such as the avoidance of collection, transportation and management of biowaste.

Decentralised composting (bin and box composting), composting machines; and Vermicomposting should be practiced where small quantity of wet waste is generated. All ULBs of Alwar district have a large amount of legacy waste at old dump site. Reclamation work of this waste should be initiated. The treatment and disposal of Legacy waste can be done by the process of Bioremediation and Bio-mining. Before starting the process of Bio-remediation and Bio-mining, a survey or mapping of the site must be done. The ULBs have a tendency of using fine fraction for land application. This should be practiced with caution as the old legacy waste may have harmful constituents owing to disposal of mixed waste together on dump sites. For provision of sanitary landfill, a cluster of ULBs may be formed and suitable piece of land may be allotted for the waste disposal from cluster. To avoid the mismanagement of cluster landfill, a separate entity may run the landfill independent of ULBs.

Regular monitoring and data collection are essential for designing an efficient SWM framework system. Research institute should be involved for providing scientific creativity.

Table 4.19 ULB wise action plan for Alwar district

ULBs action area	Alwar, Bhiwadi,	Tijara, Kishangarh bas, Behror, Thanagazi, Kherli, Rajgarh, Khairthal, Laxmangarh, Bansur, Ramgarh
Collection	● Source- segregation of the waste ● Awareness programs for the general public especially at the school level and institution levels (e.g., all bulk waste generators may be first directed to segregate their waste) ● Collection frequency of the waste as per waste type e.g. daily collection of wet waste and sanitary waste; weekly collection of dry waste and domestic hazardous waste ● Inclusion of the houses/commercial establishments present on the fringes of a ULB in waste collection program ● Introduction ICT and IoT based monitoring of Door-to-Door waste collection, ensuring 100% waste collection and better efficiency in operations Using electrical or biofuel-powered vehicles for collection	● Source- segregation of the waste ● Awareness programs for the general public especially at the school level and institution levels (e.g., all bulk waste generators may be first directed to segregate their waste) ● Collection frequency of the waste as per waste type e.g. daily collection of wet waste and sanitary waste; weekly collection of dry waste and domestic hazardous waste ● Inclusion of the houses/commercial establishments present on the ● fringes of a ULB in waste collection program. ● Using electrical or biofuel-powered vehicles for collection ● Inclusion of the houses/commercial establishments present on the
Processing	● Mechanised MRF with the full capacity of 50 tons/day for dry waste ● Inclusion of rag-pickers in MRF operations ● Mechanised composting plant of 70 tons/day for wet waste ● Sanitary waste to be disposed of on daily basis by an incinerator; ● Integrated domestic hazardous waste management centre in Alwar for recovering recyclables from domestic hazardous waste and final disposal into a hazardous waste landfill ● Regular testing of heavy metals, pesticides and insecticides in waste collected, compost and RDF produced Regular Monitoting and Compilation of Data	● Mechanised/manual MRF for dry waste ● Inclusion of rag-pickers in MRF operations ● Mechanised composting for wet waste ● ULB to start a local collection and storage facility centre for domestic hazardous waste ● Regular Monitoting and Compilation of Data

Disposal	• Legacy waste treatment to be completed as soon as possible; Apply extreme precaution in disposing the different fractions of legacy waste • Engineered landfill for the Bhiwadi • Establishing linkages with a hazardous waste landfill in the region for disposing off residue ash from incinerator and residue from Integrated domestic hazardous waste management • Engineered land fill for Bhiwadi	• Legacy waste treatment to be completed as soon as possible; Apply extreme precaution in disposing the different fractions of legacy waste • Engineered landfill for the cluster of Tijara, Khairthal, Kishangarh Bas • Engineered landfill for the cluster of Behror and Bansur • Engineered landfill for the cluster for Laxmangarh, Kherli, Ramgarh • Engineered landfill for Rajgarh

4.2.3 Plastic Waste Management

Data Provided by ULBs

Sustainable Inventory of Plastic Waste Generation

Estimated quantity for plastic waste generation is only provided for Kishangarh bas, Behror, Kherli, Rajgarh, ULBs which is 114 kg, 114kg and 0.25 kg and 114 kg respectively. 100% door-to-door collection is implemented for all ULBs. 100% waste segregation is done for only Alwar ULB. Plastic waste generation data for Alwar, Bhiwadi, Tijara, Thanagazi, Khairthal, Laxmangarh, Bandur, Ramgarh ULBs is not provided. Authorization of plastic waste picker is initiated for Alwar, Kharli ULBs.

Table 4.20 Report on Inventory of Plastic Waste Generation

Sl. No.	Parameters		Urban Local Bodies										
			Bhiwadi	Tijara	Kishangarh bas	Behror	Thanagazi	Kherli	Rajgarh	Khairthal	Laxmangarh	Bansur	Ramgarh
A	**Inventory**												
1	Estimated Quantity of plastic waste generated in District (TPD)				114 kg	114 kg		0.25	114 kg			Not Estimated	
B	**Implementation of collection**												
1	Door to Door collection (%)	100%	100%	100%	100 %			100 %	100%		not initiated	100 %	not initiated
2	Segregated Waste collection (%)	partial	partial	0	100 %	100 %		80 %	100%		not initiated	100 %	not initiated
3	Plastic waste collection at Material Recovery Facility	MRF used	MRF used	Not installed	not installed	100 %		MRF Used	not installed		not installed	not installed	not installed
4	Authorization of PW pickers (Nos.)		initiated		not initiated	not installed		Initiated	not initiated		not initiated	not initiated	not initiated
5	PW collection Centres (Nos.)	1			not established	not initiated		Established	not established		not established	not established	not established

Establishment of Linkage with Stakeholders and Availability of Facilities for Recycling or Utilization of Plastic Waste

The concept of PRO is recognized in plastic waste management primary burden on the producer for collection of waste plastic products. They need to establish a system for collecting back the waste generated due to their products. Linkages with PROs (*Producer Responsibility Organization*) of produces and NGOs are not established for ULBs. Plastic waste recycler is only assigned for Bhiwadi ULBs. No plant for Plastic pyrolysis is established in Alwar district. Co-processing of plastic waste in cement kiln is only done in Bhiwadi, Rajgarh, Kherli, Behror ULBs.

Table 4.21 Report on linkage with stakeholders & Availability of facilities for recycling/utilization of PW

Sl. No.	Parameters	Urban Local Bodies										
		Bhiwadi	**Tijara**	**Kishangarh bas**	**Behror**	**Thanagazi**	**Kherli**	**Rajgarh**	**Khairthal**	**Laxmangarh**	**Bansur**	**Ramgarh**
C	**Establishment of linkage with Stakeholders**											
1	Established linkage with PROs of Producers	1			not established		0	not established		not established	not established	not established
2	Established linkage with NGOs	2		not established	not established		1	not established		not established	not established	not established
D	Availability of Facilities for Recycling or Utilization of Plastic Waste											
1	No. of PW recyclers (Nos.)	1		not established	0		0	0		0	0	0
2	No Manufacturers (Nos.)	1			0		0	0		0	0	0
3	No of pyrolysis oil plants (Nos.)			0	0			0		0	0	0
4	Plastic pyrolysis (Nos.)	0.5		0	0		0	0		0	0	0
5	Use in road making (Nos.)			0	0			0		0	0	0
6	Co-processing in Cement Kiln (TPD)	0.5		0	0.5		0.30	0.5		0	0	0

Implementation of PW Management Rules, 2016 and Implementation of Extended Producers Responsibility (EPR) Through –Producers/Brand-Owner

The Central Government, in its 2016 Plastic Waste Management Rules, had banned the manufacture and usage of single-use plastic that is thinner than 50 microns. Action on Sealing of units producing < 50-micron plastic is partially done in Alwar district. EPR puts the financial and/or physical onus on manufacturers--meaning plastic producers, importers and brand-owners--for the treatment, recycling, reuse or disposal of products after a consumer has used and disposed of them. No action is taken for implementation of Extended Producers Responsibility in Alwar district.

Table 4.22 Report on Implementation of PW management rules, 2016 and Implementation of ERP

Sl. No.	Parameters	Urban Local Bodies											
		Alwar	**Bhiwadi**	**Tijara**	**Kishangarh bas**	**Behror**	**Thanagazi**	**Kherli**	**Rajgarh**	**Khairthal**	**Laxmangarh**	**Bansur**	**Rangarh**
E	**Implementation of PW Management Rules, 2016**												
1	Sealing of units producing < 50-micron plastic		Partial		Partial	Partial		Partially sealed	Partially sealed		no action		no action
2	Prohibiting sale of carry bags < 50 micron		Prohibited		Prohibited	Partially sealed		Prohibited	Prohibited		no action	no action	no action
3	Ban on Carry bags and other single use plastics as notified by State Government		Implemente d		Partial	Prohibited		Impleme nted	Implemented		Partia l	Implemente d	Partia l
F	**Implementation of Extended Producers Responsibility (EPR) through Producers / Brand-owners**												
1	No of Producers associated with ULBs (Nos.)							0					
2	Financial support by Producers / Brand owners to ULBs												
3	Amount of PRO Support (INR)												
4	Infrastructure support by Producers / Brand owners to ULBs												
5	No of collection centres established by Producers / Brand owners to ULBs(Nos.)												

Inferences from Present Scenario

Estimated quantity of plastic waste generated is not estimated in Alwar Nagarparishad, Bhiwadi, Tijara, Kishangarh Bas, Laxmangarh, Bansur, Ramgarh.

Door to door waste collection system has not been implemented Tanagazi, Behror, Laxmangarh, Ramgarh within all the ULBs. Segregated waste collection is done partial in Alwar Nagarparishad, Bhiwadi, Kherli ULB whereas, in Tijara, Thanagazi, Khairthal, Lxmangarh, Ramgarh Nagarpalika ULB it is not implemented.

Authorization of initiated PW pickers in Bhiwadi, Kherli. Further one plastic waste collection centres are established in Alwar ULBs. Plastic waste collection centers have not been established other ULBs

Establishment of linkages with stakeholders (PROs and NGOs) has been established in only Bhiwadi ULBs. There are no Manufacturers and Pyrolysis oil plants present in any of the ULBs. Nowhere plastic waste is used for construction roads whereas, co-processing in cement kiln is carried out in Bhiwadi, Behror, Kherli, Rajgarh ULBs.

Enforcements have been carried out in some of the ULBs as per the Plastic Waste Management Rules 2016. Sealing of units producing < 50-micron plastic has been partially implemented in all ULBs except Laxmangarh and Ramgarh. Prohibition of sale of carry bags <50 micron is completely implemented in some ULBs. Further, ban on carry bags and other single use plastics as notified by State Government has been implemented within Alwar, Bhiwadi, Tijara ULBs. There is partial implementation in Kishangarh Bas, Ramgarh, Laxmangarh.

None of the Extended Producers Responsibility (EPR) through Producers/Brand-Owners has been implemented in any of the ULBs.

4.2.4 Action Area for Plastic Waste Management

For Alwar district, the action plan for plastic waste management includes activities door-to-door plastic waste collection and plastic waste segregation at source, immediate actions like ban on carry bags and other single use plastics as notified by State Government and ensuring no open burning and littering. It also incorporates the management by waste generator through EPR and PRO to be implemented in all the ULBs of Alwar District and future implementations to be done such as utilization of non-recyclable plastic waste (road construction, waste to fuel, waste to energy, alternative uses identification etc.

Table 4.23 Action Plan for Plastic Waste Management

Sl. No.	Action Area	Timeline	Department/ Agencies
1	Door to Door plastic waste collection	Regular activity	Nagr Parihad- Alwar, Bhiwadi Nagar Palika- Tijara, Kishangarh bas, Behror, Thanagazi, Kherli, Rajgarh, Khairthal, Laxmangarh, Bansur, Ramgarh
2	Plastic waste segregation at Source.	Regular activity	Nagr Parihad- Alwar, Bhiwadi Nagar Palika- Tijara, Kishangarh bas, Behror, Thanagazi, Kherli, Rajgarh, Khairthal, Laxmangarh, Bansur, Ramgarh
3	Management by waste generator through EPR and PRO	Implement in all ULBs	Nagr Parihad- Alwar, Bhiwadi Nagar Palika- Tijara, Kishangarh bas, Behror, Thanagazi, Kherli, Rajgarh, Khairthal, Laxmangarh, Bansur, Ramgarh
4	Utilization of Non-recyclable plastic waste (Road Construction, Waste to Fuel, Waste to energy, alternative uses identification etc.	Implemented in future	Nagr Parihad- Alwar, Bhiwadi Nagar Palika- Tijara, Kishangarh bas, Behror, Thanagazi, Kherli, Rajgarh, Khairthal, Laxmangarh, Bansur, Ramgarh
5	Ban on Carry bags and other single use plastics as notified by State Government.	Immediate	Nagr Parihad- Alwar, Bhiwadi Nagar Palika- Tijara, Kishangarh bas, Behror, Thanagazi, Kherli, Rajgarh, Khairthal, Laxmangarh, Bansur, Ramgarh
6	Ensuring no open burning and littering.	Immediate	Nagr Parihad- Alwar, Bhiwadi Nagar Palika- Tijara, Kishangarh bas, Behror, Thanagazi, Kherli, Rajgarh, Khairthal, Laxmangarh, Bansur, Ramgarh

4.2.5 Construction and Demolition Waste Management

Data provided by ULBs

Inventory of C&D Waste

Table 4.24 presents the total quantity of C&D waste generated/ collected, amount of C&D collected and dump in each ULBs. At present total C&D waste generated in Alwar district is 1250 kg/day. Generated quantity for is estimated for Khaerli, Khairthal.

Table 4.24 Inventory of C&D waste

Name of ULB	[name of ULB]	**Alwar**	**Bhiwadi**	**Tijara**	**Kishangarh bas**	**Behror**	**Thanagazi**	**Kherli**	**Rajgarh**	**Khairthal**	**Laxmangarh**	**Bansur**	**Ramgarh**
Population	**[Nos as per 2011 census]**	**341422**	**104921**	**24734**	**20814**	**29531**		**17634**	**26631**	**38298**	**26103**	**27354**	**33194**
Inventory of C&D waste generation													
Estimated Quantity	[Kg/Day] / [Not estimated]	N.E.	N.E.	0	Not estimate	Not estimate		500	Not estimate	750	Not estimate	Not estimate	Not estimate

Implement scheme for permitting bulk waste and C&D Waste deposition center

Table 4.25 presents the information about scheme for bulk waste generator and C&D waste deposition center. All ULB provided the data about the implementing scheme for permitting bulk waste except Tijara, Thanagazi, Laxmangarh, and Ramgarh ULBs. Only Tijara, Thanagazi, Laxmangarh, Bandur, Ramgarh ULBs have no establishment of C&D waste deposition Centre’s.

Table 4.25 Scheme for bulk waste generator and C&D waste deposition center

Name of ULB	[name of ULB]	Alwar	Bhiwadi	Tijara	Kishangarh bas	Behror	Thanagazi	Kherli	Rajgarh	Khairthal	Laxmangarh	Bansur	Ramgarh
Population	**[Nos as per 2011 census]**	**341422**	**104921**	**24734**	**20814**	**295 31**		**17634**	**26631**	**38298**	**26103**	**27354**	**33194**
Implement scheme for permitting bulk waste generators													
Issuance of Permissions by ULBs	[Initiated] / [Not initiated]	initiated	initiated	Not initiated	Initiated	Initi ated		Initiated	Initiated	Initiated	Not initiated	Not initiated	Not initiated
Establishment of C&D Waste Deposition centers													
Establishment of Deposition Points	[Yes] / [No]	Yes	Yes	No	Yes	Yes		Yes	Yes	Yes	No	No	No
C&D Deposition point identified	[Yes] / [No]	Yes	Yes	No	Yes	Yes		Yes	Yes	Yes	No	No	No

Implementation of By-Laws for C&D Waste Management and C&D Waste recycling plant

Table 4.26 By-laws and recycling plant for C&D waste presents the data about the Implementation of By-Laws for CD Waste Management and C&D Waste recycling plant. Alwar, Bhiwadi, Kishangarh Bas, Behror, Kherli, Rjgarh, Bnasur ULBs have provided the data about implementation of By-Laws and the collection of deposition/disposal charges. Establishment CD Waste Recycling Plant is done done in all ULBs

Table 4.26 By-laws and recycling plant for C&D waste

Name of ULB	[name of ULB]	Alwar	Bhiwadi	Tijara	Kishangarh bas	Behror	Thanagazi	Kherli	Rajgarh	Khairthal	Laxmangarh	Bansur	Ramgarh
Population	**[Nos as per 2011 census]**	**341422**	**104921**	**24734**	**20814**	**29531**		**17634**	**26631**	**38298**	**26103**	**27354**	**33194**
Implementation of By-Laws for CD Waste Management													
Implementation of By-laws	[notified] / [not notified]	notified	notified	[not notified]	Notified	Notified		Notified	Notified	Notified	not notified	notified	not notified
Collection of Deposition / disposal Charges	[Initiated] / [Not initiated]	initiated	notified	[not notified]	Initiated	Initiated		Initiated	Initiated	Notified	not notified	Not initiated	not notified

Establishment of C&D Waste recycling plant or linkage with such facility													
Establishment CD Waste Recycling Plant	[Established] / [Sent to shared Facility] / [No facility exists]	No facility	No facility	NO	No facility exists	No facility exists		No facility exists	No facility exists	No facility exists	No facility exists	No facility exists	No facility exists
Capacity of CD Waste Recycling Plant	[MT/Day] / [Not available]	not available	not available	[Not available]	Not available	Not available		Not available	Not available	Not available	Not available	Not available	Not available

Inferences for present scenario

This section presents the inferences compiled from the data provided by the ULBs in Alwar district.

The estimated quantity of C&D waste is not known for Alwar, Bhiwadi, Behror, Tijara, Kishangarh Bas, Rajgarh, Laxmangarh, Bansur, Ramgarh ULB. No ULB have the data about the amount of C&D waste recycled/treated. None ULBs have provided the data about number of vehicles of C&D waste collection and transportation.

Tijara, Laxmangarh, Bansur, Ramgarh have not issuance of permission by ULB for implement scheme for permitting bulk waste and identified C&D waste deposition center

4.2.6 Action Areas for C&D Waste Management

ULBs should make bye-laws as well as special arrangements for storage, transportation, processing and disposal of Construction and Demolition waste.

Small municipalities under 1 Lakh population should make simple arrangements as under (ULBs – Tijara, Kishangarh Bas, Behror, Khairthal, Bansur, Ramgarh, Laxmangarh, Kherli, Rajgarh)

Notify locations, preferably in each zone (North, South, East, West) and centre of the city, where waste generators having small quantities of C&D waste under 1 MT load should be allowed to deposit their waste. Construct an enclosure at each notified location for storage of small quantities of waste or place tractor trolley at each such location for storage of C&D waste.

Arrange for transportation of C&D waste deposited at collection centres through covered tractor trolleys or trucks to the area designated for bulk storage. Citizens to avail of the facility at designated locations and refrain from disposal of C&D waste at any other location or in MSW bins.

Plan for reuse and recycling of such waste with private sector participation or use the same for land reclamation by filling in low lying areas or for carrying out bio engineering works to prevent mosquito breeding, by using C&D waste to fill in areas where stagnant water is repeatedly observed.

In cities above 1 Lakh population, the municipality should make elaborate arrangements as under (Alwar and Bhiwadi):

Notify suitable locations in different parts of the city where waste generators having small quantities of C&D waste under 1MT load can deposit their waste conveniently. Create a system of renting skips or containers for storage of C&D waste at source departmentally or through an authorised private operator, where the generation of such waste is greater than 1 MT.

Prescribed rates for collection and transportation of C&D waste to be published or notified. Citizens to avail the facility and refrain from disposal of small quantities of C&D waste anywhere else.

Arrange for transportation of C&D waste through skip lifting system departmentally or through designated contractor. Normally 4.5 cu.m open skips and 10 cu.m roll on and roll of open containers (to be hauled by hook loaders are suitable for C&D waste. Plan for reuse and recycling of such waste with private sector participation. The rejects from these plants (soft fines) are used for filling in low lying areas.

While depositing waste in the bins, care should be taken by the small generators to see that waste material is not dumped outside the bin or skip. These bins or skips should be periodically inspected by the municipal authority to ensure that they are cleared before they overflow. Littering should be strictly prohibited; particularly C&D waste should never be allowed to be deposited in open or covered drains.

Large generators who are provided with open skips or tractor trolleys on rent by the local body or its authorised private operators, should inform the municipal authority or concerned agency when the containers are likely to be full in order to replace the filled skip or trolley with an empty one and transport the waste at a designated site. In case of very large generators responsible for demolition, renovation, construction of infrastructure projects like bridges, fly-over, roads, large commercial or housing complex or demolition of unauthorised structures by municipality etc., the area should be screened and cordoned off and the material should be stacked systematically without obstructing traffic or causing any hindrance to the neighbourhood. Different waste components may be segregated and stored separately. Segregated material should be loaded into tipper lorries or tractors with the help of front-end loaders or back hoes and transported to designated sites for further processing or other use. Private sector may be encouraged to facilitate reuse and recycling of C&D waste.

The ULB should fix and notify charges for doorstep collection and transportation of C&D waste, based on the volume generated.

Placement of Skips on Public Roads: Normally for bulk generators dedicated hook loader bins or skips may be provided at a cost wherever required and should be kept within the construction sites.

The ULB should notify byelaws with regard to management of C&D waste and safety requirements of such containers on public roads.

Table 4.27 Action points for C&D waste management

Sr. No.	Action Area	Timeline	Department/ Agencies
1	Proper collection, transportation, processing and disposal of C&D Waste	Regular Activity	All Concern ULBs
2	Approval of Waste Management Plan submitted by Waste Generators before Construction starts.	Immediate	All Concern ULBs
3	Provisions for using materials made by C&D Waste in Construction Activity like paving blocks, lower layers of road pavements, colony and rural roads etc.	Immediate	All Concern ULBs
4	Collection of deposition charges should be initiated in all ULBs.	Immediate	All Concern ULBs
5	Deposition point for waste shall be established	Shall be established in future	All Concern ULBs
6	Information, Education & Communication (IEC) for C&D waste management.	Regular Activity	All Concern ULBs

4.2.7 Biomedical Waste Management

With a total population of 3,674,179 in the 8 statutory towns, the district has 351 healthcare facilities of which 350 are authorized by the SPCB and out of these 107 are non-bedded facilities. The district also has 6 veterinary hospitals and 70 pathlabs distributed in all of the ULBs. There is a Common Bio-medical Waste Treatment and Disposal Facility (CBWTF) for Alwar and Bharatpur district.

As per the report published by the pollution control board the amount of total BMW generated is 749.6 kg/day for the Alwar and Bharatpur district. Total number of HCFs covered for this in lwar district is 199 (RSPCB, 2019).

Data Provided by ULBs

Data for different action areas are collected form heath department. These data include details of number of hospitals (HCFs, clinics, blood bank etc), amount of waste generated per day and, CBMWTFs in Alwar district.

The district Alwar have two regional offices which are RO, Alwar and RO, Bhiwadi. Data are separetly provided by these regional offices. As per the data provided 126 medical facilities in the Alwar district have installed captive disposal facility for treatment of bio-medical waste at hospital level.

Table 4.28 Report on Inventory of Biomedical Waste Generation, 2019

Sr No.	Action Areas	Measurable Outcome	Please enter Measurable Outcome for District RO, RPCB, Alwar	Please enter Measurable Outcome for District RO, Bhiwadi(Tehsil-Tijara)
	Name of ULB	[name of ULB]		
	Population	[Nos as per 2011 census]		
A	**Inventory of Biomedical Waste Generation**			
	Total no. of Bedded Hospitals	[Nos] / [No inventory]	282	69
	Total no. of non-bedded HCF	[Nos] / [No inventory]	88	19
	Total no. Clinics	[Nos] / [No inventory]	23	13
	No of Veterinary Hospitals	[Nos] / [No inventory]	6	0
	Pathlabs	[Nos] / [No inventory]	65	5
	Dental Clinics	[Nos] / [No inventory]	2	3
	Blood Banks	[Nos] / [No inventory]	2	1
	Animal Houses	[Nos] / [No inventory]	0	0
	Bio-research Labs	[Nos] / [No inventory]	0	0
	Others	[Nos] / [No inventory]	0	0
B	**Authorization of HCFs by SPCBs / PCCs**			
	Bedded HCFs	[Nos Authorized]	282	68
	Non-bedded HCFs	[Nos Authorized]	88	19
C	**Biomedical Waste Treatment and Disposal Facilities (CBMWTFs)**			
	No of CBMWTFs	[Nos] / None	1	0
	Linkage with CBMWTFs	[Yes] / [no linkage]	307	88
	Capacity of CBMWTFs	[Adequate] / [Not adequate]	Adequate	
	Requirements of CBMWTFs	[Require] / [not required]	Required	
	Captive Disposal Facilities of HCFs	[Nos] / [None]	63	63
D	**Compliance by CBMWTFs**			
	Compliance to standards	[Meeting] / [Not meeting] / [NA]	meeting	
	Barcode tracking by HCFs / CBMWTFs	[100%] / [Partly %] / [None]	Partly	Partly
	Daily BMW lifting by CBMWTFs	[Kg / day]	613 kg/day	86 kg/day
E	**Status of Compliance by Healthcare Facilities**			
	Pre-segregation	[100%] / [partly %] / [None]	Partly	Partly
	Linkage with CBMWTFs	[100%] / [partly %] / [None]	307	88

Inferences for Present Scenario of Alwar

Although the whole district has linkages with a common treatment facility for managing the biomedical waste, there are a number of issues which may be improved for biomedical waste management. First the inventory of all the entities producing biomedical waste should be completed. The practice of tracking of biomedical waste using barcode has not been followed strictly in the district. The other main concern is the compliance by the common biomedical waste treatment facility in Alwar.

4.2.8 Action Areas for Bio-Medical Waste Management

The action areas of the Strategy set out how the main goals of the Strategy will be achieved in terms of areas of need, timeline, and responsible agency. Action plan for segregation, collection, transport, disposal and data management with timeline and responsible department is given in the table below.

Table 4.29 Action Plan for Bio-Medical Waste Management

S.No.	Action Area	Timeline	Department/ Agencies
1	Segregation of Bio Medical Waste (BMW) at source of generation in specified Color-Coded bags	Regular Activities	Health Department/ HCFs
2	Inventorisation of Medical facilities producing Bio-Medical Waste	Immediate	Health Department
4	Collection of Solid Waste other than BMW from HCFs	Regular Activities	CBWTFs
5	Captive Disposal Facilities of HCFs shall be established.	Immediate	Health Department/ HCFs
6	Authorization to HCFs and Occupiers and Submission of Annual report to CPCB.	Immediate	RPCB
7	GPS enabled vehicles for Biomedical wastes transportation	Immediate	Health Department/RPCB/ CBWTFs
8	Information, Education & Communication (IEC) for Bio-medical waste management.	Regular Activities	Health Department / NGOs/ Education Department
9	Monitoring compliance by common biomedical waste treatment facility	Regular activity	RO, SPCB

4.2.9 Hazardous Waste Management

Data provided by ULBs

Table 4.30 shows the Hazardous Waste Datasheet for Alwar district. The industrial cluster of Alwar and Bhiwadi have 332 authorized industries generating 23,310.63 MT per annum of hazardous waste. The district recycles/utilizes around 14,696 MT/annum hazardous waste. The quantity of hazardous waste which goes to landfill and incineration is 7582.58 and 1030.87 respectively.

Table 4.30 Hazardous Waste Datasheet for Alwar district

No.	Action Areas	Measurable Outcome	Outcome for District RO, RPCB, Alwar	Measurable Outcome for District RO, Bhiwadi(Tehsil-Tijara)
A	**Inventory of Hazardous Waste**			
	No of HW Generating Industry	[Nos.]	151	181
	Quantity of HW	[MT/Annum]	5978.737	17331.9
	Quantity of Incinierable HW	[MT/Annum]	432.36	598.51
	Quantity of land-fillable HW	[MT/Annum]	3901.386	3681.2
	Quantity of Recyclable / utilizable HW	[MT/Annum]	1644.91	13052.19
B	**Contaminated Sites and illegal industrial hazardous waste dumpsites**			
	No of HW dumpsites	[Nos] / [None]	Nil	
	Probable Contaminated Sites	[Nos] (provide list)	Nil	
C	**Authorization by SPCBs/PCCs**			
	No of industries authorized	[Nos]	151	181
	Display Board of HW Generation in front of Gate	[Nos]	151	181
D	**Availability of Common Hazardous Waste TSDF**			
	Common TSDF	[Exists] / [No] / [Sent to Other District within State]	Exist-01 Also sent to other district within state	NO
	Industries linkage with TSDF	[Nos.]	123 units are of Alwar district Total connected - 264 of Rajasthan	
F	**Linkage of ULBs in District with Common TSDF**			
	ULBs linked to Common TSDFs for Domestic Hazardous Waste	[Yes] / [No]		

Inferences for present scenario

Out of 23,310.63 MT hazardous waste generated by 332 HW generating units, 63.04 % is recyclable, 0.04 % is incinerable and 32.52 % is land filled. Ther is no hazardous waste dumpsite in district. One TSDF unit exists in the Alwar region but there is no TSDF facility for Bhiwadi industrial region as there are more number of industries as compare to Alwar. As for common TSDF, there is no data of how much HW is being exported to other districts.

4.2.10 Action Areas for Hazardous Waste Management

Hazardous Waste Management Rules are notified to ensure safe handling, generation, processing, treatment, package, storage, transportation, use reprocessing, collection, conversion, and offering for sale, destruction and disposal of Hazardous Waste. This action should be completed on a timeline by responsible department.

Table 4.31 Action Plan for Hazardous Waste Management

S. No.	Action Area	Timeline	Department/ Agencies
1.	Hazardous waste segregation at Source	Regular activity	All ULBs
2.	Circular economy approach may be followed in the industries e.g. modifications in input side leading to changes in resulting waste compositions circular economy as one that is restorative, and one which aims to maintain the utility of products, components and materials and retain their value	5-years	RSPCB (help from technical institutes may be sought)
3.	More opportunities my be searched for utilization of hazardous waste	5-years	RSPCB (help from technical institutes may be sought)
4.	Information on domestic hazardous waste generated should be collected and maintained	Implemented in future	All ULBs
6.	Education on Identification of different HW classification and their respective handling and storing methods	Immediate	All ULBs

4.2.11 E-Waste Management

Data Provided by ULBs

Details for different paramets of E-Waste management i.e., collection centers, authorizedrecyclers/dismantler etc are provided by district authorities. Table 4.37 gives details regarding e-waste management in the district.

Table 4.32 Report on E-Waste Management

No.	Action Areas	Measurable Outcome	Please enter Measurable Outcome for District RO, RPCB, Alwar	Please enter Measurable Outcome for District RO, Bhiwadi(Tehsil-Tijara)
A	**Status of facilitating authorized collection of E-Waste**			
	Does the citizen are able to deposit or provide E-Waste through Toll-free Numbers in the District	[Yes] / [No]	no	no
	Collection centers established by ULB in District	[Nos] / [None]	none	none
	Collection centers established by Producers or their PROs in the District	[Nos] / [None]	3	none
	Does the district has linkage with authorized E-Waste recyclers / Dismantler	[Yes] / [No]	no	NO
	No authorized E-Waste recyclers / Dismantler	[Nos] / [None]	4	**7**
B	**Status of Collection of E-Waste**			
	Authorizing E-Waste collectors	[Authorized] / [None]	none	NONE
	Involvement of NGOs	[Yes] / [No] / [Nos]	no	NO
	Does Producers have approached NGOs/ Informal Sector for setting up Collection Centers.	[Yes] / [No] /[Nos]	no	NO
	Does ULBs have linkage with authorized Recyclers / Dismantlers	[Yes] / [No]	to be provided by ULB	to be provided by ULB
C	**Control E-Waste related pollution**			
	Does informal trading, dismantling, and recycling of e-waste exists in District	[Yes] / [No]	may be	may be
	Does the administration closed illegal E-Waste recycling in the District	[Yes] / [No] / [Nos]	no	no
	No of actions taken to close illegal trading or processing of E-Waste	[Nos]	none	none

D	**Creation of Awareness on E-Waste handling and disposal**			
	Does PROs / Producers conducted any District level Awareness Campaigns	[Yes] / [No] / [Nos]	no	no
	Does District Administration conducted any District level Awareness Campaigns	[Yes] / [No] / [Nos]	no	no

Inferences from Present Scenario

There is no E-waste management infrastructure in the Alwar district. Only 3 collection centers were established by Producers or their PROs in the District. Total of 11 authorized E-Waste recyclers / Dismantler exists in the district. The creation of Awareness on E-Waste handling and disposal has not been taken up in a vigorous way by any of the ULBs.

The generation of e-waste is going to be increased in the future. So, it is important to spread awareness about the harmful effect of the disposal of e-waste. Collection centers for disposed of e-waste should be installed. ULBs should start the process of estasblishing linkages with authorized PROs for proper management of discarded e-waste.

ULBs should establish Toll-free number helpline where a citizen can contact for deposition of their e-waste. Awareness programme should be initiated by the ULBs and NGOs. A common recycling/dismantle facility may be established at the two regional level of Alwar and Bhiwadi as these are the most populated as well as industrialised towns.

4.2.12 Action Plans for E-Waste Management

The lack of primary data is the major concern faced by all the institutions. So, to formulate a site-specific action plan, firstly requires the data regarding the site. This includes data regarding the generation, current status of collection of E-waste, the facilities provided by the district used by the citizens, availability of collection centre under ULBs, status of dismantlers, involvement of formal informal sectors, about trading, recycling and illegal activities surrounding this etc. Based on these data an action plan has been formed to the better functioning with the timeframes and requirement pattern with regards to infrastructural development of the area.

Table 4.33 Action Plan for E-Waste Management

S. No	Action Points	Departments/Agencies
1	Collection, Segregation and Channelization of e-waste pertaining to orphan products to recyclers/dismantlers	ULBs
2	Segregation of E-waste at source from MSW	ULBs/Nagar Nigam/ Waste Generator
3	Ensuring no illegal processing of e-waste and no dumping of e-waste, HW & other wastes on banks of river and no illegal transportation of e-waste.	District Administration /ULBs/SPCB/RTO
4	Industrial skill development activities for workers in dismantling and recycling units.	Labor Department
5	Monitoring & Compliance of Extended Producers Responsibility (EPR) - Authorization issue by CPCB.	SPCB
6	Information, Education & Communication (IEC) for E-waste Management.	ULBs/ SPCB/ Development Authority/ NGOs/Education
7	Authorization to Manufacturers, Dismantlers, Recyclers, Refurbishers and Action against defaulters.	SPCB
8	Integrated plan for implementation of EWM Rules, 2016.	SPCB
9	Earmarking or allocation of industrial space or shed, abandoned mills/factories for e-waste dismantling/recycling units in industrial clusters	Department of Industries
11	Recognition and Registration of workers of dismantling and recycling units.	Labor Department
12	Implementation of EPR from producers.	Department of Industries/SPCB

4.3 Summary

4.3.1 Municipal Solid Waste Management

In summary, the current state of solid waste management revealed that there are significant issues with unauthorized waste disposal practices due to the lack of proper waste management process. This has significantly impacted on the natural environment. The lack of public waste bins and proper waste collection processes have significantly affected the unauthorized waste disposal practices. Moreover, the absence of sanitary land filling and inadequate processes are significant issues with SWM. The absence of practical usage of regulation and laws is identified as a barrier to residents engaging in proper waste management processes with recycling and waste separation because the council could not enforce these practices. Lack of knowledge, awareness and cooperation have been identified. As more and more waste is generated yearly, it is evident that this increasing trend is unacceptable in the long run. Landfills and recycling can only temporarily mitigate the immediate consequences of this large waste production. However, if the problem of municipal solid waste is to be truly addressed, the root of the issue must be looked at first. If less waste is generated in the first place, the challenge of finding environmentally feasible ways of disposing of waste will be much easier.

Table 4.34 Summary for SWM in all ULBs of Alwar District

ULBs	Aspect	Collection and Transportation	Processing and disposal
Nagar parishad Alwar	Present Status	100% door to door collection Waste is first transferred to transfer station and then to the dumpsites Partial efficiency in segregated waste transport	80% of the waste is used for composting Material Recovery facility has been initiated Recycling of waste is not done Sanitary landfill is present One dumpsite is present
	Action points	Source Segregation of waste. Educating general public at school level. Modification in collection frequency of waste based on type of waste. Incorporation of households on the extremity in waste collection programme. Use of ICT and IoT in waste collection operations. Use of electrical or biofuel powered vehicles.	Mannual MRF with capacity of for dry waste Mechanised composting plant for wet waste Integrated domestic hazardous waste management centre for recovering recyclables from hazardous waste Incineration of sanitary waste on daily basis Completion of treatment of legacy waste as soon as possible Engineered landfill
Nagar Parishad Bhiwadi	Present Status	100% door to door collection No transfer station is present, so waste is directly dumped to dumpsites Segregated waste transport is not initiated	No composting unit is present but 20% of the waste is used for composting operations Material Recovery facility has been initiated Recycling of waste is not done Sanitary landfill is not present One dumpsites are present
	Action points	Source Segregation of waste. Educating general public at school level. Modification in collection frequency of waste based on type of waste. Incorporation of households on the extremity in waste collection programme. Use of electrical or biofuel powered vehicles.	No MRF with capacity of for dry waste Composting plant of capacity for wet waste Local collection and storage facility for domestic hazardous waste Incineration of sanitary waste on daily basis Completion of treatment of legacy waste as soon as possible Engineered landfill for Bhiwadi
Nagarpalika Tijara	Present Status	100% door to door collection No transfer station is present, so waste is directly dumped to dumpsites Partial segregated waste transport is initiated	No composting unit is present Material recovery facility has been not initiated Recycling of waste is not done No sanitary landfill site is present One old dumpsite is present
	Action points	Source Segregation of waste.	No MRF for dry waste

		Educating general public at school level. Modification in collection frequency of waste based on type of waste. Incorporation of households on the extremity in waste collection programme. Use of electrical or biofuel powered vehicles.	No composting plant for wet waste Local collection and storage facility for domestic hazardous waste Incineration of sanitary waste on daily basis Completion of treatment of legacy waste as soon as possible Engineered landfill for the cluster of Tijara, Kishangarh Bas, Khairthal
Nagarpalika Kishangarh Bas	Present Status	100% door to door collection No transfer station is present, so waste is directly dumped to dumpsites 100% efficiency in segregated waste transport	No composting unit is present Material recovery facility has been initiated Recycling of waste has been not initiated Zero sanitary landfill site is present one dumpsites are present
	Action Points	Source Segregation of waste. Educating general public at school level. Modification in collection frequency of waste based on type of waste. Incorporation of households on the extremity in waste collection programme. Use of electrical or biofuel powered vehicles.	MRF for dry waste composting plant for wet waste Local collection and storage facility for domestic hazardous waste Incineration of sanitary waste on daily basis Completion of treatment of legacy waste as soon as possible Engineered landfill for the cluster of Tijara, Kishangarh Bas, Khairthal
Nagarpalika Behror, Bansur, Thanagazi	Present Status	100% door to door collection No transfer station is present, so waste is directly dumped to dumpsites 100% efficiency in segregated waste transport	No composting unit is present but 2% of the waste is utilized in composting operations Material recovery facility has been initiated Recycling of waste has not been initiated Zero sanitary landfill site is present One dumpsite is present
	Action Points	Source Segregation of waste. Educating general public at school level. Modification in collection frequency of waste based on type of waste. Incorporation of households on the extremity in waste collection programme. Use of electrical or biofuel powered vehicles.	MRF with capacity dry waste Mechanised composting plant for wet waste Local collection and storage facility for domestic hazardous waste Incineration of sanitary waste on daily basis Completion of treatment of legacy waste as soon as possible Engineered landfill for the cluster of Behror and Bansur
Nagarpalika Laxmangarh and	Present Status	No door to door collection No transfer station is present, so waste is directly dumped to dumpsites Segregated waste transport is not	No composting unit is present Material recovery facility has not been initiated Recycling of waste has not been initiated Zero sanitary landfill site is present

Ramgarh		initiated	One dumpsite is present
	Action Points	Source Segregation of waste. Educating general public at school level. Modification in collection frequency of waste based on type of waste. Incorporation of households on the extremity in waste collection programme. Use of electrical or biofuel powered vehicles.	MRF with for dry waste Mechanised composting plant for wet waste Local collection and storage facility for domestic hazardous waste Incineration of sanitary waste on daily basis Completion of treatment of legacy waste as soon as possible Engineered landfill for the cluster of Laxmangarh, Kherli, Ramgarh
Nagarpalika Kherli ,Rajgar, Khairthal	**Present Status**	100% door to door collection No transfer station is present, so waste is directly dumped to dumpsites Segregated waste transport is not initiated for Khairthal	No composting unit is present Material recovery facility has not been initiated Recycling of waste has not been initiated Zero sanitary landfill site is present One dumpsite is present
	Action Points	Source Segregation of waste. Educating general public at school level. Modification in collection frequency of waste based on type of waste. Incorporation of households on the extremity in waste collection programme. Use of electrical or biofuel powered vehicles.	MRF with for dry waste Mechanised composting plant for wet waste Local collection and storage facility for domestic hazardous waste Incineration of sanitary waste on daily basis Completion of treatment of legacy waste as soon as possible Engineered landfill for the disposal

4.3.2 Plastic Waste Management

ULBs should incorporate personnel from the informal sector, improve their skills via training and seminars, and increase material recovery facilities in cities. ULBs should integrate these informal employees into formal chains through waste management concessionaires, self-help groups, or non-governmental organizations (NGOs), ensuring that these workers of last resort are elevated and relocated to formal jobs.

Waste segregation at the source is a critical component that can improve material recovery and recycling rates. Once garbage is identified at the source as dry, moist, or hazardous, there is a considerable possibility to recover plastics from dry waste in material-recovery facilities. As a result, citizen involvement and engagement in plastics management are equally important.

The table below highlights the current status and future action plan for all ULBs in order to handle plastic waste efficiently.

Table 4.35 Summary about PWM for all ULBs of Alwar District

Name of ULB	Present Status	Action Plan for future
Alwar and Bhiwadi Nagar parishad ULB	Quantity of plastic waste generated has not been estimated. There is 100% provision of door-to-door collection of waste. partial waste segregating is carried out during waste collection. Plastic waste collection at Material Recovery Facility has been installed. There are no authorized PW in Alwar ULB. There is one PW collection center for Alwar. Linkages with PROs & NGOs have not been established for Alwar. There are one PW recyclers for Bhiwadi, none Manufacturers, Pyrolysis oil plants, 0.5 MT for Plastic pyrolysis plants at Bhiwadi. Nowhere plastic is utilized for road construction. Plastic is used in cement kins at Bhiwadi Units producing <50 micron carry bags are partially sealed for Bhiwadi. Sale of carry bags <50 micron is strictly prohibited. Ban on carry bags and other single use plastics as notified by State Government is implemented. The EPR through Producers/Brand-Owner has not been implemented. No producers are associated with ULB, no financial or infrastructure support is given, and no collection centres have been setup.	Plastic waste segregation should be done at source as a regular activity. Implementation of Management by Waste Generator through EPR and PRO. Utilization of Non-recyclable plastic waste (Road Construction, Waste to Fuel, Waste to energy, alternative uses identification etc. to be implemented. Strict violations on open burning and littering.

Nagarpalika- **Tijara, Khairthal, Thanagazi, Laxmangarh, Ramgarh, Bansur**	The estimated quantity of plastic waste generated is not estimated. There is no 100% provision of door-to-door collection of waste for Khairthal, Laxmangarh, Ramgarh, Only 20% waste segregation is done during waste collection. Plastic waste collection at Material Recovery Facility is not installed. Linkages with PROs & NGOs have not been established. There are no PW recyclers but, no Manufacturers, no Pyrolysis oil plants, and no plastic pyrolysis plants in the ULB. Plastic is utilized for road construction but, about 0.5 MT/MONTH of plastic is co-processed in cement kiln. No action has been taken for sealing of units producing <50-micron plastic. Sale of carry bags <50micron is strictly prohibited. Ban on carry bags and other single use plastics as notified by State Government is implemented. The EPR through Producers/Brand-Owner has not been implemented. No producer is associated with ULB, no financial or infrastructure support is given, and no collection centres have been setup.	Plastic waste segregation should be done at source as a regular activity. Implementation of Management by Waste Generator through EPR and PRO. Utilization of Non-recyclable plastic waste (Road Construction, Waste to Fuel, Waste to energy, alternative uses identification etc. to be implemented. Strict violations on open burning and littering.

Nagarpalika-Kishangarh bas, Behror, Kherli, Rajgarh	Quantity of plastic waste generated has been estimated. There is 100% no provision of door-to-door collection of waste at Behror. Partial waste segregating is being out during waste collection. Plastic waste collection at Material Recovery Facility is not installed. There are no authorized PW pickers in the ULB. PW collection centers are not established. Linkages with PROs & NGOs have not been established. There are no PW recyclers, Manufacturers, Pyrolysis oil plants and Plastic pyrolysis plants. Nowhere plastic is utilized for road construction and neither co-processed in cement kiln. Units producing <50 micron carry bags are totally sealed. Sale of carry bags <50micron is partially prohibited. Ban on Carry bags and other single use plastics as notified by State Government is implemented. The EPR through Producers/Brand-Owner has not been implemented. No producer is associated with ULB, no financial or infrastructure support is given, and no collection centres have been setup.	Plastic waste segregation at source should be done effectively as a regular activity. Implementation of Management by Waste Generator through EPR and PRO. Utilization of Non-recyclable plastic waste (Road Construction, Waste to Fuel, Waste to energy, alternative uses identification etc. to be implemented. Strict violations on open burning and littering.

4.3.3 Construction and Demolition Waste Management

The inventory of C&D waste suggests that a significant proportion of construction waste can be recycled and reused and brought back to construction to substitute naturally sourced material. This demands a circular economy that can turn C&D waste into a resource. This can help reduce energy intensity and environmental footprints of buildings and infrastructure.

Management of construction and demolition waste in the state shall be done in accordance with the construction & Demolition Rules 2016. Each local body shall issue detail directions to the generators and other involved in the process on proper management of construction and demolition waste within its jurisdiction in accordance with the provisions of these rules. Each ULB shall make a reasonable estimate on the quantity of construction and demolition waste generated in its jurisdiction and also work out the projections for the future years. The ULBs shall ensure separate storage, collection and transportation of construction and demolition wastes. The ULBs shall make arrangements for collection and transportation of Construction & Demolition waste either through own resources or by appointing private operators.

Every ULB shall develop the collection centre or alternate collection mechanism for construction and demolition waste and hand it over to the authorized processing facility of construction and demolition waste.

ULB shall also keep a track of the major generation of construction and demolition waste within its jurisdiction and establish a data base and update once in a year. ULBs shall create a sustained system of information, education and communication for construction and demolition waste through collaboration with expert institutions and civil societies and also disseminate through their own website;

Table 4.36 Summary for C&D waste management in all the ULBs of Alwar District

ULBs	Present Status	Action Points	Strategy and Approach
Nagar Parishad- Alwar and Bhiwadi **Nagar Palika- Tijara, Kishangarh bas, Behror, Thanagazi, Kherli, Rajgarh, Khairthal, Laxmangarh, Bansur, Ramgarh**	1. Estimated quantity of C&D waste is not mentioned properly. 2. Amount of C&D waste collected, dump is calculated. 3. Implement scheme for permitting bulk waste is not being issued by ULB. 4. Issuance of permission by ULB for establishment of C&D waste deposition is not being initiated and C&D waste deposition is not identified there. 5. Implementation of By-Laws for C&D waste management is being notified. 6. Collection of deposition/disposal charge is being initiated. 7. C&D recycling plant doesn't exist.	Inventory of C&D waste generation	1.Survey and Investigate the C & D generators under the jurisdiction of ULB. 2. Identify regular bulk waste generators (Contractors or Builders) 3. Distribution of Staffs in Collecting, Transporting and Processing of C & D 4. Treatment of C & D Wastes or Transformation
		Implement scheme for permitting bulk waste generators	1. Contractors/Builders should have registration id in the ULBs to collect & transfer the C & D Wastes to the C & D Deposition Center for treatment. 2. The Generators should contact the ULB staffs or Constructors/Builders. 3. The generators should be charged as per by law.
		Establishment of C&D Waste Deposition centers	1. Identify the transportation point.
		Establishment of C&D Waste recycling plant or linkage with such facility	1. Involve NGOs or to startups to establish a C&D Waste recycling plant, 2. ULB of Alwar should established C&D recycling plant in the form of cluster

4.3.4 Bio-Medical Waste Management

The need of proper biomedical waste management has been recognized by both government agencies and non-governmental organizations. There are several hazards and dangerous objects that should be handled and disposed of with care. Inadequate and inefficient segregation and transportation networks may constitute a severe hazard to society, necessitating the installation of safeguards and laws in writing. All of these circumstances enhance the likelihood of biomedical hazards being exposed to employees, patients, and the general public.

To accelerate the creation of appropriate processing and management processes, timely regulatory and legislative rules and procedures are required. To be properly separated, processed, and isolated, wastes must be well-characterized, which is difficult. Handling biomedical waste properly and effectively is not just a legal requirement, but also a social obligation.

A lack of caring among people working in the sector, a lack of motivation, a lack of awareness, and a cost aspect are some of the challenges encountered in proper hospital waste management. In order to perform complete surveys of waste management processes in various practices, it is required to undertake thorough surveys of waste management processes in various practices. There is clearly a need for more education about the consequences of improper waste disposal.

Given the lack of understanding of biomedical waste management at all levels of health-care employees, an effective communication strategy is critical.

Table 4.37 Summary about Bio-Medical Waste Management for all the ULBs of Alwar District

District	Present Status	Action Plan for future
Alwar District	• Quantity of Bio Medical waste generated at each ULB has not been provided for the latest data. There is only data available for the year 2008. • There is 100% provision of segregation at source and collection of non-hazardous waste in Municipal Solid Waste. • Common Bio-Medical Waste Treatment Facility has not been installed. One CBMWTF present at sri-ganganagar is being used. • Barcode on Colour Coded Bags are not being placed for tracking of waste in ULBs.	• GPS enabled vehicles for Biomedical wastes transportation • Authorization to HCFs and Occupiers and Submission of Annual report to CPCB. • Authorization to HCFs and Occupiers and Submission of Annual report to CPCB. • Compliance of regulation by common biomedical waste treatment facility

4.3.5 Hazardous Waste Management

To summarize, the district has seven authorized industries capable of generating hazardous waste and recycles/utilizes around 384.27 MT/annum hazardous waste. The focus should be on industrial waste documentation in individual ULBs, hazardous waste segregation at source and maintaining a detailed hazardous waste profile.

Table 4.38 Summary of present status and action points for HWM in all the ULBs of Alwar

Name of District	Present status	Action Points	Strategy and approach	Stakeholder responsible
Alwar	Generates maximum amount of domestic hazardous waste and sanitary waste in the district No details on type of HW collected, quantity of HW recycled and disposed, no information of import/export of HW	Hazardous waste reduction measures Inventory of hazardous waste recycled and disposed Inventory of industrial HW Maintenance of Hazardous waste profile	Stricter laws for enforcing hazardous waste segregation at source/ Reward system Recycle more waste rather than disposal Documentation of hazardous waste profile Stricter registration of hazardous waste generating industries	ULB staff, waste generators

4.3.6 E-Waste Management

Currently there is nothing done for the E-waste management at any of the ULB.

E-waste management should be considered as an urgent need and measures have to be taken. The future projection for each ULB shows that there is considerable increase in the quantity of E-waste generated. The lack of grass root level data on management system including quantification, characteristics and existing disposal practices makes detailed assessment of the current and future scenario very difficult. A holistic approach which is also self-sustained to manage the system from the generation to disposal will be effective in handling the issue. It can make use of technological advancements and create a sustainable consumer culture where the public is aware of the environmental and health hazards caused by E-waste. Care should also be taken to ensure the E-waste policy is functional and strengthening the legal aspects of the system.

5. Water Quality Management

5.1 Water Quality Monitoring

The term "water quality" is assessed in terms of physical, chemical or biological characteristics of water by which the user evaluates the acceptability of water. According to the Constitution of India, water supply is the subject of a state jurisdiction while, the Union Government is only responsible for setting the water quality standards. To address the monitoring of drinking water quality in India, a programme on community-based water quality monitoring (CBWQM) was initiated under the Rajiv Gandhi National Drinking Water Mission (RGNDWM). This initiative was started to ensure the safe water for Indian citizens through a comprehensive surveillance process, incorporating monitoring, data processing, evaluation, sanitary monitoring, evaluation, sanitary surveys, public health assessment and remedial and preventive action throughout the length and breadth of the country (R. K. Sharma et al., 2017).

The water quality management plan is made with an objective of reducing the discharge of pollutants into the urban runoff from the development projects. This can be done by reducing or eliminating the source of pollutants and managing site run off volumes and flow rates through application of the best management practices.

5.1.1 Literature review

Water quality is deteriorating all over the world, in both developed and developing countries. The types, extents and magnitudes of water quality problems differ from country to country and sometimes within the same country. In global context, at least 4 billion people in the world do not have access to safe drinking water. In the entire South Asian region, over 1.7 billion people are dependent on the tap water for drinking purpose, and majority of people think that the tap water is safe to drink. However, due to the high concentration of dissolved salts and carcinogenic impurities, ground water is no longer considered good for the human health. World Health Organization’s data reports that 3.4 million people die due to the water borne diseases. Ground water quality measures should be ensured to prevent water-borne diseases, harm to environment, soil degradation and damage to sensitive crops. The global focus has always been on providing the water to every living beings; but with ever increasing industrialization and urbanization, the quality of water is continuously deteriorating. In developing countries less than 10% of population have access to wastewater collection and treatment facilities Sharma et al., 2017).

Water quality was listed as one of the primary challenges in Asia in the next century by the United Nations in its recent analysis of global water scarcity. The most visible evidence of water quality degradation in most of the Asian countries is of serious human health issue which is linked to the discharge of pathogens into drinking water resources. Apart from affecting the human health it is causing severe impact on aquaculture in surface water resources which can be observed by spread of algae on surface water, eutrophication of lakes and kills of water habitats. Wastewater discharged into water bodies is causing destructive influence in near-shore and off-shore marine environments in Asia. The status of water quality should form the basis for a national action programme on water quality management in the developing countries of Asia and Pacific region. Countries in the Asia Pacific region faces many problems in water quality monitoring such as parameters used for water quality monitoring is out-of-date, methodology used is very old, data collection is sometimes unreliable that cannot be used for decision making (Castonguay et al., 2018).

According to the government of India, in 2016, 21 million people in over 23,500 habitations were affected by arsenic and fluoride contaminated groundwater. In December 2018, the Minister of State for Drinking Water and Sanitation mentioned that out of 25,000 odd habitations across 16 states, 15,811 were affected by arsenic, and 9,660 were affected by fluoride (A. Biswas, 2019).

The groundwater is being exploited excessively in past few decades for several uses such as for drinking, farming, industries, and construction and this is increasing the amount of the chemical contamination. This is the reason why the drinking water schemes have been introduced wherein the use of groundwater has been decreased to some extent whereas, the use of surface water has increased.

Government of India has come up with National Water Policy in year 2012 (GOI, 2012) to ensure an integrated approach to water resource development, with rational and equitable resource distribution and priority for the poor and unserved. Efficient policy mechanisms to address the entire water cycle and to manage the water quality must be established. Establishing standards and objectives, as well as a mechanism to track and use them as a benchmarks for planning and management, should be part of an effective policy process. The government's goals and strategies for achieving them should be stated in a national water sector strategy. It will provide investment and project planning recommendations, with the goal of ensuring that water supply development considers water resource management and environmental factors, such as fair allocation of water resources and pollution prevention.

Governance and Management Structure

Rajasthan State Pollution Control Board

The Rajasthan State Pollution Control Board was constituted under section 4 of the Water (Prevention and Control of Pollution) Act, 1974 on 7th February 1975, with the objectives of prevention, and control of water pollution and maintaining or restoring the quality of water. Water (Prevention and Control of Pollution) Cess Act, 1977 has been passed to make the State Board financially independent. Under this act, the State Board has been given powers to collect cess based on water consumed by the industries etc. Enactment of the Environment (Protection) Act, 1986 has further widened the scope of the activities of the Board. This Act being umbrella legislation, different rules for addressing the problems of various sectors have been enacted under this Act. The State Board is engaged in implementation of the rules made under the Environment Protection Act, 1986.

Public Health Engineering Department

PHED, Rajasthan is responsible for providing potable water to every citizen of Rajasthan state. PHED is shifting from ground water-based schemes to surface water source-based schemes in the phased manner. PHED is using different water resources available to tackle the water problems of the state such as erratic rainfall, depleting water table and degraded quality of natural water available.

Best practices for Water Quality Management

Integrated Urban Water Management (IUWM)

Integrated Urban Water Management (IUWM) is mainly based on the planning, managing and maintaining the water sector in cities by considering entire urban water loop. IUWM has been acknowledged in India since the year 2015 as the robust solution to manage the urban water sector. City's hydrology, economy, institutional mechanisms, governance and social structure need to take into consideration while adopting the integrated approach for water sector in India. The framework can be divided into three major parts namely environment, institutional arrangements, and management instruments. Different agencies which are working in the water sector of the city helps in adopting this framework. Coordination among these agencies needs to be improved. Closing the loop of water sector will help in sustainable development of the cities. It ensures the water supply, sewage management, solid waste management and storm water management.

Wastewater Management

One of the major causes for the degradation of surface water quality is wastewater which is directly disposed into the surface streams or lakes. To manage the pollution caused by these sources, Wastewater Management is necessary.

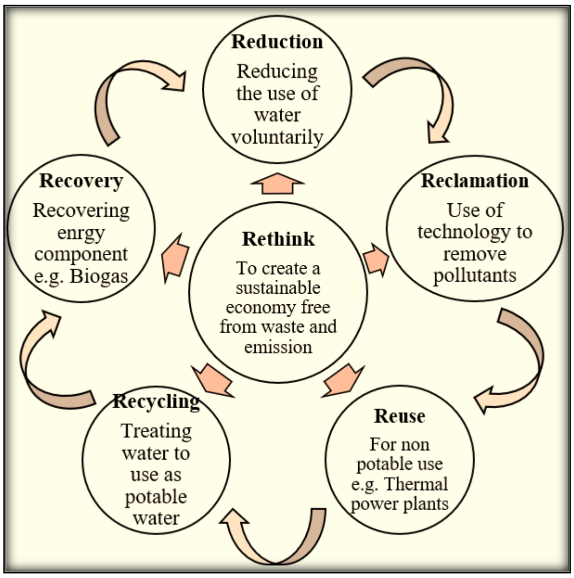


Figure 5.1 Circularity in Waste water Management

A transition from linear economy to circular economy will be helpful in adoption of wastewater reuse in the community. The reclaimed water reuse is adopted by many countries in the world, but the proportion of water reuse is still very less. Circular economy will help to achieve the sustainable development goals. Circularity in the wastewater management can be achieved by reduction, reclamation, reuse, recycling, recovery and rethink (Figure 5.1). These practices will ensure the awareness in the public, reduce the quantity of wastewater and reduce the cost of treatment of wastewater which will finally lead to Zero Liquid Discharge (ZLD). ZLD will ensure to recover all the water and contaminants are separated. This will decrease the waste volume produced (Tong & Elimelech, 2016).

5.1.2 Present Scenario and Gap Identification

STUDY AREA

Alwar is located in the north-east of Rajasthan between 27°34′ & 28°4′ north Latitudes and 76°7′ and 77°13′ east Longitudes. It is bounded by Mahendragarh (Haryana) in north-west, Gurgaon (Haryana) in the north and north-east, by Bharatpur in the east, by Dausa in south and Jaipur in south-west & west direction.

The total area of District is 8380 Sq. Kms. Its greatest length from south to north is about 137 Kms and greatest breadth from east to west about 110 Kms. The city is located at 165 kms from Jaipur the state's capital city which is also the nearest airport. Excellent rail and road links connect Alwar to the rest of the state.

Administratively, it has only one Lok Sabha constituency, the district is divided into 16 tehsils and 14 Panchayat Samitis. The district has 1991 villages, 9 urban towns and 6 Municipalities. Rural and urban population in the district is 30.18 lacs and 6.54 lacs respectively (Census, 2011). Density of the population is 438persons/sq.km (GoR, 2021c).

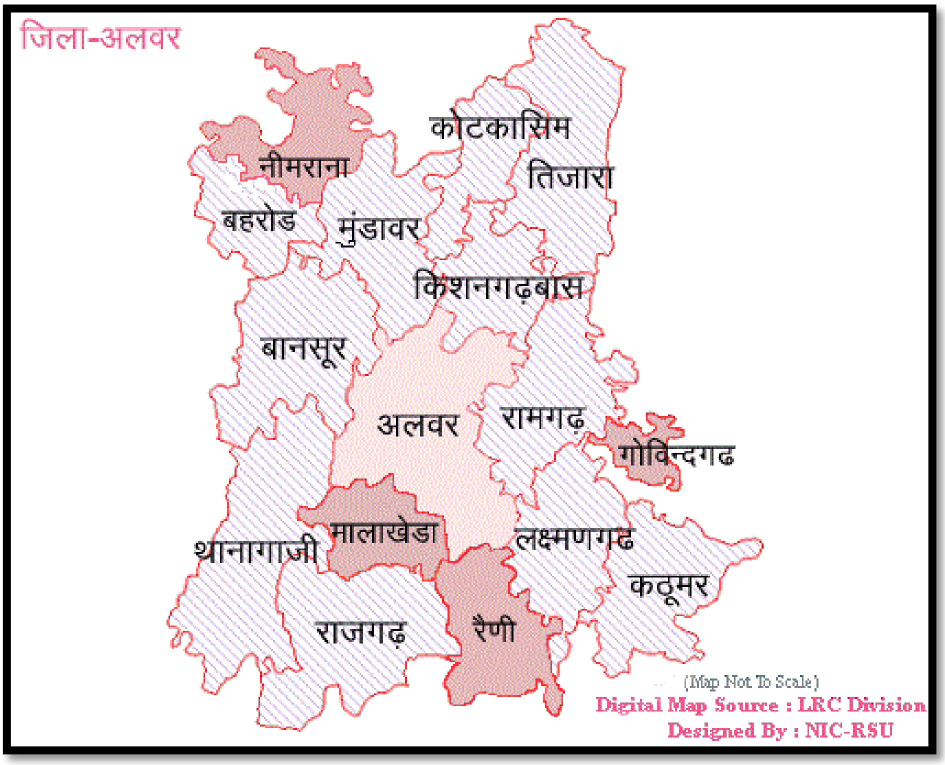


Figure 5.2 Administrative Division

Climatic Condition

Climate of the district can be classified as semi-arid. It is characterized by very hot summer and very cold winters with fairly good rainfall during southwest monsoon period. The potential evapotranspiration rates are quite high especially during May and June. Normal annual rainfall of the district is 631mm.

The average wind speed in Alwar is 2.4 m/s with the maximum wind speed of around 8 m/s. The average ambient temperature remains 25.4°C, varies from 4.8°C to 44.2°C. The average relative humidity remains around 58.4%, varies from 7.5% to 98.9%. The station pressure varies from 974 hPa to 956 hPa, averaged around 989 hPa (GOI, 2017).

Rainfall

Normal annual rainfall of the district is 631mm. The rainy period of the year lasts for 5.6 months, from April 30 to October 17, with a sliding 31-day rainfall of at least 0.5 inches. The most rain falls during the 31 days centered on August 3, with an average total accumulation of 6.2 inches (GOI, 2017.

The rainless period of the year lasts for 6.4 months, from October 17 to April 30. The least rain falls around November 29, with an average total accumulation of 0.1 inches.

- Most rainfall (rainy season) is seen in July and August.
- Alwar has dry periods in January, February, March, April, May, October, November and December.
- On average, August is the wettest month with 7.56 inch (192.0 mm) of precipitation.
- On average, November is the driest month with 0.12 inch (3.0 mm) of precipitation.
- The average amount of annual precipitation is: 23.58 inch (599.0 mm)

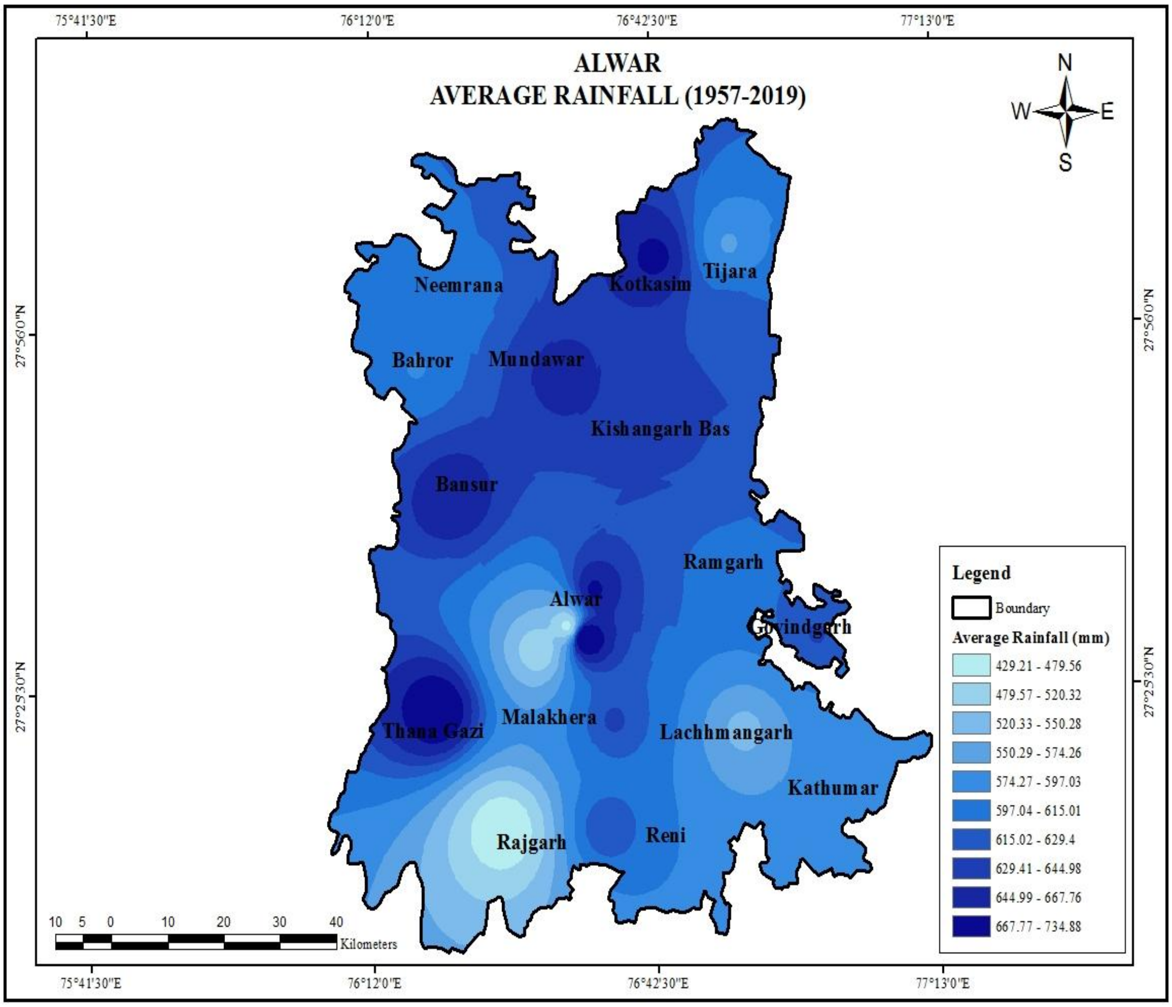


Figure 5.3 Average Rainfall for Alwar District (1957-2019)

Land Use

The socio-cultural and economic factors have significantly influenced over land use both in rural and urban areas in the district. Land forms, slope, soils and natural resources are some of the important which control the land use pattern of the district (GOI, 2017).

Table 5.1 Land Use, Alwar District

Sl.No.	Land Use	Area in hectare	%
1	Total geographical area	783281	-
2	Forest	84886	10.84
3	Uncultivable land	126280	16.11
4	Land not cultivated including pasture land; barren land; trees, grooves & orchards; padat land	70702	8.91
5	Actual sown area (subtracting double)	502413	64.14
6	Gross sown area	866860	
7	Area sown more than once	364447	

Drainage and Hydrology

There is no perennial river in the district. The seasonal rivers, which flow through the district and carry the runoff from the hills are Sabi (Sahibi), Ruparail (Barah), Chuhar Sidh and Landoha. Several of these rivers and their tributaries have been impounded at suitable sites and the water is used for irrigation if remains available. The natural drainage is from southwest to north east. Tehsil wise river basin area of district is given in Table 5.2 (GOI, 2017).

Table 5.2 Tehsil-wise distribution of River Basin area, Alwar District

S.No.	Name of Tehsil	River Basin (sq. km)		
		Sabi	Ruparail	Banganga
1	Alwar	87.7	1077.8	0.3
2	Bansur	551.4	98.9	-
3	Behror	242.6	-	-
4	Kathumar	-	-	-
5	Kishangarh	564.9	138	-
6	Kot kasim	-	-	-
7	Laxmangarh	-	-	967.1
8	Mandawar	607.4	-	-
9	Rajgarh	-	254.6	725.6

10	Ramgarh	-	659.3	-
11	Thanagazi	68.1	114.8	554.6
12	Tijara	625.3	193.6	-
Total		**2747.4**	**2537.0**	**2247.6**

Hydrology

There is no natural lake in the district. However, there are 24 talab/bunds in the district used for irrigation if water is available. The tehsil wise status of bunds existing the district is presented in Table 5.3. Bunds/talabs dried up during summer period and water are not available for irrigation during kharif cultivation. Irrigated area by bund/talab is only 17 hectare (GOI, 2017).

Table 5.3 Status of Irrigation Bunds, Alwar District

S.No.	Tehsil	No. of Talab/ Bunds	Gross Water Capacity (million feet)	Normal Water Capacity (million feet)	Command Area (hec)	Water Catchment	Length of canals(km)
1	Rajgarh	4	1432.52	1294.60	4419.00	114.50	39.25
2	Laxmangarh	1	106.00	212.40	3419.78	70.70	21.80
3	Kathumar	1	106.40	106.40	691.00	21.20	0.00
4	Tijara	3	152.38	151.45	1366.00	19.20	9.02
5	Kishangarh	3	454.00	311.00	1657.00	151.70	13.16
6	Mundawar	2	34.43	33.52	334.00	7.68	9.02
7	Behror	0	0.00	0.00	0.00	0.00	0.00
8	Bansur	2	333.00	418.00	3472.00	136.00	22.15
9	Alwar	3	1643.00	1301.25	6129.00	152.20	53.95
10	Thanagazi	4	644.71	330.31	2436.00	130.31	14.30
11	Ramgarh	1	0.00	0.00	2284.00	133.00	0.00
12	Kotkasim	0	0.00	0.00	0.00	0.00	0.00
Total		**24**	**4936.44**	**4158.93**	**26207.78**	**936.49**	

Depth to Water Level

Central Ground Water Board periodically monitors the ground water regime through 36 active National Hydrograph Network Stations (NHNS) four times a year i.e. in January, May, (Premonsoon), August and November (Post monsoon) including one time ground water sampling during May measurement. Depth to water level varies widely depending upon topography, drainage, bed rock, geology etc (GOI, 2017).

Pre-monsoon (May-2015):

The depth to water level varies widely from about 4.70 (lowest at Tehla in Rajgath block) to about 75 mbgl (deepest at Behror in Behror block). Water level is comparatively shallow in the southwestern, eastern parts and in Sabi river basin and Barah river basin, especially along river. Whereas it is deeper in the Northwest and western parts of the district. Block-wise water level ranges are given below:

Table 5.4 Block-wise Range of Depth to ground Water Level, Alwar District (May, 2015)

S.No.	Name of Block	Depth to Ground Water Level Range (mbgl)	
		From	To
1	Bansur	26.59	36.50
2	Behror	75.00	75.00
3	Kathumar	18.90	33.15
4	Kishangarh Bas	38.72	38.72
5	Kotkasim	19.00	26.15
6	Laxmangarh	7.68	36.70
7	Mandawar	34.10	49.60
8	Neemrana	58.21	59.15
9	Rajgarh	4.70	13.26
10	Ramgarh	21.30	23.25
11	Reni	23.35	23.35
12	Thanagazi	27.00	27.00
13	Tijara	7.25	24.06
14	Umrain	13.45	41.80

Post-monsoon (Nov, 2015):

The depth to water level varies widely from about 5.72 (lowest at Tehla in Rajgath block) to about 76.10 mbgl (deepest at Behror in Behror block). Water level is comparatively shallow in the south western, eastern parts and in Sabi river basin and Barah river basin, especially along river (GOI, 2017).Whereas, it is deeper in the North West and western parts of the district. Block-wise water level ranges are given in below:

Table 5.5 Block-wise Range of Depth to ground Water Level, Alwar District (Nov, 2015)

S.No.	Name of Block	Depth to Ground Water Level Range(mbgl)	
		From	**To**
1	Bansur	27.10	37.10
2	Behror	28.48	76.10
3	Kathumar	17.92	33.15
4	Kishangarh Bas	38.47	38.47
5	Kotkasim	19.00	26.30
6	Laxmangarh	7.93	22.30
7	Mandawar	34.95	49.55
8	Neemrana	60.65	61.53
9	Rajgarh	5.72	17.36
10	Ramgarh	16.36	23.15
11	Reni	20.45	50.52
12	Thanagazi	27.00	27.00
13	Tijara	8.10	24.30
14	Umrain	13.20	43.52

Long Term Water Level Trend (2001-2012):

Block-wise long term ground water level trend for the period 2001 to 2012 are given below:

Table 5.6 Block-wise Ground Water Level Trend(2001-2012), Alwar District

S.No.	Name of Block	Ground Water Level Trend (meter/year)	Remarks
1	Bansur	1.24	Declining
2	Behror	2.55	Declining
3	Kathumar	1.33	Declining
4	Kishangarh Bas	1.11	Declining
5	Kotkasim	1.02	Declining
6	Laxmangarh	0.97	Declining
7	Mandawar	1.09	Declining
8	Neemrana	1.08	Declining
9	Rajgarh	(-) 0.014	Marginal Rising
10	Ramgarh	0.60	Declining]
11	Reni	0.45	Declining
12	Thanagazi	0.0183	Declining
13	Tijara	0.35	Declining
14	Umrain	0.94	Declining

The trend data indicates that declining trend has been observed in all the blocks except in Rajgarh block where marginal rising trend of 0.014 m/year has been found. Declining trend ranges from

0.0183 m/year (Thanagazi Block) to 2.55 m/year (Behror Block). Declining trend has been resulted due to the overdraft of ground water resources than its natural replenishment. Marginal rising trend may be due to the less withdrawal of ground water in the area being hilly and less availability of cultivable area. The long term hydrograph of selected monitoring stations are depicted in Figure (GOI, 2017).

Water Table

The general slope of water table in the area is towards east. In Barah basin, it has a south easterly slope in the north-eastern part of the district; easterly slope in a major part of the area between Alwar and Nagar and north-westerly and south easterly slope in the southern part of the area between Rajgarh and Malakhera. However, near Dhakpuri, water table slopes towards north-easterly direction. In the northern part of the district, the general slope of water table in the area is broadly towards north-easterly direction. The highest water table lies at an elevation of more than 400 mamsl in Thanagazi block and minimum elevation at less than 190 mamsl in Kathumar block. Water table slope gently in the eastern direction averaging about 1.02 m/km. The hydraulic gradient in Berah sub-basin is not very steep ranging from 0.60 to 2 m/km (GOI, 2017).

Ground Water Quality

Ground water in the area is alkaline in nature with pH varying from 7.02 to 8.26. In general, quality of ground water is suitable for irrigation and domestic uses.

Electrical Conductivity (EC)

EC varies from 500 μs/cm at 25°C at Chatarpura, Bansur Block to 12000 μS/cm at 25°C at Sundana, Laxmangarh Block. Electrical conductivity in major part of the district is below 3000μs/cm at 25°C. EC value of 2000 to 3000 μS / cm at 25°C has been observed in parts of Neemrana, Behror, Tijara, Mandawar, Kishangarh Bas, Reni, Umrain and Kathumar blocks. Higher EC values varying from 3000 to 10000 μS/cm at 25°C have been reported from Ramgarh, Laxmangarh and Kathumar blocks and EC more than 10000 μS / cm at 25°C has been reported from localized pockets in Kathumar block (GOI, 2017). The TDS content is also found to be higher than the permissible limit of 500 mg/L in almost all the ULBs. In Behror and Kherli area, the TDS content in the drinking is even higher than 1000 mg/L, which is not good for health.

Fluoride

Fluoride concentration in ground water has been found to vary from 0.672 mg/l at Tapukara, Tijar block to 3.42 mg/l at Ramgarh. It is found to be within the permissible limit of 1.5 mg/l in major part of the district. However, Neemrana, Ramgarh and Kathumar blocks have excess fluoride. Fluoride contamination in ground water has also been reported from parts of Kotkasim, Mandawar, Behror, Bansur, Thanagazi, Rajgarh, Reni, Umrain, Laxmangarh and Kishangarh Bas blocks (GOI, 2017).

Nitrate

Nitrate concentration in ground water has been found to be within the maximum permissible limit of 45 mg/litre in major part of the district. However, higher values of nitrate in excess of 45 mg/l have been reported from parts of Umrain, Tijara, Thanagazi, Neemrana, Kishangarh Bas, Laxmangarh and Ramgarh blocks (GOI, 2017). A very high level of nitrate in these areas may be due to the large number of industries which discharged untreated waste into the environment. The nitrate content in the Bhiwadi city was found to be in the range of 30 to 80 mg/L which is not good for health and water is unsafe for drinking purpose. This is mainly due to the discharge of untreated water in the open nallah and open ground which causes contamination of the ground water.

Iron

Iron concentration in ground water has been observed within the permissible limit of 1 mg/litre in most parts of the district except isolated pockets in Umrain, Laxmangarh, Rajgarh and Reni blocks. Iron content varies from 0 in Neemrana and Kanhawas in Neemrana block and Holawas in Behror block to 1.395 mg/l at Govindgarh, Laxmangarh block (GOI, 2017).

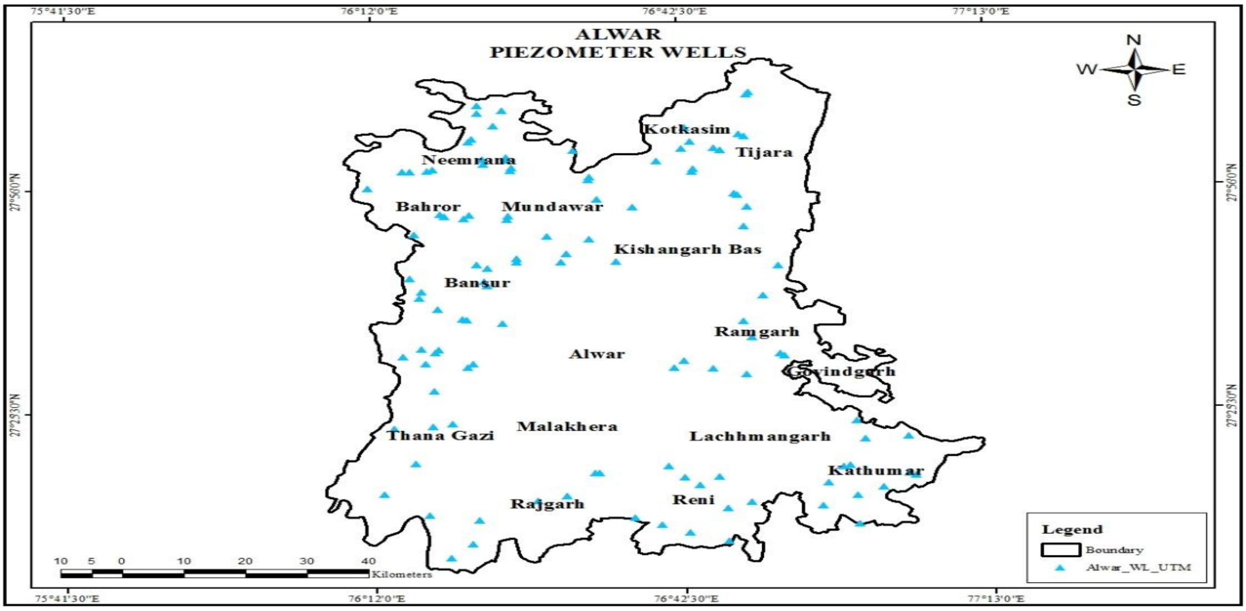


Figure 5.4 Location of Piezometer Wells in Alwar District

Groundwater Related Issues

Most of the blocks in the district fall under the ‘over exploited’ category indicating that the ground water is under stress and exploitation exceeding recharge. Two blocks viz., Behror and Rajgarh have been put in ‘notified’ category which implies a severely stressed ground water situation.

Table 5.7 Categorization on the basis of stage of development of ground water for blocks of Alwar

Categorization on the basis of stage of development of ground water	Block Name
Over Exploited	Neemrana, Bansur, Reni, Tijara, Kishangarh, Bas, Mandawar, Kotkasim, Umren, Ramgarh, Lachhmangarh, Kathumar, Thanagazi
Notified	Behror, Rajgarh

The following ground water related issues have been emerged for the Alwar district:

Decline in Water Level

Long term water level data (pre-monsoon, 2001-2012) have indicated declining water level trend ranging from 0.0183 to 2.55m/year. It has resulted due to the overdraft of ground water resources for various uses than its annual recharge. All the blocks are over exploited having stage of ground water development ranging from 102.04% (minimum in Thanagazi Block) to 293.81% (maximum in Behror Block). Deep water level has caused more consumption of power to draw ground water and deterioration in ground water quality.71% area has water level more than 20m in the district.

Depletion of Aquifer

Decline in water level has resulted in drying of alluvial aquifer particularly in parts of Behror and Umrain blocks where water level has entered into the underlying hard rock.

Ground Water Salinity

Ground water salinity with EC more than 3000µs/cm at 25°C has been found in south eastern part of district covering parts of Ramgarh, Laxmangarh & Kathumar blocks and EC more than 10000 µs/cm at 25°C has been reported from localized pockets in Kathumar block. The TDS content is also found to be higher than 500 mg/L in almost all the ULBs and even higher than 1000 mg/L in Behror and Kherli.

Ground Water Pollution

Industrial clusters have been developed at Bhiwadi, Alwar, Neemrana and Behror in Alwar district. Untreated disposal of effluents into the open nallah/open depression have caused the contamination of ground water and thereby unsuitable for human consumption. Pollution study carried out by CGWB at Bhiwadi industrial cluster, has clearly indicated the contamination of ground water with presence of high concentration of toxic substances viz. cadmium, lead and nickel more than the acceptable limit of Drinking Water Specification (2012) and rendering ground water unhealthy/unfit for drinking use. Bhiwadi industrial Cluster has been ranked 6th in the country and 1st in Rajasthan state with CEPI score 82.91 indicating critically polluted cluster (MOEF, J-11013/5/2010-IA.II(I), New Delhi dated 13.1.2010). Similar pollution studies are to under taken in other industrial clusters in the district to assess the ground water contamination

The following tables (table 5.8 to 5.12) provides the details regarding inventory of water resources in District, Control of Groundwater Water Quality, Availability of Water Quality Data, Control of Water Pollution in Rivers etc. The area of different lakes, ponds and river which are being used as a water resources in the district are detailed in the table.

Table 5.8 Datasheet for Water Quality Management for Alwar

S.No.	Details of Data Requirement	Units	Outcome for District	
A	**Inventory of water resources in District**			
1	Rivers	[Nos] and [Length in Km]	Sabi	60
			Ruparail	84
			Banganga	4
2	Length of Coastline	[in Km]	Sabi	60
			Ruparail	84
			Banganga	4
3	Nalas/Drains meeting Rivers	[Nos]	Landava Nala	25
			Dam	[Area in Hectares]
4	Lakes / Ponds	[Nos] and [Area in Hectares]	Jaisamand	4790
			Siliserh	845
			Mangalsar	958
			Mansarovar	843
			Rampur	1052
			Jaisagar	949
			Deoti	1410
			Dhamrad	637
			Laxmangarh	512
			Bhagarikhurd	316
			Jiroli	426
			Khanpur	920
			Harsora	1821
			Jaitpur	518
			Babriya	1852
			Silibari	836
			Bigota	410
			Tusari	718
			Nimbhari	459
			Sarankhurd	915
			Samarsarovar	359
			Atriya	-
5	Total Quantity of sewage and industrial discharge in District	[Automatic] (SW1a+IW1b)		

Water Supply and Quality for Alwar District

The responsibility of water supply in the whole district and maintenance of this quality is allocated to Public Health and Engineering Department (PHED), PHED distributes the water connection throughout 8 circles into categories: Domestic, Non-domestic, Industrial, and State/Center Govt. as detailed in the table 5.9. The total number of connections are depicted in the table given below

Table 5.9 City-wise, category- wise data of number of WS connections

City	Water supply connections				
	Domestic	Non Domestic	Industrial	State / Centre Govt.	Total
Alwar	41778	3819	125	338	46060
Behror	4057	94	0	28	4179
Bhiwadi maintened by phed	1677	0	0	0	1677
Bhiwadi maintened by UIT	-	-	-	-	3650
Khairthal	6066	17	0	33	6116
Kherli	2727	3	0	9	2739
Rajgarh	3797	290	15	57	4159
Tijara	2881	72	0	35	2988

PHED have responsibility for distribution of water in all 8 circles of Alwar district. Number of population which get served through PWS is depicted in the table 5.10. Out of the all circles only Behror gets 100% water supply by PHED. The remaining population is getting water supply from the public stand post.

Table 5.10 City-wise, data of population served by piped water supply

City	Present Population	Population served by PWS	Remarks (% Pop. Served by PWS)	
Alwar	386707	350000	90	
Behror	35438	35438	100.00	**Remaining population is getting water through public stand posts**
Bhiwadi maintened by phed	126954	76172	59.99	
Khairthal	45958	36766	80.00	
Kherli	21300	18000	84.51	
Rajgarh	32200	25438	79.00	
Tijara	29944	26350	87.99	
Total	**773414**	**700000**		

The water supply in all the cities of Alwar district is through ground water only and no surface water source is available for water supply in the district. The ground water extraction in Kilo Litre per Day (KLD) for all cities is given in the table 5.11.

Table 5.11 city-wise and source- wise data of water supply

City	Source	Production of water in KLD		Total Production in KLD
		Surface Source	Ground water	
Alwar	290	0	33800	33800
Behror	33	0	2745	2745
Bhiwadi maintened by phed	129	0	17139	17139
Khairthal	39	0	2400	2400
Kherli	6	0	700	700
Rajgarh	15	0	1540	1540
Tijara	32	0	4042	4042

Chemical quality testing data on four parameters (Total Coliform, Fluoride, TDS and, Nitrate) for the Alwar district is shown in table 5.12. Nitrate level for Bhiwadi region is exceeding the permissible limit of 45 as per BIS standards. TDS for the all regions exceeds the permissible limit. The data for sample test is shown in the table below. The nitrate content in Bhiwadi city is above the permissible limit and reached to an alarming state.

Table 5.12 City-wise/PHED circle water quality data

City	Bact. Quality (Total Coliform per 100 ml)	Chemical Quality ((Min - Max)						Remark
		Fluoride Min	Fluoride Max	TDS Min	TDS Max	Nitrate Min	Nitrate Max	
Alwar	Nil	0.4	0.8	450	860	20	40	
Behror	Nil	0.60	0.80	850	1270	22	35	
Bhiwadi	Nil	0.40	0.80	525	712	38	80	Unpotable
Khairthal	Nil	0.40	1.00	410	865	18	36	
Kherli	Nil	0.80	1.2	952	1625	20	32	
Rajgarh	Nil	0.40	0.80	592	816	18	28	
Tijara	Nil	0.40	0.80	466	848	15	38	

Inferences from Present Scenario

Water quality parameters include chemical, physical, and biological properties and can be tested or monitored based on the desired water parameters of concern. Parameters that may be tested include temperature, pH, turbidity, salinity, nitrates and phosphates. The Bureau of Indian Standards (BIS) has specified drinking water quality standards in India to provide safe drinking water to the people. According to the Central Ground Water Board, BIS (IS_10500 and revised module IS 10500:2012) has specifications in Uniform Drinking Water Quality Monitoring Protocol. This standard has two limits i.e. acceptable limits (Maximum Limit) and permissible limits in the absence of an alternate source. If any parameter exceeds the permissible limit, the water is considered unfit for human consumption. The standards of drinking water quality are mentioned in the table 5.13 given below.

Table 5.13 Drinking Water Quality Standards

S. No	Parameters	Permissible Limit	Maximum Limit	S. No	Parameters	Permissible Limit	Maximum Limit
1	pH	6.5 to 8.5	No relaxation	10	Arsenic (mg/l)	0.01	0.05
2	TDS (mg/l)	500	2000	11	Copper (mg/l)	0.05	1.5
3	Hardness (as $CaCO_3$) (mg/l)	200	600	12	Cadmium (mg/l)	0.003	No relaxation
4	Alkalinity (as $CaCO_3$) (mg/l)	200	600	13	Chromium (mg/l)	0.05	No relaxation
5	Nitrate (mg/l)	45	No relaxation	14	Lead (mg/l)	0.01	No relaxation
6	Sulfate (mg/l)	200	400	15	Iron (mg/l)	0.3	No relaxation
7	Fluoride (mg/l)	1	1.5	16	Zinc (mg/l)	5	15
8	Chloride (mg/l)	250	1000	17	Fecal Coliform (cfu)	0	0
9	Turbidity (NTU)	5	10	18	E. Coli (cfu)	0	0

Figure 5.5 Overhead Water Supply Tank in Rajgarh ULB (27°14'08.8"N 76°36'41.8"E)

The picture shows a traditional water conservation structure known as *Bawari*. With rapid urbanisation and water pollution are putting enormous pressure on the quantity and quality of surface and ground water. Water conservation is a key element of any strategy that aims to alleviate the water scarcity. With the construction of the canal that used to divert the rainwater into the human-made tanks, the major water issues of the population can be solved.

Figure 5.6 Baveri- Artificial Water Storages Structure (27°14'08.8"N 76°36'41.8"E)

The long-term data indicate that a declining trend has been observed in all the blocks except in Rajgarh. The declining trend has been resulted due to the overdraft of groundwater resources than its natural replenishment.

The pH of groundwater makes it alkaline with a range of 7.02 to 8.26, which is suitable for irrigation and domestic uses. Electrical Conductivity (EC) and fluoride concentration in groundwater have been found within the permissible limit. Nitrate concentration is found within the maximum permissible limit of 45 mg/L in the major part of the district, however in Bhiwadi city it exceeds the maximum permissible limit and therefore water is found to be not suitable for the drinking. TDS for the whole district is found to be higher than the permissible limit of 500 mg/L and therefore unsafe for the drinking purpose.

Industrial clusters have been developed at Bhiwadi, Neemrana, and Behror in the Alwar district. Untreated disposal of effluent into open space and in open depression has caused contamination of groundwater. At the Bhiwadi cluster pollution studies shows the presence of a high concentration of toxic substance viz. Cadmium, Lead and Nickle as well as nitrate content is also very high.

5.1.3 Action Plan

As per data provided by PHED many circles are having high amount of Fluoride, TDS, and Nitrate. At Bhiwadi area the water is unpotable due to industrial activity as well as due to the discharge of untreated industrial wastewater in the open area. The polluting chemicals in the water supplied to people often go unchecked. The constant supply of polluted water leads to several diseases among people over the period of time.

Small-scale systems for decentralized solutions for the improvement of water quality that cater to several families or a small community should be established where water quality is poor. Under a government initiative the rural areas which have population of about 1,000 residents, the state government will install an RO plant with a capacity of filtering 500 litres of water every hour. Membrane filtration systems with primarily reverse osmosis plants should be established for water and waste-water treatment, in water-scarce regions.

The water supply to the population in only dependent on the groundwater extraction without any recharge strategy for the depleting ground water. The data provided by the water resources department depicts that there is sources of surface water. The district has three seasonal river Sabi, Ruparail, Banganga there are also many lakes/ponds in the district, which have area that can hold large quantity of water. Lakes are usually situated in valleys that catch the runoff from the surrounding area. Location of these lakes/ponds needs to be identified needs to rejuvenate its traditional water management systems as per their suitability for drinking water supply or irrigation purpose.

The seasonal river of the Alwar district can also be used for water supply by making proper arrangement for the water collection and storage through dam. Anicuts and check dam can be created to hold some quantity of water in rainy season. By developing the catchment area of these river a drainage system could be established which will divert the water to a reservoir.

Institutional Reform

There is no close interaction between agricultural managers and water quality managers; it leads to non-availability of data base which is required to assess the agricultural impacts. If the Government-operated programmes are inefficient, the project can be outsourced with appropriate Q&A control, use of Public-Private Partnership, fee-for-service and income generation models can be selected.

Management Strategies

All the blocks are over exploited, thereby, leaving no/limited scope of further ground water development for various consumptions and area is devoid of sustained surface water bodies. In order to manage the ground water resources and to control further decline in water levels, a management plan has to be proposed. The management plan comprises two components- supply side management and demand side management. Since there is very little surface water available in this district, very little intervention in the form of supply side management could be proposed.

Supply Side Management

The supply side management of ground water resources can be done through the artificial recharge of surplus runoff available within river sub basins and micro watersheds. Also it is necessary to understand the unsaturated aquifer volume available for recharge. The unsaturated volume of aquifer for the Alwar district is computed based on following; the area feasible for recharge, unsaturated depth below 5 m bgl and the specific yield of the aquifer.

Artificial recharge to ground water through interventions of various structures. The following parameters are inevitable for planning of artificial recharge to ground water.

- Availability of sufficient storage space to accommodate recharged water
- Availability of surplus water to recharge
- Feasibility of sub-surface geological formations

In case of Alwar district, sufficient sub-surface storage space is available to accommodate the recharged water.

Out of total computed 128 no. of feasible recharge structures, only 72 are possible as per the availability of water bodies in the zones of Behror, Mandawar and Neemrana blocks. Remaining surplus water for recharge of 1.68mcm after intervention of 72 recharge structures, may be recharged through 9 no. of possible percolation tanks. The additional net ground water recharge is 2.68mcm. Summary of recharge structures and percolation tanks and their cost component is as below:

Table 5.14 Summary of recharge structures and percolation tanks

Information	Figure
Surplus available	3.83 MCM
Number of recharge shafts (in existing village ponds)	72
No. of percolation tanks	9
Net ground water recharge	2.68 MCM
Total cost of proposed interventions	Rs 7.81 crore

Demand Side Management

Though not much augmentation can be done through supply side management due to less availability of surplus water, applying the techniques of demand side management can save large amount of water. Demand side management has been proposed through two interventions – changing the more water intensive wheat crop to gram (chick pea) and use of sprinkler irrigation in the areas where rabi crop is being irrigated through ground water and

Change in cropping pattern

In view of the alarming decline of water level, drastic reduction in saturated thickness of aquifer and resulting of depletion of aquifer, there is need to bring paradigm change/shift in cropping pattern in the area. It is proposed to grow low water requirement crop like gram in the instead of wheat. Growing of gram will save the water to the tune of about 95.72mcm per annum @ 0.1m.

Adoption of modern practice of sprinkler irrigation/improved irrigation practices

Data indicate that flooding method of irrigation is still in practice in many parts of the district which causes wastage of ample quantity of water. In view of this, it is proposed to bring about 50% of total irrigated area under sprinkler irrigation which may save water to the tune of about 192.23mcm/annum @0.08m. Total cost of sprinkler sets has been computed as Rs. 1201 crore @50,000/hectare.

Table 5.6 Action Area Plan in Different ULBs and Timelines

S. No.	Action point	Deficiency in present status and, planning for future	Timeline	Stakeholders responsible
1	Ground water depletion	1) Drying of alluvial aquifer in part of Behror and Umarain 2) Water level is declining in 13 blocks of Alwar (in range from 0.018-2.55 m/year). But there is marginal rising in Rajgarh block (0.014 m/year) 3) Most of the district falls under 'over exploited' category except Behror and Rajgarh blocks Artificial recharge of ground is needed in this block. Rainwater harvesting should be encouraged in this are by constructing anicuts, bunds and check dams. Roof top rain water harvesting techniques should be promoted in this area. Rejuvenation of Bunds/talab should be done	Immediately in all blocks	All ULBs
2	Quality of ground water	1)Contamination issues in industrial clusters of Bhiwadi, Neemrana, and Tijara 2) Indication of contamination of ground water with presence of toxic substance in Bhiwadi. Bhiwadi with CEPI score 82.91(Critically polluted cluster) ranked 6 th in country 3) Salinity with EC more than 3000µ/cm has been found in south eastern part of district which is not fit for the drinking and agriculture purposes. 4) Fluoride is found within permissible limit of 1.5 mg/L in major part of district. Tijara and Ramgarh blocks exceeds the limit with 3.42 mg/L. 5) Iron concentration is in permissible limit of 1 mg/L for major block of district except, Behror and Laxmangarh block was found with 1.395 mg/L 6) TDS is found to be higher than the permissible limit of 500 mg/L in all the ULBs of Alwar district and even more than 1000 mg/L in Behror and Kherli area 7) Nitrate level was found to be higher than the permissible limit of 40 mg/L in Bhiwadi city Quality of ground water based on fluoride, nitrate and iron should be measured on regular basis. Saline ground water available in the district can be used for agriculture	Immediately in all blocks	ULBs- Bhiwadi, Tijara, Ramgarh, Neemrana, Behror

3	Required water quality for irrigation purpose	1) EC value of 2000 to 3000 μS /cm has been observed in parts of Neemrana, Behror, Tijara, Mandawar, Kishangarh Bas, Reni, Umrain and Kathumar blocks. Higher EC values varying from 3000 to 10000 μS/cm have been reported from Ramgarh, Laxmangarh and Kathumar blocks and EC more than 10000 μS / cm at 25°C has been reported from localized pockets in Kathumar block which is not good for irrigation High water requirement crops need to be discouraged. Knowledge of low water requirement crops should be given to farmers. Modern agricultural management techniques have to be adopted for effective and optimum utilization of the water resources.	Over the 5-7 years	ULBs of Neemrana, Behror, Tijara, , Kishangarh Bas, Kherli

5.1.4 Summary

Deteriorating water quality is matter of concern in all over the world in developing countries. Tap water is not considered as safe to drink without treating it. In developing countries fewer than 10% of people have access to wastewater collection and treatment. Degradation in the water quality in Asian countries is causing serious human health issues. Along with human health it is causing ill impact on aquaculture in surface water resources. The parameters on which the water quality in India is checked are very less. For better water quality monitoring number of these parameters should be increased. Water quality monitoring requires a trained worker; it is necessary to improve the system which manages the water quality management.

Taking into consideration the present scenario of ground water quality in Alwar district, it is observed that there is decrease in the ground water level over the years. Because of the water supply for the whole district is depend on the ground water extraction. Without any recharge practices for the ground water or any water supply source (lake, dam etc.) the water level is going to decrease continuously. The fresh water availability of Alwar district is through ground water sources. District has high concentration of nitrates and sulphates which is very harmful chemical constituents in the water. TDS value of all the blocks in the district exceeds the permissible limits.

By adopting some artificial measures ground water can be recharged. The seasonal river of the Alwar district can also be used for water supply by making proper arrangement for the water collection and storage through dam. Anicuts and check dam can be created to hold some quantity of water in rainy season. Small-scale systems for decentralized solutions for the improvement of water quality that cater to several families or a small community should be established where water quality is poor.

Membrane filtration systems with primarily reverse osmosis plants or adsorption units with suitable adsorbents like alumina or hydroxyapatite should be established for water and waste-water treatment, in water-scarce regions. Adoption of some modern techniques in agriculture will help in getting more yields. Modern agricultural management techniques have to be adopted for effective and optimum utilization of the water resources.

Table 5.7 Summary of Water Quality Management for all the ULBs of Alwar District

Name of District	**Present Status**	**Action Plan for future**
Alwar	1)Contamination issues in industrial clusters of Bhiwadi, Neemrana, and Tijara 2) Indication of contamination of ground water with presence of toxic substance in Bhiwadi. 3)Water level is decling in 13 blocks of Alwar (in range from 0.018-2.55 m/year). But there is marginal rising in Rajgarh block (0.014 m/year) 4) EC more than 10000 μS / cm at 25°C has been reported from localized block which is not good for irrigation	Survey and Identification of the area Artificial recharge of ground water by means of rainwater harvesting, anicuts and check dams. Water should be treated before providing to community for drinking purpose Modern water treatment techniques such as membrane filtration systems with primarily reverse osmosis plants and adsorption units with suitable adsorbents like alumina or hydroxyapatite should be established for water and waste-water treatment, in water-scarce regions Modern agriculture management techniques have to be adopted for effective and optimum utilization of water resources. Identify fresh water aquifers through borehole logging to avoid failure of tube wells in saline belt.

5.2 Rainwater Harvesting

Rainwater Harvesting is referred to as the collection of rain water in household tanks and tunkies, local surface storages like dams or tanks and anicuts and subsurface aquifers through roof-water harvesting constitute a fair source of water supply to fulfil our needs. Shekhawati region is known for having different water storage structures through centuries. The surface water harvesting structures as local tanks and ponds or an exclusive storage for water supply should not only be developed but also maintained properly in all district towns and villages (Singhai et al., 2019). The ground water structures should also be supported through additional recharge on sustainable basis. An integrated approach of water management is essential for sustainable water supply (G. Singh, 2012).

Figure 5.7 Slogan Writing for Water Conservation

Watershed Structures

Check dams/ Ponds and Anicuts Water harvesting structures should be maintained on priority by people’s participation, sharing with them locally generated resources in terms of water, fodder, vegetation, wood and land on rent or lease. Large scale watershed structures may be planned and implemented as per real site-specific design requirements. Integrated Watershed Management Programme (IWMP) is a modified programme oferstwhile Drought Prone Areas Programme (DPAP), Desert Development Programme (DDP) and Integrated Wastelands Development Programme (IWDP) of the Department of Land Resources. The main objectives of the IWMP are to restore the ecological balance by harnessing, conserving and developing degraded natural resources such as soil, vegetative cover and water. Different project has been completed through IWMP, area which was covered through implementation is given in the table below.

Table 5.15 Locations of Watersheds in Alwar

(Integrated Watershed Management Programme) IWMP No.	Location, (Alwar)	Area (ha)
IWMP-27	Neemrana	4755
IWMP-28	Jatpur (Ramgarh)	7902
IWMP-29	Kathumar	4891
IWMP-30	Jamdoli (Reni)	7264
IWMP-31	Umrain	5000
IWMP-32	Silapata	4400

Surface Water Structures

The water structures such as Anicuts, Tanks, and Dams are divided between Panchayat department and Irrigation department. Normally irrigation tanks of more them 50 mcft capacity are with Irrigation department. Panchayat department should get activated to manage planning, design, construction, and maintenance of their water structures by arranging money (budget) and manpower on priority. All structures need proper maintenance and management through people's active participation. Water User Associations (WUAs) who should be properly educated and equipped with the intervention of government and NGOs. There is a need of large-scale planning and implementation of small tanks & dams.

Ground Water Structures

These water structures are completely under the fold of private farmers except that of drinking water structures under PHED. Farmers are more anxious to drill new bore wells or replace open wells by bore wells at high cost, which is a dangerous/ negative economic trend and need to be curbed due to over exploitation and mining of ground water at great environmental risks. Over 121 pumping of ground water should be checked & controlled through education restriction in power supply and legislative regulation & control. Feasibility of deep bore well drillings should be checked.

Water Supply Structures

Water Supply Structures run by the Public Health Department (PHED) should also develop its own surface water tanks/ dams or renovate existing tanks at its own cost and maintain, protect and manage drinking water wells & bore wells/ tube wells and avoid depletion of water table and pollution. Pump houses need to be constructed on drinking water tube wells (mobile or permanent as per the health of the structure). PHED may monitor water levels and quality of all its wells, hand pumps, bore wells and anicuts.

5.3 Domestic Sewage Management Plan

5.3.1 Literature review

Domestic sewage consists of wastewater produced by households, businesses, and organisations in a given area. It transports wastewater from numerous establishments such as kitchens, toilets, and sinks. Domestic wastewater is mainly classified into three forms: (i) Black water – water grossly contaminated with human excreta e.g., toilet water, composting toilet leachate; (2) Grey water – water that comes from the kitchen, bath/shower and laundry. (3) Sewage – a combination of both black and grey water (A. K. Biswas & Tortajada, 2019).

Improper sewage management can have a variety of negative environmental consequences. The degradation of surface water occurs when untreated sewage is discharged into water bodies. Sewage may potentially contaminate groundwater as a result of poorly constructed infrastructure. Waterborne diseases such as cholera, typhoid, and polio are spread through contaminating surface and groundwater. (Yoder and Rankin, 1998).

Domestic wastewater is expected to be 22,900 million liters per day (MLD) in metropolitan areas, compared to 13,500 MLD for industrial wastewater in India. Domestic wastewater treatment capacity is just 5,900 MLD as compared to 8,000 MLD for industrial wastewater. The data shows that only 25% of domestic wastewater is treated per day and almost 75% is directly discharged into open land and water bodies. As a result, there is a significant treatment gap in domestic wastewater treatment. Based on the average wastewater generation recorded during CPCB's, per capita wastewater generation is roughly 121 litres per day. Wastewater generation is expected to reach around 132000 MLD by 2051, based on the estimated population.

The per capita water supply and sewage generation have a linear connection. According to Central Public Health and Environmental Engineering Organization (CPHEEO) estimates, wastewater accounts for 70-80 percent of total water provided for domestic consumption. The wastewater generation per capita in India's Class-I cities and Class-II towns, which account for 72 percent of the country's urban population, is projected to be around 98 lpcd.

According to a study by the Central Pollution Control Board, Rajasthan has established 16 STPs in selected towns with a total treatment capacity of 384.5 MLD. A total of 11 STPs with a capacity of 149.3 MLD have been built or are in the process of being built. In addition, further 36 STPs with a capacity of 322.12 MLD are intended to be built *(NIUA, 2019).*

Technologies for Domestic Sewage Waste Management

Sewage Collection Systems

Sewage collection systems which includes underground pipes, manholes, and maintenance structures used to convey wastewater to a sewage treatment facility, where it is treated through various physical and chemical processes to make it reusable. The wastewater collection system is one of the most valuable and largest infrastructure assets which can brought dramatic improvements to public health. Most sewers carry wastewater from households and commercial establishments of a city/town and are referred to as domestic sewage waste.

In Sewage treatment plant, unit operations and processes are grouped together to provide various levels of treatment such as preliminary, primary, secondary (biological treatment), and advanced (or tertiary) treatment. In preliminary treatment, large objects, rags, and grit are removed, whereas in the subsequent primary treatment units, a physical operation, usually sedimentation, is used to remove the floating and settable materials. In Secondary treatment methods, biological and chemical methods are used to remove most of the organic matter from wastewater. Most common secondary methods such as the Activated Sludge Process (ASP), Waste Stabilization Pond (WSP), Up Flow Anaerobic Sludge Blanket (UASB) Reactor, and other traditional sewage treatment technologies are routinely employed in sewerage systems to treat wastewater up to secondary levels in line with effluent regulations. Due to advantages such as minimal land needs, high effluent quality, and so on, JNNURM projects have allowed technologies such as Sequencing Batch Reactor (SBR) and Moving Bed Biofilm Reactor (MBBR)/ Fluidized Aerobic Bioreactor *(CPHEEO, 2012)* for their use in sewage treatment plant as an secondary treatment.

Sequencing Batch Reactor (SBR)

This ASP consist of five steps, which are carried out in sequence as follows: (1) fill, (2) aeration (reaction), (3) settling (sedimentation/clarification), (4) decanting, and (5) idle (for sludge settling). The sewage water is treated in a sequence of sequential and possibly simultaneous reactions in the same basin on a timed cycle. As a result, dual basins are used, with one tank settling and discharging the treated sewage in a cyclically repeated process while the other basin is at the aeration stage of the cycle. It is preferable to utilize fine bubble non-clog membrane diffused aeration with a high efficiency. In comparison to the well-known reaction kinetics of continuous flow steady state ASP for the sewage features, the bio-kinetic response rate in the non-steady state batch process needs to be explored for its larger rate or otherwise. The Sequencing Batch Reactor (SBR) process is depicted in a schematic diagram (CPHEEO, 2012).

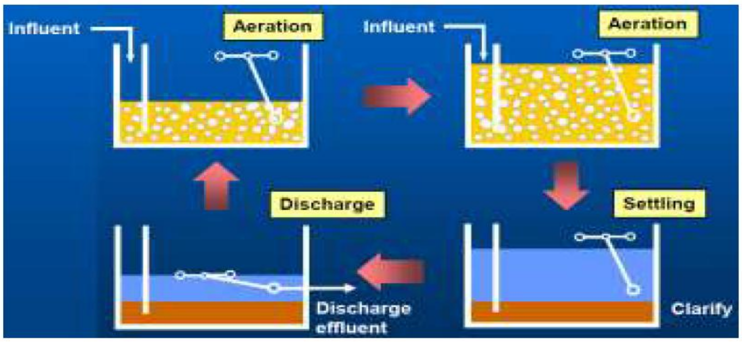


Figure 5.8 Sewage Treatment Technologies

Moving Bed Bio Reactor (MBBR) / Fluidized Aerobic Bioreactor (FAB)

The material suspended in the reactor provides extra surfaces for the microorganisms to thrive on, making this technology similar to activated sludge. This, in turn, maximizes the development of microorganisms in a given volume of aeration tank, making it appear to be advantageous in that regard to ordinary aeration without the media. Diffuse aeration is, of course, essential. The FAB technique is similar to MBBR, except that the media in the aeration tank is fixed and fluidized rather than suspended. The figure depicts a schematic flow diagram of the MBBR process (CPHEEO, 2012).

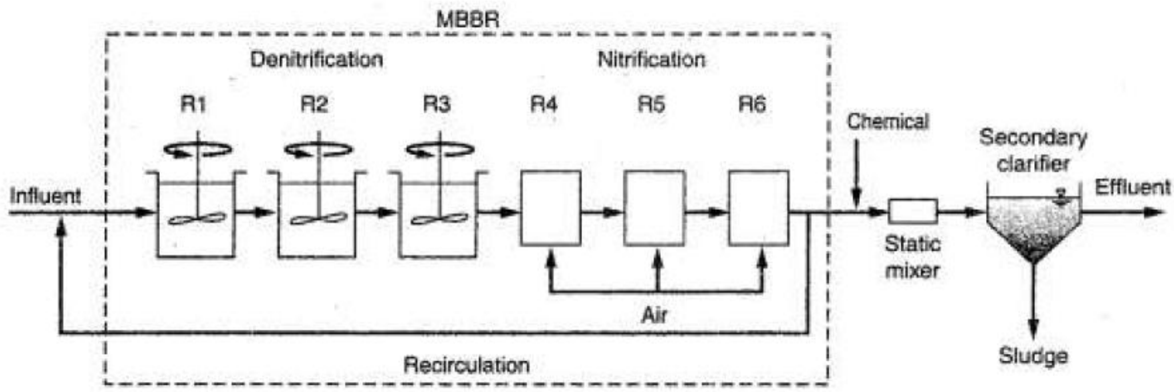


Figure 5.9 Schematic flow diagram of MBBR process (Source: urbanindia.nic.in)

Membrane Bio Reactor (MBR)

This system integrates the aeration and secondary clarifier in one tank by sucking out the aerated mixed liquor through membranes rather than settling in a separate downstream tank. It produces treated sewage with virtually no BOD and suspended solids, making it clear and nearly transparent, as well as its better ability to hold and sustain mixed liquor suspended solids (MLSS) makes it superior than other ASPs. Diffuse aeration is, of course, essential. Because the membrane is a proprietary issue, the throughput per membrane module offered by various manufacturers varies, as do the shapes of membranes promoted by each vendor, such as flat sheet, cross flow, dead end flow, and so on. Therefore,universally recognized standard design criteria are difficult to come by. Figure shows a schematic flow diagram of the Submerged Membrane Bioreactor process. (CPHEEO, 2012).

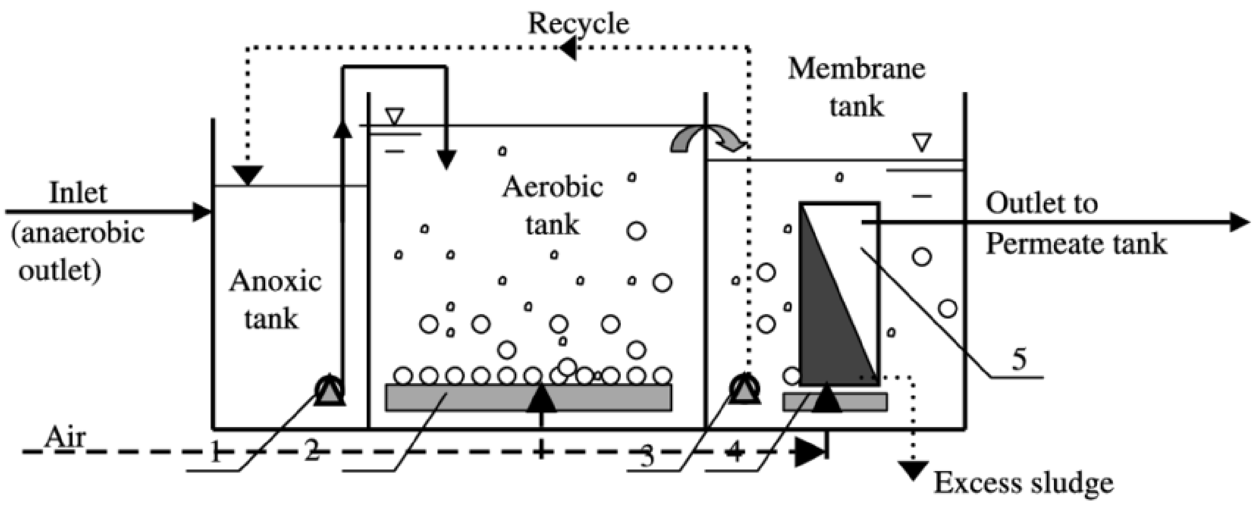


Figure 5.10 Schematic flow diagram of Submerged Membrane Bioreactor process ***(Source: urbanindia.nic.in)***

Approach towards Recent Technologies

When formulating the DPR for STPs, a techno-economic feasibility analysis of all conventional technologies such as the Activated Sludge Process, UASB, WSP, and other technologies such as SBR, MBBR, and others approved under JNNURM may be carried out, and the most appropriate technology suitable for the local conditions may be proposed in the DPR. During the techno-economic analysis, life cycle costs for all of these technologies can be evaluated, taking into account capital expenses, operating and maintenance costs for a certain period, land costs, and so on. Input quality, effluent quality standards, effluent quality for reuse, and resource recovery (gas/electricity generation) are all aspects to be considered for selecting the most suitable technology. The schedule of rates or the previously awarded cost of similar capacities of STPs (average cost of other STPs) based on these technologies in the relevant State can be used to develop a detailed cost estimate for the STP.

Constructed wetlands

Constructed wetlands have certain distinct advantages over other treatment systems, despite the fact that their principle is similar to those of other technologies. It is an organic wastewater treatment system that boosts the efficiency of procedures that filter water in the same way that naturally occurring wetlands do. Water, aquatic plants (such as reeds and duckweed), naturally occurring microorganisms, and a filter bed (typically made of sand, soils, and/or gravel) are all necessary components of the system. Constructed wetlands can handle secondary or tertiary wastewater treatment. There are a variety of design, technology, and material alternatives that can be used to tailor the created wetland according to the land availability and local conditions.

The main idea behind this method is that plants, microbes, and substrates all work together to purify water. Water is first slowed as it reaches the marsh to allow solids to settle. Meanwhile, plant roots and the substrate remove the bigger particles in the effluent. Pollutants and nutrients in wastewater are then naturally broken down and absorbed by bacteria and plants. The pathogens in wastewater are also killed by the wetland's retention time, UV radiation, and antibiotics secreted by plants. The water can then be released safely into surface waterways or utilised for a variety of reasons.

Wetland technology has a number of distinguishing characteristics: Construction, operation, and maintenance costs are low; wastewater from human waste, agricultural runoff, storm water, and some metals or pollutants from mining and industry are effectively treated; and a home for plants and animals is provided, contributing to environmental protection. These wetlands employs basic technology that is easy to comprehend and administer; operations consume little energy; treated water can be reused; aids in the maintenance of groundwater and surface water levels; and provides a way of water storage and pleasant natural aesthetics (Mustafa, 2013).

Fecal Sludge & Septage Management:

Fecal Sludge and Septage Management (FSSM) is important in the Indian context since roughly 60% of homes rely on on-site sanitation facilities. Because FS&S has a high polluting capability and can affect both humans and the environment, and thus careful management is required until its safe disposal/end-use. The cost of inadequate sanitation to the country is enormous, and thus making efficient management of fecal sludge and septage collected from onsite sanitation systems (OSS) such as septic tanks and leach pits are even more important. Recycling and repurposing can be used in agriculture as an oil conditioner and fertiliser.

Fecal Sludge & Septage Value Chain

The FS&S value chain starts with the user interface, which is toilets (individual, community, and public), emptying, transportation, treatment, and reuse/disposal. Domestic FS&S becomes a resource once it is properly managed. FS&S is a beneficial soil conditioner that contains nutrients that can help farmers lessen their dependency on artificial fertilizers. Figure 5.41 depicts the procedure for treating fecal sludge.

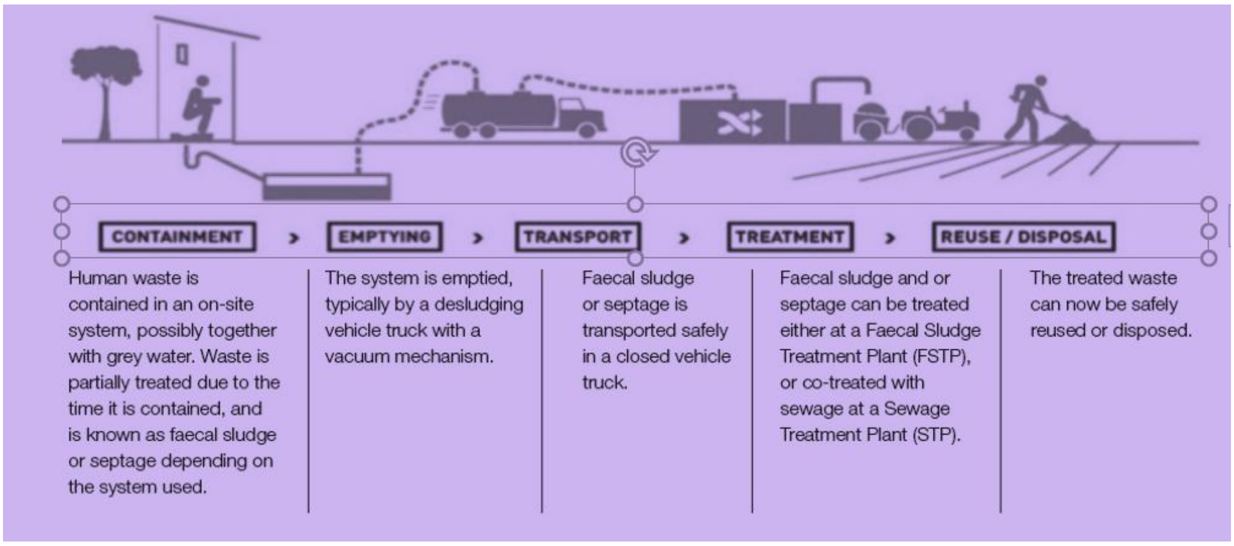


Figure 5.11 Process followed in fecal sludge treatment *(Source:cpeeho.gov.in)*

Financial Sustainability of Sewerage and Sewage Treatment Services

The bulk of India's metropolitan municipal administrations are financially stressed and unable to carry out their assigned obligations for a variety of reasons. Sewerage and sewage treatment, as well as sanitation, have gotten minimal attention. According to the study conducted by National Institute of Urban Affairs (NIUA), sanitation services either earn no money or produce a small amount of money. Because India's current sewage tariff levels are too low and do not reflect the true economic cost of providing sewage collection, treatment, and disposal services, and thus raising tariffs to a level that ensures the sewerage system generates enough revenue to cover capital and operating costs and becomes self-sustaining may not be possible in one fell swoop. This could be accomplished by progressively increasing tariffs over time.

It is recommended that tariffs be set early on to ensure that they cover at least the sewer system's O&M costs. After operational efficiency is established with the infusion of private sector participation, user approval of a tariff increase by ULBs will improve.

Rates can then be raised to cover capital as well as operating and maintenance expenditures. In the case of a PPP, the concession should be built to support a rising tariff scenario, with promises from ULBs to raise charges in the future and requirements from the private partner to increase service levels.

Governance and Management

The principles in the National Urban Sanitation Policy (NUSP) of 2008 should be adopted for designing wastewater management projects in urban areas, and the City Sanitation Plan (CSP). A variety of technologies, such as a traditional sewerage system, decentralised wastewater management systems, or on-site sanitation, could be used for management. The following principles are set by NUSP (2008)

- Elimination of Open Defecation
- Conversion of insanitary toilets to sanitary ones
- Retrofitting of on-site containment/treatment structures like septic tanks as per recommended specifications
- In areas where water supply is inadequate, provision for decentralized wastewater management system including treatment and non-conventional sewers (settled or simplified sewers/small bore sewers)

- Fecal sludge and septage management in areas dependent on on-site sanitation in the form of leach pits, twin pits, septic tanks with/without soak pits etc. – desludging of containment units, transportation, treatment and reuse/disposal

- Mechanization of cleaning of sewers and emptying of septic tanks, safety gear for sanitation workers

- Planning for conventional sewerage system in areas with a minimum of 135 lpcd water supply or where contemplated

- Plan for recycling and reuse of treated wastewater and sludge

- Provision of public toilets with appropriate containment/treatment systems

Urban Local body

The Rajasthan Government has formulated a detailed State Sewerage and Wastewater Policy (SSWWP) to address the problems of centralized sanitation. The important provisions of this policy are as follows:

- All ULBs will prepare city sanitation plans (CSP) in accordance with\the Central Public Health and Environmental Engineering Organization’s (CPHEEO) revised Manual on sewerage and sewage treatment as published in 2013.

- These plans have to be in accordance with the overall town plans so as to avoid mismatches in the development and to ensure the proper treatment and reuse of wastewater.

- Technologies such as Geographical Information Systems (GIS), Ground Penetrating Radar (GPR) and Total Station Surveyors (TSS) should be used to prepare detailed maps of the sewer network. These maps should be updated every ten years and linked to an MIS (Management Information Systems) for detailing the assets and their parameters.

Best Practices

This section describes case studies from specific regions/cities.

Surat city is located on the west coast of India, in the southern part of Gujarat state. Surat Municipal Corporation (SMC) has undertaken numerous initiatives to improve the city environment in various ways and the results are visible in the city's sewage treatment capabilities. It has expanded sewerage networks in the urban areas and upgraded existing STPs to provide for secondary treatment processes under JNNURM. Sewage gas generated in these STPs during the anaerobic process of sludge treatment is utilized as a fuel to run gas engines to produce electrical energy that replaces grid electricity required to run the sewerage system. The main focus of the approach followed by SMC is the actions taken for climate change mitigation resulting in the reduction of greenhouse gas (GHG) emissions and any additional benefits that may be associated with the action.

Planning and design of wastewater treatment facilities offers more possibilities for energy conservation. After sewage treatment, a particular amount of sludge is generated. It consists of residual organic matter and dead bacteria used in the treatment process. This can be used for agricultural purposes as manure after primary and secondary treatment. It can help in reduction of usage of chemical fertilizers. Initiative of good sewage treatment also helps in reduction of water pollution. Sewage generated from households, restaurants, and commercial buildings usually contain microorganisms such as bacteria, virus, fungus or parasites which may create water borne diseases. Treated sewage will help to reduce the chances of the above consequences. It will also help to increase the chances of better public health and reduction in mortality rate (Espíndola & Presents, 2020).

5.3.2 Present scenario and gaps identification

Data Provided by ULBs

Inventory of Sewage Management

As per the data provided in the table below the district has three Class II and Class III towns based on the Census classification of towns. Alwar being the most populous city also produces the highest amount of domestic sewage (5 MLD) in the district.

Table 5.16 Report on Inventory of domestic sewage

Details of Data Requirement	**Measurable Outcome**	**Alwar**	**Bhiwadi(Tehsil-Tijara)**
	Population	3,41,422	1,04,921
Inventory of Sewage Management			
Total Quantity of Sewage generated in District from Class II cities and above	[MLD]	5	4
No of Class-II towns and above	[Nos]		
No of Class-I towns and above	[Nos]		
No of Towns needing STPs	[Nos]	5	5
No of Towns STPs installed	[Nos]	5	4
Quantity of treated sewage flowing into Rivers (directly or indirectly)	[MLD]	0	0
Quantity of untreated or partially treated sewage (directly or indirectly)	[Automatic]		4
Quantity of sewage flowing into lakes	[MLD]		0
No of industrial townships	[Nos]		1
Adequacy of Sewerage network			
% sewage treated in STPs	[Automatic]	58	4
Total available Treatment Capacity	[MLD]	20 MLD	9.2
Additional treatment capacity required	[MLD]	Nil	
No of ULBs having partial underground sewerage network	[Nos]		
No of towns not having sewerage network	[Nos]	1	
% population covered under sewerage network	[Automatic]	64%	

Inferences from Present Scenario

Wastewater generation in the Alwar and Bhiwadi is about 5 MLD and 4 MLD, respectively as per the data received from Alwar and Bhiwadi ULBs. The wastewater quantities that are being generated currently from all the ULBs are not estimated. During the ULB visit, it was found that the domestic sewage management for the Nagar Palika (Tijara, Kishangarh Bas, Khairthal, Ramgarh, Laxmangarh, Rajgarh) are very poor and no drainage system for the domestic sewage is functioning.

As per the data, the 64% household have sewage network connection and the remaining population has no option but to discharge the household wastewater directly into the open area as evident from the Fig. 5.14. Looking at the present scenario, it is utmost important to establish a collection system to collect the sewage from the households. The entire population of the city should be covered under the domestic sewage network system. Out of the total sewage generated, only 58% and 4 % is treated at the STP of Alwar and Bhiwadi city respectively, and the remaining is disposed in an open area. For Alwar district the installed capacity of the STP is 20 MLD but only 58% of the sewage is being treated indicating the poor quality and improper maintenance of the STP. Which depicts that the STPs are not functioning properly. During the site visit at STP (Fig 5.13) it is found that the plant is not functioning. The filter screen of the plant was not functioning during the visit (Fig 5.13 E) and the plant was operated by un-skilled labors.

From the data and physical observations during the site visit it is concluded that there is no proper functioning of Domestic sewage management with connection, collection, and treatment phases.

Figure 5.12 Google Earth view of 20 MLD STP, Alwar ULB

Fig. A

Fig. B

Fig. C

Fig. D

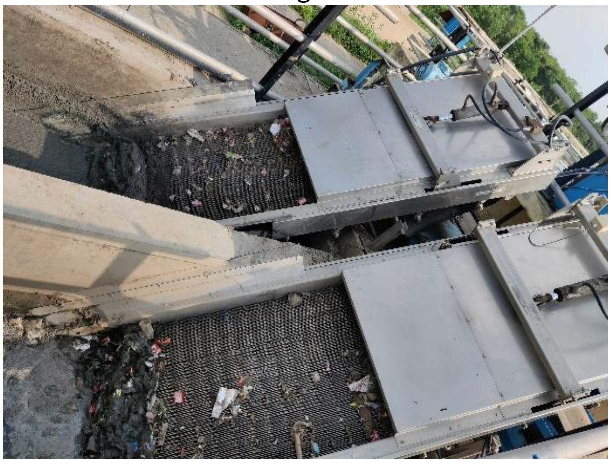


Fig. E

Fig. F

Fig. G **Fig. H**

Figure 5.13 20 MLD STP at Alwar ULB (27°30'46.3"N 76°44'47.1"E)

Fig.A Kishangarh Bas

Fig.B Ramgarh

Fig.C Ramgarh

Fig.D Ramgarh

Fig.E Ramgarh **Fig.F Laxmangarh**

Fig. G Laxmangarh **Fig.H Laxmangarh**

Fig.I Laxmangarh

Figure 5.14 Site Picture of Status of Domestic Sewage in ULBs

Figure 5.15 Google Map View Waste water in Market Laxmangarh ULB (Coordinates- 27°21'53.3"N 76°51'43.0"E)

Figure 5.16 Domestic Sewage dump site, Ramgarh ULB (Coordinates- 27°35'39.5"N 76°49'06.5"E)

5.3.3 Action Plan

To avoid the harmful effects of wastewater, it becomes important to treat the wastewater generated in a ULB. Although 100 % of the wards in a municipality may be connected to sewer network, the whole arrangement without a STP would be posing a serious risk to the general public and the environment. Sewage Treatment plants are used to treat sewage generated from residential, institutional, commercial and industrial establishments which includes household waste liquid from toilets, baths, showers, kitchens, sinks and so forth that is disposed of via sewers. In India, different treatment technologies like ASP, UASB, Oxidation Pond and advanced technologies like SBR, MBR are adopted for the treatment of sewage. On the basis of a country-wide study done in India, CPCB concluded that 816 number of STPs (including operational, non-operational, under construction and proposed) are available having treatment capacity of 23,277 MLD equipped with different technologies like ASP, OP, USAB, SBR etc. It was also find out that maximum STPs having ASP based treatment technology and nowadays SBR based technology widely used for the treatment of sewage (CPCB, 2015).

Treatment wetlands are also promising technologies with a number of advantages (e.g., low cost and maintenance), especially for ULBs with smaller population (IWA, 2017). Costs associated with the construction of the treatment system can be divided into direct costs (land acquisition, earthwork, pipes and fittings, pumps, filter media, liner, and plants) and indirect costs (site evaluation, permitting, and start-up services). Main O&M cost components include energy to run pumps (when necessary), compliance monitoring, maintenance of access roads and berms, and replacement or repair of mechanical components. If the wetland system can be loaded via gravity, no external energy is required and thus no pumping costs occur. Costs for vegetation management depend on items such as harvesting and pest control. Current design guidelines for VF wetlands foresee cutting of plants and removal of litter every two to three years. In general, less labor is required for O&M of treatment wetlands compared to other wastewater treatment plants. Thus, O&M costs of treatment wetlands are lower than those for other conventional wastewater treatment technologies

In Alwar district, the sewage treatment plants have been constructed in the ULBs where sewer network have been laid. From data available, it can be deduced that treatment plants are not being utilized for their full capacity as the sewer network has not reached all the wards in the municipality. For such ULBs, urgency should be demonstrated in laying the sewer network. It is also very important that all the ULBs should have their own STPs and necessary steps should be initiated to commission STPs at all ULBs on immediate basis.

The ULBs which are yet to construct their STPs can go for a combination of technologies e.g., one plant may be based on SBR, while a new one may be constructed based on treatment wetland technology. The ULBs having smaller population have the advantage of land availability and cheap labor (as the living cost is lower in these areas). Both factors vigorously support the treatment wetland technologies. As most of the ULBs still do not have connectivity to wastewater collection system, it becomes important to plan and lay down the complete sewage network system. Apart wastewater management, the development of strategies and treatment options to manage the fecal sludge should also be initiated.

The properties of FS that require attention during treatment are BOD, Ammonia, suspended solids and pathogens. The treatment of FS includes solid-liquid separation first and then treating the liquid and solid streams separately. Solid-liquid separation can be done by: (i) drying beds, (ii) settling tank, (iii) settling pond, (iv) Anaerobic digestion, (v) co-treatment with sewage sludge. For the solid fraction, various technologies available are: (i) co-composting with organic solid waste (ii) natural drying. For the liquid fraction, treatment can be carried out using: (i) co-treatment with wastewater (ii) waste stabilization ponds and (iii) constructed wetland.

Table 5.17 Actions and timelines for domestic waste management

S. No.	Action point	Deficiency in present status and, planning for future	Timeline	Stakeholders responsible
1	Inventory of Sewage collection network	1) 100% households are not connected to sewerage network in any of the ULB. 2) Survey and identification of all households to ensure proper drainage of sewage in all the ULBs.	1-year	All Nagar Parishad and Nagar Palaika
2	Provision of Sewerage Network	1) Sewerage networks are to be laid in all the ULBs and accordingly the capacity of the existing STPs should be enhanced and updated with the latest technologies. 2) To take advantage of the sewerage network, quality assurance for the sewerage pipes should be an ongoing activity and not be limited to at the time of construction only. 3) For all new Greenfield developments, sewerage network should be designed and installed before the construction starts.	5-years	All Nagar Parishad and Nagar Palaika

3	Adequacy of available Infrastructure for Sewage treatment	1. Presently STPs available are under-utilized in Alwar and Bhiwadi due to poor maintenance. 2. Only Alwar and Bhiwadi city have their own STPs and therefore it is utmost important to establish new STPs in the remaining ULBs 2. Efforts should be at priority to utilize the full capacity of these STPs. More areas have to be connected to sewer network and to STP in turn. 3. STPs should be operated by the skilled labor and regular inspection of the STPs should be made 4. A combination of technologies should be employed for treatment. The advantage may be in potential to treat domestic wastewater and other streams e.g. fecal sludge or leachate from the sanitary landfill.	3- years for utilizing the full capacity of STPS; 5-years for installing the treatment plants to the full capacity.	All Nagar Parishad and Nagar Palaika
4	Fecal sludge management	A program should be undertaken by the ULBs inspecting tanks for leakages A regular monitoring program for groundwater across the ULB and subsequent analysis will also help understanding the relation between fecal sludge and groundwater quality. Regular emptying of tanks by awareness campaign Use of information and communications technology (ICT) for GPS tracking of trucks and mobile applications (apps) to centrally coordinate service providers Selection of appropriate technology for fecal sludge treatment	Immediate	All Nagar Parishad and Nagar Palaika

5.3.4 Summary

As of now only partial of urban population is covered with sewerage system and the remaining is either serviced on onsite sanitation facilities or unserviced. Out of the total 12 ULBs, only 2 ULBs i.e. Alwar and Bhiwadi have their own STPs. Moreover, these STPs are not functioning at their full capacity due to poor maintenance and management by unskilled labor. Only 64% population of the Alwar city is connected through the sewage network system. In the present scenario it is necessary to do the survey and identification of all households to ensure proper drainage of sewage and connecting each and every household to the sewerage network. Efforts for full utilization of existing STP by updating the existing STPs with latest technologies, proper maintenance of the STPs, Skill development of the labor, and regular inspection of STPs should be made. It is also necessary to establish new STPs in all the ULBs which do not have their own STPs. The sewage connection, collection, and treatment should me managed and monitored

Table 5.18 Summary about Domestic Sewage Management Alwar District, highlighting present status and action plan for future

Name of District	Present Status	Action Plan for future
Alwar	The estimated quantity of domestic sewage generated in Nagar Parishad is 5 MLD (Alwar) and 4 MLD (Bhiwadi) % Sewage treated- 58% for Alwar and 4 % for Bhiwadi % population covered under sewerage network- 64% (Alwar)	Survey and identification of all households to ensure proper drainage of sewage and connecting each and every household to the sewerage network Efforts for full utilization of existing STP, proper maintenance of the STPs, Skill development of the labor, Inspection of STPs Establishment of new STPs in all the ULBs which do not have their own STPs Sewage connection, Collection, and treatment should be Managed and Monitored.

6. Air and Noise Pollution Management Plan

6.1 Air Quality Management

6.1.1 Literature Review

The level of pollution-free environmental air, assessed by a number of pollution indicators, is called air quality. It has an impact on our health, the livability of our communities, and the environment. Air pollution, especially that caused by human activity, can cause heart and lung difficulties, as well as cancer. The health of one can also be hazardous to short exposure to air pollution. Air pollution affects children, elderly people and anyone with heart or lung diseases in a very detrimental way. For example, a person consumes roughly 2-4 litres of water per day, whereas the total volume of air inhaled per day is approximately 15,000 gallons. Air quality monitoring offers information on the current state of the air. It aids in the evaluation of current policies as well as their effective implementation. Planning, designing, and establishing a monitoring network based on air quality objectives is an important component of any air quality monitoring programme *(Gulia et al., 2015).)*.

Air pollution has been a major cause of concern for India, a developing country trying to achieve a balance between development and environmental conservation. In this regard, India accept the foundations of sustainable development as the cornerstone for a nation's long-term economic prosperity and is working to solve the critical issue of air quality control (Kapoor, 2012).

According to Article 253 of the Constitution, the Air (Prevention and Control of Pollution) Act, 1981, the United Nations Conference on Human Environment held in Stockholm in June 1972, in which India participated, was adopted to implement the conclusions taken. Sustainable development is an inherent aspect of India's development ideology in terms of improving human well-being. In the last three decades, India has gone through an accelerated phase of industrial activities. The corresponding boom in urban development and industrialization led in a considerable increase in pollution, especially the atmosphere. In recent years, pollution levels in medium and small towns and cities have increased, quickly reflecting in India's non-attainment cities. In recent years, air pollution has become a big problem, mainly due to its adverse health consequences (Sundaray et al, 2020).

Air pollution management programmes have concentrated on point and area source emissions since the enactment of the Air Act in 1981, and many localities have benefited from these measures. Despite the high level of control given to numerous point sources, most cities in the country continue to have particle non-attainment concerns due to aerosols of unknown origin (or those not considered for pollution control) (M. Sharma, 2020).

India is dedicated to creating a pollution-free environment and clean air and water. India's environmental conservation and environmental protection requirements within the SDGs are reflected in the fact that for quite some time many administrative and regulatory measures, including a distinct air and water pollution statute, have existed (Sundaray et al, 2020).

All of the activities that a regulatory authority conducts to assist protect human health and the environment from the adverse impacts of air pollution are referred to as air quality management. As shown in Figure 6.1 Air Quality Management Cycle, the process of managing air quality can be depicted as a cycle of interconnected aspects (EPA, 2020a).

The Air Quality Management Plan (AQMP) is a methodical approach for evaluating air pollution control strategies proposed in order to lower air pollution levels in metropolitan areas. This method combines air quality modelling and mathematical programming approaches to create a decision-support system for determining the best combinations of air pollution reduction choices based on the characteristics and demands of the locations being studied (Gulia et al., 2015).

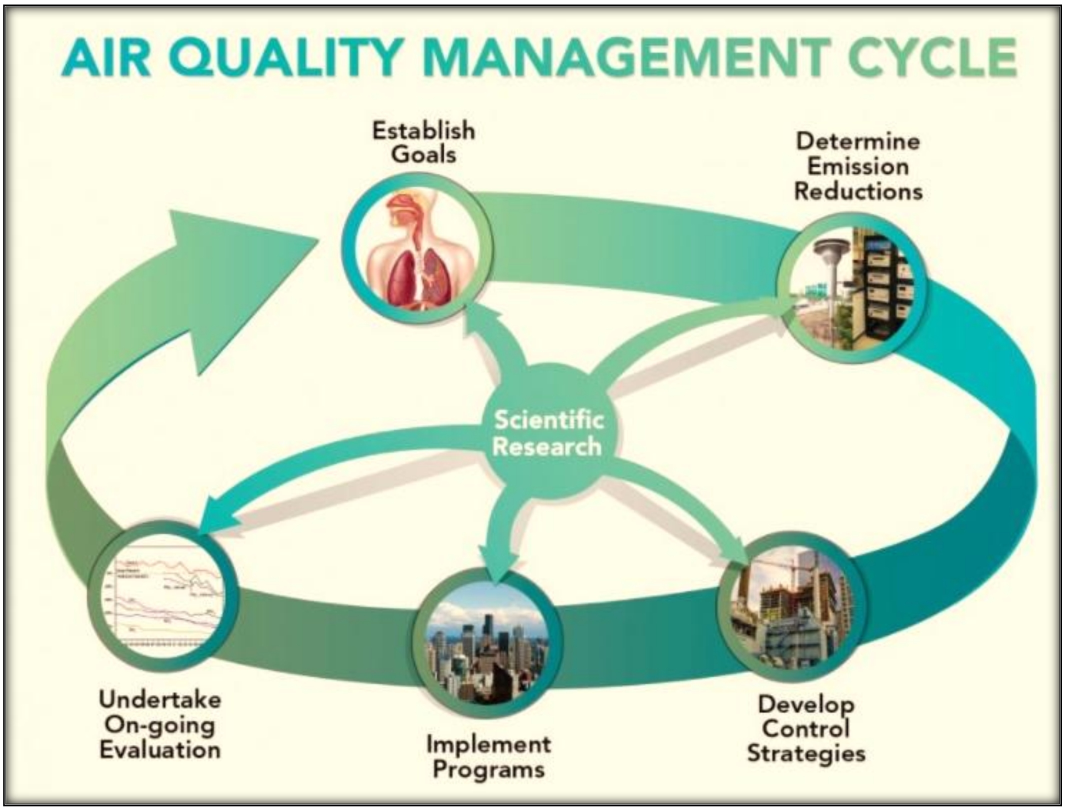


Figure 6.1 Air Quality Management Cycle

Modelling air quality is useful for the development and administration of air pollution control because it guides good planning for air quality. Its major goal is to predict ambient air pollutant concentrations of one or more species in place and time as a function of independent variables like emission and meteorological variables (Gulia et al., 2015)

In terms of Air Quality Measurements; approximately five air quality measurements have been prevailing in the district namely, PM_{10} (particulate matter of size under and equal to 10 µm diameter), $PM_{2.5}$ (particulate matter of size less than and equal to 2.5 µm diameter), SO_2, NO_2, VOCs (volatile organic compounds) etc. The vehicle emission contribution is significant for CO, NOx, PM_{10}Band $PM_{2.5}$. There is a relatively large contribution of diesel vehicles (trucks, buses, cars, etc.) to PM_{10}, CO, SO_2, $PM_{2.5}$ and NOx. Out of about 7 t/d emission of PM_{10} and $PM_{2.5}$ from vehicles, over 80% is from diesel vehicles, especially from trucks and buses. Therefore, control measures have to focus on advanced technological intervention for diesel vehicles or change in fuel to CNG (compressed natural gas) especially local transport of buses and light commercial vehicles (M. Sharma, 2020).

Air Quality Index

An AQI is described as an aggregate system that turns into a number or set of weights the separate factors associated with air pollution (SO_2, CO, visibility, etc.) (CPCB, 2014).

AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m^3)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.6 –1.0
Moderate (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10.1-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17.1-34	801-1600	1201-1800	3.1-3.5
Severe (401-500)	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

**One hourly monitoring (for mathematical calculation only)*

Figure 6.2 Breakpoints for AQI Scale 0-500 (units: µg/m^3 unless mentioned otherwise)

Rajasthan is located in the country's arid and semi-arid agro-climatic zone; therefore, dust is frequent due to dry climatic conditions combined with strong hot air movement. When the phenomena of thermal inversion occur in the summer and winter, the presence of Particulate Matter in the atmosphere is particularly high. At all CAAQMS locations, the yearly average from January to December 2019 shows that both particle pollutants, $PM_{2.5}$ and PM_{10}, are typically over acceptable levels.

Governance and Management

Following the 1972 Stockholm Conference on the Human Environment, Indian politicians grew interested in ways to manage air pollution and realised that environmental legislation was needed in order to reduce air pollution. The Air (Prevention and Control of Pollution) Act of 1981 was enacted as a result, with the purpose of preventing, controlling, and abating air pollution. It is a comprehensive law that authorises SPCBs to identify pollution management areas, to limit certain industrial plants to minimise their air pollutant emissions, and to enter, inspect, and monitor these areas. It is also a complete legislation. In addition, the CPCB provides technical help and guidance to the SPCBs, as well as conducting and sponsoring air pollution investigations and research.

The CPCB issued the first ambient air quality regulations for 3 criterion pollutants (SO_2, SPM, and NO_2) separately for industrial, residential, and sensitive regions in 1982. In 1994, the NAAQS were updated to include 3 more contaminants for everyday and yearly averages (except CO which is 8-hour average). In 2009, the most recent NAAQS were amended for a total of 12 contaminants (Gulia et al., 2018).

Monitoring ambient air quality is a major part of Urban Local Air Quality Management since it monitors current air quality and reviews existing policies. By comparing pollutant concentrations to criteria, air quality monitoring is used to recognize and proclaim NAAs. CPCB has already created a methodology for ambient air quality monitoring, which includes real-time continuous monitoring (Brauer et al., 2019).

Central Government

Under the National Air Monitoring Programmes, in 28 states and 7 Union territories India has 793 stations (NAMP). There are 261 continuous Ambient Air Quality Monitoring Stations connected to the web-based system giving Real-Time Ambient Air Quality information in 134 cities across 23 states and union territories.

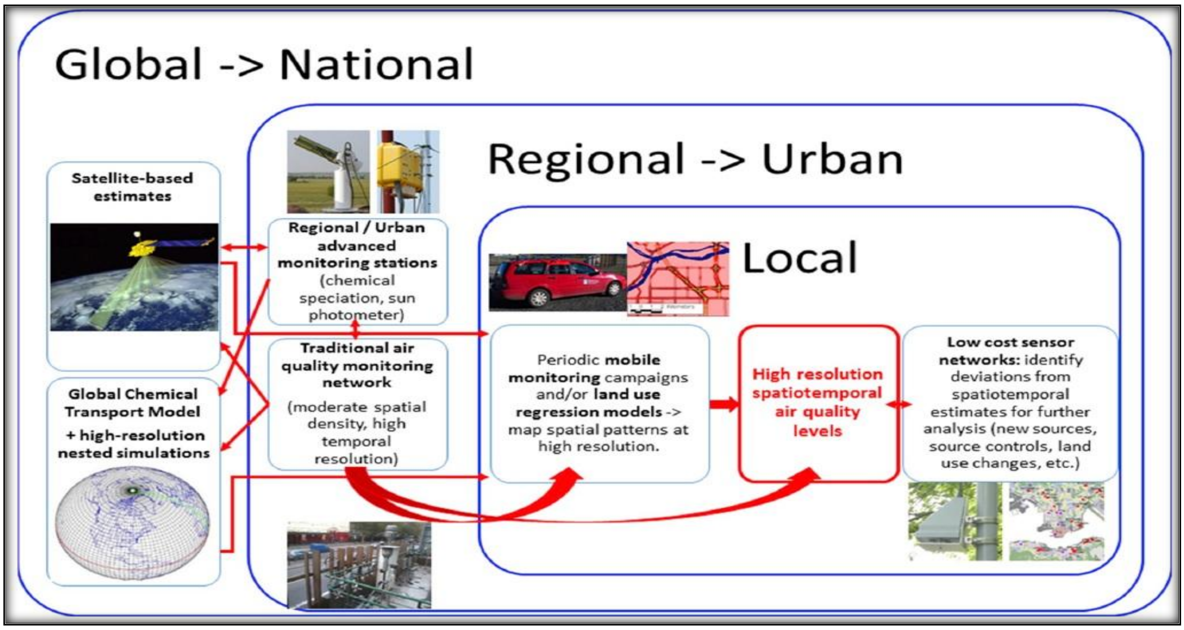


Figure 6.3 Schematic of an integrated global to local framework for air quality monitoring.

City-specific action programmes have been designed and implemented in 122 non-attainment cities recognised by the CPCB based on air Quality levels above national environmental standards (NAAQS) from 2014 to 2018. Controlling automobile emissions, road dust, biomass/crop/MSW burning, building activity, industrial pollution, and other city-specific sources are all part of city action plans (MoEFCC, 2020).

The CPCB estimates 4 monitors per 100,000 inhabitants (for urban areas), which is comparable to monitor density in the United States and several other high-income nations with similar population density. In accordance with the CPCB recommendations, the high estimate of CPCB contains increased monitor density in key cities; to achieve this high estimate, India would need to be the most densely monitored country in the world (Brauer et al., 2019).

Rules and regulation for air quality management has been defined under different laws which are specified in the Table 6.1.

Table 6.1 Other Applicable rules and regulations for the district

Law	**Description**	**Requirement**
Environment (Protection) Act, 1986 and CPCB Environmental Standards.	Emissions and releases from facilities to be established or renovated or expanded conform to the norms notified	
Rajasthan State Environment Policy, 2010 including And Rajasthan Environment Mission and Climate Change Agenda for Rajasthan (2010-14)	The main targets and policies are - conservation and enhancement of natural resources; ensuring environmental sustainability of major economic sectors; and improved environmental governance and capacity building - It offers specific policies and activities to tackle critical environmental problems: water resources, desertification and land degradation, forest and biodiversity, air quality, climate change: adoption and mitigation, mining, industry, tourism, energy, urban development, etc. - Establishment of the Environment Mission in six critical areas, chaired by the Chief Minister and Chairman of the Steering Committee, Rajasthan Government Task Force.	Project implementation should adhere to the policy aims of: Environmental conservation and improvement, integration of environmental issues into project plans and capacity building in environmental management management - under water sector, major concerns, as the policy notes, are: huge water losses & wastage, declining water availability, pollution reuse and recycling.

State Government

In India, 28 states and seven union territories are responsible for SPCBs (state pollution control boards) and pollution control committees (PCCs). The State Pollution Control Board is responsible for the following: Advise the State Government on pollution and industrial location problems; Plan programmes for pollution control; information gathering and dissemination; inspection; effluent and emission regulations standards; to grant industry approval and other compliance actions to stipulated emission and effluent standards; Issuing consent for companies and other activities to meet the emission and effluent requirements prescribed.

State Pollution Control Boards' other functions i. To create and secure a comprehensive air pollution prevention, control or reduction programme; ii. advise the State Government in all matters relating to air pollution prevention, control or reduction; iii. Work with the CPCB in organising training for persons, participate in or participate in a programme on air pollution prevention or reduction, and establish mass education programmes; iv. To check any inspection equipment, industrial plant or production process at any reasonable time and to provide, by request of any person, such instruction as may be necessary for taking measures to avoid, control or reduce pollution in the air; v. To check air pollution control regions at intervals as it considers essential, assess air quality and take action to avoid or mitigate air pollution in such places.; vi. Identify the air emissions criteria from industrial facilities and motor vehicles into the atmosphere or discharge from any other sources, not a ship or aircraft, in cooperation with CPCB and taking into consideration the standards for the air quality set by CPCB.; vii. Advise the State Government from time to time of the fitness of any premises, entrusted by the CPCB or the State Government to perform such other things and act as it considers necessary to execute its funtions properly, and in general to fulfil the purposes of the Act (MoEF&CC, 2016)

The state government, in cooperation with SPCBs, can designate specific locations as "air pollution control areas." State governments, in consultation with SPCBs, may impose conditions on such areas, such as prohibiting the the use, or burning, of any fuel or equipment other than those approved (other than fuel) such as garbage and other waste products, which may cause or is likely to cause air pollution, by publishing a notice in the official gazette. Under section 21 of the Air Code a person is further required to obtain prior authorization from an SPCB for the creation or operation, in the air pollution control areas, of industrial plants. Similarly, Section 22 prohibits a person to discharge or cause, or permit the discharging in excess of SPCB requirements, of the emissions of atmospheric pollutants at any industrial facility in any air pollution control area (Kapoor, 2012).

Urban Local body

The RSPCB has established thirteen regional offices in different parts of the state to keep in check the application of various allocation including The Air (Prevention and Control of Pollution) Act, 1981 and its rules.

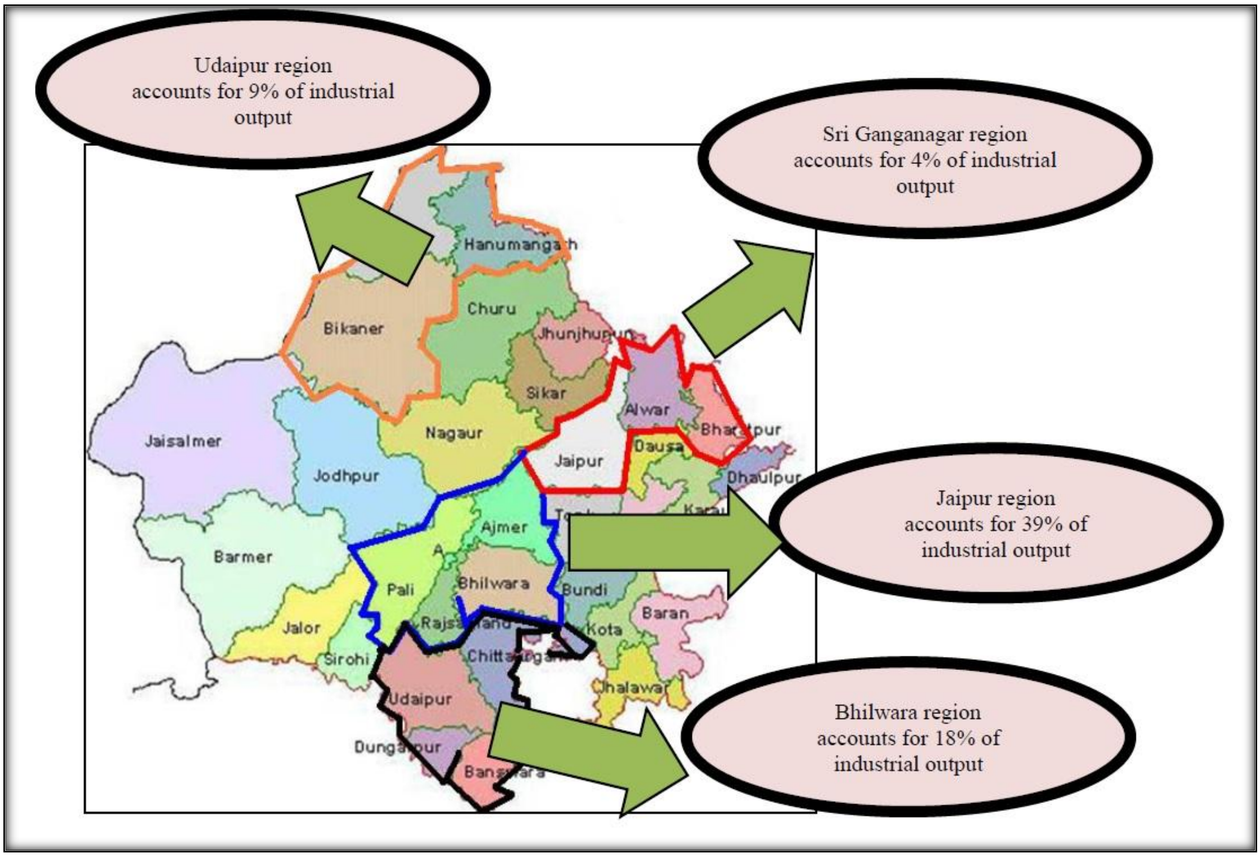


Figure 6.4 Rajasthan's major industrial zones with industrial output

Best Practices for Air Quality Management

The planning for air quality management is generally based on data from a number of evaluations merged in an air quality management system (AQMS). The AQMS depends on the technical and analytical tasks that follow: i. Create a pollutant activity and emissions inventory. ii. Air pollution monitoring and parameters of dispersion. iii. Air pollution levels calculated using dispersion models. iv. Expo and damage assessment. v. Estimating the impact of the measures of reduction and control. vi. Setting and enhancing legislation and policies on air pollution. These activities, and the institutions necessary to carry them out, constitute the prerequisites for establishing a functioning AQMS.

An air quality standard AQMP discusses how air quality has changed in recent years and what may be done to ensure clean air in a certain area. The development and deployment of an AQMP is a dynamic process with six parts as Figure 6.5 shows: i. Goal setting. ii. Baseline air quality assessment. iii. Air quality management system (AQMS). iv. Strategies for intervention. v. Action Plans Implementation. vi. Evaluation and follow up (Sivertsen & Bartonova, 2012).

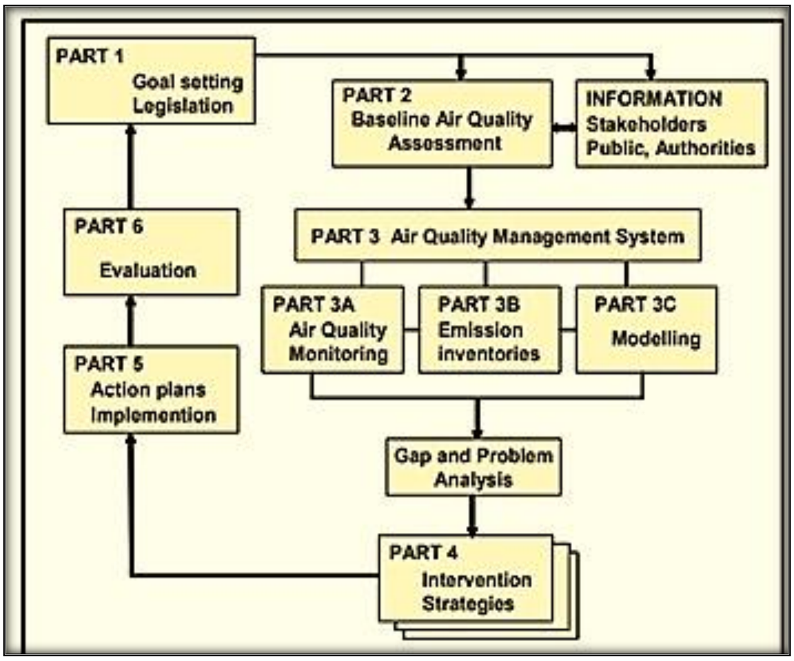


Figure 6.5 AQMP 6 step procedure

Multi-pollutant management initiatives can save money and time, as well as provide considerable economic, environmental and health advantages, all while lowering the costs and burdens associated with air pollution sources.

Many environmental pollutants (e.g., industrial installations) generate a variety of environmental and health pollutants that react or cause more harmful pollutants in the environment. Multiple pollutants can be reduced using some management strategies. Developing integrated control techniques that handle several contaminants rather than separate measures for each pollutant can be more efficient.

When establishing an air pollution control plan, air quality managers might take into account a variety of policy objectives. Climate change mitigate and adaptation are all policy objectives that can be addressed in such a programme: reducing ozone, particle matter and dangerous air (hazardous air pollutant (HPA) like mercury levels; and preparing transport and energy requirements.

EPISODIC URBAN AREA QUALITY MANAGEMENT PLAN

The e-UAQMP (Figure 6.6) addresses the repercussions of 'extreme' pollutant concentrations, which occur mostly at urban 'hotspots,' such as traffic conjunction, crossroads, and signalized roadways, and are influenced by the complexities of traffic-generated 'wake' effects. The e-UAQMP (based on a probabilistic method) also serves as an effective preventive tool for predicting the "likelihood of exceedances" in order to plan a successful policy response for the protection of the urban environment, as well as conveying information to its sensitive "receptors" (Gokhale & Khare, 2007)*)*.

The integrated air shed structure could help address current information gaps and provide a basis for more efficient routine network expansion over time as an economical approach to provide more detailed information on air quality on a national to local level so as to link local data with global satellite estimates and a global network (Brauer et al., 2019)

In order to limit pollutant activities from each source, India has been using a command and control (CAC) method, seting standardised technology, procedures and emissions regulations. The government aims to reduce pollution, while this method is effective at keeping pollution controlled by applying standards and controlling emissions; It yet gives the polluter no incentive to stop polluting. A number of empirical investigations have shown that CAC is an inadequate strategy as it does not fully take into consideration societal costs i.e., In general, they do not produce optimal pollution-decrease results that equate the marginal social benefit of the decline with their marginal social costs.

A number of economic techniques were developed to internalise external costs of pollution, make the polluter pay, And to lower costs of a particular degree of reduction in terms of production and reduction costs under certain conditions.

Economic instruments such as tradable permits, emission and effluent charges, competitive performance subsidies, and economic instruments that create income in combination with taxes, and give incentives for environmental changes, are all instances of environmentally friendly sustainable insights. India is looking forward to formulating the best combination of these instruments to punish polluters while also incentivizing pollution reduction *(*Kapoor*, 2012*).

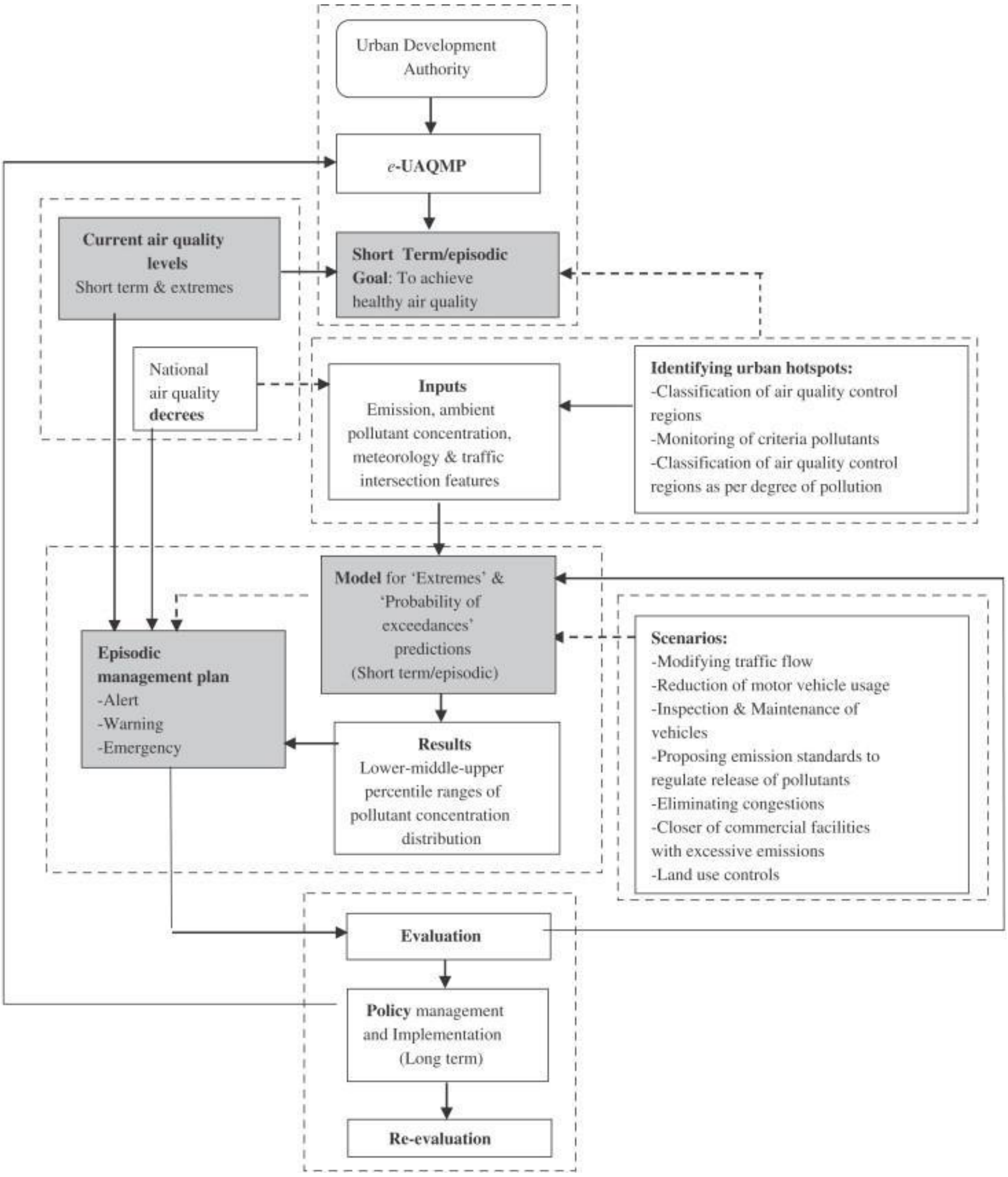


Figure 6.6 Episodic Urban Area Quality Management Plan (Gokhale & Khare, 2007)

NATIONAL AIR QUALITY MONITORING PROGRAMME (N.A.M.P.)

A national programme known as the National Air Quality Monitoring Program is implemented by the Central Pollution Control Board (NAMP). The system comprises of 804 operational stations across 28 states and 6 Union Territories of the nation, encompassing 344 cities/cities. Four air pollutants Sulphur Dioxide (SO_2), Oxides of Nitrogen as NO_2, Respirable Suspended Particulate Matter (RSPM /PM_{10}) and Fine Particulate Matter ($PM_{2.5}$) have been recognized for regular monitoring at each place under N.A.M.P (CPCB, 2019b).

National Clean Air Programme

In 2019, the Center started the National Clean Air Programme in 122 cities. The towns are referred to be non-attainment cities since, over the period 2011-2015 under the National Air Quality Monitoring Programme, they failed to comply with national environmental quality requirements (MoEF&CC, 2019).

Table 6.2 7 Non-attainment Cities of Rajasthan State

City	Major Sources of Pollution	Pollutants of Concern
Alwar	Vehicles, Industries, Natural dust	PM_{10}
Jaipur	Vehicles, Industries	PM_{10}
Jodhpur	Vehicles, Industries, Natural dust	PM_{10}
Kota	Vehicles, Industries, Natural dust	PM_{10}
Udaipur	Vehicles, Industries, Natural dust	PM_{10}

Strategies for Control of Air Pollution in Urban centers via City Planning and Management

Other than emission control, pollution can be reduced to some extent by urban design, topography, and meteorological conditions. City planners can efficiently scheme the spatial distribution of pollution point sources, such as factories, landfills, treatment plants, transportation path, and open spaces, that have an impact on the quality of air in an urban area. Long-term regional and metropolitan strategies should be combined with small-scale, short-term site and design initiatives. The shape, density, and organisation of settlement areas, as well as the direction and composition of subareas, the design and kind of transportation systems, and the shape and placement of open spaces, all have a significant impact on air pollution. Although several forms of urban development might be selected, designs which could increase the efficiency of air pollution distribution and reduce drive travel have to be given priority. In order to reduce journey lengths, automobile traffic, and urban sprawl, a balanced sub-regional approach for regional and metropolitan development with integration of mass transportation has been found to be beneficial. Reduced population density around industrial zones or in the downwind direction can assist reduce exposure to pollutants emitted by industries through land use planning. In order to improve the spatial arrangements of industrial, commercial, and residential regions, detailed studies of local meteorology and topography are required. Open areas that operate as buffer zones are equally vital, although they are frequently absorbed for other land use purposes during the development plan's lifetime, necessitating robust legislation and enforcement to ensure their preservation. Solid waste management site planning and placement must also be done with care and foresight. Prior environmental approval is required for large projects, which provides procedures for reducing key negative environmental impacts.

State/UT Town and Country Planning Acts should be updated in accordance with the Urban and Regional Development Plans Formulation and Implementation (URDPFI) principles, which were released in 2014. A few urban design interventions can also be achieved through making changes to development regulations and construction bylaws. Master plans/development plans, such as city development plans, city mobility plans, and other special plans, should place a high emphasis on integrating land use and transportation planning, as well as some of the themes indicated above. The use of relevant tools and approaches, such as simulation tools (which are also included in the URDPFI standards), can substantially aid in the selection of superior alternatives (plan proposals).

Supply to rural and urban slum regions of cleaner fuels and furnace supplies: LPG or PNG access must be expanded, as well as packaging reduction and safe refill choices when appropriate. Several government programmes aimed at increasing LPG/PNG access have been successful in increasing the usage of clean fuel in urban areas across India. During the period 2000–12, the proportion of urban homes using LPG climbed from 44.2 percent to 68.4 percent. Improved biomass-based cook stoves that are more fuel-efficient can bring exposure levels closer to cleaner fuels. Despite the government's goal of delivering LPG to everyone, it is clear that due to economic, supply, and transport difficulties, many million families will continue to rely on traditional biomass for cooking. Furnace enhanced with efficiency ranging between 30 and 40%, compared to 8 and 10% for typical cook stoves, are needed to make more efficient use of biomass as a cooking fuel. The usage of better cook stoves, as opposed to older ones, has resulted in lower indoor pollution concentrations. The necessity for research into the creation of efficient fuel processing with a higher calorific content and less smoke is also critical. (Fullerton et al., 2008).

Rural and urban slums have solar lighting options: In India, 7% of urban homes still use kerosene for lighting (Census 2011). Solar lamps, which may be utilised even after grid-based electricity is given, could help them until they can connect to electricity (IEP 2008). For selling and after-sales service, sufficient institutional processes and delivery networks are required. Solar lamps should be pushed to kerosene-using Urban and rural slums families without electrification, while the kerosene subsidy should be phased out.

Increased adoption of modest household-level solutions such as better ventilation and the use of cleaner conventional fuels would require awareness-raising programmes.

Controlling trash burning, maintaining the quality and cleanliness of roads, dust control at building sites, travel demand management (TDM), fuel quality and vehicle emission requirements, and so on are some of the other strategies (Seth Block, 2018).

Monitoring and modelling scientific studies

Monitoring requirements: India does not have a sufficient air quality monitoring network., since the CPCB's National Ambient Air Quality Monitoring Programs cover about 600 monitoring stations across the country. The Bureau of Indian Standards (BIS) has recommended the requirements for a city's minimum number of stations. This will necessitate the installation of 3,300 monitoring stations in 605 Indian cities with populations of more than 50,000 people. The monitoring network must be gradually upgraded, not only in terms of quantity of stations but also in terms of monitoring quality. Air quality monitoring is currently limited to cities, but it should be expanded to rural and regional levels. This is especially important for pollutants like ozone, which tend to be higher in areas outside of cities. The existing network monitors PM_{10}, SO_2 and NOx regularly in all stations, although it does not cover all the contaminants referred to in the National Standards for Environmental Air Quality. Corporate financing might be obtained through CSR efforts in order to expand monitoring networks and improve monitoring capabilities.

Emissions, simulation, and forecasting: In addition to pollution monitoring, modelling capabilities are needed to understand existing and future air quality. There is currently no national or regional database of emissions. These inventories must be created and kept up to date. TERI has developed national energy and emission model-based inventories for India for years to come (Sharma and Kumar 2016). These inventories can be perfectly targeted to produce a national emission database particular to India. While there have been a lot of studies on air quality simulation at the urban scale in India, there have been few studies on air quality simulation at the regional/national scale. TERI has used state-of-the-art models to estimate $PM_{2.5}$ and ozone concentrations at the national level in India, and the results reveal an increase in pollutant concentrations that could occur in the future if things continue as they are. It also depicts the areas with the highest amounts of pollution as well as the causes that contribute to this. As a result, regional action plans for air quality control may be established.

The AQMP shall be developed by MoEFCC and CPCB through identified research institutions for the purpose of carrying out source distribution studies together with the AQMP. AQMPs should be developed at city level by SPCBs. SPCBs must be institutionally strengthened in order to enable the successful and effective implementation of the AQMP's strategies. This will necessitate increased funding allocations, scientific professional recruiting, and training in air quality monitoring and modelling techniques. Regular board training might be arranged through institutional collaborations (Seth Block, 2018).

Inferences for Best Practices

In the deterioration of air quality in numerous Indian cities, there are common driving causes, but in different proportions. On the basis of priorities and the conclusions of source apportionment studies, every city should implement the techniques presented in this short. Figure 6.7 shows a step-by-step approach to determining air quality management in cities (Seth Block, 2018).

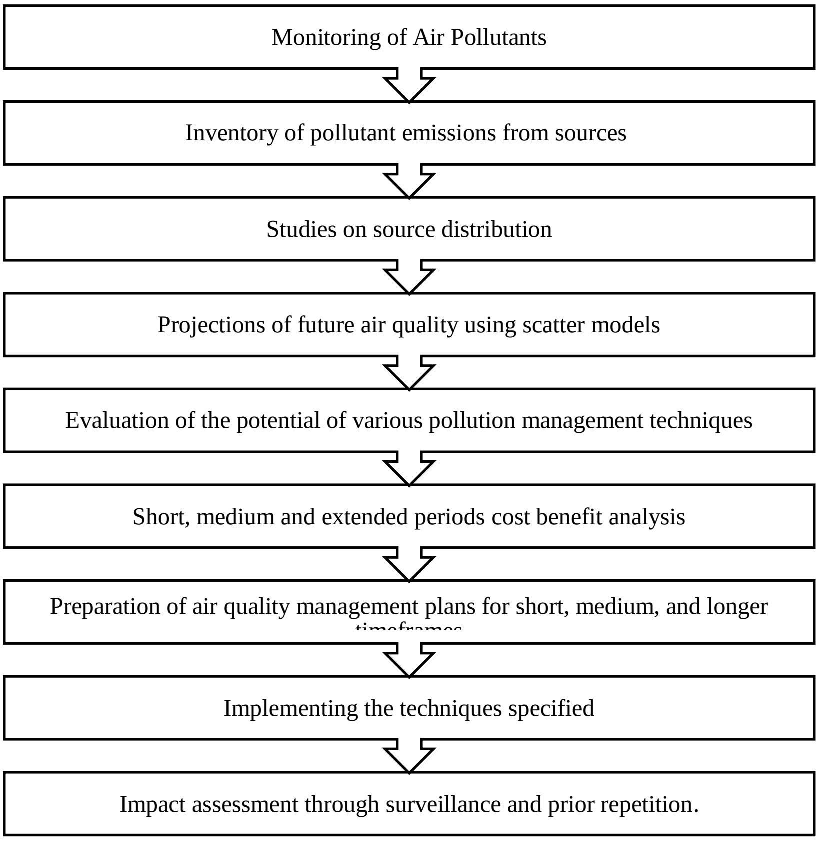


Figure 6.7 Best Practices as Policy Brief (Seth Block, 2018)

6.1.2 Present Scenario

Despite all of the other pressing environmental challenges, air pollution is quickly becoming one of the country's most serious environmental threats. Air pollution is not just a concern for the environment, but it also has health repercussions for humans. As a result, India is under tremendous international and domestic pressure to improve air quality and take this issue seriously. Despite the urgency, the government's piecemeal approach to solving the problem is yielding unsustainable short-term gains and a fragmented air quality management system (Kapoor, 2012).

Data provided by ULBs

The data provided by the various ULB's in the district of Alwar, is hereby formulated in Table 6.3. Details of data regarding availability of air quality monitoring network in district, different sources of pollution, number of industries meeting standards etc.

Table 6.3 Air Quality Management Datasheet Alwar District

S.No.	**Action Areas**	**Details of Data Requirement**	**Measurable Outcome**	**Please enter Measurable Outcome for District RO, RPCB, Alwar**	**Please enter Measurable Outcome for District RO, Bhiwadi(Tehsil-Tijara)**
A	AQ1-Availability of Air Quality Monitoring Network in District	Manual Air Quality monitoring stations of SPCBs /CPCB	[Nos] / [None]	3	3
		Automatic monitoring stations Operated by SPCBs / CPCB	[Nos] / [None]	1	1
B	AQ2-Inventory of Air Pollution Sources	Identification of prominent air polluting sources	[Large Industry] / [Small Industry] / [Unpaved Roads] / [Burning of Waste Stubble] / [Brick Kiln] / [Industrial Estate] / [Others] (Multiple selection)	Large Scale-45 Small scale-503 Brick Kiln-130	Large Scale-68 Small scale-346 Brick Kiln-04
		No of Non-Attainment Cities	[Nos / [None]	1	None
		Action Plans for non-attainment cities	[Prepared] / [Not yet prepared]	prepared	
C	AQ3-Availability of Air Quality Monitoring Data at DMs Office	Access to air quality data from SPCBs & CPCB through Dashboard	[Available] / [Not yet Available]	Available	Available
D	AQ4-Control of Industrial Air Pollution	No of Industries meeting Standards	[Nos]	654	385
		No of Industries not meeting discharge Standards	[Nos]	24	33
E	AQ5-Control of Non-industrial Air Pollution sources	Control open burning of Stubble –during winter	[Nos of fire incidents]	NA	NA
		Control Open burning of Waste – Nos of actions Taken	[Nos]	NA	NA
		Control of forest fires	[SOP available] / [No SoP]	NA	NA
		Vehicle pollution check centers	[% ULBs covered]	NA	NA
		Dust Suppression Vehicles	[% ULBs covered]	NA	NA
F	AQ6-Development of Air Pollution complaint redressal system	Mobile App / Online based air pollution complaint redressing system of SPCBs.	[Available] / [Not available]	Not Available	Not Available

As per the table all industries in the district are meeting the air quality standards. However, 24 are not meeting standards. A number of data are missing for the district such as Control open burning of Stubble, Control Open burning of Waste, Control of forest fires, Vehicle pollution check centers and Dust Suppression Vehicles

Inferences from data provided

Rajasthan is one of the six Indian countries with the largest per-capita financial loss due to air pollution according to the 2019 Global Burden of Disease Study. The Central Pollution Control Board (CPCB) has identified 124 cities as **"non-attainment cities"** i.e., they have failed to meet the prescribed standards on air pollution. Five of these 122 cities are in Rajasthan: Jaipur, Jodhpur, Kota, Alwar, and Udaipur. Their levels of PM_{10} and $PM_{2.5}$ are higher than prescribed limits even though they meet SO_2 and NO_x standards. Bhiwadi, a city in Alwar district, has also been identified as a hotspot primarily because of its being a hub for many polluting industries.

Based to one of a coordination with the Indian Institute of Technology (IIT) Kanpur, the Rajasthan State Pollution Control Board (RSPCB) started a comprehensive investigation in 2016 in several of these cities. The purpose of the study was to create a thorough inventory of air pollution sources and magnitude. The research has shown that road dust contributes considerably to air pollution in the state—which is frequently not policy important. For example, on Jaipur Road, dust accounts for 46 percent of the emissions of $PM_{2.5}$ and 48 percent in Bhiwadi. At the same time there is also an emphasis on municipal waste treatment, as there is evidence that large-scale combustion of urban garbage and garden waste considerably adds to $PM_{2.5}$ or PM_{10} emissions.

Bhiwadi is classified as an industrial city. Due to the government policies and Bhiwadi's proximity to Delhi, the city has attracted many large and MSME industries. The city of Bhiwadi, which is part of Delhi-NCR and home to a range of large, medium and small-scale industries, from steel mills and furnaces to automobile and electronics manufacturing, is among the most polluted in the state with high $PM_{2.5}$, PM_{10} and NO_2 concentration throughout the three years. Most of these industries use boilers and furnaces. The winter is seen as crucial when it comes to dispersion of pollutants and pollution consequences (IITK, 2020).

Table 6.4 Overall Baseline Emission Inventory (2017) for the Bhiwadi City (kg/day)

Category	PM_{10}	$PM_{2.5}$	CO	SO_2	NOx
Industrial Point	736	663	3070	1901	1712
Vehicles	1485	1336	16439	384	14428
Road Dust	21654	5239	0	0	0
Hotels/Restaurants	42	21	76	29	12
Domestic	172	156	901	14	46
Industrial Areas	3246	2921	4784	9207	5122
DG Set	317	285	966	295	4474
MSW Burning	296	177	1553	18	111
Construction Demolition	229	58	-	-	-
Agriculture Soil Dust	44	-	-	-	-
Total	**28221**	**10855**	**27789**	**11848**	**25905**

Numerous studies have found an association between air pollution and several adverse health effects in the population. Pollutants with the strongest evidence for public health concern mainly include particulate matter (PM), Nitrogen dioxide (NO_2), and Sulphur dioxide (SO_2). Monthly average concentration for the Alwar and Bhiwadi cities for PM, NO_2, SO_2 is shown in following table.

Table 6.5 Monthly Average Concentration of Pollutants in Alwar City

MONITORING SITES		**Regional Office, RSPCB**			**Jain Irrigation Systems Ltd., MIA, Alwar (Old Location-RIICO Pump House)**				**Vintage Distillers Ltd., MIA, ALWAR (Old Location-Gaurav Solvex)**			
S. NO.	Month	MONTHLY AVERAGE(µg/m3)			Month	MONTHLY AVERAGE(µg/m3)				MONTHLY AVERAGE(µg/m3)		
		SO_2	NO_2	PM_{10}		SO_2	NO_2	PM_{10}	Month	SO_2	NO_2	PM_{10}
1	January	10.3	34.5	159	January	12.07	39.03	198	January	13.5	41.11	242
2	February	10.1	33.7	186	February	13.9	37.8	194	February	14.7	38.6	230
3	March	9.66	33.7	146	March	13.71	35.03	158	March	13.57	40.56	195
4	April	10.9	35.09	144	April	14.8	37.89	154	April	14.92	40.84	210
5	May	9.44	30.18	168	May	11.41	34.31	186	May	12.25	38.31	207
6	June	8.39	29.3	174	June	11.71	33.38	180	June	11.75	34.29	213
7	July	7.64	26.15	131	July	10.8	31.42	146	July	10.87	35.73	171
8	August	7.35	24.05	97	August	9.87	29.25	95	August	10.59	32.37	119
9	September	8.46	25.82	102	September	11.63	30.03	112	September	11.76	31.39	126

10	October	9.32	26.22	124	October	12.19	34.64	142	October	12.95	35.21	167
11	November	9.56	27.41	177	November	11.7	32.38	190	November	12.48	34.24	218
12	December	11.19	32.4	224	December	14.21	36.82	207	December	15.41	38	272
	AVERAGE	9.4	29.9	152.7	**AVERAGE**	12.3	34.3	163.5	**AVERAGE**	12.9	36.7	197.5

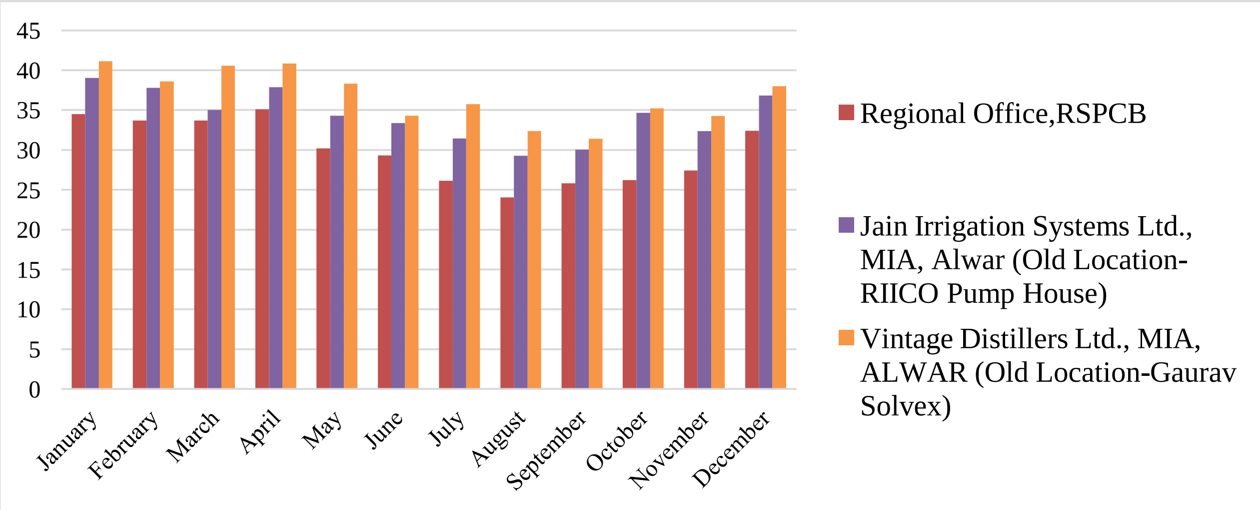


Figure 6.8 Graphical Representation of Monthly Average Concentration of PM_{10} in Alwar City

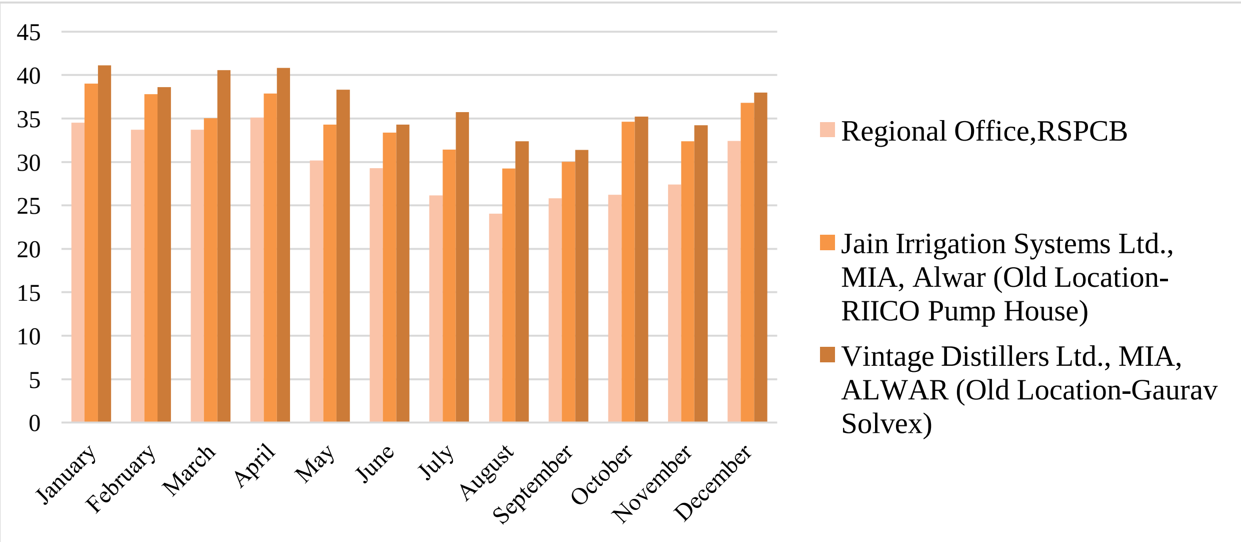


Figure 6.9 Graphical Representation of Monthly Average Concentration of SO_2 in Alwar City

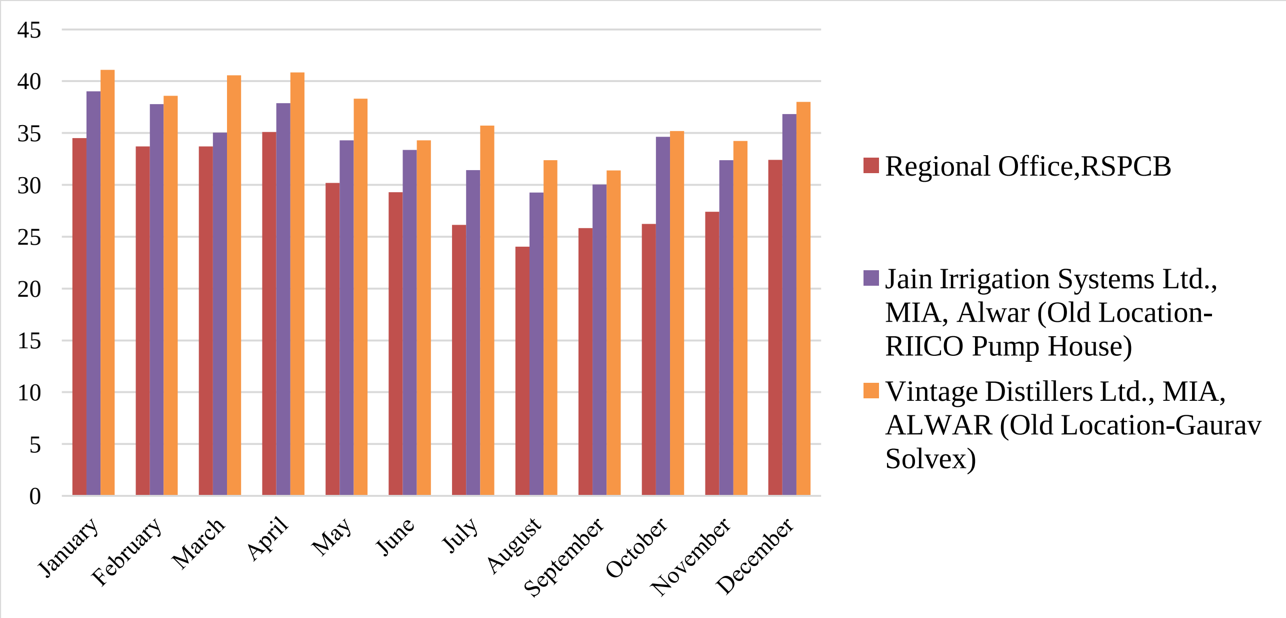


Figure 6.10 Graphical Representation of Monthly Average Concentration of NO_2 in Alwar City

As from the data the concentration of these pollutants is less in summer and high in Winters.

Table 6.6 Monthly average concentration of Pollutants in Bhiwadi City

MONITORING SITES		**Regional Office, RSPCB**			**UIT Guest House**				**Uttam Strip Ltd**			
S. NO.	Month	MONTHLY AVERAGE(µg/m3)			Month	MONTHLY AVERAGE(µg/m3)			Month	MONTHLY AVERAGE(µg/m3)		
		SO_2	**NO_2**	**PM_{10}**		**SO_2**	**NO_2**	**PM_{10}**		**SO_2**	**NO_2**	**PM_{10}**
1	January	29.75	50.08	325	January	17.36	50.74	322	January	25.31	48.71	277
2	February	30.98	59.86	269	February	24.98	51.57	277	February	24.23	57.38	236
3	March	30.77	56.72	252	March	27.59	53.37	296	March	27.41	51.22	281
4	April	29.03	57.62	296	April	26.47	59.51	270	April	30.74	52.37	239
5	May	29.58	44.44	270	May	25.9	41.81	271	May	21.48	33.36	264
6	June	27.78	37.1	274	June	14.38	42.6	137	June	20.67	37.04	206
7	July	21.68	38.8	210	July	15.04	23.14	122	July	15.45	26.54	139
8	August	29.03	31.44	127	August	*		*	August	20.36	40.82	180
9	September	24.51	28.07	164	September	*		*	September	21.6	30.9	163
10	October	31.2	46.19	210	October	*		*	October	32.97	40.86	212
11	November	28.63	42.49	269	November	*		*	November	27.11	42.58	281
12	December	29.7	40.3	274	December	*		*	December	29.03	39.17	246
	AVERAGE	28.6	44.4	245	**AVERAGE**	21.7	46.1	242.1	**AVERAGE**	24.7	41.7	227

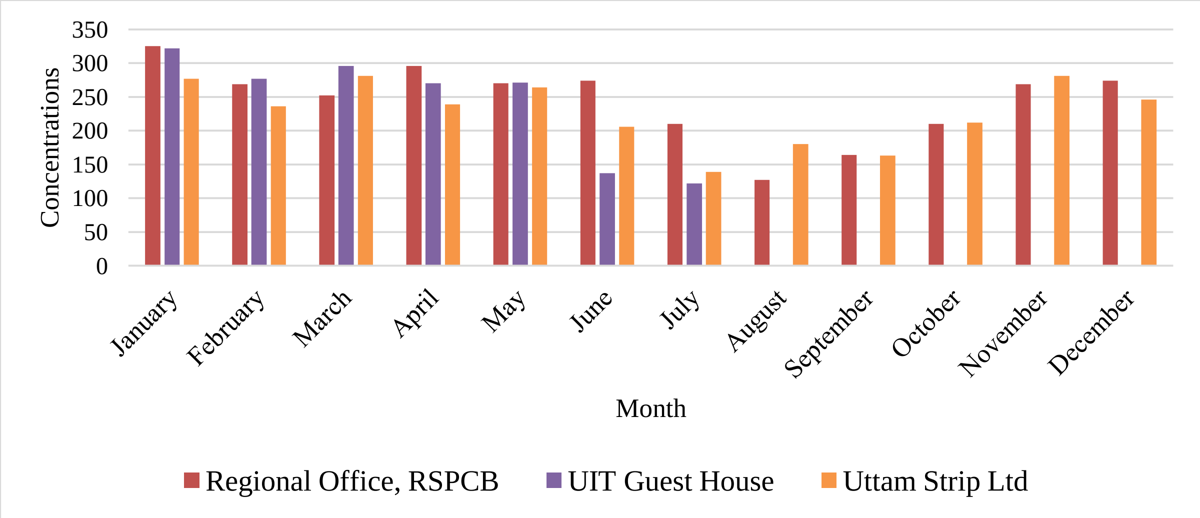


Figure 6.11 Graphical Representation of Monthly average concentration of PM_{10} in Bhiwadi City

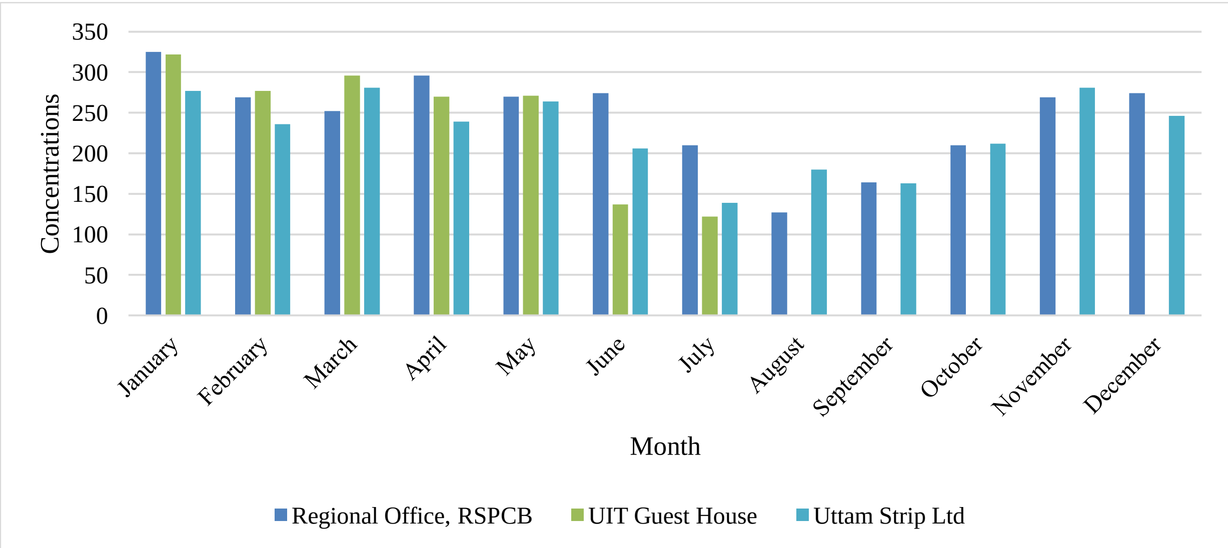


Figure 6.12 Graphical Representation of Monthly average concentration of SO_2(µg/m3)

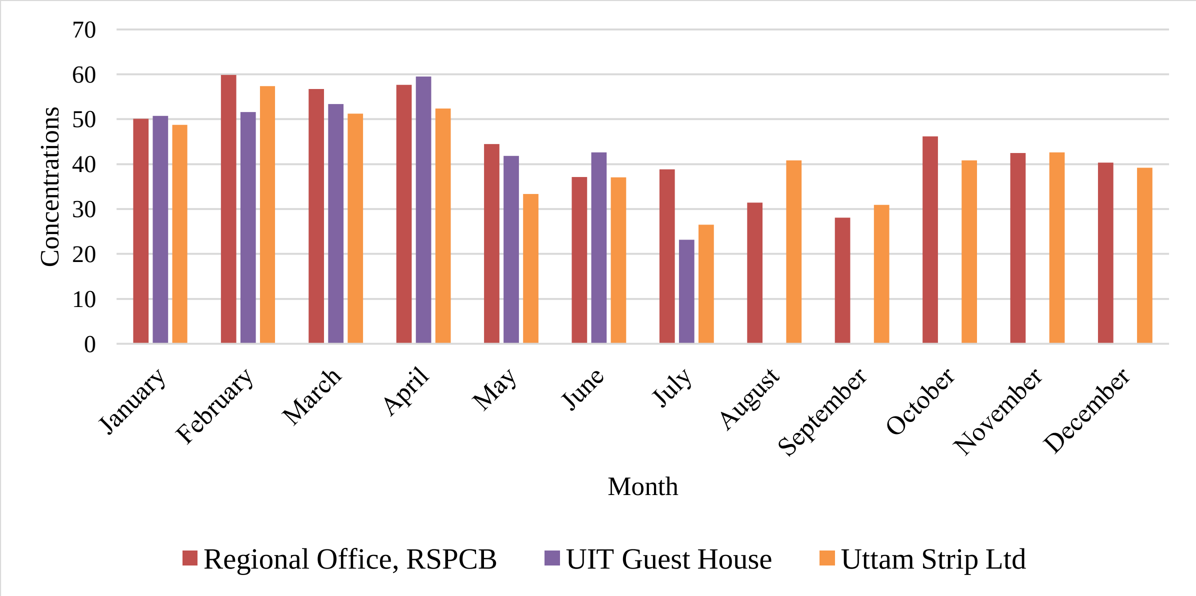


Figure 6.13 Graphical Representation of Monthly average concentration of NO_2(µg/m3)

6.1.3 Action Plan

The action plan for air pollution control needs to take into account various sources present in a region. Table 6.7 presents the action plan for air quality management in Alwar. Looking at the number of large, small scale industries and brick kilns in the district, controlling the air pollution becomes of paramount importance.

Table 6.7 Action Plan for Alwar Air Quality Management

Source group/Activity	Action Points	Implementation period	Responsible agency
Air Quality Monitoring	Performance monitoring of major air polluting industries for assessment of compliance of the notified air emission standards.	3 Years	Rajasthan State Pollution Board
	(i) Installation of additional real Time Continuous Air Quality Monitoring System in such a direction and location that it is able to capture pollutants from industries. (ii) For other ULBs, manual air monitoring may be for different seasons in a year.	3 Years	Rajasthan State Pollution Board
Vehicles Emission Control	1. Launch extensive drive against polluting vehicles for ensuring strict compliance and regular checking of vehicular emission and issue of PUC certificate	Short Term	Dept. of Transport, Traffic Police
	2.Launch Public awareness campaign for air pollution control, vehicle maintenance, minimizing use of personal vehicle, lane discipline, etc.	Short Term	Traffic Police
	3. Prevent parking of vehicles in the non-designed areas.	Long Term	Dept. of Transport

	4. Initiate steps for retrofitting of particulate filters in diesel vehicles, when BS-V fuels are available.	Short Term	Dept. of Food & Supplies
	5. Prepare action plan to check fuel adulteration and random monitoring of fuel quality data.	Mid Term	LSG, Development Authorities Municipal ,Corporations UITs in their jurisdiction
	6. Prepare plan for widening of road and improvement of Infrastructure for decongestion of road.	Long Term	NHAI, PWD
	7. Prepare plan for construction of expressways/bypasses to avoid congestion due to non-destined vehicles	Short Term	Dept. of Transport
	8. Steps for promoting battery operated vehicles/ Promotion & operationalization of E-rickshaw	Long Term	NHAI, PWD
	9. Install weigh in motion bridge at boarders of cities/towns and States to prevent overloading of vehicles	Long Term	Traffic Police
	10. Synchronize traffic movements /Introduce intelligent traffic systems for lane-driving.	Long Term	Traffic Police
	11.Installation of remote sensor based PUC system	Long Term	Dept. of Transport
	12. Restriction on plying & phasing out of 15 years old commercial diesel driven vehicles.	Long Term	Dept. of Transport , Food &Supplies
	13. Introduction of cleaner fuel for CNG/LPG vehicles	Mid Term	Dept. of Transport
	14. Plan for restriction on the registration on diesel driven Auto-rickshaw & Tempo	Mid Term	Dept. of Transport
	15. Monitoring on vehicle fitness	Mid Term	Dept. of Transport
	16. Periodic calibration test of vehicular emission monitoring instrument	Long Term	UDH Development authorities in their jurisdiction
	17. Preparation of plan for development Multi level Parking	Mid Term	NHAI, PWD, Urban local body
Re-Suspension of Road Dust and Other Fugitive Emission Control	1. Prepare plan for green buffers along the traffic corridors.	Mid Term	NHAI, PWD, Urban local body
	2.Maintain potholes free roads for free roads for free flow of traffic	Mid Term	NHAI, PWD, and Urban local body
	3. Introduce water fountain at major traffic intersection wherever feasible	Mid Term	Urban local body, Development Authorities Municipal Corporations UITs in their jurisdiction
	4. Greening of open areas, gardens, community places, schools and housing societies	Mid Term Short Term	Urban local body, Dept of Education

	5. Blacktopping metaled road including pavement of road shoulders.	Mid Term	NHAI, PWD, Urban local body
	6. Widening of roads and construction of pucca footpath along main roads (RIICO Industrial Areas)	Long Term	RIICO as per requirement and feasibility
	7. Regular cleaning of road (RIICO and other areas)	Long Term	RIICO, UDH
	8. Tree plantation along the roads (RIICO Industrial Areas)	Long Term	RIICO
Control of Emissions from Biomass/Crop Residue/Garbage /Municipal Solid Waste burning	1.Launch extensive drive against open burning of bio-mass, garbage, leaves, etc.	Short Term	Urban local body
	2. Regular check and control of burning of municipal solid waste.	Short Term	Urban local body
	3. Ensure ban on burning of agriculture waste and crop residues and its implementation	Long Term	Department of Agriculture Revenue
	4. Construction of advanced waste management Site.	Mid Term	Urban local body
	5. Restriction on open burning of municipal solid waste biomass and plastic (RIICO Industrial Areas)	Short Term	RIICO
	6. Restriction on open burning of biomass and plastic	Short Term	Urban local body
	7. Immediate lifting of solid waste generated from desilting and cleaning of drains for its disposal	Short Term	RIICO, Urban local body
	8. Transportation of solid waste, construction material and debris in covered system.	Short Term	RIICO, Urban local body
Control Of Industrial Emissions	1. Identification of brick kilns and their regular monitoring including use of designated fuel and closure of unauthorized units.	Mid Term	State Pollution Control Board
	2. Conversion of natural draft brick kilns to induced draft.	Mid Term	State Pollution Control Board
	3. Action against non-complying industrial units.	Short Term	State Pollution Control Board
	4. Regulation on setting up of new air polluting industries in industrial areas located in urban limits of these 5 cities.	Mid Term	State Pollution Control Board, RIICO
Control of emissions from brick kilns	1. Switching to more efficient technologies, mainly during brick firing,	Mid Term	State Pollution Control Board
Control of Air Pollution from Construction and Demolition activities	1. Enforcement of Construction and Demolition Waste Rules	Short Term	Urban Local Bodies; Development authorities under their jurisdiction

	2. Control measures for fugitive emissions from material handling-conveying and screening operations through water sprinkling, curtains, barriers and dust suppression units.		
	3. Ensure carriage of construction material in closed / covered vessels	Short Term	Urban Local Bodies, RIICO
	4. Covering of construction sites and Restriction on storage of construction materials along the road	Long Term	RIICO, Urban local body
	5. Restriction on storage of construction materials along the road.	Short Term	RIICO, Urban Local Bodies
Other Steps to control Air Pollution	1. Air Quality Index to be calculated and disseminated to the people through website and other media.(on maximum weekly basis for manually operated monitoring stations and real time basis for continuous monitoring stations)	Short Term	State Pollution Control Board
	2. Establish an Air Quality Management Division at SPCB/PCC Head Quarters to oversee air quality management activities in the State and interact CPCB.	Short Term	State Pollution Control Board
	3. Set-up and publicize helpline in each city/town as well as SPCB/PCC HQ for complaints against reported non-compliance	Short Term	State Pollution Control Board
	Engage with concerned authorities on continual basis for maximizing coverage of LPG /PNG for domestic and commercial cooking with target of 100% coverage.	Short Term	State Govt.
	Monitoring of DG sets and action against violations.	Short Term	State Pollution Control Board
	Involvement of industrial associations in awareness program (RIICO Industrial Areas)	Mid Term	RIICO
	Development/maintenance of green areas, gardens and parks (RIICO Industrial Areas)	Long Term	RIICO
Hotels/ Restaurants	Restaurants of sitting capacity more than 10 should not use coal and shift to electric or gas-based appliances.	1 year	
	Link Commercial license to clean fuel	1 year	
	Ash/residue from the tandoor and other activities should not be disposed near the roadside.	1 year	
Domestic Sector	LPG to all. Slums are using wood as cooking fuel.	2 years	
	By 2030, city may plan to shift to electric cooking or PNG.	2 years	

Municipal Solid Waste (MSW) Burning	Any type of garbage burning should be strictly stopped.	Immediate	State Pollution Control Board
	Surveillance is required that hazardous waste goes to TSDF.		
	Desilting and cleaning of municipal drains		
	Waste burning in Industrial area should be stopped.		
	Daily, Monthly mass balance of MSW generation and disposal		
	Sensitize people and media through workshops and literature distribution.		
Construction and Demolition	Wet suppression	Immediate	State Pollution Control Board
	Wind speed reduction (for large construction site)		
	Enforcement of C&D Waste Management Rules. The waste should be sent to construction and demolition processing facility		
	Proper handling and storage of raw material: covered the storage and provide the windbreakers.		
	Vehicle cleaning and specific fixed wheel washing on leaving the site and damping down of haul routes.		
	Actual construction area should be covered by a fine screen.		
	No storage (no matter how small) of construction material near roadside (up to 10 m from the edge of the road)		
	Builders should leave 25% area for green belt in residential colonies to be made mandatory.		
	Sensitize construction workers and contract agency through workshops.		
Road Dust	The silt load in Alwar and Bhiwadi should be controlled. The silt load on each road should be reduced under 3 gm/m2. Regular vacuum sweeping should be done on the road having silt load above 3 gm/m2.		
	Convert unpaved roads to paved roads. Maintain pot hole free roads.		

	Implementation of truck loading guidelines; use appropriate enclosures for haul trucks and gravel paving for all haul routes.		
	Increase green cover and plantation. Undertake greening of open areas, community places, schools and housing societies.		
	vacuum assisted sweeping carried out four times in a month, this will reduce road dust emission by 71% (Resultant emissions: PM2.5=4 ton/day)		
For Vehicles	Diesel vehicle entering the city should be equipped with DPF which will bring a reduction of 40% in emissions (This option must be explored once Bharat stage VI fuel is available.)	3 years	Dept. Of Transport
	Industries must be encouraged to use Bharat stage VI vehicles for transportation of raw and finished products	Immediate	
	Restriction on plying and phasing out of 10 years old commercial diesel driven vehicles.	2 years	
	Introduction of cleaner fuels (CNG/ LPG) for vehicles.	2 years	
	Check overloading: Expedited installation of weigh-in- motion bridges and machines at all entry points to Alwar and Bhiwadi	Immediate	
	Electric/Hybrid Vehicles should be encouraged; New residential and commercial buildings to have charging facilities. Buses should be CNG or Electric.	1 year	
	Depot spaces should be rationalized to ensure more efficient utilization. Multi-modal, multi-use bus depots to be developed to provide high-class bus services and terminal experience to passengers. Should include well- equipped maintenance workshops. Charging stations shall be set-up.	1year	
	Enforcement of bus lanes and keeping them free from obstruction and encroachment.	1 year	
	Ensure integration of existing metro system with bus services.	1 Year	
	Route rationalization: Improvement of availability by rationalizing routes and fleet enhancement with requisite modification.	1 year	
	IT systems in buses, bus stops and control center and passenger information systems for reliability of bus services and monitoring.	1 year	
	Movement of materials (raw and product) should be allowed between 10 PM to 5 AM.	1 year	
	Ensuring emission standards in industries. Shifting of polluting industries.	1 year	
	Strict action to stop unscientific disposal of hazardous waste in the surrounding area	1 year	
	There should be separate Treatment, Storage, and Disposal Facilities (TSDFs) for hazardous waste.		

Industries and DG Sets	Industrial waste burning should be stopped immediately	2 years	
	Follow best practices to minimize fugitive emission within the industry premises, all leakages within the industry should be controlled	Immediate	
	Area and road in front of the industry should be the responsibility of the industry	Immediate	
	Category A Industries (using coal and other dirty fuels)		
	boilers and furnaces in Alwar and Bhiwadi are running over coal, wood, and other dirty solid fuels which should be shifted to natural gas and electricity		
	Almost all rotary furnace having significant emissions are running on coal that needs to be shifted to natural gas and electricity		
	Multi-cyclones should be replaced by baghouses. Ensure installation and operation of air pollution control devices in industries.	2 years	
	Category B Industries (Induction Furnace)	2 years	
	Recommended Fume gas capturing hood followed by Baghouse should be used to control air pollution		
	Diesel Generator Sets	2 years	
	Strengthening of grid power supply, uninterrupted power supply to the industries		
	Renewable energy should be used to cater the need of office requirement in the absence of power failure to stop the use of DG Set	2 years	
Decongestion of Roads at High Traffic Areas	Strict action on roadside encroachment.	2 years	Dept. of Transport
	Disciplined Public transport (designate one lane stop).	6 months	
	Removal of free parking zone		
	Examine existing framework for removing broken vehicles from roads and create a system for speedy removal and ensure minimal disruption to traffic.		
	Synchronize traffic movements or introduce intelligent traffic systems for lane-driving.		
	Introduction of one-way traffic in selected areas to reduce the traffic density		
Implementation of Traffic Master Plan	Banning entry of heavy commercial vehicle inside the city to reduce vehicular pollution	1 year	Dept. of Transport
	Issuing licenses to LPG based autos as per notification dated 22/12/2010	1 year	
	Continuous monitoring of vehicles by flying squads of transport department to check PUC	1 year	
	Regular monitoring of the quality of the fuel being used by the vehicles	1 year	

	Periodic education and awareness campaigns for the public, drivers, transporters and other stake holders	1 year	
	Removal of encroachment on the road side	1 year	
	Development of parking arrangements by traffic management near the commercial areas by concerned ULB	1 year	
	Widening of main roads for reducing the traffic congestion and periodic maintenance of Road	1 year	
	Development of roadside bushes	1 year	

6.1.4 Summary

There are number of government initiatives such as National Air Quality Monitoring Programme, National Clean Air Action Plan, CPCB Guidelines, TERI Policy etc. which focuses on short-term and long-term measures from broader to local air quality management. As there is no data available for Alwar district, it is very difficult to comment on the air quality of the region. For an industrial district like, Alwar more monitoring stations should be installed as soon as possible. In the meantime, the focus of mitigation may be on major sources e.g. vehicular sources, brick kilns, MSW burning and other industries. Planning and monitoring for brick kiln should be done immediately.

Table 6.4 Summary for Air Quality Management Alwar

S.No.	Urban Local Body	Present Status	Strategies and Action Plan
1.	Nagar Parishad, Alwar	Manual Air Quality monitoring stations- 3, Automatic monitoring stations- 1, No of Industries not meeting discharge Standards- 24	• Air Quality Monitoring Control Action • Source based control action for hotels/ restaurants, vehicles, industries and DG sets, construction and demolition, domestic sector etc. • Decongestion of roads in high congestion areas and implementation of traffic management plans.
2.	Nagar Parishad, Bhiwadi	Manual Air Quality monitoring stations- 3, Automatic monitoring stations- 1, No of Industries not meeting discharge Standards- 33	• Air Quality Monitoring Control Action • Source based control action for hotels/ restaurants, vehicles, industries and DG sets, construction and demolition, domestic sector etc. • Decongestion of roads in high congestion areas and implementation of traffic management plans.

The Alwar district doesn’t have a district environment plan yet, it has various regulations for environmental clearances for industries and other major infrastructure facilities such as urban transport and need environment clearances including air quality management for its functioning. The inventory for air quality measurements is not updated which is essential to begin with air quality control and last official document stating the measurements was till 1995. The districts lack in air quality monitoring stations and have one regional pollution board which is accountable for the air quality management along with other environment controls.

6.2 Noise Pollution Management

6.2.1 Literature Review

Noise is defined as unwanted sound that interferes with one's quality of life. Sound pollution occurs when there is a great deal of noise in the environment. A person's personality cannot withstand noise levels exceeding 85 decibels (dB) When sound interferes with routine activities such as working, resting, or conserving resources, it becomes unwelcome. It has an underappreciated environmental disadvantage because to the fact that we can't see, smell, or style it. “Noise should be regarded as a severe hazard to human well-being,” as depicted by World Health Organization.

The following is a list of noise pollution classifications: I Community Noise: Noise released from all sources, except at the economic work place, is mentioned as community noise (also known as environmental noise, home noise, or household noise). Road, rail, and traffic noise, construction and public works noise, and neighbourhood noise are all common sources of community noise. Live or recorded music, as well as stock such as barking dogs, are common sources of neighbourhood noise; (ii) Occupational Noise: Noise is generated by industrial machinery and process, such as rotors, gears, turbulent flow, impact processes, electric machines, internal combustion engines, pneumatic equipment, drilling, crushing and blasting. In addition, flooring, ceiling and instrumentality also reflect the sound produced; (iii) Aircraft pollution: aircraft noise flying across residential areas interferes with the capacity of individuals to think, study and sleep in school, leading to poor land values in the regions in question. aircraft pollution With the growth in passenger volumes and the construction of new and bigger airports, noise is becoming increasingly important; (iv) Roadway noise pollution: the sound of the aggregate emission of motor vehicles and automobiles roadways; (v) Underwater noise pollution (UNP) is a type of noise pollution caused by humans in the aquatic environment. All contributory elements include explosives, oceanographical experiments, geological analysis, undersea building, ship transportation, powerful active sonars and air cannons used for unstable oil surveys and associated operations; (vi) Construction noise: Construction noise from roads, city streets, and buildings may be a significant component to the urban scene. The noise of construction involves all kinds of gas hammers, air-compressors compressores, bulldozers, loaders, dump trucks (and their backup signals).

Humans may develop a noise-induced hearing condition as a result of prolonged exposure to noise. Hearing sensitivity in older guys exposed to vital activity noise is significantly lower than in non-exposed peers. Unwanted noise is harmful to one's physiological and psychological well-being. Air pollution, aggressiveness and heart disease, over-stress, tinnitus, hearing loss, sleep problems and other unpleasant effects might result in pollution. High noise levels can contribute to vascular effects and exposure over a period of eight hours to moderately high blood pressure increases by five to ten points and increased stress and restriction leading to a rise in blood pressure and a higher risk of coronary artery disease.

Noise is harmful to animals, it increases the risk of death, disturbs the delicate balance of detection and avoidance of predators, and it interferes with the use of sounds, especially in terms of the pertinence of replication and navigation. The loss of usable surround that noise zones may create is one effect of noise on animal life, and in the case of species, this could be a part of the path to extinction. Pollution has resulted in the death of tethered whale species that have aground when exposed to the loud sound of military measuring systems. Hormone imbalance, chronic stress, panic and escape behaviour, abandonment of offspring, injury, and increased loudness of lay to rest species communication are some of the other consequences on life and aquatic animals.

Scenario in country

In the current state of affairs in India, pollution may be a natural occurrence, particularly in urban areas. Typical illustrious sources of pollution are transportation or traffic-related pollution, as well as mill or activity pollution. Such responsible pollution is an unavoidable part of everyday life, and no one wants to be concerned about it. During festivals like Diwali, where hearth haywire is blamed for pollution, the sources of noise pollution tend to rise. Noise pollution appears to be a tradition at public festivals, just as it appears to be at weddings, birthdays, and election successes. Hearth haywires and bands were important causes of pollution in the past, but in recent years, other variables have been added to create undesired sound.

The traditional image seen during public competition events and private festivities such as weddings, birthdays, and election victories is walls of large speakers accompanied by hearth haywires and bands. The most terrifying of these is walls of large speakers playing the loudest music at the same time, nonstop; the intensity is so high that you will just feel the vibrations around you, and you will feel the palpitations, despite the fact that you are simply going by. Surprisingly, you will notice that not only adults, but also children, spend hours in such a noisy environment doing arts and enjoying the music made by it. Such reasonable exposure adversely affects one's health in the same way as social risks do, and it is particularly harmful to children.

Though their square measure legislations regulation pollution, however non-implementation of legislations ends up in ever-rising rather multiplying pollution with the addition of the latest equipment of pollution.

Governance and Management Structure

The various concerned institutions involved in the process of Noise Management are: Central Pollution Control Board, Rajasthan State Pollution Control Board, sustainable goals given by world health organization.

Roles and Responsibilities

The Central Pollution Manage Board has a responsibility to regulate and control noise sources with a view to maintaining environmental standards in air quality.

State Pollution Control Board responsible for regulation and controlling of noise producing sources and noise monitoring in the state

Sustainable Development Goals

The aim of noise control is to maintain low levels of noise to protect human health and well-being (Greenberg & Schneider, 2019). In any case, noise in an exceedingly explicit situation, according to the precautionary principle should be minimised to the lowest possible level. In cases with an enough risk of endangering public health, action should not wait for extensive scientific evidence but should be acted to safeguard public health. The Polluter Pays Principle states that individuals responsible for supplying noise should pay the whole cost of sound pollution (including monitoring, control, lowering levels, and oversight).

The interference principle states that if it is possible to reduce noise at the source, action should be performed. Associate degree environmental health impact assessment that addresses noise as well as alternative contaminants should be used to guide land-use planning.

The noise levels in any space/zone must not exceeding the narrow air quality standards with regard to noise as specified in the Table, and noise levels in any space/zone shall not exceed narrow air quality standards with regard to noise as set out in the Schedule for enforcement and social management of sound pollution control measures. The authority is responsible for enforcing sound pollution control measures and, as a result, ensuring that the near air quality standards in the area of noise are met.

National Rules and Regulation for Noise Pollution (Ministry of Environment & Forests, 2017)

Section three of the environmental protection act of 1986 let to noise regulations rules (2000). The Environmental Protection Agency is that the umbrella legislation to influence each dynamic issue in relevance environmental preservation. The foundation regulates noise levels in Table 6.4

Table 6.8 Ambient air quality standards in respect of noise for different areas/zones

Sr. No.	Category of Area/Zone	Limits in dB(A)	
		Day	Night
1	Industrial area	75	70
2	Commercial area	65	55
3	Residential area	55	45
4	Silence Zone (near hospitals, schools etc.)	50	40

The regulations together assign these requirements to the native district courts by the administrative authority. Some observations from the foundations are essential:

Any authority to utilise public address systems inside 10 pm and before 6 am cannot give a permit to use them within the open. There is no possible exception. The sound shall be within the sound limitations laid out under the Noise Rules after approval has been obtained. This may be measured on a metre of sound. Every person who violates the foundation is susceptible to remission under the regulations of the EPA. If the authorities don't act to Prevent violation of the Noise Rules, the subject Whoever submitted criticisms will approach the Court with his critique when the Court starts prosecution 60 days in advance. The rules conjointly fix totally different close air quality levels for firecrackers and industrial activities.

Rajasthan State Rules for Noise Pollution: in accordance with the authorities conferred in Section 9 the Rajasthan Noises Management Act, 1963 (Rajasthan Act 12 of 1963) at intervals that not everybody shall use or play a loud-speaker or sound electronic equipment for broadcasting any speech, sermon, music or radio-Programme or attach identical to any wireless radio receiver or phonograph, shall be as state against every, namely-

Table 6.9 Rajasthan Noises Management Act, 1963

1.	From hospital or from a building during which there's a phone exchange	150 meters
2.	From any educational institution managed, maintained, recognized or controlled by the authorities or a University established beneath any law for the nowadays good or a neighborhood authority, throughout the hours or operating of such establishment.	150 meters
3.	From any hostel maintained or recognized by the one hundred fifty meters authorities or University or government agency once such hostel is within the use of scholars.	150 meters
4.	From a building during which a court or Government workplace is control throughout the hours of operating of such court or office	150 meters

Best Practices

Noise Abatement Approaches (SCU, 2017)

Rolling noise and drive noise combine to create road traffic noise owing to the vibrations and interactions between the vehicle's tyre and its surface (emanating from the engine itself). When cars are travelling faster than 30 km/h, rolling noise dominates noise emissions, while propulsion noise is the main source of noise below this speed. Quieter engines, quieter road surfaces, quieter tyres, electric vehicles, traffic management, and engineering can all help to reduce traffic noise.

Reduced wheel roughness, such as by replacing cast iron brake blocks, is the most effective approach for reducing railway noise. A new style of low-noise brake block (LL-blocks) may readily replace noisy cast iron brake blocks, lowering freight train noise by up to 12 decibels (on a nicely kept path). Isolating the tread from the web of the wheel and optimising the size and form of the wheel to reduce vibration can also be useful, albeit this is only possible with new vehicles. Acoustic grinding, which has been found to reduce sound levels by 2.5–5 dB on the track side, can be used to minimise the roughness of the rail line. Rail vibration can be reduced by using stiffer rail pads, and adding a rail damper can reduce noise by up to 3 dB(A), though questions about its cost and safety persist.

The aircraft itself is the primary source of airport noise, because it generates noise during parking, taxiing and while it is running, departure, flying and landing. The main noise sources are aircraft noise (because of the airflow around the airplane's main bodyshell that increases at speed and low levels), engine noise/mechanical noise (because of the jet engines that predominate during start-up or climbing) and noise from aircraft systems (from the auxiliary power unit, which is used to start the main engines and provide power while the aircraft is on the ground).

Noise reduction at source: new technology, noise regulations, fleet evolution, air traffic control at source might be explored for aircraft noise reduction.

The design and management of land uses includes zoning, which controls development and bans the construction of sound-sensitive land uses in the vicinity of an airport or a flight route (e.g. houses, schools and hospitals). Mitigation techniques include isolation of the noise-sensitive façades surrounding buildings, tax incentives and financial penalties, for example.

The operational techniques for noise reduction are as follows: Lower noise roads or paths, limited motor use on the ground, and shifted landing thresholds: Changing where planes can land on a runway to lessen noise pollution in sensitive areas. The continuous descent approach (CDA) decreases noise pollution for towns below by reducing power/drag by keeping the aircraft at a higher altitude for the majority of the descent than the traditional "stair step" approach.

Cross-functional methods to noise reduction: Although some noise reduction techniques are unique to certain kinds of noise, some are suitable for several types of noise:

Noise barriers: A significant noise reduction method is the use of noise barriers. Lärm barriers, such as those seen near busy roads, are effective means to minimise excessive noise levels. By preventing it from immediately spreading from the source to the recipient, they minimise noise.

A. Noise Barrier

B. Sonic Crystal

Figure 6.14 Different type of Noise Barrier

Building design: Architects can significantly improve the noise levels within a building during the planning stages. A technique to do this is to position less soundproof rooms, such as a kitchen or storehouse, closer to a potential source of noise such as a road, and more noiseproof areas such as bedrooms and the living room further. When designing the geometry of complete structures, it's also a good idea to think about noise interactions. Noise reflections onto a building can be reduced by certain orientations. Additional architectural features can also help with noise reduction. Internal noise exposure can be reduced greatly by orienting windows apart from the noise source and covering them with wing walls. Balconies, depending on their specifications, offer a high noise reduction capacity (5–14 dB).

There is no specialised data of individual land-use planning or ‘zoning,' which entails taking into account the position of future buildings in relation to other areas, such as domestic areas and green space. Noise-sensitive and peaceful locations that should be protected from noise in the future can be identified with proper planning. This could entail establishing a sufficient distance between locations to prevent noise transmission, or including noise abatement into new development plans.

Building sound insulation: Sound-insulated windows can reduce noise by up to 30 decibels, which is comparable to solid doors. Special sound-dampening windows can reduce emissions by up to 40 decibels, albeit this is dependent on the building and window features, and is only effective when the windows are closed.

Sonic crystals: Sonic glass may block sound waves transmitted at certain frequencies that can be adjusted by a change in the crystal's size and shape.

To decrease occupational exposure, ear protection devices should be given for those working in noisy locations such earplugs, mufflers, noise helmets, headphones, etc. Proper lubrication has to be done for old machines to reduce the noise. Increased distance between source and receiver by zoning of noisy industrial areas like bus stands and railway stations away from silence zones near residential areas, educational institutions and hospitals. Planting plants and bushes beside highways, hospitals and schools significantly helps to reduce noise.

6.2.2 Present Scenario and Gap Identification

There are 12 ULBs in Alwar district namely two Nagar Parishad Alwar, and Bhiwadi, 10 Nagar Palika Tijara, Kishangarh Bas, Khairthal, Bansur, Behror, Thanagazi, Ramgarh, Laxmangarh, Kherli, Rajgarh. The very less information that is available regarding noise in Alwar district is shown in the table below.

Table 6.10 Present Scenario in Alwar district

No.	Action Areas	Details of Data Requirement	Measurable Outcome	Please enter Measurable Outcome for, RO,Alwar, District	Please enter Measurable Outcome for District RO, Bhiwadi(Tehsil-Tijara)
A	NP1-Availability Monitoring equipment	No. of noise measuring devices with district administration	[Nos] / [None]		
		No. of noise measuring devices with SPCBs	[Nos] / [None]	2	2
B	NP2-Capability to conduct noise level monitoring by State agency / District authorities	capability to conduct noise level monitoring by State agency / District authorities	[Available] / [Not available]	Available	
C	Management of Noise related complaints	No of complaints received on noise pollution in last 1 year	[Nos]		
		No of complaints redressed	[Nos]		

D	Compliance to ambient noise standards	Implementation of Ambient noise standards in residential and silent zones	[Regular Activity] / [Occasional] / [Never]		
		Noise monitoring study in district	[carried out] / [not carried out]	Not Carried Out	Not Carried Out
		Sign boards in towns and cities in silent zones	[Installed] / [Partial] / [Not Installed]		

Inferences from present scenario

There is no dedicated data of individual ULBs. Sign boards in towns and cities in silent zones should be installed. Noise measuring devices should be provided to the district administration. Noise monitoring study should be carried out in all ULBs.

6.2.3 Action Plan

The action plan for noise pollution management in Alwar district is shown in the table below.

Table 6.11 Action Plan for Noise Pollution Management

S. No.	Action points	Time Frame for implementation	Suggested Responsible stakeholders/ Agency involved
1.	Monitoring the noise pollution especially in residential and silence zones	1- year	RSPCB
2.	Monitoring the noise levels in areas of traffic congestion/ commercial areas	1-year	RSPCB
3.	Strict implementation of noise control from vehicles in terms of honking or engine noise	3-years	Traffic police
4.	Determining the level of noise control required in different areas of an ULB	3-years	RSPCB (technical institutes may also be employed for the same)
5.	Installation of noise barriers e.g. planting vegetation and earth barriers for areas where source control is difficult	5-years	ULB (Tijara, Kishangarh Bas, Khairthal, Bansur, Behror, Thanagazi, Ramgarh, Laxmangarh, Kherli, Rajgarh)

6.2.4 Summary

The noise abatement strategy typically starts with the development of noise standards or guidelines, and the identification, mapping and monitoring of noise sources and exposed communities. A powerful tool in developing and applying the control strategy is to make use of modeling. These models need to be validated by monitoring data. Noise parameters relevant to the important sources of noise must be known.

There is no detailed or proper information regarding the noise levels in Alwar and in all particular ULBs. Therefore, the action plan suggested in the study is more focused on noise monitoring but not on the controlling measures. Hence it is required to conduct noise survey in the district in order to know the intensity of the noise so that an effective action plan can be framed and implemented in the district. The monitoring suggested in the action plan is more focused on residential and silence zones since they are more susceptible to noise pollution. The focus is also made on traffic noise since the proportion shared by vehicles in producing noise is higher than any other noise producing source. Noise barriers are recommended in the action plan because there are some situations where source control is not possible hence, we have to take certain control measures at least not to transfer the noise to the surroundings. There are a range of approaches available to reduce exposure to noise locally, from well-established methods such as insulation and speed limits to more novel strategies such as low-noise road surfaces. In conclusion, a mix of mitigation at source and noise abatement at the receiver end will be important to target noise hotspots.

Table 6.12 Summary for noise management in Alwar district

Name of the ULBs	Present Scenario	Action Plan for future
Nagar Parishad Alwar, Bhiwadi **Nagar Palika- Tijara, Kishangarh Bas, Khairthal, Bansur, Behror, Thanagazi, Ramgarh, Laxmangarh, Kherli, Rajgarh**	● There is no data about noise measuring devices with district administration. ● There are only 2 noise measuring device with SPCB. ● No data regarding the capability to conduct noise level monitoring by State agency/ District authorities. ● No data regarding the number of complaints received and number of complaints redressed. ● No data regarding the implementation of ambient noise standards in residential and silent zones ● Noise monitoring study in district is not carried out. ● No data about sign boards in towns and cities in silent zones.	● Monitoring the noise pollution especially in residential and silent zones for 1 year by RSPCB. ● Monitoring the noise levels in area of traffic congestion/commercial areas for 1 year by RSPCB. ● Strict implementation of noise control from vehicles in terms of honking or engine noise for 3 years by traffic police. ● Determining the level of noise control required in different areas of an ULB for 3 years by RSPCB. ● Installation of noise barriers e.g. planting vegetation and earth barriers for areas where source control is difficult for 5 years by ULBs

7. Industrial Waste Management

7.1 Literature Review

Industrial trash encompasses all sorts of waste generated by local businesses, including wastewater, air pollution, and solid waste. Furthermore, because industrial waste can be harmful, scientific handling of industrial waste is even more important. Toxins released from industrial waste can contaminate the soil, air, and water as a result of poor industrail waste management. Solid waste disposal programmes are still in effect for large and medium-sized firms in designated industrial zones. As a result, local governments must develop a strategy for appropriate collection and disposal of industrial solid waste in coordination with the State Pollution Control Board (SPCB) (Jadhav & Hocheng, 2012)..

India's urbanisation is accelerating, with the percentage of people living in cities rising from 14 percent in the 1940s to nearly 35 percent in 2020. The much-needed boost to industrial development has resulted in large residuals that are having out-of-proportion detrimental effects on the environment - air, water, and land in comparison to their contribution to overall economic growth. The iron and steel industry, for example, accounts for 55 percent of total particulate matter emissions while generating just 16 percent of total industrial output. Chemical and food processing industries account for up to 86 percent of total industrial BOD load, compared to the industry's 25% contribution to overall industrial production (Brueckner et al., 2014).

Scenario in Country

India creates around 74.6 lakh tonnes of hazardous waste each year from various sectors. The amount of waste that can be disposed of in landfills is around 34.1 lakh tonnes, or 46% of total waste. Recycling accounts for 33.5 lakh tonnes of recyclable hazardous waste, or 45 percent of the total. Because recyclable hazardous waste accounts for a large fraction of the total, India should improve its trash recycling operations. Hazardous waste is created by a range of industrial enterprises in India. Hazardous waste was also brought into India for reprocessing and recycling until the newly updated rules of 2016 put an end to it. Currently, the majority of India's hazardous waste is disposed of at ordinary garbage dumping sites rather than specially built landfills for industrial hazardous waste disposal (Gautam et al., 2017).

Due to the lack of adequate treatment and management, the volume of industrial wastewater in India is rapidly increasing, contaminating the country's limited freshwater sources. Industrial waste is dumped into the environment, rendering the available water supply worthless. In the present scenario, chemical industries such as petrochemicals, textiles, fertilizer, pharma, etc. are producing large amount of highly polluting effluent due to the poor atom economy and selectivity’s of the conventional processes. The treatment of such effluent is another big task for such industries and most of the industries either do not have complete solution for the treatment of effluent or they cannot afford the high treatment cost and hence these industries are directing their effluents to the CETP. But the numbers of CETP units in industrial zones are limited and the loads on these units are continuously increasing due to their ineffectiveness in treating complex biorefractory pollutants. The report about the performance of the CETP plants in North India published in 2014-15 by Central Pollution control board (CPCB) indicated that almost double the quantity of effluent than the pumping capacity of the treatment plant was reaching the pumping stations of Common Effluent Treatment Plants (CETP) at Kanpur and around 50 % of the effluent having COD as high as 5,000 mg/L was being directly discharged into River Ganga. This report indicated that the Up-flow Anaerobic Sludge Blanket (UASB) system installed at this CETP unit was not achieving the treatability at the desirable level to comply with discharge limit set for on land discharge for irrigation. This report also indicated that most of the CETP units along the river Ganga are not working at full efficiency due to their inefficiency in handling the high intake load and inability in treating the biorefractory pollutant. Industry produces around 13468 MLD of wastewater, of which only 60% is treated, with large-scale enterprises accounting for the majority. (Raveesh et al., 2015). Due to the regional water shortages, several companies have been discovered to use water recycling technologies. Common Effluent Treatment Plants (CETP) have been built up for clusters of small size companies that may not be able to pay the expense of a waste water treatment facility (CPCB, 2005). Some of the treatment techniques employed in these facilities include dissolved air floatation, dual media filter, activated carbon filter, sand filtration and tank stabilisation, flash mixer, clariflocculator, secondary clarifiers, and sludge drying beds. Traditional wastewater treatment systems are expensive and difficult to operate and maintain. (Dhingra et al., 2015).

Scenario in State

There are 193 Urban Local Bodies (ULBs), 295 Panchayat Samitis, and 9,892 Gram Panchayats throughout Rajasthan's 33 districts (GPs). According to the 2011 Census, the state's population is 6.86 crores, with 24.78 percent living in urban areas and 75.13 percent in rural areas. The discharge of untreated industrial effluents has resulted in groundwater pollution in numerous areas of Rajasthan. (Nandan et al., 2017).

Governance and Management Structure

The various concerned institutions involved in the process of Industrial Waste Management are: Central Pollution Control Board; Department of Environment Science and Technology; Ministry of Environment, Forest and Climate Change; Central Public Health and Environmental Engineering Organization; the Energy and Resource Institute and; Ministry of Housing and Urban Affairs.

Roles and Responsibilities

Central Pollution Control Board

Responsibilities include regulating and managing air, water, and noise pollution in order to maintain acceptable levels of ambient air quality, water quality and noise level.

Department Of Environment, Science and Technology

Through regulation, policy formulation, and supervision and monitoring, responsible for planning, coordinating, promoting/overseeing environmental, science and technology, pollution prevention, abatement, and control activities and programmes for environmental protection, conservation, and enhancement using innovative technologies.

Ministry of Environment, Forest and Climate Change (MoEF&CC)

Responsible for the successful execution of legislation, with a focus on waste reduction, source segregation, recycling, and waste pickers, recyclers, and waste processors' participation in the collecting of plastic waste fractions from households and other sources of generation.

The Energy and Resource Institute (TERI)

Dedicated to developing technology and solutions that reduce waste creation while also converting all waste into usable commodities. Its goals include encouraging the circular economy in industries through boosting resource-efficient and clean production, as well as improving resource recovery and recycling for landfill-free communities.

Ministry of Housing and Urban Affairs (MoHUA)

Increasing the ability of Urban Local Bodies (ULBs) through infrastructure development, capacity training, and communication, with an emphasis on various aspects of solid waste management and holistic sanitation, such as wastewater treatment.

Responsibility of Local Body

Urban local governments may collect, transport, and dispose of solid waste on a cost-recovery basis in accordance with existing laws, and they may choose acceptable sites for final treatment and disposal of industrial solid waste in accordance with existing rules.

Responsibility of State Pollution Control Board (As Per Rule 12)

Management of Industrial Solid Wastes-Coordination (RSPCBs & Local Bodies) (CPHEEO, 2016): Inventorisation of industries could be attempted through Rajasthan State Pollution Control Board (RSPCBs) or industries department for characterization of wastes. Rajasthan State Pollution Control Board (RSPCBs) may take necessary actions for issuance of consents/Authorizations to the industries under relevant Acts and Rules. The State Pollution Control Board's primary goal is to enhance air quality, promote water body purity, and avoid pollution (CPHEEO, 2016a).

Rules and Regulations

The water (prevention and control of pollution) act 1974

Allow the SPCBs to establish and maintain site and source-specific wastewater discharge standards. The real enforcement mechanisms, such as fines, imprisonment, and so forth, are limited to source-specific regulations for particular polluters (GOI, 1974).

The air (prevention and control of pollution) act 1981

The Board is responsible for preventing, reducing, and regulating air pollution in the country, as well as providing advice to the Central Government. It is in charge of creating and executing a national plan for air pollution prevention, control, and reduction. The goal is to advice the central government on matters pertaining to air and air pollution, advice and support state boards in carrying out their functions, carry out research related to air pollution, and spread awareness and information about air and air pollution through mass media (GOI, 1981).

The Environment (Protection) Act, 1986

The Environment (Protection) Act of 1986 gives the federal government the authority to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the development and/or operation of any industrial facility for environmental reasons (GOI, 1986).

Hazardous Waste Management Rules, 2016

To distinguish between Hazardous Waste and other wastes, rules have been established. Trash tires, paper waste, metal scrap, old electronic products, and other wastes are all recognized as resources for recycling and reuse. These resources enhance industrial operations while reducing the burden on the country's virgin resource. The hierarchy of waste management has been integrated, with the top priorities being prevention, minimization, reuse, recycling, recovery, co-processing, and safe disposal. The essential need of infrastructure to protect public health and the environment from the waste processing sector has been established as Standard Operating Procedures (SOPs), which must be followed by all stakeholders and ensured by the SPCB/PCC when giving such authorization. The procedure for establishing a hazardous waste disposal facility and importing other wastes has been streamlined by combining all permissions into a single window clearance. The following are the state government's responsibilities for ecologically solid waste disposal of hazardous and other wastes: Set up/ allocate industrial space or sheds for hazardous or other trash recycling, pre-processing, and other uses. Workers participating in recycling, pre-processing, and other usage operations must be registered. To establish labor groups to make the installation of such facilities easier. To carry out industrial skill development operations while also ensuring worker safety and health (GOI, 2016).

Environment (Siting for Industrial Project) Rules-1999

The Environment (Siting for Industrial Projects) Rules, 1999, contain detailed provisions relating to areas to be avoided for industrial project siting, site selection precautions, and environmental protection aspects that should have been incorporated during the implementation of industrial development projects (GOI, 1999).

The National Environment Appellate Authority Act, 1997

An Act to create a National Environment Appellate Authority to hear appeals relating to the restriction of areas in which any industries, operations, processes, or processes shall not be carried out or shall be carried out subject to certain safeguards under the Environment (Protection) Act, 1986, and for matters related there to (GOI, 1999).

Best Practices

The best practices for Common Effluent Treatment Plants are described in this section (CETP). Rapid industrialization is critical for a country's economic development, especially in emerging markets, but it also has a global environmental impact. If industrial wastewater is not properly treated, it can have harmful environmental implications. To reduce pollutants released by industry, cleaner manufacturing techniques and waste reduction initiatives are encouraged. CETPs (Common Effluent Treatment Plants) are one of the wastewater treatment options available to small and medium-sized industries (H. D. Sharma et al., 1995). The main objective of establishing CETP are: To reduce the treatment cost for individual units while protecting the environment, To achieve ‘Economies of scale’ in waste treatment, thereby reducing the cost of pollution abatement for individual factory, To minimize the problem of lack of technical assistance and trained personnel as fewer plants require fewer trained personnel, To solve the problem of lack of space as the centralized facility can be planned in advance to ensure that adequate space is available, To reduce the problems of monitoring for the pollution control boards, To organize the disposal of treated wastes and sludge, and To improve the recycling and reuse possibilities. Till 1990, India had only one CETP in Jeedimetla near Hyderabad (Andhra Pradesh). Till 2005, around 88 CETPs had been established across the nation. The number of CETPs rose to more than 150 by the year 2011 (DOIFODE & MATANI, 2015).

Effluent Treatment Technologies

Wastewater depending on its characteristics is subjected to different treatment options as shown in fig. 7.1.

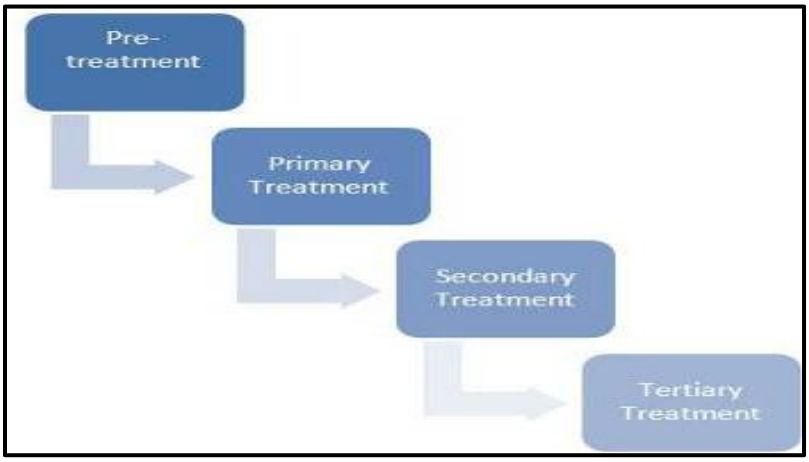


Figure 7.1 Effluent Treatment Technologies

Preliminary treatment is required to remove coarse particles and other large items from raw wastewater. Large materials are removed using screens and grates, coarse particles are ground using comminutors, and odour is controlled using pre-aeration. Before transferring the effluent to CETP for further processing, member industries may execute on-site preliminary treatment. CETP's performance can be improved by conducting preparatory treatment or pre-treatment in individual member industries.

To physically separate suspended elements from wastewater, primary clarifiers are used. This approach can minimize total suspended solids (TSS) and related biochemical oxygen demand (BOD). Primary treatment is to remove organic and inorganic solids that settle through sedimentation, as well as floatable materials (scum) by skimming. About 25 to 50 percent of the incoming biochemical oxygen demand (BOD5), 50 to 70% of the total suspended solids (TSS), and 65 percent of the oil and grease are removed during primary treatment. For advanced primary treatment, chemicals such as flocculants and coagulants are added to enhance the removal of suspended solids and, to a lesser extent, dissolved solids

After the preliminary and primary treatment units, wastewater stream is subjected to secondary treatment which mainly degrades organic matters (in solution or suspension). During this process, microbes degrade floating and dissolved organic molecules in wastewater. The most often used biological treatment techniques are activated sludge or biological filtration. Biological therapy can be aerobic, in which bacteria need oxygen to thrive, anaerobic, in which bacteria can grow without oxygen, or facultative, in which bacteria can grow in the presence or absence of oxygen. Microorganisms can be adhered to the surface, as in a trickling filter, or they can be suspended in a liquid suspension, as in the activated sludge process. The activated sludge process is an aerobic biological treatment method that utilizes the suspension development of aerobic bacteria to breakdown organic pollutants.

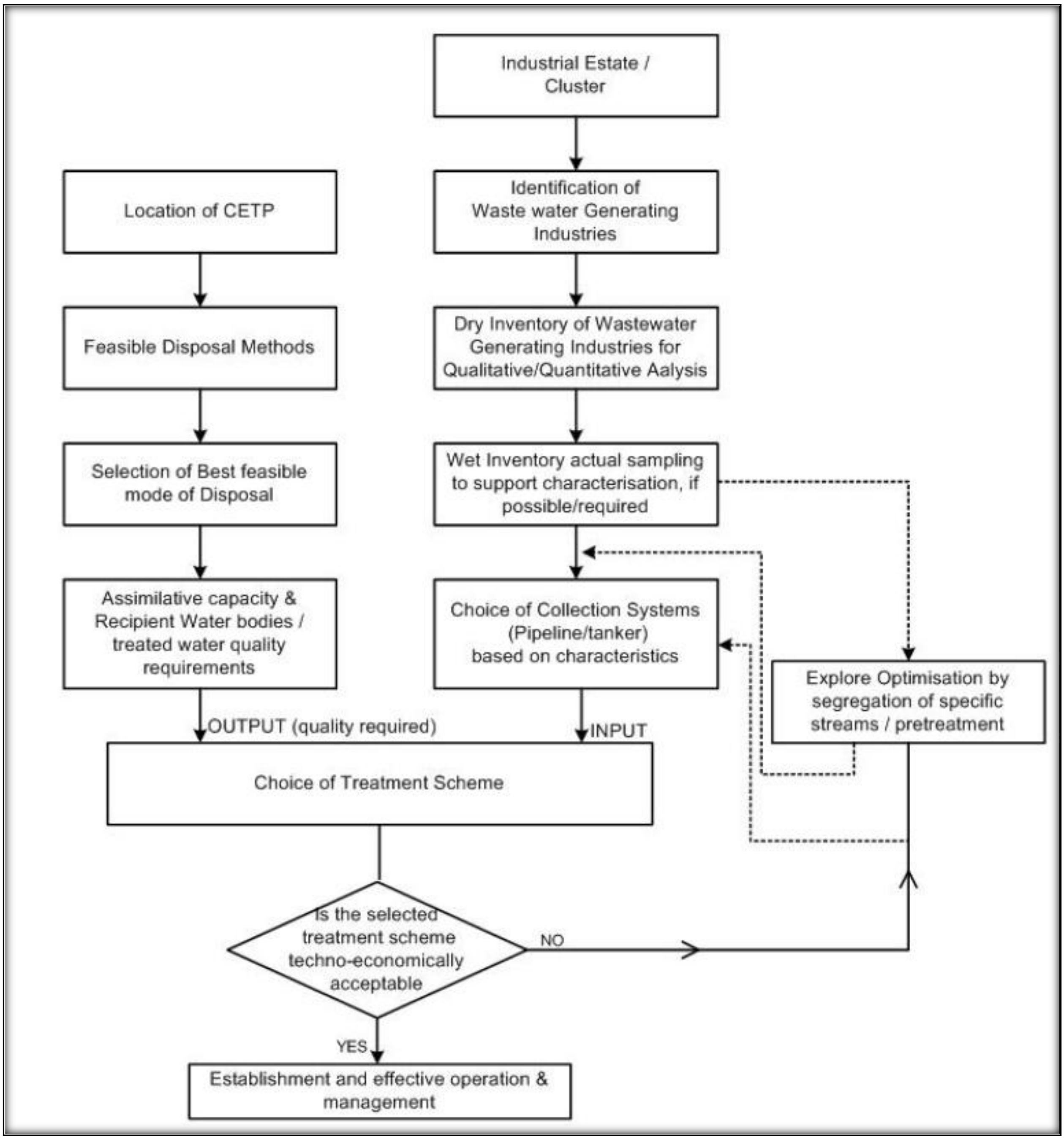


Figure 7.2 Planning Process of a CETP

Because anaerobic treatment systems do not use oxygen, they save energy by reducing the amount of energy required for oxygen generation and/or transmission. When sulphur is present, these reactions are slower than aerobic breakdown and create poisonous hydrogen sulphide gas. Although the initial cost is significant, biogas recovery can help to offset some of it. They are not commonly used in CETP wastewater treatment systems, except for sludge stabilization.

The final step in the wastewater treatment process is the tertiary treatment which improves the quality of the wastewater before it is reused, recycled, or discharged into the environment. Among other things, tertiary treatment polishes effluent (BOD, TSS), removes nutrients (N, P), and removes toxins (pesticides, VOCs, metals). Activated carbon adsorption, flocculation/precipitation, membrane filtration, ion exchange, de-chlorination, and reverse osmosis are all physical-chemical separation processes that can be utilised in tertiary treatment.

7.2 Present Scenario and Data Gap

Main industries in the Alwar district are Chemicals, Pesticide, Pharma, Automobile, Dye, Mettalurgical, Mines, etc. Micro and small-scale industries such as Gypsum Grinding, Plaster of Paris, Cotton Ginning and Processing, Cotton Spinning Mill, Solvent Extraction Plant, Particle Boards from cotton Stocks, Roller Flour mill, Straw Board, Processed Food/Achar and Murabba, Mini Dal Mill, Oil Refinery, Cattle Feed, etc. are situated in the Alwar district.

Data Provided by ULBs

As per the data provided by Alwar and Bhiwadi ULBs (Table 7.1), there are 446 industries which collectively generates 22.315 MLD of industrial wastewater. It has also found that CETP facility is not available in these two ULBs. Out of the total industrial wastewater generated, 1.188 MLD of untreated industrial wastewater is discharged in the Agyara Dam. Three industries in Alwar and 7 industries in the Bhiwadi region do not meet the discharge standards and are not able to treat the industrial wastewater at their facility. Apart from the data provided by the ULBs, it has also been noticed that the industrial wastewater is discharged in the open causing water clogging on the main road as shown in fig. 7.3. Table 7.1 and 7.2 present the current status of compliance by industries and action taken against those who does not meet the discharge standards shows that there are 10 industries in Alwar and Bhiwadi ULBs which does not meet the discharge standards and one industry is closed for exceeding standards in last 3 months.

Data for soil quality, ground and surface water, air quality should be provided for environmental assessment of Industrial Clusters based on Comprehensive Environmental Pollution Index (CEPI)

Table 7.1 Inventory of industrial wastewater Generation in Alwar

No.	Action Areas	Details of Data Requirement	Measurable Outcome	Please enter Measurable Outcome for District RO, RPCB, Alwar	Please enter Measurable Outcome for District RO, Bhiwadi(Tehsil-Tijara)
A	**Inventory of industrial wastewater Generation in District**				
		No of Industries discharging wastewater	[Nos]	193	253
		Total Quantity of industrial wastewater generated	[MLD]	10.315 MLD	Appox. - 12 MLD
		Quantity of treated IWW discharged into Nalas / Rivers	[MLD]	N/A	N/A
		Quantity of un-treated or partially treated IWW discharged into lakes	[MLD]	1.188 MLD is discharging in Agyara Dam	
		Prominent Type of Industries	[Agro based] / [Chemical – Dye etc.] / [Metallurgical] / [Pharma] / [Pesticide] / [Power Plants] / [Mining] / [Automobile] : Multiple selection based on size of operation and number	Chemical-65, Pesticide-2, Pharma-1, Automobile- 70, Dye-4, Mettalurgical-55, Mines-176	Chemical-96, Pesticide-4, Pharma-20, Automobile-85, Mettalurgical-48
		Common Effluent Treatment Facilities	[Nos] / [No CETPs]	NIL	NIL
B	**Status of compliance by Industries in treating wastewater**				
		No of Industries meeting Standards	[Nos]	190	246
		No of Industries not meeting discharge Standards	[Automatic]	3	7
		No of complaints received or number of recurring complaints against industrial pollution in last 3 months	[Nos]	NIL	
C	**Status of Action taken for not meeting discharge standards**	No of direction issued by SPCB[Nos]			
		No industries closed for exceeding standards in last 3 months	[Nos]	1	
		No of industries where Environmental Compensation was imposed By SPCBs	[Nos]	NIL	

Table 7.2 Status of compliance by Industries and action taken in treating wastewater

S. No.	Details of Data Requirement	Units	Outcome for District
1	No of Industries meeting Standards	Nos.	436
2	No of Industries not meeting discharge Standards	Nos.	10
3	No of complaints received or number of recurring complaints against industrial pollution in last 3 months	Nos.	NIL
4	No industries closed for exceeding standards in last 3 months	Nos.	1
5	No of industries where Environmental Compensation was imposed By SPCBs	Nos.	Nil

Inferences from Present Scenario

This section presents the inferences compiled from the data provided by the ULBs in Alwar district. As per the data provided there is no CETP functioning in the district but there is an CETP of capacity 9 MLD is already established by "Bhiwadi Jal Pradushan Niwaran Trust". CETP have advance treatment technology by the application of Reactor Clarifier, Rapid Gravity sand filter & ultra-filtration followed by Reverse Osmosis Technology (BJPNT, 2021). At present there are 3 industries from Alwar and 7 industries from Bhiwadi which are not meeting the prescribed wastewater discharge standards. Some rectification measures should be implemented immediately to meet the prescribed effluent discharge standards and environmental regulation for these industries.

During the site visit to Bhiwadi nagar parishad, it was found that the untreated industrial wastewater was discharged directly into the open area causing water clogging over the road as shown in fig.7.3. Industrial effluent dumped in the open area has very foul odors, unsightliness and bad odour affect the aesthetic value of our environment. The industrial waste is more hazardous as compared to municipal waste. However, it is confined to industries and hence can be easily managed. Moreover, small scale industries may be supported by the CETP unit and looking at the present scenario it is necessary to establish one such CETP unit for the Alwar ULB. As per the data provided by Alwar ULB, 1.188 MLD untreated industrial wastewater is discharged into the Agyara Dam, a surface water sources. This will result in the pollution of ground water as well as surface water. It also harms the aquatic life which caused ecosystem degradation.

Bhiwadi an industrial cluster with area of 5300 acres. is rapidly evolving into a bustling industrial and residential real estate hub in the Delhi-NCR region. The state government's and local authorities' expedited focus on boosting the suburb's socio-economic and infrastructural development is going to unlock the economic potential of Bhiwadi and drive the region's growth in the coming years. According to the data there are 193 and 253 industrial eatablishment at Alwar and Bhiwadi respectively. Rajasthan State Industrial Development and Investment Corporation (RIICO) on the other hand has been relentlessly developing clusters of industrial areas in and around the Bhiwadi region. As per the data, different categories of industries like Chemical, Pesticide, Pharma, Automobile, Dye, Mettalurgical, Mines etc. are functioning in the Bhiwadi and Alwar region. As per the Industrial Potential Survey by RIICO, units of large/medium and small scale sector have been registered in the district. Registered industries which are most polluting to the environment are presented in the table 7.3 (GoR, 2019).

Small-scale industries produce mass consumption items: wool, silk and synthetic fibre textiles, cotton textiles, chemical and chemical products, hosiery and garments, leather and leather goods, automobile components, paper products and printing, stationary items, plastic and rubber goods, safety matches, food products, paints and varnishes and domestic utensils. Among the sophisticated items, Small-scale industries produce televisions, calculators, surgical items and pesticide formulators among many others. These also produce a variety of parts and components required by large enterprises.

Table 7.3 Registered Small Scale Industries in District Alwar

S. No	Industry Description	Units
1.	Mining of Metal Ores	30
2.	Mfg of Food Products and Beverages	385
3.	Mfg of Textiles	42
4.	Mfg of Wearing Apparel; Dressing and Dyeing of Fur	222
5.	Mfg of Leather and Leather Product	65
6.	Mfg of Paper And Paper Products	60
7.	Mfg of Coke & Refined Petroleum Products and Nuclear Fuel	5
8.	Mfg of Chemicals and Chemical Products	75
9.	Mfg of Motor Vehicles, Trailers and Semi-Trailers	30
10	Repair & Maintenance of Motor Vehicle, Retail Sale of Automotive Fuel	35

To minimize the environmental pollution due to the small and medium-scale industries, cleaner production technologies and formation of waste minimization circles should be encouraged at the industrial clusters along with the centralized treatment facilities like CETP should be established to boost the industrial development as well as to keep the environment clean. As per the data provided, for industrial cities like Bhiwadi and Alwar which houses almost 500 industrial establishments there is no CETP available for the treatment of large quantity of the industrial effluent. The establishment of CETP at Alwar and Bhiwadi must be set on priorities.

Figure 7.3 Industrial Waste dumped in open at Bhiwadi ULB

7.3 Action Plan

To minimize the environmental pollution due to the small, medium and large scale industries, it is important to implement, Cleaner production technologies, Waste minimization methods and centers, and establishment of a Common effluent treatment plant (CETP). Collective treatment of effluent from a large number of small-scale facilities at a single site where the effluent undergoes similar treatment instead of what it would be subjected to individually. This helps in terms of land conservation, better treatment at one location, easy operation and maintenance, and shared expenses. CETPs should be designed to collect and treat effluent from a multitude of facilities, which require CETPs to deal with varying qualities and quantities of effluent.

For industrial city of Alwar and Bhiwadi where a large number of small and medium scale polluting industries are established, establishment of CETPs for treatment of effluents generated in clusters is very important.

The future action plans from different agencies for Alwar have been summarized in table provided below with time frame for implementation.

Table 7.4 Action Area for Industrial Waste Management

S. No.	Action points (Including source and mitigation measures)	Time frame for implementation	Suggested Responsible stakeholders/ Agency involved
1.	Monitoring of soil and Groundwater quality where industrial waste has been discarded without any scientific measures	Urgent	State Groundwater Board
2.	Installation of Flow meter / Water mater with each industrial unit for monitoring of compliance of the permitted discharge quality.	Urgent	Industrial Association, RIICO
3.	Periodic water audit of industries	Urgent	RSPCB and ULB
4.	Periodic audit of industries in regard to the industrial wastewater generated, quantity of industrial wastewater discharged, and quality of the discharged wastewater	Urgent	RSPCB and ULB
4.	Provision of potable water for affected villages, if any	Urgent	PHED
5.	Inventory of Industrial emission by doing survey of all industries to ensure inventory of emission	3-years	RSPCB
6.	Adequacy of Available Infrastructure for Pollution Control: (i) Air Pollution Monitoring and Control (ii) Industrial Waste water monitoring and Control (iii) Hazardous Waste Monitoring and Control	5-years	RSPCB
7.	Environment Compensation	21-year	RSPCB

There is a need for proper monitoring of the management of industrial waste so that further deterioration of the soil and water quality in the area can be prevented.

Suggested Interventions

It is necessary to close the gap between wastewater treatment technology vendors and industry professionals. For industries, the water metering and accounting system should be made stricter. Auditing of water and wastewater should be made mandatory. Industrial locations should be chosen with the least environmental and social effect in mind, and e-filing of the quantity of water utilized and wastewater released should be done. Industries should be informed about the most recent advances in wastewater treatment technology on the market. Desalination, ultrafiltration, Nano filtration, membrane bioreactors, and other sophisticated effective technologies should be rewarded with incentives. Subsidies for wastewater recycling and reuse should be made available to businesses. To minimize the environmental pollution due to the small, medium and large scale industries, it is important to implement cleaner production technologies, Waste minimization methods and centers, and establishment of the Common effluent treatment plant (CETP) in the industrial cluster zone.

It is necessary to do proper monitoring of scattered waste littered on the open ground. If this waste is already there, then it should be sent to landfill and if it discharged somewhere else it should meet the standards set by regulatory authority.

7.4 Summary

In summary there are 10 industries in the Alwar and Bhiwadi industrial area which does not meet the discharge standards. According to RSPCB, no CETP is functioning for the Bhiwadi and Alwar industrial area. Details for CETPs proposed for the industrial area is not provided. No proper mechanism is available or used for the handling of industrial wastewater and a very careless approach is used in the district for the industrial wastewater recycling as evident from the open discharge of the industrial wastewater. It is very important to make it compulsory for all the industries to follow the zero discharge policy or alternatively should be supported by establishing the Common effluent treatment plant (CETP) in the different industrial areas of the Alwar and Bhiwadi district on an immediate basis.

Table 7.5 Summary about Industrial Waste Management in Alwar District

Name of District	Present Status	Action Plan for future
Alwar	• 193 and 253 industries are discharging waste water in Alwar and Bhiwadi respectively. • Quantity of untreated and treated IWW is 10.31 MLD (Alwar), 12 MLD (Bhiwadi). • Quantity of un-treated or partially treated IWW discharged into lakes- 1.188 MLD is discharging in Agyara Dam for Alwar • Common Effluent Treatment (CETP) Facility has not been installed.	• Monitoring of soil and groundwater quality • Installation of Flow meter / Water mater with each industrial unit for monitoring of compliance of the permitted discharge quantity. • Periodic water audit of industries • Establishment of CETP units for both Alwar and Bhiwadi industrial area • Inventory of Industrial emission by doing survey of all industries to ensure inventory of emission • Utilization of Environment Compensation for pollution Control • Provision of potable water for affected villages.

8. Mining Activity Management Plan

8.1 Literature Review

A mineral is a crystalline element or chemical compound that has developed as a result of geological processes (Aznar-Sánchez et al., 2018). Mining, like agriculture, is one of the world's oldest industries. Mineral extraction has a long history in India, dating back to the Harappa culture. The abundance of minerals in the form of abundant rich deposits made the mining sector in India particularly conducive to growth and development. The minerals and mining business is a vital part of the Indian economy, as the country is rich in mineral resources. The country's quick growth rate necessitates the rapid development of the mining industry, which supports the majority of the manufacturing sector's basic industries. Mineral extraction and development are inextricably tied to other natural resources such as land, water, air, and forest (Scoble et al., 2003). As a result, the management of this valuable resource, as well as its optimal and cost-effective usage, are national priorities. The fundamental goal of a Mining Activity Management Plan is to formalise the actions and policies that, when done together, will keep environmental impacts to acceptable and sustainable levels in the medium and long term. Fig. 8.1 explains the waste generation in mining activities. Environment baseline studies have to be conducted in respect of micrometeorology, air quality, ambient noise levels, biological environment (flora & fauna), water quality, soil quality & socio-economics in the core and buffer zone of 10 km radius (Lèbre et al., 2017).

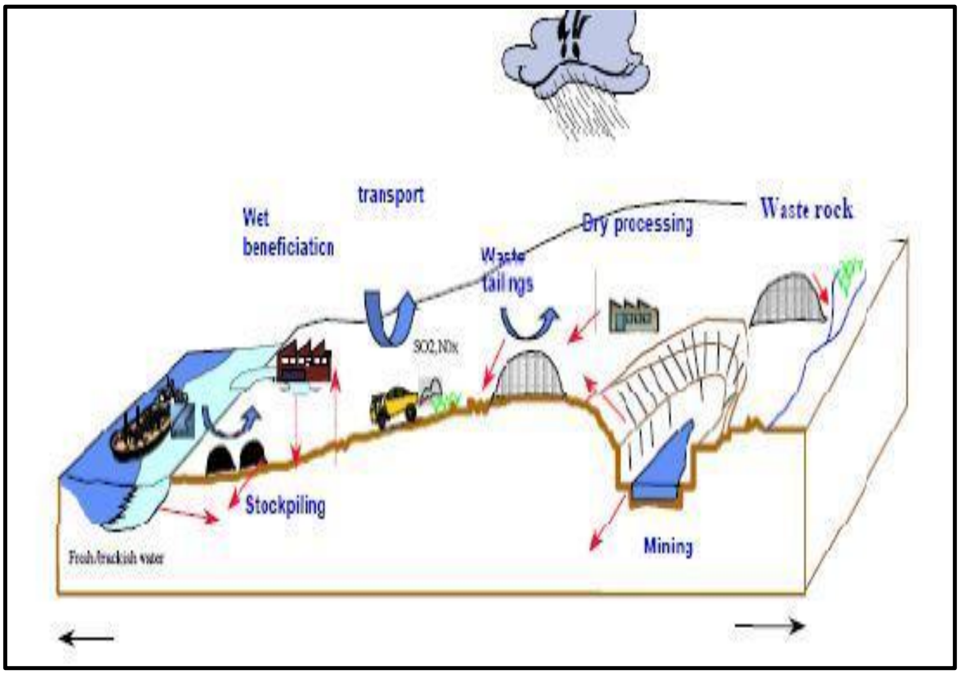


Figure 8.1 Waste Generation in Mining Cycle

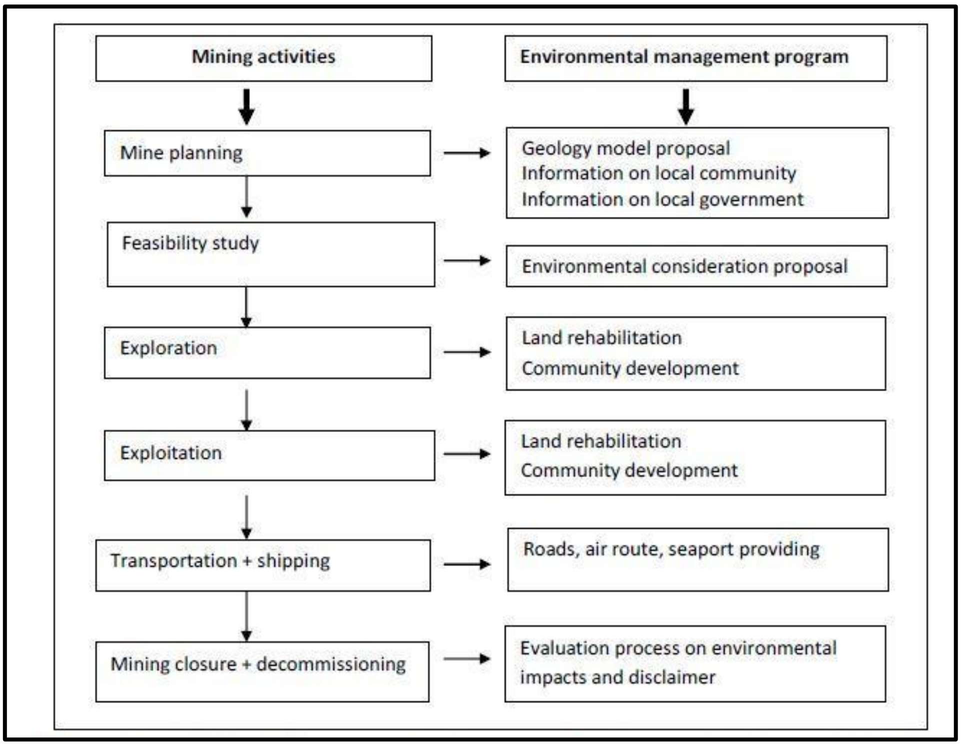


Figure 8.2 Methodology applied to good mining practice

Environmental Impacts of Mining projects

Impacts on water resources

The consequences of a mining project on water quality and availability of water resources within the project region have the greatest influence. Acid mine drainage and contaminant leaching have the greatest impact on water resources. Erosion of soils and mine wastes into surface waters, which has resulted in the loss of potential of soil and sediment eroding into and reducing surface water quality, is a critical problem (Nickel & Mandarino, 1987).

Impacts of mining projects on air quality

Airborne emissions occur at every stage of the mining process, but particularly during exploration, development, building, and operations. Large amounts of material are mobilised during mining operations, and waste piles containing minute particles are easily scattered by the wind. Mercury leaks by accident, as well as noise and vibration, are all major issues.

Impacts of mining projects on wildlife, Habitat fragmentation

The destruction of vegetation and topsoil, the displacement of wildlife, the release of pollutants, and the emission of noise all have an impact on the ecosystem and associated biota. Habitat fragmentation occurs when huge amounts of land are split up into smaller and smaller chunks, making native species dispersal difficult or impossible from one patch to the next and cutting off migratory routes.

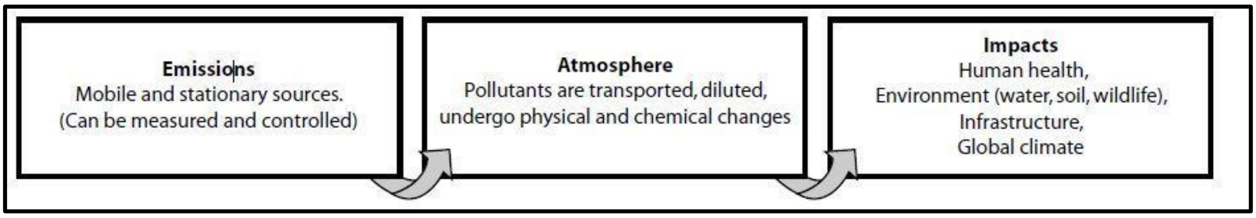


Figure 8.3 Impacts of mining projects on wildlife, Habitat fragmentation

Impacts of mining projects on soil quality, social values

Mining has the potential to contaminate soils across a vast area. Agricultural operations in the vicinity of a mining activity may be especially impacted. Erosion of exposed soils, mineral ores, tailings, and fine particles in waste rock piles can cause significant sediment loading in surface waters and drainage ways. In addition, hazardous substance spills and leaks, as well as the deposition of polluted windblown dust, can contaminate the soil.

Human displacement and Resettlement, lost access to clean water, impacts on public health, impacts on livelihoods

Displacement of settled communities is a major source of anger and conflict in areas where large-scale mineral exploitation is taking place. Entire communities may be uprooted and compelled to relocate, frequently to purpose-built towns that they did not want. Communities may lose their land, and hence their livelihoods, in addition to their homes.

Climate change Considerations

Large-scale mining projects have the potential to alter global carbon in at least the following ways: Many large-scale mining projects are proposed in heavily forested areas of tropical regions that are critical for absorbing atmospheric carbon dioxide (CO_2) and maintaining a healthy balance between CO_2 emissions and CO_2 uptake.

Suggestive Interventions for Mining Waste Management

During the construction of a trash dump, there are two significant issues that arise. The first is the availability of adequate land (that is technically, environmentally, and commercially viable), followed by the capacity to control the construction of that property. Technically suitable means that the land can accommodate the volume of trash and can endure ground bearing pressure. Allowable pollution of ground/surface water; restoration of top soil in both disposal and mining areas, among other things. Tailing and other finer waste can be disposed in various ways. By order of importance, the disposal of tailings is generally by:

Terrestrial Impoundment: The most common form of tailings disposal is by burying them in the ground. It has to do with fine trash and slurries like mill tailings. The goal of tailings dams (or ponds) is to dispose of tailings in a way that allows them to be reprocessed in the future (once improved technology or a significant increase price makes it profitable).

Underground Backfilling: This method is possible only for ore deposit without communication with an aquifer. Such an operation is usually costly and will be carried out for stability and safety reasons.

Deep Water Disposal: The disposal of tailings and solid waste directly into bodies of water although sometimes used in past operations, is rapidly becoming non-authorized as a standard practice due to the significant

Recycling: Depending on its geotechnical and geochemical qualities, coarse mining waste and especially barren rock are occasionally regarded as materials for roads, building foundations, or cement factories. Recycling is not the same as dumping. Solid waste is recycled 22%, 58 percent is dumped, and 7% is backfilled in the German potash industry; liquid waste is disposed of in deep wells and 5% is discharged into rivers. Waste rock may not have a market at this time. If a market develops later, the rock that has been temporarily stored can be sold as aggregate once environmental requirements are met. The tailings can be recycled using modern procedures. This strategy necessitates specific circumstances and effect assessments. In the medium term, scientists appear to agree that a correctly constructed underwater disposal of sulphide tailings is the optimal solution from an environmental standpoint, with control of the water level (Gadd, 2007).

Scenario in Country

According to the International Organizing Committee for the World Mining Congress's Report on Mineral Production, India ranked fourth among mineral producing countries, behind China, the United States, and Russia, in terms of volume of production in 2009. However, it ranked eighth in terms of value of mineral production in 2009. As a result, the mining industry is an important part of India's economy, accounting for around 2% of GDP. However, the sector's contribution to India's GDP has been declining. In 1992-93, the mining sector contributed 3.4 percent of India's GDP. In 1999-2000, it fell to 3.0 percent, and then to 2.3 percent in 2009-10. And, since the sector has shrunk in absolute terms in recent years, the mining sector's contribution to India's GDP has dropped to just 2% in 2012-13.

There are 87 minerals produced in India, including four fuel minerals, ten metallic minerals, 47 non-metallic minerals, three atomic minerals, and 23 minor minerals (including building and other materials). After a five-year average growth rate of 4.8 percent from 2006-07 to 2010-11, the industry has now experienced negative growth of 0.6 percent for two years in a row (2011-12 and 2012-13). In India, there are over 3000 mines. There are 560 coal mines (19% of total), 553 limestone mines (19% of total), and 316 iron ore mines in the country (11 percent of total number). They comprise about half of the total number of reporting mines. The number of mines engaged in extraction was also significant in cases of bauxite (189), manganese (141), dolomite (116) and Steatite (113).

Scenario in State

There are 193 Urban Local Bodies (ULBs), 295 Panchayat Samitis, and 9,892 Gram Panchayats throughout Rajasthan's 33 districts (GPs). According to the 2011 Census, the state's population is 6.86 crores, with 24.78 percent living in urban areas and 75.13 percent in rural areas. Rajasthan is today regarded as a mineral museum, with both metallic and non-metallic minerals, as well as renowned construction stones. It is in a unique situation since it has large radioactive mineral, lignite, petroleum, and natural gas deposits. Rajasthan is the richest state in the country in terms of mineral supply and variety, producing 57 different minerals. Rajasthan is the only state that produces lead and zinc ores, as well as selenite and wollastonite. Rajasthan was the only garnet (gem) producer until 2004-05. Rajasthan produces the majority of the country's calcite, natural gypsum, and silver. Ball clay, calcite, clay, copper ore/conc., feldspar, fireclay, limestone, ochre, phosphorite/rock phosphate, and steatite are all key products produced in the state. Marble, granite, sandstone, and Kota stone in various colours are also produced in large quantities throughout the state. The Makrana area is a world-renowned marble mining centre. Potash (94 percent), lead and zinc ore (89 percent), wollastonite (88 percent), silver ore (88 percent), gypsum (82 percent), ochre (81 percent), bentonite (75 percent), fuller's earth (74 percent), diatomite (72 percent), feldspar (66 percent), marble (63 percent), asbestos (61 percent), copper ore (54 percent), copper ore (54 percent), calcite (5 percent) are all resources (27 percent).

In 2014-15, the state produced roughly 12% of the total value of mineral production in the country, placing it second among the states. It was the only company that produced lead and zinc ores and concentrates, as well as selenite and wollastonite. During the 2014-15 fiscal year, the State recorded almost all of the country's silver production. Rajasthan was the leading producer of gypsum accounting for 99%, calcite 96%, phosphorite 95%, ball clay 92%, ochre 89%, talc/soapstone/steatite 82%, fireclay 36% and limestone 21% of the total production of respective minerals in the country. Besides, it was the second leading producer of copper concentrates contributing 41%, petroleum (crude) 24% and kaolin 16% of the nation’s output for the year 2014-15.

Governance and Management structure

Concerned Institutions

The Ministry of Mines (MoM), the Government of India is in charge of the whole minerals and mining sector in the country, including law, administration, policy formulation, and so on, for all mines and minerals other than coal, lignite, natural gas, and petroleum, as well as offshore minerals. Minerals are divided into two categories in India: minor minerals and big minerals. The power to

create minor mineral policy and legislation is wholly devolved to state governments, whereas the MoM is in charge of big mineral policy and law. The Ministry is responsible for the administration of the Mines and Minerals (Development and Regulation) Act, 1957 and rules made there under in respect of all mines and minerals other than coal, natural gas and petroleum. MoM through its attached office, Geological Survey of India (GSI), facilitates exploration, geological mapping and mineral resource assessment in the country. Indian Bureau of Mines (IBM), a subordinate office of the mom is mainly responsible for regulation of mining in the country. The Ministry also administers the Offshore Areas Mineral (Development and Regulation) Act, 2002 and rules made there under. Mineral concessions in India are granted to Indian nationals or entities incorporated in India only.
Attached Office / Subordinate Office: Geological Survey of India (Headquarters at Kolkata) is an attached office and Indian Bureau of Mines (Headquarters at Nagpur) is a subordinate office of the Ministry. Public Sector Undertakings: There are three Public Sector Undertakings under the Ministry of Mines, namely:-National Aluminum Company Limited (NALCO), Bhubaneswar Hindustan Copper Limited (HCL), Kolkata Mineral Exploration Corporation Limited (MECL), Nagpur Autonomous Bodies There are three Research Institutions which are Autonomous Bodies of this Ministry: Jawaharlal Nehru Aluminum Research Development and Design Centre (JNARDDC), Nagpur; National Institute of Rock Mechanics (NIRM), Kolar Gold Fields, Karnataka, and National Institute of Minerals Health (NIMH), Nagpur.

Roles and Responsibilities

National Mineral Policy, 1993

The National Mineral Policy was launched in March 1993 as part of the fiscal, economic, and trade reforms initiated by the Government of India in July 1991. The National Mineral Policy acknowledged the need of attracting state-of-the-art technology and fostering private investment, especially Foreign Direct Investment (FDI). The policy stated that the Central Government will continue to formulate legal measures for the regulation of mines and the development of mineral resources in consultation with state governments to ensure basic uniformity in mineral administration so that mineral resource development keeps pace with national policy goals.

Rajasthan Mineral Policy, 2015

The goal of the policy is to develop economically viable and stable mining, minerals, metal, and mineral reclamation sectors. Orderly and cost-effective development of indigenous mineral resources, reserves, and metals and mineral reclamation in order to meet industrial, security, and environmental needs Study and development of methods for the disposal, control, and reclamation of mineral waste products, as well as the reclamation of mined land, in order to reduce any negative effects of mineral extraction and processing on the physical environment that may arise from mining or mineral activities.

Rajasthan State Mines and Minerals Limited (RSMML)

Rajasthan State Mines & Minerals Ltd. is a company based in Rajasthan, India (A Govt. of Rajasthan Enterprise). With a corporate headquarters in Udaipur and a registered office in Jaipur, the company is involved in the mining and related business of various minerals, primarily Rock Phosphate, Lignite, Limestone, Gypsum, and other minerals. Rajasthan State Mines & Minerals Limited (RSMML) is one of the state's most innovative and forward-thinking businesses. It occupies a place of pride in production and marketing of non-metallic minerals in India. RSMML is multi mineral and multi-location enterprise engaged in mining of Rock Phosphate, Lignite, SMS grade Limestone and Gypsum. RSMML is a national leader in the mining and sale of Rock Phosphate and Gypsum, as well as a global pioneer in open-cast mining and mineral beneficiation of Carbonate Rock Phosphate. RSMML has also ventured into the energy sector, constructing a 106.30 MW installed capacity Wind Power Project in Jaisalmer, Rajasthan.

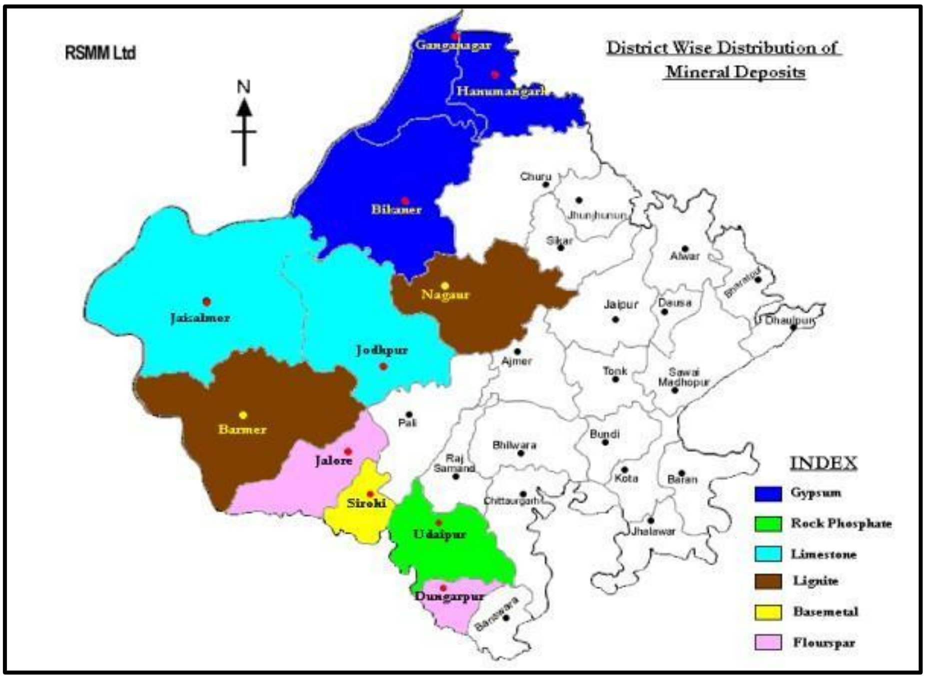


Figure 8.4 District wise distribution of mineral deposits

Mines and Minerals Development and Regulation (MMDR) Bill, 2011

The Bill seeks a comprehensive and holistic reform of the mining industry, including provisions to address issues such as sustainable mining and local area development, as well as a benefit sharing mechanism for those affected by mining operations. It also aims to ensure transparency, equity, the elimination of discretions, effective redresses and regulatory mechanisms, and incentives to encourage good mining practices. The Bill's main features are: it establishes a simple and transparent mechanism for granting a mining lease or prospecting license through competitive bidding in areas where mineralization is known, and on the basis of first-in-time in areas where mineralization is unknown; it establishes a simple and transparent mechanism for granting a mining lease or prospecting license through competitive bidding in areas where mineralization is not known; and it establishes a simple and transparent mechanism for granting a mining lease or prospect; It enables the central government to promote scientific mineral development, through mining plans and mine closure plans enforced by a central technical agency namely the Indian bureau of mines, as well as the regulatory authorities and tribunals; It empowers the state governments to cancel the existing concessions or debar a person from obtaining concession in future for preventing the illegal and irregular mining.

Geological Survey of India

The GSI is the primary agency in charge of assessing the country's geological and regional mineral resources. Scientific surveys and research with the purpose of discovering mineral resources are among its areas of operation. Six regional offices and four specialist wings – marine, coal geophysics, airborne surveys, and training – make up GSI. The GSI is responsible for geological mapping that covers approximately 3.146 million sq. km, or 94 percent of India's land area. The maps are 1:63,360/1: 50,000 scale, with the data synthesized to provide 1: 2,000,000 scale geological maps of India that have been correlated with the global set up in accordance with international standards. The GSI is also actively involved in mapping and exploration technology research and development. It has established a network of contemporary petrological, paleontological, chemical, mineralogical, geochronological, geotechnical, and geophysical laboratories across its several operational bases, which it makes available for a fee. Commercial geological maps and data are available through GSI.

Indian Bureau of Mines

The Ministry of Mines has formed a committee to evaluate and restructure the activities and role of the Indian Bureau of Mines (IBM) in accordance with the policy guidelines set forth in the National Mineral Policy, 2008. The Committee has created a draught report, which has been posted on the Ministry's website for stakeholders to comment on. The geological services of IBM include survey and preparation of mine plans, preparation of geological plans, preliminary geological appraisal of mineral properties, including the formulation of an initial scheme of detailed exploration with estimate of cost and preliminary reconnaissance, quick survey to determine potential areas out of large properties, etc. IBM also performs regulatory functions, namely: enforcement of Mines and Minerals (Regulation and Development) Act, Mineral concession Rules, Mineral Conservation and Development Rules and compliance with Environmental Protection Act. Separately, the IBM had obtained administrative clearance to fill up 86 scientific and technical previewed posts in various groups. Of these 29 posts have been filled up. The remaining posts are at various stages of being filled up.

Public Sector Undertaking (PSUs)

Mineral Exploration Corporation Ltd. (MECL): MECL is responsible for detailed exploration of various minerals/ ores by drilling and exploratory mining and proving reserves for their eventual exploitation. National aluminum Company Limited (NALCO), Bhubaneswar, Bharat Aluminum Company Limited (BALCO), New Delhi; Hindustan Zinc Limited (HZL), Udaipur; Hindustan Copper Limited (HCL), Kolkata; Mineral Exploration Corporation Limited (MECL), Nagpur; Bharat Gold Mines Limited (BGML), Kolar Gold Fields (Karnataka); Sikkim Mining Corporation (a Company jointly owned by the State Government of Sikkim and the Central Government); Research Institutions.

State Directorate of Mining and Geology

The State Governments have been asked to prepare an Action Plan for strengthening the State Directorate of Mining and Geology in accordance with the recommendation of the National Mineral Policy, in light of the increase in royalty revenues to the State Governments following the revision of royalty rates in August 2009. This topic is evaluated on a regular basis in the Ministry of Mines' Central Coordination-cum-Empowered Committee meetings, which include participation from state governments.

Geological Programming Board

The GSI's Central Geological Programming Board is currently in charge of coordinating government agencies' regional exploration efforts. Before being incorporated into the annual programme, the disaggregated projects are often addressed in State Level Committees and other technical forums. The National Mineral Policy of 2008 (NMP) mandated that the existing system be overhauled to guarantee that projects and programmes be prioritised in accordance with national policy goals and that private sector exploration work is taken into account. The Central Geological Programming Board has, since, been revamped and the Board will meet at least twice a year as part of the process to strengthen the linkage between the Central Geological Programming Board and the State Geological Programming Boards. The CGPB has held its latest meetings on 2nd and 3rd February, 2012. Accordingly, it is expected that the Central Board will effectively articulate the policy and programmatic requirements in a technically feasible and scientifically desirable manner, so that projects and programmes are prioritized in line with national policy goals and take into account and facilitate the exploration work of the private sector (MoM, 2008).

Initiatives/new developments for mining sector

Mining Tenement System (MTS)

The MTS was created with the goal of automating the different operations related with mineral concessions. The Scheme's goal is to create an online National Mineral Information System for investors by connecting Central and State agencies involved in mineral resource management in the country. The Mining Tenement System (MTS) would include both a graphical information database (GIS) and textual data. These two databases, the non-special database and the special database, would be smoothly merged such that graphical and textual information could be retrieved. As a result, the system will be web-enabled, and prospective investors, government entities, and the general public will be able to access it via the Internet, as per government policy. This would not only give the decision-making process a boost, but it would also increase transparency and efficiency. The MTS will not only allow for online application filing, but it will also aid in the identification of potential mineral concession regions. IBM has been named as the project's Nodal Implementing Agency by the Ministry. The Core Committee has already accepted MTS's Detailed Project Report (DPR). In addition, a request for proposals (RFP) for the design, development, maintenance, and operation of MTS was released. As a result, the retendering of the Request for Proposal (RFP) for the selection of an implementing agency for the design, development, maintenance, and operation of the Mining Tenement System is currently underway (MoM, 2017).

Mining within a Sustainable Development Framework (SDF)

The National Mineral Policy 2008, which finds a mention in the MMDR Act following its revision, includes a Sustainable Development Framework 2011 (SDF) for the mining sector, which includes suitable compensation for persons harmed by mining-related operations. The SDF framework was created with the International Council for Metals and Mining (ICMM) in mind, and it includes the following seven principles: Consider environmental and social concerns while making lease selections. At regular periods, conduct strategic assessments of significant mining regions. Sound management systems are used to manage affects at the mine level. Prioritize land, R&R, and other societal impacts. Encourage community involvement, benefit sharing, and socioeconomic development contributions. Ensure that mine closure planning, execution, and post-closure operations are completed in a timely manner, and that assurance and reliable reporting systems are in place.

At multiple levels, mining-related activities must be closely integrated with the economy, including aligning exploration and mining to maximise long-term efficient mineral production; improving the efficiency of the interface between mineral extraction and metal production to increase potential for manufacturing and jobs, as well as resource use efficiency; and promoting and incentivizing investment (MoM, 2011).

Mining Lease

An application for a mining lease shall be presented to the District Collector of the State Government concerned, along with the prescribed fee, for any area in which minerals vest in the government. The consent of the landowner and any individual with occupation rights over the land should be included in any such application. A mining lease is provided for the purpose of carrying out activities in order to obtain any mineral. It enables the development and production of minerals from ore deposits uncovered through prospecting and exploration. A Mining Lease is given for a minimum of 20 years and a maximum of 30 years for any mineral or designated group of linked minerals. A Mining Lease can be renewed for a maximum of 20 years each time. A person can be awarded a maximum area of 10 square kilometres in one or more Mining Leases in a State, but if the Central Government believes it is required for the development of any resource, the maximum area limit can be modified (GOI, 1957).

Central Government

The Central Government is required to take actions to conserve and develop minerals in India in a systematic manner, as well as to safeguard the environment by preventing and managing pollution produced by prospecting and mining operations. The Central Government develops guidelines to guarantee that mineral conservation and development are carried out without causing undue environmental harm (Section 18). The Government has the power of search, entry and inspection of mines and recovery of amounts due as arrears of land revenue (Sections 23B, 24 and 25) (GOI, 1957).

Sustainable development (SD)

SD is an all-encompassing, somewhat confusing notion that fundamentally signifies long-term economic and social development, with intergenerational equality as its core principle. All stages of the mine life cycle — exploration, mine planning, construction, mineral extraction, mine closure, and post-closure reclamation and rehabilitation – can benefit from sustainability concepts. The Central Government shall take all necessary actions to protect key mineral resources in the national interest, as well as to scientifically develop and utilise all mineral resources. The Central Government shall cause the development of a National Sustainable Development Plan in order to facilitate the scientific development and exploration of mineral resources, as well as to ensure environmental protection and pollution prevention and control from prospecting and mining-related operations.

In Canada, constitutional law requires the government and mining companies to engage in meaningful discussions with Aboriginal communities living on land where mineral extraction is planned. Mineral rights holders in South Africa must also plan for socio-economic development in the vicinity of their mining project. A Social and Labor Plan must be presented before mining and production rights can be granted, according to the mining law (Mineral and Petroleum Resources Act 2002 - MPRDA). The most pressing requirement in the Indian mining sector is to ensure that existing mining and environmental law is effectively, efficiently, and meaningfully implemented to ensure scientific mining, optimal mineral resource utilisation, and environmental integrity. The largest hindrance to the mining industry's long-term development appears to be the dual federal and state control over mineral administration, as well as the plethora of regulatory organisations with insufficient people and funding (GoSA, 2012).

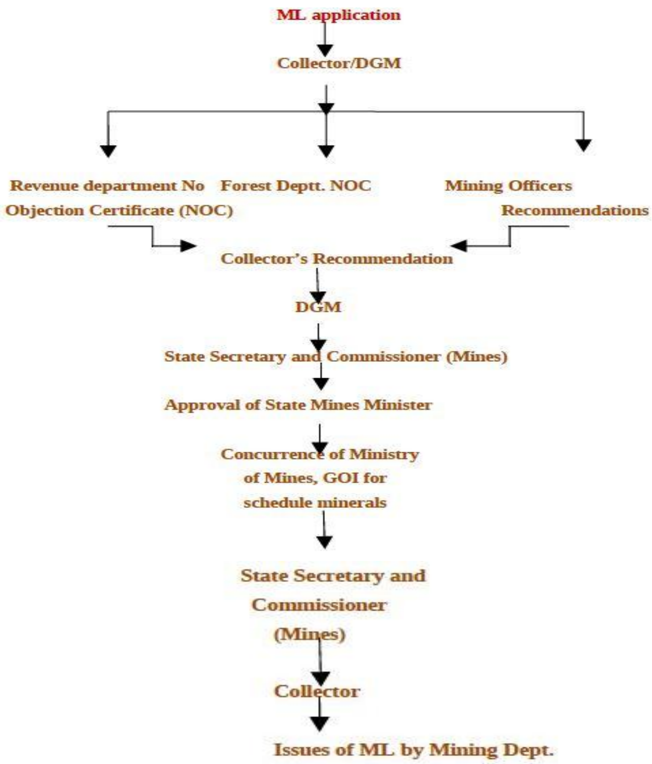


Figure 8.5 Issue of Mining Lease by Mining Department

Issues of resource efficiency and resource security in mining

The extraction efficiency of natural resources is one of the primary challenges in Indian mining. For "Making in India," "Exploring in India": Co-production of by-product metals from base metal ores through process R&D should be prioritised in order to effectively meet the country's needs for so-called Technology Metals and Energy Critical Metals, as well as provide raw material security and a competitive edge for the country's manufacturing sector. Developing a venture-capital-backed methodology To extract metals of strategic significance that occur in minuscule amounts, an R&D setup is plainly necessary. In the interest of extraction efficiency and resource securing, the introduction of the "Large Area Prospecting License (LAPL)" specifically for minerals other than iron ore, bauxite, limestone, etc. (bulk or surficial minerals) and for deep exploration, as well as providing a separate channel that allows the LAPL concessionaire to claim assured and direct mining rights (including transferability thereof), is necessary (TERI, 2019).

8.2 Present Scenario and Gap Identification

Data provided by ULBs

Data has been provided by the department of mining in Alwar district. Type of mining activities and other geographical details of the district.

Table 8.1 Mining Activity Datasheet

S.No.	Details of Data Requirement	Units	Outcome for District
A	**Inventory**		
3	Type of Mining Activity	[Sand Mining] / [Iron Ore] / [Bauxite] / [Coal] / Other [specify]	326(masonry stone marble, silica sand, granite, chart, soapstone, fireclay, dolomite, limestone)
		Multiple selection in order of magnitude of operations	
4	No of Mining licenses given in the district	[Nos]	326
5	Area covered under mining	[Sq Km]	570.2795hect.
6	Area of District	[Sq Km]	8380sq.km.
7	Sand mining	[yes] / [no]	No
8	Area of sand Mining	[River bed] / [Estuary] / [Non -river deposit]	Nil
B	**Compliance to Environmental Conditions**		
1	No of Mining areas meeting Environmental Clearance Conditions	Nos.	Monitring by RSPCB
2	No of Mining areas meeting Consent Conditions of spcbs / pccs	Nos.	Monitring by RSPCB
C	**Mining related environmental Complaints**		
1	No of pollution related complaints against Mining Operations in last 1 year	Nos.	Nil
D	**Action against non-complying mining activity**		
1	No of Mining operations suspended for violations to environmental norms	Nos.	Nil
2	No of directions issued by spcbs	Nos.	Nil
3	Provision of pollution abatement (Air/water/noise) budget allocated for environmental Protection		

Inferences from present scenario

This section presents the inferences compiled from the data provided by the ULBs in Alwar district. There is no mining operations suspension for violations the environmental norms. To prevent pollution by mining industry in the district, there is provision of providing spray, plantation in mining area by permit holders. Also, as per data provided by the mining department (Figure 8.6), all the operations are meeting environmental clearance conditions. Alwar district that has been adversely affecting the forests and also the nearby Sariska tiger reserve and Bharatpur bird sanctuary. All mining activity of minor minerals in district Alwar in relation to the site Tijara, Tapukada and Kishangarh are hereby prohibited. On December 20, 2018 the National Green Tribunal (NGT) ordered all mining activities within 10 km of the Sariska Tiger Reserve stopped (Pardikar, 2018).

Figure 8.6 Marble Industries in Ramgarh ULB (27°34'56.5"N 76°48'30.4"E)

Figure 8.7 Google Map Earth View of Marbel Industries at Ramgarh ULB

The mining impacts the society in a number of ways in Alwar district. The positive contribution may be noticed in the form of increasing income source, job creation increasing employment, migration, community formation, population growth and maintenance of social activities. The negative impacts include labor migration, loss of cultural heritage, and risk of health hazards and change of local population of the area by inviting labor from outside leading to income inequality among the employees, which further leads to community conflicts, and environment concerns. In addition to these, removal of vegetation, topsoil, waste and ore bring inevitable natural consequences such as deforestation, climate change, erosion, and air and water pollution. The most noticeable impacts on the ecosystem are degradation of land, deforestation, displacement of wildlife, effects on aquatic ecosystem, loss of habitat for biodiversity including rare flora and fauna. These impacts included land degradation, damage to water quality, pollution, and harm to livestock and wildlife biodiversity**.**

The lack of effective or adequate employee training compounds the negative impacts of closure, including inadequate job creation. Unemployment, loss of social services and amenities, pollution, disturbance of the landscape, the loss of land utility and increased risks to health and safety. The society living near mining industry is at higher risk of facing adverse effects of unplanned mine closure in near future illustrated abandoned mine sits after the closure of mining activities continue to pose potential threat to human safety, health and environment.

8.3 Action Plan

Suggested Interventions/ Strategies

To accomplish asset productivity, the Indian mining area is now anticipating receive progressed mine studying and investigation advancements (utilizing geophysics applications utilizing 2D and 3D seismic overviews) alongside the use of programming arrangements by using 3D programming bundles. Various literature indicates that improved mine closure and mine site rehabilitation planning are best mining procedures, identifies mining for closure as a sustainability issue, and is no longer simple an environmental issue.

After the closure mine, mining sites should be reused as recreational land, visitor attractions, creative gardens and lakes with the collaboration of mining companies, investors, and land use planners etc. to enhance the job opportunities for the local people. Mining must be environmentally sustainable by innovative methods that decrease the environmental impact caused by mining activities. These methods include parameters such as decreasing water and energy utilization, minimizing land mismanagement, water and air pollution at mine sites and maintaining prosperous mine closure and reclamation activities.

To eliminate these negative impacts or at least to minimize their effects, it is recommended to establish a geological study and advanced mining exploration at the deposits to be exploited future as well as evaluate their mining potential before start of exploitation. This will facilitate the choice of the exploitation method, better start mining operations, and ensure good ore recovery rate. Follow an exploitation technic well adapted to the morphology of the ore deposit. The chosen method must consider the different geometric and geotechnical parameters of the mineralization. Since the majority of deposits are favonian with high dip and competent surrounding rock, it is recommended to use the method of cut-and-fill mining and sublevel stopping. It will allow a good ore recovery rate and avoid having long and deep trenches that alter the appearance of the area. Cut-and-fill mining is suitable for a steeply dipping mineral deposit contained in a rock mass with good to moderate stability. It removes the ore in horizontal slices starting from a bottom cut and advances upwards, allowing the stop boundaries to be adjusted to follow irregular mineralization. Sublevel stopping (SLOS) is used for mining mineral deposits with; steep dip where the footwall inclination exceeds the angle of repose; stable rock in both hanging wall and footwall; competent ore and host rock; and regular ore boundaries. SLOS recovers the ore in large open stopes, which are normally backfilled to enable recovery of pillars. The orebody is divided into separates topes, between which ore sections are set aside for pillars to support the roof and the hanging wall. Pillars are normally shaped as vertical beams, across the ore body. Horizontal sections of ore are also left as crown pillars. These conditions correspond perfectly to that of the studied mines. Rehabilitate mining sites at the end of their life. The authorities should require operator rehabilitating abandoned sites for example by making a fence around the mine. It is also possible to transform the old mines to geoparks by their rehabilitation, thereafter; they can be open to tourists. To avoid these negative effects of barite exploitation on environment, it is recommended to establish a geological study and advanced mining exploration at the deposits to evaluate their mining potential before start of exploitation; follow an exploitation technic well adapted to the morphology of the ore deposit like cut-and-fill mining and sublevel stopping methods.

Role of Government in Forest Conservation: Although the government of every country is very particular about conservation of its forest resources and has several rules and laws for the protection of forests but, they are not implemented in an effective manner. Both national and provincial governments can take some steps in this direction, such as: passing acts for the conservation of forests, Survey of the forest resources, Categorization of forest areas and proper delimitation of reserved forest areas, Find out the areas where reforestation can be done, Regulate the commercial use of forest products, Protect forest from pre, mining and other natural calamities, Develop national parks, Encourage forests developmental activities like social forestry, etc., and Prepare master plans.

Table 8.2 Responsibility of the district with plan of Action

Responsibly of the district Committee/ Action Areas	Plan of Action	Responsibility
Preventing illegal mining	Identification of stretches where there are chances for illegal mining. Frequent checks in those stretches by the Taluk Level Task Force and submit reports to District Level Task Force fortnightly. To infuse greater transparency and enhance efficiency in grant of mining activity.	Department of mining
Mining related environmental complains.	District Level Task Force shall meet once in a month to discuss the illegal mining /transporting /damage caused to the environment and send report to State Level Proper policies, and regulations that govern Environment during mining and after mine closure.	Department of mining; RSPCB
No of Mining operations suspended for violations to environmental norms	District Level Task Force shall meet once in a month to discuss the illegal mining /transporting /damage caused to the environment and send report to State Level. No of Mining areas meeting Environmental Clearance Conditions	Department of mining; RSPCB
Closure of mines	Mining sites should be reused as recreational land, visitor attractions, creative gardens and lakes with the collaboration of mining companies, investors, and land use planners etc. to enhance the job opportunities for the local people.	Department of mining; RSPCB

8.4 Summary

The district has mining activities related to masonry stone, marble, silica, sand, granite, chart, soapstone, fireclay, dolomite, limestone. A total of 326 mining licenses have been authorized for the district. The summary of mining activities and action plan for future have been provided in Table 8.5.

Table 8.3 Summary Table for Mining Activity Management for Alwar district

Name of district	Present Status	Action Plan for future
Alwar	Type of Mining Activity - 326(masonry stone marble, silica sand, granite, chart, soapstone, fireclay, dolomite, limestone) Area covered under mining-570.2795 hect. Area of District: 380 Km² Sand mining: No Area of sand Mining: Nil	● Proper policies, and regulations that govern Environment during mining and after mine closure. ● Identification of stretches where there are chances for illegal mining, frequent checks in those stretches by the Taluk Level Task Force and submit reports to District Level Task Force fortnightly. ● District Level Task Force shall meet once in a month to discuss the illegal mining /transporting /damage caused to the environment during mining and after mine closure. Also send report to State Level regarding number of Mining areas meeting Environmental Clearance Conditions. ● Mining sites should be reused as recreational land, visitor attractions, creative gardens and lakes with the collaboration of mining companies, investors, and land use planners etc. to enhance the job opportunities for the local people.

9. Rural Environment Management Plan

This chapter aims to discuss the best practices for solving environmental problems in rural areas. It also discusses the soil and land management practices and their effects.

Waste generation and other problems in urban and rural areas are different. In rural areas, services do not exist at all in many cases and economic and social barriers prevent many people from accessing basic services. However, realizing the value of small or intermittent waste streams also has great potential benefits for rural communities. For example, decentralized resource recovery systems can be developed, especially sewage, food, livestock and agricultural waste (Baguma et al., 2010). Villagers have been recovering resources from the waste stream for a long time, but it cannot be done systematically. Soon, population growth and improved living standards will hinder people's food, water and energy supply. Innovation is needed to increase supply, improve distribution, reduce waste, increase efficiency, and reduce demand in rural areas. Because the relationship between food, water and energy is so closely intertwined, possible solutions or needs in one area are often reflected in another area. Rural communities actively participated in cooperation with village committees and regional administrative departments, and many successful cases were produced.

9.1 Literature Review

9.1.1 Soils of India

India is a country of varied conditions of geology, relief, climate and vegetation. Therefore, India has a large variation in soil groups, particularly different from one another. Indian soils classification is based on various criteria: -geology, relief, fertility, chemical composition and physical structure, etc. The formation of the soil in a particular climate is so perfect that each climate type has its soil type.

The Indian Council of Agricultural Research (ICAR) is responsible for setting up an All-India Soil Survey Committee in 1963 which divided the Indian soils into eight major groups: **i)** Alluvial soils **ii)** Black soils **iii)** Red soils **iv)** Laterite and Lateritic soils **v)** Forest and Mountain soils **vi)** Arid and Desert soils **vii)** Saline and Alkaline soils and **viii)** Peaty and Marshy soils.

These Indian soils classification has gained wide acceptance over the years.

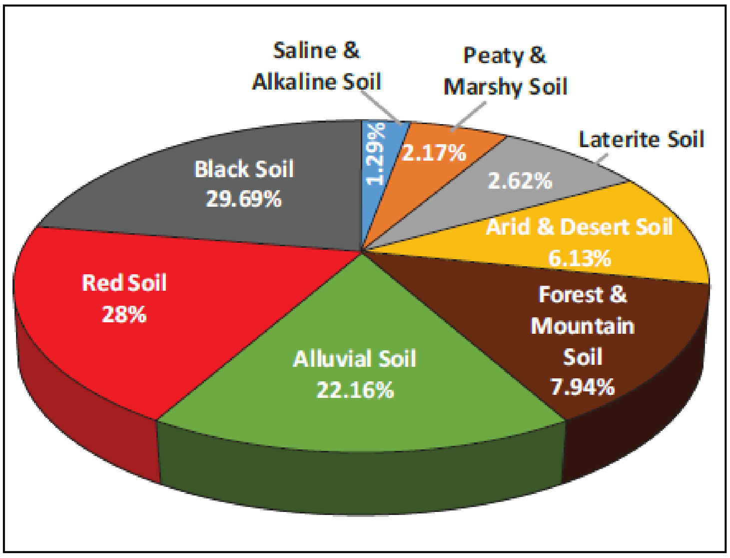


Figure 9.1: Major Soil types and their percentage in India (Maps of India, 2021)

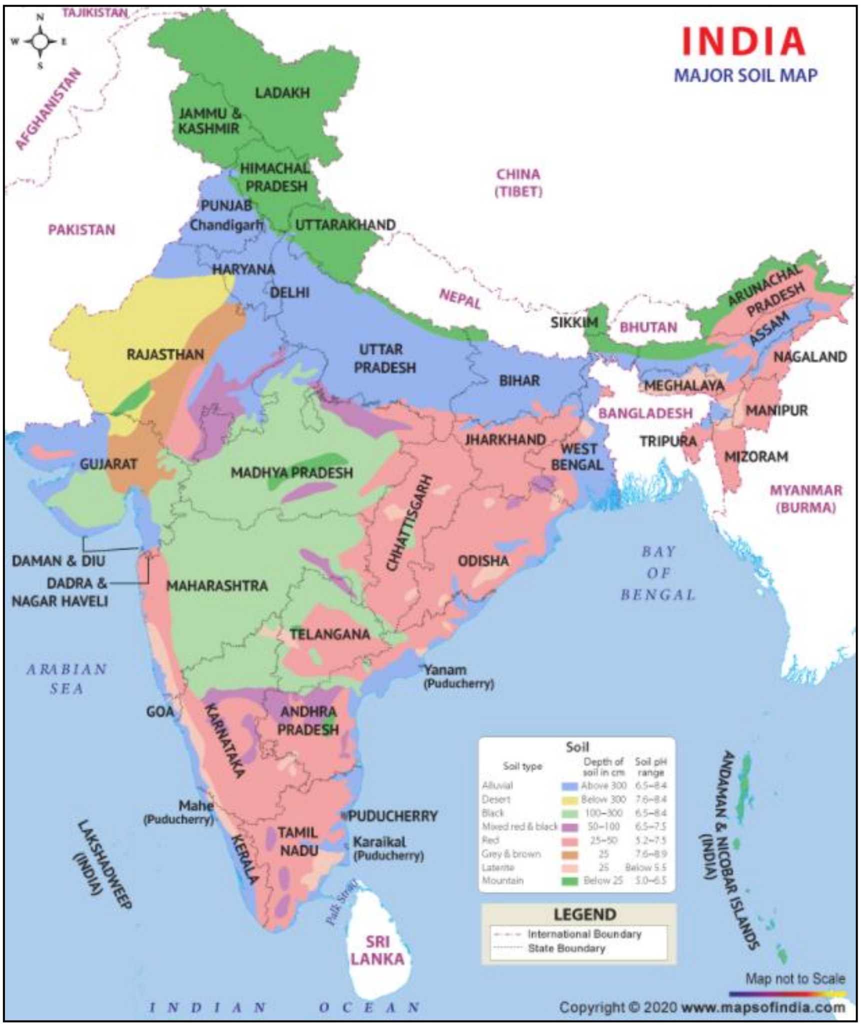


Figure 9.2 Soil Map of India (Maps of India, 2021)

9.1.2 Agriculture in India

India's economic security has been majorly dependent upon the agriculture sector, and the situation is unlikely to alter in the estimative future. At the time of independence, about 75% of the population was dependent on agriculture and even to date, agriculture is the support system for 58% of the population. During this period, the contribution of agriculture and the allied sector to the Gross Domestic Product (GDP) has fallen from 61 to 19%. To date, India provides a support system to 16.8% of world's population based on 2.3% of global land and 4.2% of the world's water resources. And per capita the availability of resources is about 4 to 6 times less as compared to the overall world's average. This is likely to further decrease due to increasing demographic pressure and consequent diversion of the land for non-agricultural uses.

As compared to 11% of the world average, around 51% of India's geographical area is already under cultivation. The current value of cropping intensity of 136% has recorded an upsurge of only 25% since independence. Also, out of the total net sown area, 65% is constituted by rain fed dry lands. Along with the fall in the rate of growth of total factor productivity, there is also an exceptional dilapidation of land (107 million ha) and groundwater resources. This slowing down needs to be attended and agricultural efficiency has to be doubled to meet growing demands of the population by 2050. Efficiency-mediated upgrading in productivity is the most feasible option to raise production.

India recorded remarkable achievements in agriculture during three decades, ever since the onset of green revolution in the late sixties, thus enabling the country to overcome extensive hunger and starvation; achieving self-sufficiency in food; reducing poverty and bringing economic alteration in millions of rural families. However, this situation started turning contrary for the sector around mid-nineties, with slowdown in growth rate of output, which then resulted in inactivity or even decline in farmers' income leading to agrarian anguish, which is dispersing and turning increasingly serious.

The provider for sustainable production, natural resource base of agriculture, is shrinking and degrading, and is adversely affecting production capacity of the ecosystem, however, the demand for agriculture is rising rapidly with increase in population and per caput income and also for the growing demand from industrial sector. Thus, there is an urgent need to identify severity of problems faced by the agriculture sector, to re-establish its vigour and put it back on higher growth trajectory. The problems, are however surmounted, particularly when upgraded and fresh tools of science and technology have started proposing great opportunities for application in agriculture.

The projected production requirements of various agricultural commodities in India by 2020-21:

Table 9.1 Projections of various food products demand in India for 2020-2021(million tonnes) (Ch. Srinivasa Rao & Sumanta, 2014)

Commodity	Base year (2004-2005)	Projection (2020-21)
Cereals	192.8	262.0
Pulses	14.2	19.1
Food Grains	207.0	281.1
Milk and Milk Products	91.0	141.5
Egg(number billion)	44.1	81.4
Meat	6.0	10.9
Fish	5.9	11.2
Edible Oilseeds	35.5	53.7
Vegetables	90.6	127.2
Fresh Fruits	52.9	86.2
Sugar (in terms of Cane)	262.3	345.3

The above table (table 9.1) indicates manifold increase in demand of various food products, primarily owing to increase in population compared to the base year. These demands increasing the avenues of production and agricultural yield. In order to ensure that the projected demands are met India needs intervention strategies at national, state and local level which can drive the anticipated agricultural development towards sustainability.

In comparison to many parts of the world, yield gaps in India have been much higher. Due to changes in management, soil type, climatic parameters, varietal performances and many more, yield performances of crops at diverse places may vary extensively. A yield gap equal to present national average yield, is being faced by major cereal and pulse crops of India, as observed in multi-location demonstrations and simulation models (ICAR, 2007).

Agricultural zones in India

As a part decision of the Seventh Plan, the Planning Commission, has divided the country into fifteen wide-ranging agro-climatic zones based on physiography, soils, geological formation, Climate, cropping patterns, and improvement of irrigation and mineral resources for broad agricultural planning and developing future strategies. These zones are further divided into more homogeneous 72 sub-zones. In these, fourteen regions are in the main land and the remaining ones in the islands of Bay of Bengal and the Arabian Sea.

The integration of plans of the agro-climatic regions with the state and national plans for enabling and enhancing policy development based on techno-agro-climatic criterion and considerations, was the main objective of the planning commission. Further sub-regionalization based on agro-ecological parameters, is possible in the agro-climatic regional planning (PCI, 1989).

Table 9.2 Yield Gaps in dryland agriculture in India (Ch. Srinivasa Rao & Sumanta, 2014)

Crop	**Average Yield (t/ha)**		**Yield Gap (t/ha)**
	National Demonstration	**National Average**	
Cereals			
Kharif	1.40	0.78	0.62
Rabi	1.73	0.92	0.81
Millets	0.92	0.61	0.31
Pulses	0.75	0.35	0.40
Oil Seeds			
Edible Oilseeds	0.60	0.34	0.26
Castor Bean	0.52	0.23	0.29

Assessing the average yield especially in dryland agriculture, India has a yield gap, this factor can be addressed by plans and policies directed towards agricultural production enhancement and introducing enabling technologies best suited and adopted to India context.

ICAR launched National Agricultural Research Project (NARP) for the objective of initiating agricultural research in the agro-climatic zones of the country. The main persistence of NARP was the setting up or up gradation of a zonal research station in every agro-climatic zone, for producing location specific, need based research data, particularly targeting the specific agro-ecological situations. The main focus was on scrutinizing agro-ecological conditions and cropping patterns and emerge with a programme directly targeted to solve the major hold-ups of agricultural growth in a particular zone, based on natural resources, major crops, farming systems, production restrictions and socio-economic conditions dominant in the zone. More stress was implied upon the generation of technology. As per NARP, the division of the country was into 127 agro-climatic zones.

Table 9.3 Agro-climatic Regions/zones in India (PCI, 1989)

S.No.	**Agro-climatic region / Zone**	**States Represented**
1	Western Himalayan Region	Himachal Pradesh. Jammu and Kashmir, Uttarakhand
2	Eastern Himalayan Region	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, West Bengal
3	Lower Gangetic Plain Region	West Bengal
4	Middle Gangetic Plain Region	Uttar Pradesh, Bihar
5	Upper Gangetic Plain Region	Uttar Pradesh
6	Trans Gangetic Plain Region	Chandigarh, Delhi, Haryana, Punjab, Rajasthan
7	Eastern Plateau and Hills Region	Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, West Bengal
8	Central Plateau and Hills Region	Madhya Pradesh, Rajasthan, Uttar Pradesh
9	Western Plateau and Hills Region	Madhya Pradesh, Maharashtra
10	Southern Plateau and Hills Region	Andhra Pradesh, Karnataka, Tamil Nadu
11	East Coast Plain and Hills Region	Andhra Pradesh, Odisha, Puducherry, Tamil Nadu
12	West Coast Plain and Ghat Region	Goa, Karnataka, Kerala, Maharashtra, Tamil Nadu
13	Gujarat Plain and Hills region	Gujarat, Dadra & Nagar Haveli, Daman & Diu
14	Western Dry Region	Rajasthan
15	Island Region	Andaman & Nicobar Islands, Lakshadweep

Agro-ecological regions by the National Bureau of Soil Survey & Land Use Planning (NBSS & LUP):

Another classification for the agro-ecological zones was suggested by the National Bureau of Soil Survey & Land Use Planning (NBSS&LUP) which came up with twenty zones based an integrated criteria of soil groups and effective rainfall. Adjustment to district boundaries was done with respect to these delineated boundaries, with a minimal number of regions. Further sub- division of these twenty agro-ecological zones, resulted in the formulation of 60 sub-zones (PCI, 1989).

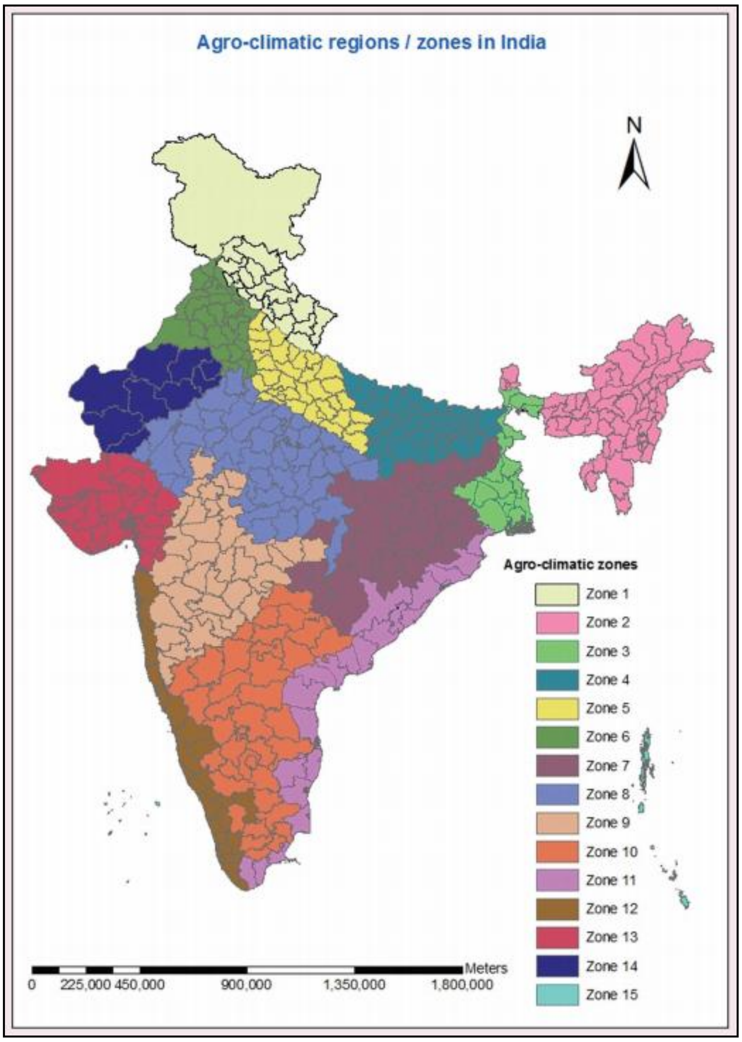


Figure 9.3 Agro-climatic Regions/zones in India as per the planning commission (PCI, 1989)

9.1.3 Present Scenario in Rajasthan

Soils and Agro-climatic zones of Rajasthan

Our state of Rajasthan has been divided into 10 agro-climatic zones by the Indian Council of Agricultural Research. These zones are classified on the basis of agro-climatic parameters like rainfall, temperature regime, topography, soil characteristics, cropping pattern and irrigation availability.

Agriculture in Rajasthan

Being the largest state of India, Rajasthan is gifted with assorted soil and weather conditions which comprise of several agro-climatic situations thereby helping the state to adopt differentiated and diverse cropping and agricultural implementation pattern. Apart from being India’s largest production house of mustard, pearl millet (bajra), Rajasthan is also the largest producer of three spices (coriander, cumin, and fenugreek), cluster beans, and isabgol. The state is also the second-largest producer of maize in the country. The state of Rajasthan encompasses a substantial area for vegetable crops. The state also comprises of the second largest herd of livestock amongst all the other Indian state, thereby contributing to about 10 per cent of the country's milk and 30 per cent of the country's mutton produce. This diversification helps the state in the management of wide range of risks linked with dryland agriculture. The state, however, faces many hindrances that are to be systematically addressed for the facilitation of sustainable development of the sector (Hussain, 2015).

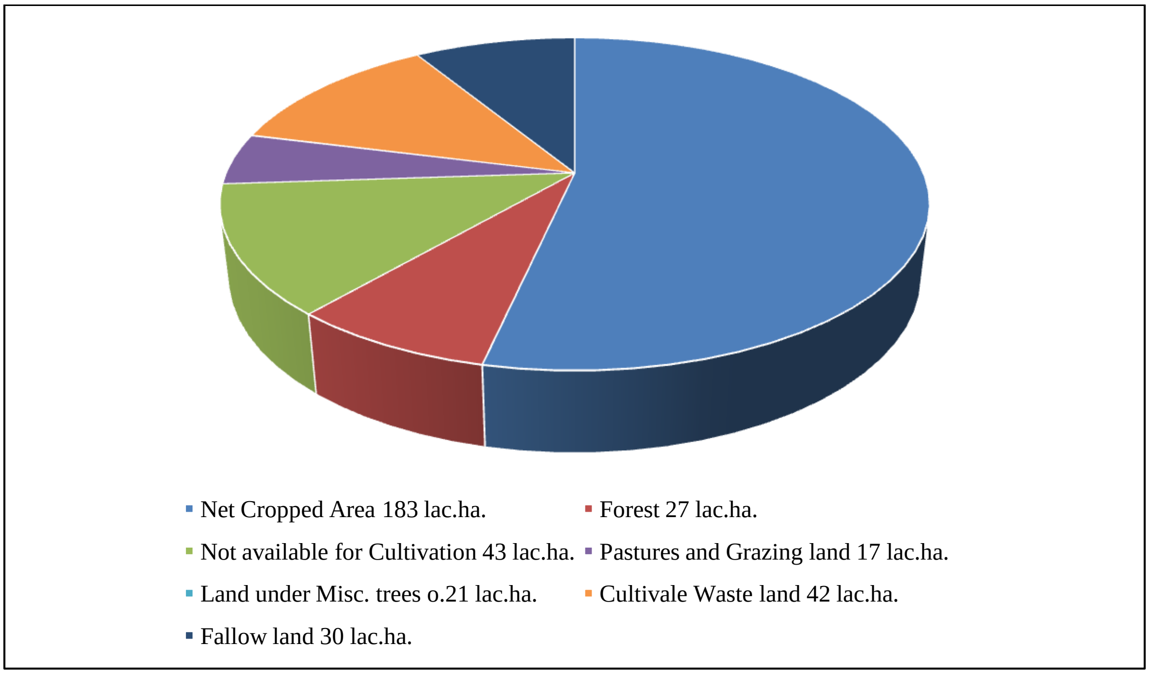


Figure 9.4 Land use Area (lac. Ha.) pattern in Rajasthan (as per 2016 Statistics) (DoA, 2021)

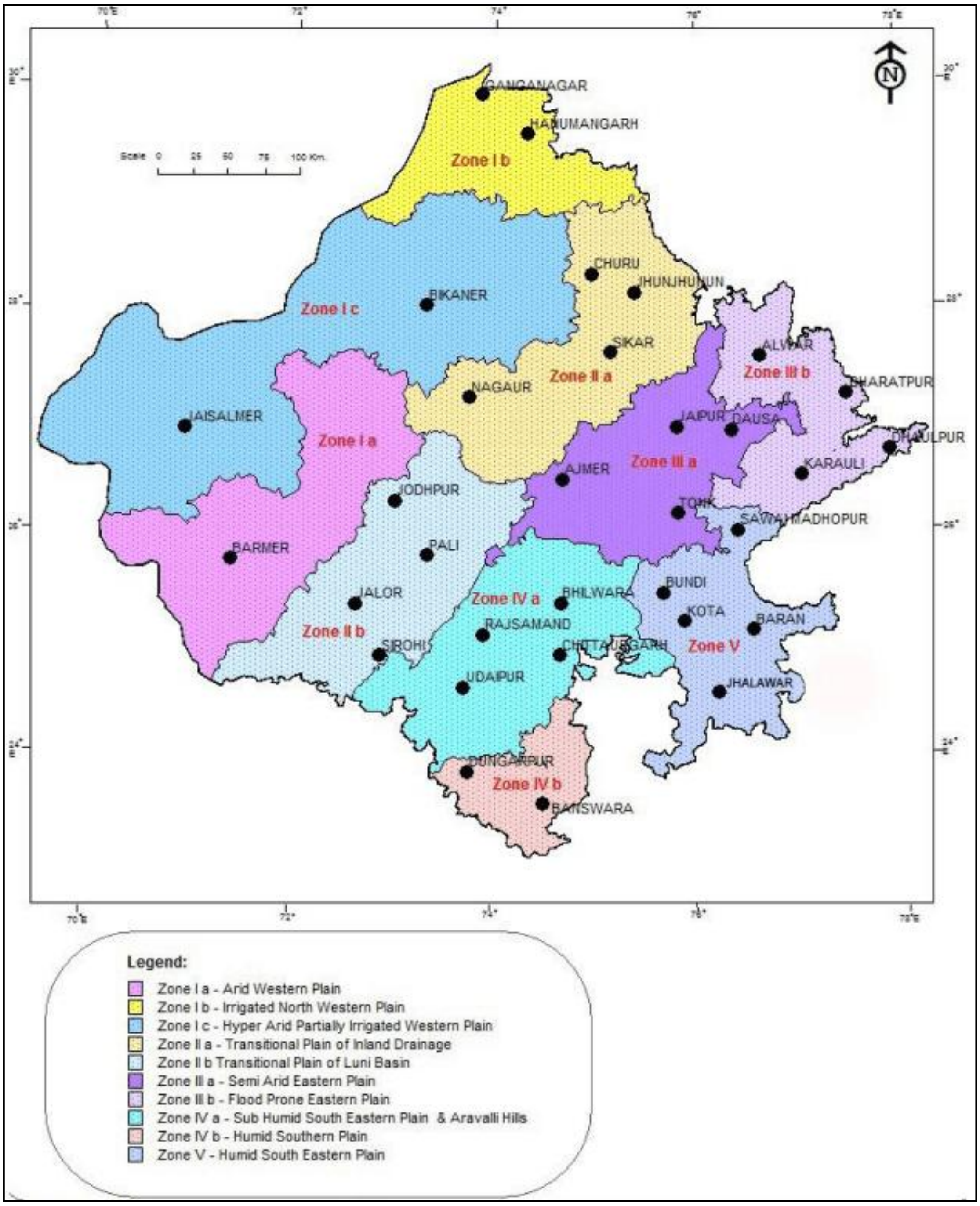


Figure 9.5 Agro-climatic Regions/zones of Rajasthan (DoST, 2010)

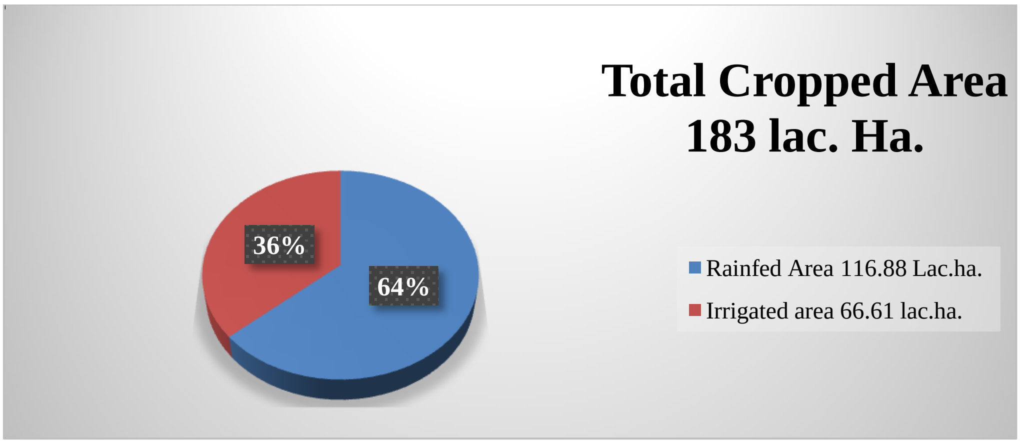


Figure 9.6 Cropped area in Rajasthan (as per 2016 Statistics) (DoP, 2017)

As underlined in the Draft State Agriculture Policy, major challenges for agriculture sector in Rajasthan are as follows: i) Death of animals, decline in productivity and reduced performance, due to frequent droughts. ii) Climate change and global warming; iii) Strengthening of comprehensive technology based developmental approach to promote dry land/ arid agriculture; iv) Deteriorating soil health including imbalanced use of fertilizers, micronutrient deficiency, lack of organic matter content, inadequate soil microbial flora and fauna etc.; v) Disparaging prices, little productivity and virtually very little value addition, distress sales, and rising cost of cultivation; vi) Lack of efforts for stabilization of sand dunes and for greening the desert through agro-forestry programs; vii) Missing mechanisms of export promotion, adherence to sanitation and phyto-sanitation (SPS) standards and measures for minimizing the export rejections; viii) Lack of integrated farming approach; xi) Lack of up-scaling of farm-validated modern technologies and agricultural Innovations; x) Gender mainstreaming in agriculture; and xi) Proper O&M (institutional mechanisms and organizational and management) alterations for incapacitating the felt restrictions coming in the way of farmland prosperity in the state (GoR, 2013).

9.1.4 Governance and Management Structure

Institutions concerning Soil management

Department of Agriculture, Co-operation and Farmers' Welfare, Government of India**,** Department of Agriculture, Government of Rajasthan**,** Department of Science and Technology(DST), Government of India**,** Ministry of Environment, Forest and Climate change, Government of India**,** Indian Council of Agricultural Research(ICAR), Ministry of Agriculture and Farmer's welfare**,** Department of Agricultural Research and Education**,** Indian Agricultural Statistics Research Institute**,** NITI Aayog, Government of India**,** National Bureau of Soil Survey and Land Use Planning, Indian Council of Agricultural Research **,** Krishi Vigyan Kendra

Roles and Responsibilities of various departments

Department of Agriculture, Co-operation and Farmer's Welfare, Government of India

The Department aims towards enhancing productivity and production of agricultural commodities to ensure food security of the Nation and also to make agriculture a sustainable and viable occupation. The mission of the department is to achieve targeted growth rate for agriculture sector with the help of State Governments and other Departments of the Government of India by the enhancement of agricultural production and making sure the farmer's welfare by effective implementation of Ministry's schemes(DoA, 2016). As per the department's objectives, the department aims at the functions as provided in Table 9.4.

Table 9.4 Roles and Responsibilities of the Department of Agriculture, Govt. of Rajasthan (DoA, 2016)

Self-sufficiency achievement in food production.
Increase in Agricultural production and hence the income of farmers and farm laborers.
Promotion of viable use of Natural Resources such as Land and Water.
Incorporation and promotion of Soil Health Management and Integrated Nutrient Management applications.
Crop Diversification.
Soil and water testing, hence recommending suitable agricultural inputs.
Assurance in quality of agricultural inputs and availability.
Promotion and application of Organic Farming.
Use of Integrated Pest – Disease Management system.
Transfer and promotion of education for modern agriculture technique developed by technical institutes and scientists.
Promoting timely agricultural operations by use of agricultural mechanization.
Promotion of mixed-intensive farming for increase in employment opportunities and income per unit area.
Development of scientific farming techniques for making agriculture more rewarding for farmers.
Increase in the production of certain agricultural commodities, ensuring availability of raw material for industries, in order to increase exports.
Reduction in cultivation cost and striving for holistic development of farmer.
Providing crop insurances to protect farmer against monsoon failure and other natural disasters.
Initiation of various programs for helping to increase per capita income of farmers in back ward areas as well as for scheduled castes and tribes.
Promotion of women empowerment in agriculture.
Organizing training programs on various traits of agro techniques for their mass broadcasting.
Providing quick and effective solutions of problems faced by farmers in day-to-day practices.

Department of Science of Technology, Government of India

With reference to Soil and Agriculture, the Department of Science and Technology aims at the following: (i) Policy formulation for matters relating to Science and Technology. (ii) Resolving problems and matters involving the Scientific Advisory Committee of the Cabinet (SACC). (iii) To promote new areas of Science and Technology with distinct prominence on incipient areas. (iv) Various processes involving research and development through its research institutions or laboratories for development of indigenous technologies concerning bio-fuel production, its processing, standardization and applications, in harmonization with the concerned Ministry or Department; (v) Promoting utilization of by-products to development value-added chemicals by perusing research and development activities in this field.

Ministry of Environment, Forest and Climate Change Government of India

The broad objectives of the Ministry are: i) Proper survey and its implementation for the conservation of flora, fauna, forests and wildlife. ii) Prevention and control of pollution. iii) Afforestation and regeneration of degraded areas. iv)Protection of the environment. v)Ensuring the welfare of animals.

Indian Council of Agricultural Research (ICAR), Ministry of Agriculture and Farmer's welfare

Responsible for co-ordinating, guiding and managing research and education in agriculture, ICAR is the top body for co-ordinating, guiding and managing research and education in agriculture and its practices. This is one of the largest national agricultural systems in the world, with 101 ICAR institutes and 71 agricultural universities spread across the country. With the help of its research and technology development, the council plays a trailblazing role in marshalling Green Revolution and its successive expansions in agriculture in India, Thus, the country has been enabled to increase the production of various commodities such as i) Fish by 16.8 times. ii)Horticultural crops by 10.5 times. iii) Food grains by 5.6 times. iv) Milk by 10.4 times. v) Eggs by 52.9 times. (Since 1950-51 to 2017-18)

Thus, ICAR has been impacting the national food and nutritional security to a great extent. The council has played a key role in endorsing excellence in higher education in agriculture. With internationally acknowledged scientists as part of it, ICAR is involved in radical areas of science and technology development in various fields. (ICAR, Ministry of Agriculture and Farmer's Welfare, Govt. of India)

Department of Agricultural Research and Education

The major responsibilities of the Department of Agricultural research and Education are as follows: i) Up keeping all aspects of the agricultural research and Education such as, horticulture, natural resources management, agriculture engineering, agricultural extension, animal science, economic statistics and marketing and fisheries, and all agricultural practices that involves coordination between the central and state agencies. ii) Attending to all the matters concerning expansion of new technology in agriculture, horticulture, natural resources management, agriculture engineering, agricultural extension, animal science, economic statistics and marketing and fisheries, as well as such functions as plant and animal introduction and exploration and soil and land use survey and planning. iii) Co-operation of various institutions in the field of agricultural research and education including relationship with foreign and international agricultural research and educational institutions and organizations, including participation in international conferences, connotations and other bodies dealing with agricultural research and education and follow-up decisions at such international conferences etc. iv) Applied, fundamental and operational research and higher education together with co-ordination of such research and higher education in agriculture such as agro forestry, animal husbandry, dairying, fisheries, agricultural statistics, economics and marketing (DoA, 2021).

Indian Agricultural Statistics Research Institute

The major responsibilities of the Indian Agricultural Statistics Research Institute are as follows: i) Undertaking research, education and training in agricultural statistics. ii) Use of computer applications and bioinformatics for agriculture research. iii) To arrange for advisory/consultancy services/ methodological support and computational solutions to NARES/NASS (National Agricultural Research and Education System/ National Agricultural Statistics System) (IASRI, 2015)

Niti Aayog, Government of India

The NITI Aayog (abbreviation for National Institution for Transforming India) is a public policy think tank of the Government of India, established to achieve sustainable development goals. The Aayog works with cooperative federalism by adopting the involvement of State Governments of India in the economic policy-making process using a bottom-up approach. Apart from various other enterprises, formulation of agriculture reforms such as Model Land Leasing Law, Reforms of the Agricultural Produce Marketing Committee Act, Agricultural Marketing and Farmer Friendly Reforms Index for ranking states, etc., comes under the functions of Niti Aayog.

National Bureau of Soil Survey and Land Use planning, ICAR **(ICAR, 2020)**

The main responsibility of the National Bureau of Soil Survey and Land Use planning is to conduct and promote research in the National Agriculture Research System in the areas of Soil Survey, Pedology, Geomorphology, Remote Sensing, Geographic Information System, Cartography, Land Evaluation, Land Use Planning.

Krishi Vigyan Kendra(s)

Usually associated with a local agricultural university, Krishi Vigyan Kendra(s) or “farm science Centres” serve as the definitive link between the Indian Council of Agricultural Research and farmers. These centres aim to apply agricultural research in a practical and more localized setting.

Citizens

Citizens and/or farmers are the key stakeholder with respect to the agricultural initiatives and rural management. These stakeholders are the one who will have the most significant impact upon the policy decisions. Hence it is vital to understand their stance and engage them by providing suitable platform while envisaging or formulating future policies and programs. In the Indian context, public participation is exhibited more in implementation of formulated plans and policies rather than participation during the formulation of those policies and plans. All the policies are implemented on or through the public, but public participation in policy formulation has not necessarily been seen as an indispensable requirement. Hence it is imperative to engage these stakeholders such that they can work in close coordination with above identified department and contribute towards the planned initiatives.

9.1.5 Rules and Regulations

The Rajasthan Soil and Water Conservation Act, 1964

The Rajasthan Soil and Water Conservation Act, came into being to provide for the preservation and enhancement of soil and water resources in the State of Rajasthan. Major regulations formulated by the act for conservation of soil are as follows: (i) Notification of areas: The State Government may, by notification in the Official Gazette, declare an area to be a notified area for this Act, in case it appears to the State Government that the area is desirable to provide for soil and water conservation ; (ii) Power to regulate, restrict or prohibit certain matters within notified areas: The State Government may, by order published in the Official Gazette, regulate, restrict or prohibit certain activities in respect of any notified area**.**

The issues to be addressed in soil and water conservation schemes are: (i) Maintaining and constructing 'mends', 'dauls', and 'bundhis' and planting of munja, sarkanda or other soil binding grasses or plant; (ii) Land levelling, land grading and irrigation layouts. (iii) Adaptation of contour cultivation. (iv) Growth of row crops to be prohibited. (v) Cultivating quick-maturing leguminous crops and close cultivating crops during rainy season; (vi) Adaptation of green manuring and application of bulky organic manures, e.g. Compost, farm-yard manures, etc (GoR, 1964).

The Rajasthan Land Revenue Act, 1956

Under the act, use of Agricultural Land for Non-agricultural Purpose may be regulated as follows: (i) No person holding any land for agriculture, and no transferee of such land or any part thereof, shall use the same or any part thereof, by the construction of buildings thereon or otherwise for any other purpose except with the written permission of the State Government obtained din the manner hereinafter laid down and otherwise that in accordance with the terms and conditions of such permission. (ii) Any such persons desiring to use such land or any part thereof for any purpose other than that of agriculture shall apply for the requisite permission in the prescribed manner and to the prescribed officer or authority and every such application shall contain the prescribed particulars. (iii) The State Government shall, after making or causing to be made due inquiry in the prescribed manner, either refuse the permission applied for or grant the same subject to the prescribed terms and conditions (GoR, 1956).

Under the act, allotment of land for agricultural purposes may be done as follows: (i) As otherwise provided elsewhere by this Act, lands for agricultural purposes shall be allotted by such authority and in such manner as may be prescribed by rules made by the State Government in this behalf. (ii) All allotment of land under this section shall be subject to the payment of rent fixed at such rates as may be fixed according to custom or by usage or any law on the subject. (iii) If there be more than one person requiring the same land, the allotment shall be made in the following order – (a) To co-sharer of the holding if it forms part of a compact block or is irrigated from the same source, preference amongst such co-sharers being given to one having land less than the area prescribed by rules made under the Rajasthan Tenancy Act, 1955 (Rajasthan Act 3 of 1955); (b) To persons residing in the village in which land be situated, preference amongst such persons being given to persons having no land or less than the area prescribed by the said rules; (c) By drawing lots: Provided that the area so taken together with the area held by him does not exceed the area prescribed by the said rules (GoR, 1955).

Notwithstanding anything here in force contained the State Government shall have power to allot land for the purpose of an industry or for any purpose of public utility on such conditions as it deems fit.

9.1.6 Literature Case Studies

The Use of Subsidies for Soil and Water Conservation- A case Study from Western India

This paper discusses the use of subsidies for soil and water conservation (SWC) in the KRIBHCO (Krishak Bharti Co-operative Ltd.), Indo-British Rain fed Farming Project being implemented in degraded areas of western India. The basis for, and impact of, embracing subsidies are summarised. Even though both project staff and farmers agree on the significance of SWC measures, only a few farmers can meet the expense of the investment of time and money.

This is mainly because production in the specified area is so little that most farmers are forced to look for off-farm work during the dry season. As this is the time when most SWC work is commenced, there is a need to balance the opportunity cost to farmers of prior employment prospects for appliance of SWC activities. Profits ascending from the practice of subsidies comprise priming of savings and credit groups and a temporary decline in annual migration levels. Major disadvantages of this approach are potential lack of equity and low level of sustainability.

The paper concludes by conversing other aid provisions including loans, differential subsidies and other such incentives. It proposes that for private farmland, farm families are subsidised with fixed land enhancement grants (rather than paying those who take part in the SWC work). Farmers and their community members should discuss how the money would best be utilised. A fixed subsidy per unit area is suggested for communal land enrichment and while watershed management is led on a village basis. A village work plan, based on the reserves available, would be articulated by the group of villagers in consultation with project team (Smith et al., 1999).

9.1.7 Environmental Management in rural areas

Solid and Liquid Waste Management under Swachh Bharat Mission (Gramin) (MoDWS, 2017)

Solid and Liquid Waste Management (SLWM) is one of the key components of Swachh Bharat Mission (SBM), released to bring development in cleanliness, hygiene and the overall quality of lifestyles in rural areas. SLWM is the collection, transportation, processing, recycling, treatment, and disposal of waste material in a scientific manner. SBM focuses on creating and supplying community-controlled sanitation structures. To put in force SLWM tasks economically and efficiently, ownership at grassroot level and community involvement at all levels are critical. Information, Education, and Communication (IEC) interventions ought to attention to SLWM to create a call for a sustainable system. This should result in setting up structures for waste disposal in one of these manners that it has tangible effect on the population. The community/Gram Panchayat (GP) must be recommended to return ahead and call for one of these systems, which they could in the end operate and maintain. Awareness and training campaigns must aim at panchayat officials, elected representatives, schools, non - governmental organizations (NGOs) operating in villages, shop keepers, families, and general public. The GP functionaries could be accountable for design, implementation, operation and maintenance (O&M) of SLWM structures with support from respective state governments. Mechanisms concerning 0.33 events in creation and control sports under GP and network supervision may be explored. In such cases, absolute readability in the roles and duties of diverse stakeholders in managing SLWM structures is a must. Community contribution and suitable person fees for sustainable SLWM tasks also are desirable.

Solid Waste Management in Rural Area

In rural regions typically the waste material is Kitchen Waste, Agriculture Waste, Horticulture Waste and domestic animal dung. All those substances are getting used for making manure by the farmers. Present statistics to be had on stable waste generated in the vicinity are to be accumulated. If possible, the existing portions of wastes – dangerous family wastes, digital wastes, biomedical and non-dangerous generated withinside the examine are to be accumulated and presented (NIRDPR, 2016).

Sanitation Programme

The term " total sanitation programme" includes seven important elements, as provide 100% sewage and drainage systems in all cities, and safely treat/recycle sewage that is ultimately used for irrigation, and completely prohibit discharge into sewers/rivers. In fact, an efficient sewer system constitutes the backbone of the urban sewer system. 100% disposal of urban and rural solid waste and final waste recycling. The coverage rate of sanitary toilets in rural households and suburbs is 100%. All open spaces in urban and rural communities are paved or asphalted. All streets are paved with concrete blocks or cobblestones. Urban and rural areas do not tolerate landfills or solid waste landfills, mainly paper and plastic. Absolutely resist the stagnation of sewage or other sewage in urban or rural areas. Daily cleaning of streets, streets or public places in rural and urban areas.

Steps to Make a Village Open Defecation Free strongly

Following are the steps in making a village open-defecation free, the following points should be considered: (i) Efficient fund flow system- Direct Beneficiary Transfer (DBT) and capacity building. (ii) Community-Led Total Sanitation (CLTS) approach. (iii) Weekly review meeting of different stakeholders by the District Magistrate. (iv) High impact campaigns and Information Education Communication (IEC) activities. (v) Involvement of locals and preparing a list of dos and don’ts. (vi) Identifying vulnerable people. (vii) Raise ODF sustainability as a topic in meetings. (viii) Put together a taskforce to promote ODF sustainability (MoDWS, 2017).

Water Management

Canals, tanks, etc. must be desilted regularly during the summer months. People should be encouraged to revive the ancient practice of protecting trees around tanks. Afforestation of barren, hilly slopes on a war footing should be carried out. Trees withstand drought better than crops. They check dust, replenish streams, provide shade to cattle and man and give fodder for cattle. They provide innumerable uses for man. Denuding the land of trees without compensatory afforestation is a suicidal and short-sighted approach to solving immediate needs. Creation of small reservoirs and percolation tanks to hold run-off water must be implemented and maintained well.

Rain Water Management in Rural Areas

Rain in these regions can be irregular from season to season and from year to year. Since most rural areas have little water storage capacity, dry periods can result in serious water shortages which hamper development, and can create serious public health problems. Destruction of forest cover has caused many formerly perennial streams to stop flowing in the dry season. Given the declining water level, various structures such as recharge pits, recharge trenches, recharge shaft, Trench with recharge well, shaft with recharge well, recharge through abandoned hand pumps, abandoned tube well, recharge well, percolation tank, and roof top rain water harvesting systems should be promoted.

Roof water harvesting rural schools, Rainwater Harvesting (RWH) from roofs is a easy low cost method that has been practiced for loads of years in the wilderness regions of India. A supply of potable water, specifically during the dry season (4- five months) Year-round water provision to enhance hygiene, e.g. low-flush public toilets.

Land Use Land Cover

In rural regions, efficient land is usually the maximum important resource for local people. It should be used successfully to fulfil the desires of the human beings for water, food, constructing materials and affordable quality of life, and to hold the functioning of natural systems on which a majority of these depend. This requires complete making plans and careful allocation of land to the maximum suitable use or aggregate of uses. Wastelands ought to be afforested on a large scale related to neighbourhood human beings. Substitutes for furnishings material and packing instances should be used. This might ease the stress on standing forests. Catchment regions or water-sheds should be thickly vegetated. This would keep rain water and recharge springs, rivers, etc. Tanks should be desilted, check dams built and small ponds created to keep run-off water. Shifting agriculture should get replaced by settled agriculture.

This chapter introduced to discuss best practices for solving environmental problems in rural areas. Waste generation and other problems in urban and rural areas are different. In rural areas, services do not exist at all in many cases and economic and social barriers prevent many people from accessing basic services. However, realizing the value of small or intermittent waste streams also has great potential benefits for rural communities. For example, decentralized resource recovery systems can be developed, especially sewage, food, livestock and agricultural waste. Villagers have been recovering resources from the waste stream for a long time, but it cannot be done systematically. In the near future, population growth and improved living standards will hinder people's food, water and energy supply. Innovation is needed to increase supply, improve distribution, reduce waste, increase efficiency, and reduce demand in rural areas. Because the relationship between food, water and energy is so closely intertwined, possible solutions or needs in one area are often reflected in another area. Rural communities actively participated in cooperation with village committees and regional administrative departments, and many successful cases were produced.

For the purpose of the implementation of rural development projects/ schemes under Panchayati Raj System, the district is divided in the 14 Panchayat Samitis (Blocks). Block Development Officer or Vikas Adhikari is the Controlling Officer of each of the Panchayat Samiti to serve as extension and developmental executive at block level.

9.1.8 Present Scenario for Alwar District

Table 9.5 Compositions of Panchayat Samities (GoR, 2021c)

S. No.	Name of Panchayat Samiti	No. of Gram Panchayat
1	Bansue	40
2	Behror	30
3	Kathumar	42
4	Kishangarh Bas	34
5	Kotkasim	24
6	Laxmangarh	45
7	Mundawara	43
8	Neemrana	33
9	Rajgarh	31
10	Ramgarh	43
11	Remi	26
12	Thanagazi	36
13	Tijara	44
14	Umren	41
Total	**14**	**512**

Alwar district has 14 Panchayat Samiti, 512 Gram Panchayats.

Table 9.6 Rural Statistics (GoR, 2011)

Number of Villages	Total	2,054
Population - Rural	Persons	3,01,728
	Males	15,89,508
	Females	14,0220
Child Population in the age group 0-6	Persons	5,02,526
	Males	2,69,105
	Females	2,33,421
Literates	Persons	17,07,998
	Males	10,83,730
	Females	6,24,268
Sex Ratio (Number of females per 1000 males)	Rural	900
Area in Square Kilometre	Rural	8,146
Number of households	Rural	5,11,517
No. of Villages with drinking water facilities (Annual Progress Report- PHED)	Rural	1,954
Total Workers (Main and Marginal)	Persons	14,87,935
	Males	8,16,267
	Females	6,71,668
I. Main workers	Persons	9,82,840
	Males	6,69,363
	Females	3,13,477
II. Marginal workers	Persons	5,05,095
	Males	1,46,904
	Females	3,58,191

For management of rural areas District Zila Parishad is the concern department. Rural environment also concern solid waste management, waste water treatment, drinking water supply etc. Some data regarding these points are acquired from the Zila Parishad, Alwar.

Table 9.7 Rural Environment Datasheet Zila Parishad, Alwar

Action Areas	**Data**
Environmental management practices/ policies of the department	Solid liquid waste management practices
Provisions of pollution abatement (Air/water/noise)	Air and water pollution reduced by IHHL and other SLEM activities
Updates on implementation of environment management policies	Activities of SBM, IHHL and solid liquid waste management practices
Budget allocated for environmental protection	SBM, FFC, SFC, MNREGA
Total population of panchayat (Nos)	3020033
Total wastewater generated in panchayat samitis (Ltr)	30913369
Total wastewater treated in panchayat samitis (Ltr)	309676
Total wastewater left untreated in panchayat samitis (Ltr)	30604569
Total solid waste generated in panchayat samitis (kg)	1223438
Total solid waste treated in panchayat samitis (kg)	78040
Total solid waste left untreated in panchayat samitis (kg)	1144868
solid and liquid waste management	-
Status of Drinkable water	Tubewells, single phase boring, Handpump and other soueces
Rain water harvesting (Nos)	453
management of non-bio decomposition like plastic waste	-
Status of contamination water	Low
current system of cow dung management	Arrangement by the village at their own level
Total number of livestock	1916150

Figure 9.7 Road site Drainage work on Village Road (Coordinates- 27°34'01.5"N 76°47'36.2"E)

Rain Water Management in Rural Areas

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Noise Pollution

Noise pollution is triggered in the regions of mining i.e., for the duration of the time of blasting, operation of energy drillers and while reducing the stones. The stage of noise pollutants might also additionally end up severe for the duration of the festive seasons. The introduction of inexperienced belt is specifically beneficial on the perimeter of aerodromes, alongside railway traces and arterial roads, via or beyond constructed up regions and adjacent business zone. Noise pollution is caused in the areas of mining i.e., during the time of blasting, operation of power drillers and while cutting the stones. The level of noise pollution may become intense during the festive seasons. The creation of green belt is particularly advisable on the perimeter of aerodromes, along railway lines and arterial roads, through or past built-up areas and adjoining industrial zone.

The Unnat Bharat Abhiyan

The Unnat Bharat Abhiyan is inspired by the vision of transformational change in rural development processes by leveraging knowledge institutions to help build the architecture of an inclusive India. Under the program, the knowledge base and resources of the premier institutions of the country will be leveraged to bring in a transformational change in the rural developmental process by creating a vibrant relationship between the society and the higher educational institutes, with the latter providing the knowledge and technology support to improve the livelihoods in rural areas and to upgrade the capabilities of both the public and private organisations in the society. The 11 districts of Rajasthan where UBA is all set for a launch are Ajmer, Alwar, Bharatpur, Bundi, Dausa, Dhaulpur, Jaipur, Karauli, Sawai Madhopur, Tonk and Sikar.

The programme will help in identifying developmental challenges and evolve appropriate solutions for accelerating sustainable growth. The main goal of the program is to build an understanding of the development agenda within institutes of higher education. The HRD ministry has identified IIT Delhi as the national coordinating institution (NCI). Later, for better coordination and quick action under this mission, NCI has identified some regional coordinating institutes (RCI). In Rajasthan, MNIT Jaipur has been identified as the RCI (Mathrani, 2021).

9.2 Conclusion

India significant proportion of population is residing in rural setups. As per the Census 2011, the total population of India was 1210.2 million. Of this, the rural population stands at 833.1 million and the urban population 377.1 million. Indian rural development demands more resources and attention. Efforts towards guided sustainable rural development will ensure food security and improved economy for the country. It is vital to formulate acts, policies, programs and plans which would pave the path to address rural issues. Rising urbanization has often over powered the agendas of policy makers. It is important to acknowledge the rural environmental concerns which often have implications on the residing population. Economic development and population growth in rural areas have led to many problems, such as pollution, land degradation, resource depletion, loss of biodiversity, loss of income, and health risks. In rural areas, there is often a lack of resources to take the necessary measures. Low population density and scattered households are not enough to implement many management strategies related to centralized and urban areas. The development of the rural economy and environmental protection must be coordinated. Regions are strategies for environmental, social and economic sustainability. Sustainable environmental management development based on integrating economic, environmental and social considerations can raise awareness of these environmental challenges and provide solutions, reduce nitrogen and phosphorus losses caused by agricultural activities, adapt to climate change, and reduce greenhouse gas emissions in rural areas. Protect the rural ecosystem, optimize and control the process of pollution reduction in rural areas, use agricultural resources and rural land management and planning.

10. Forest Conservation Practices and Management Plan

10.1 Literature Review

Forest ecosystems are a critical component of the world's biodiversity as many forests are more bio diverse than other ecosystems. They work as environment for creatures, hydrologic stream modulators, and soil monitors, establishing perhaps the most significance parts of the biosphere (Viña et al., 2016). Forests cover 31 % of the global land area. Approximately half the forest area is relatively intact, and more than one-third is primary forest (i.e. naturally regenerated forests of native species, where there are no visible indications of human activities and the ecological processes are not significantly disturbed). The total forest area is 4.06 billion hectares or approximately 5000 m^2 (or 50 x 100m) per person, but forests are not equally distributed around the globe. More than half of the world's forests are found in only five countries (the Russian Federation, Brazil, Canada, the United States of America and China) and two-thirds (66 per cent) of forests are found in ten countries (Kimdung et al., 2013).

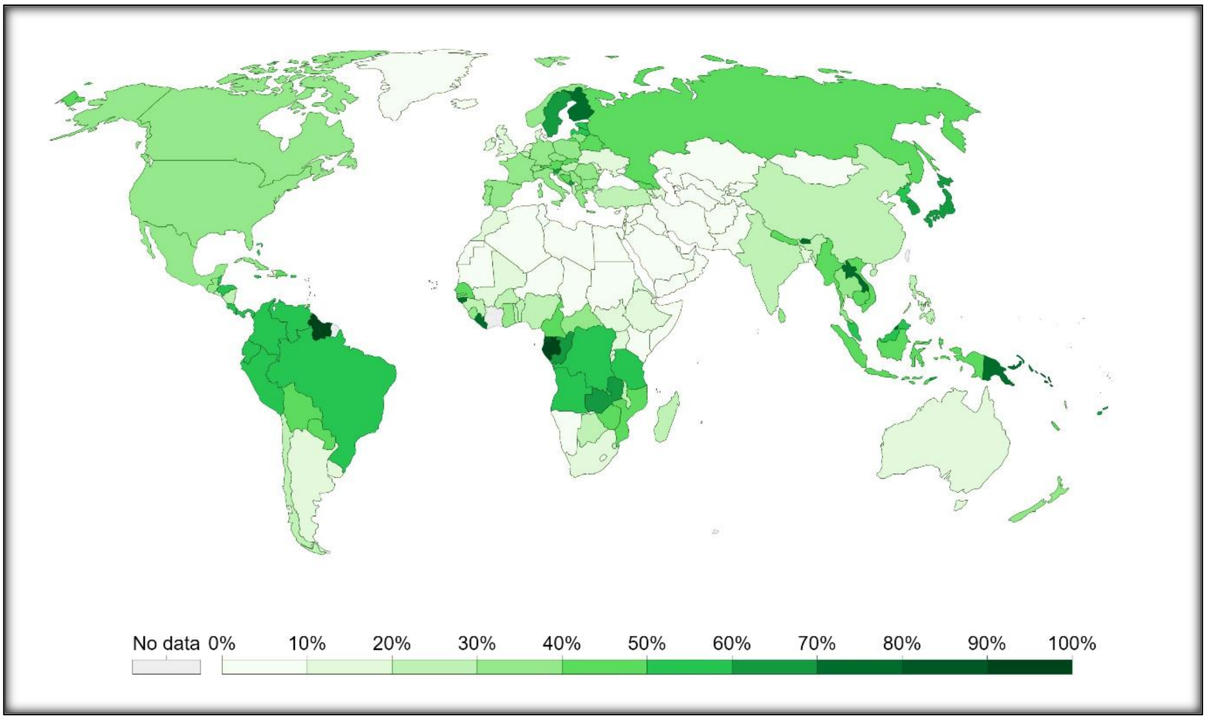

Figure 10.1 Share of forest in the world (Ritchie & Roser, 2021)

Deforestation and forest degradation is occurring at disturbing rates, which contributes essentially to the continuous loss of biodiversity. Since 1990, it is assessed those 420 million hectares of woodland have been lost through transformation to other land uses, albeit the pace of deforestation has decreased in the course of recent many years. Somewhere in the range of 2015 and 2020, the pace of deforestation was assessed at 10 million hectares each year, down from 16 million hectares each year during the 1990s. The space of essential forests worldwide has decreased by more than 80 million hectares since 1990. Agricultural development keeps on being the primary driver of deforestation and forest degradation and the related loss of woodland biodiversity. Large-scale commercial agriculture represented 40% of tropical deforestation somewhere in the range of 2000 and 2010, and nearby means agribusiness for another 33% (Kugonza et al., 2009).

Forest gives various advantages. They bring down the air temperature by delivering water fume into the air. At daytime trees create oxygen and store carbon dioxide, which assists with cleaning air. Forests draws in natural life and offer food and assurance to them. Forests offer security, decrease light reflection, offer a sound wall and help to direct wind heading and speed. Trees offer imaginative capacities, for example, making a background, outlining a view, supplementing engineering, etc. Well, oversaw backwoods supply better water with less contamination than water from different assets. Some backwoods raise all out-water stream; however, this isn't valid for all timberlands, woodlands help in controlling the level floods. Forest gives distinctive sort of wood which are utilized for various purposes like creation of furniture, paper/pencils, etc. Forests help in keeping climate sound and lovely. Woodlands likewise limit commotion contamination. They store carbon, help in directing the planetary environment, refine water and moderate normal risks like floods and avalanches. Backwoods additionally contain around 90% of the world's earthly biodiversity (Chaudhary, 2000).

Scenario in Country

The top five states in terms of increase in forest cover in India are Karnataka (1,025 sq. km.), Andhra Pradesh (990 sq. km.), Kerala (823 sq. km.), Jammu & Kashmir (371 sq. km.) and Himachal Pradesh (334 sq km) (ISFR, 2019). In terms of area, Madhya Pradesh has the largest forest cover in the country followed by Arunachal Pradesh, Chhattisgarh, Odisha and Maharashtra. In terms of forest cover as a percentage of their total geographical area, the top five states are Mizoram (85.41 percent), Arunachal Pradesh (79.63 percent), Meghalaya (76.33 percent), Manipur (75.46 percent) and Nagaland (75.31 percent). The report also highlighted that there are 62,466 wetlands in the country and amongst the states, Gujarat has the largest area of wetlands (within the RFA) in the country followed by West Bengal. The report has identified wetlands of more than one-hectare area within the RFAs. The ISFR 2019 also showed that the mangrove cover in the country has increased by 54 sq. km. as compared to the previous assessment. The maximum increase was in Gujarat which recorded an increase of 37 sq. km followed by Maharashtra (16 sq. km.) and Odisha (8 sq. km.) but it marked a decrease of mangrove cover in Tamil Nadu (four sq. km.), West Bengal (two sq. km.) and Andaman and Nicobar Islands (one sq. km.) (MoEFCC, 2019).

With respect to the forests, following terms are relevant: (i) Forest cover: Includes all lands having trees more than one hectare in area with tree canopy density of more than 10%, irrespective of ownership, legal status of the land and species composition of trees. (ii) Very Dense Forest: All lands with tree canopy density of 70% and above. The relative composition of forest cover under this category is 3.02%. (iii) Moderately Dense Forest: All lands with tree canopy density of 40% and more but less than 70%. Forest cover under this category is 9.39%. (iv) Open Forest: All lands with tree canopy density of 10% and more but less than 40 %. Forest cover of 9.26% falls under this category. (v) Scrub Forest: Lands with canopy density less than 10%. Geographical area under this category is 1.41%. (vi) Non-forest: Lands not included in any of the above classes (includes water). Geographical area under the non-forest category is 76.92% (MoEFCC, 2019).

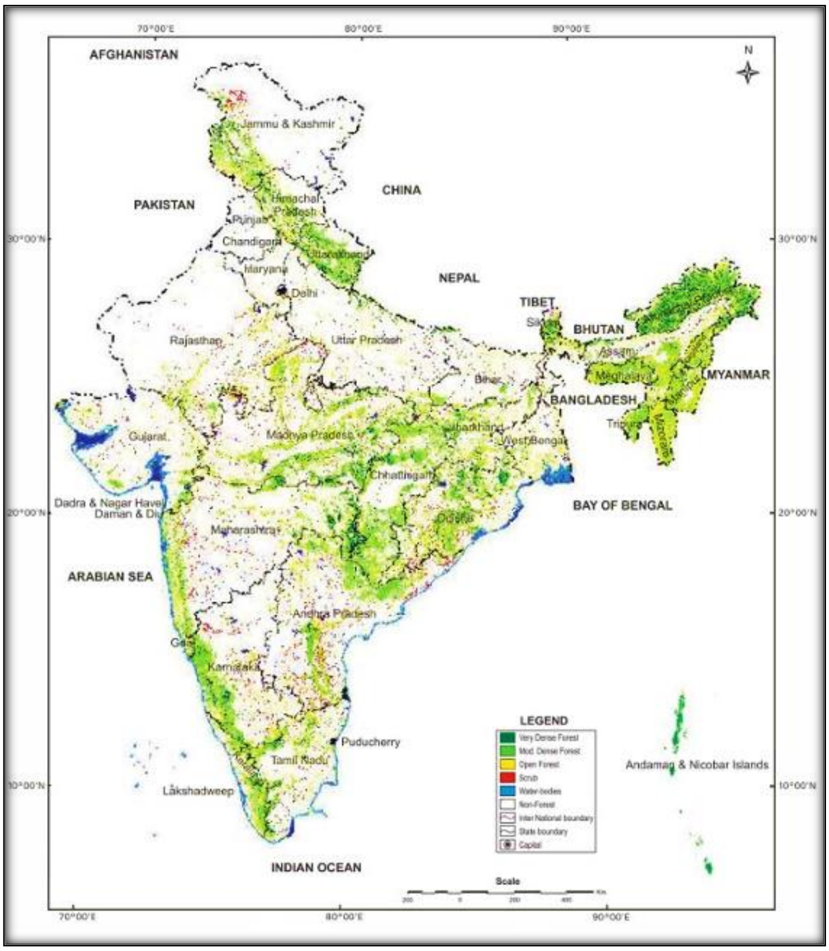

Figure 10.2 Forest Cover in India, 2015 (ISFR, 2019)

Scenario in State

Situated in the north-western part of the country, the largest state of the country, Rajasthan covers an area of 3,42,239 sq km, which is 10.40% of the geographical area of the country. The geographical extent of the State is bounded by 23°4'N to 30°11'N latitude and 69°29'E to 78°17' E longitude. The State has 4 distinct regions namely, Western Desert with Barren Hills, Level Rocky and Sandy Plains, the Aravalli Hills and South-Eastern Plateau. The climate of the State varies from semi-arid to arid. Western part of the State, including Thar Desert (also known as The Great Indian Desert), is relatively dry and infertile whereas in the south-western part, the land is wetter, hilly, and more fertile. The average annual temperature ranges between 0°C to 50°C and the average annual rainfall is in the range of 500 mm to about 750 mm. The State is drained by a number of rivers which include Banas, Chambal, Luni and Mahi (MoEFCC, 2019).

The State has 33 districts. As per the 2011 Census, Rajasthan has a population of 68.55 million accounting to 5.66 percent of India's population. The rural and urban population constitute 75.10% and 24.90% respectively. The population density is 200 per sq km which is much lower than the national average of 382 persons per sq km. The 19th Livestock census 2012 has reported a total livestock population of 57.73 million in the State. Rajasthan, ranks 15th in terms of forest deficient State. Recorded Forest Area (RFA) in the State is 32,737 sq km of which 12,475 sq km is Reserved Forest, 18,217 sq km is Protected Forest and 2,045 sq km is Unclassed Forests. As per the information receive from the State during the last two years, a total of 42,633 ha of plantations were raised Five National Parks, 25 Wildlife Sanctuaries and 11 Conservation Reserves constitute the Protected Area network of the State covering 2.92% of its geographical area. There are 3 Project Tiger (Ranthambhore, Sariska and Mukundra Hills) and two Ramsar (Keoladeo Ghana sanctuary and Sambhar Lake) sites (MoEFCC, 2019).

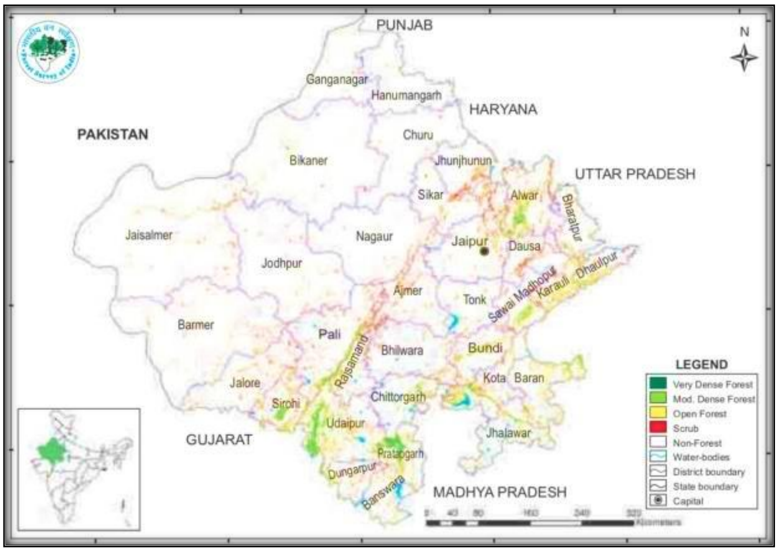

Figure 10.3 Forest cover in Rajasthan (ISFR-b, 2019)

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data of the period Oct to Dec 2017, the Forest Cover in the State is 16,629.51 sq km which is 4.86 % of the State's geographical area. In terms of forest canopy density classes, the State has 77.81 sq km under Very Dense Forest (VDF), 4,341.90 sq km under Moderately Dense Forest (MDF) and 12,209.80 sq km under Open Forest (OF). Forest Cover in the State has increased by 57.51 sq km as compared to the previous assessment reported in ISFR 2017.

Governance and management

Ministry of Environment, Forest and Climate Change

The Ministry of Environment, Forest and Climate Change (MoEF&CC) is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes.

The Ministry also serves as the nodal agency in the country for the United Nations Environment Programme (UNEP), South Asia Co-operative Environment Programme (SACEP), International Centre for Integrated Mountain Development (ICIMOD) and the follow-up of the United Nations Conference on Environment and Development (UNCED). The Ministry is also entrusted with issues relating to multilateral bodies such as the Commission on Sustainable Development (CSD), Global Environment Facility (GEF) and of regional bodies like Economic and Social Council for Asia and Pacific (ESCAP) and South Asian Association for Regional Co-operation (SAARC) on matters about the environment.

The broad objectives of the Ministry are: 1) Conservation and survey of flora, fauna, forests and wildlife 2) Prevention and control of pollution 3) Afforestation and regeneration of degraded areas 4) Protection of the environment and 5) Ensuring the welfare of animals. These objectives are well supported by a set of legislative and regulatory measures, aimed at the preservation, conservation and protection of the environment (GOI, 2021).

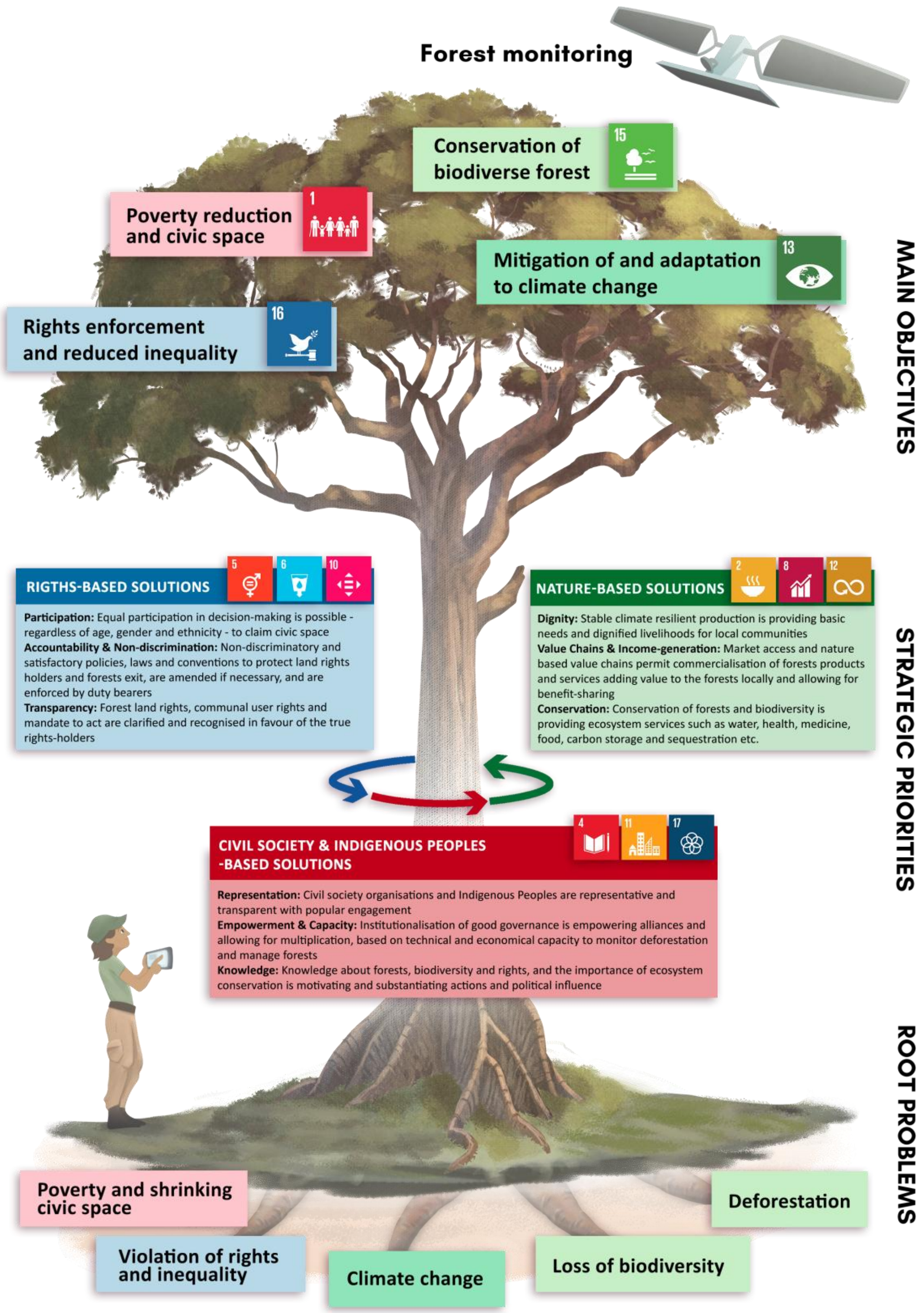

Figure 10.4 Management of forests in a region

Indian Council of Forestry Research and Education

ICFRE with its Headquarters at Dehradun is an apex body in the national forestry research system that promotes and undertakes need based forestry research extension**.** The Council has a pan India presence with its 9 Regional Research Institutes and 5 Centers in different bio-geographical regions of the country. The regional research Institutes are located at Jodhpur, Dehradun, Shimla, Hyderabad, Coimbatore, Ranchi, Bengaluru, Jorhat and Jabalpur, and the centres are at Agartala, Aizawl, Allahabad, Chhindwara and Visakhapatnam.

Vision: To achieve long-term ecological stability, sustainable development and economic security through conservation and scientific management of forest ecosystems.

Mission: To generate, advance and disseminate scientific knowledge and technologies for ecological security, improved productivity, livelihoods enhancement and sustainable use of forest resources through forestry research and education.

Objectives were: 1) to undertake, aid, promote and coordinate forestry research, education and extension leading to scientific and sustainable management of forest resources in the country. 2) To align forestry research programs in the council with national priorities including achievement of Sustainable Development Goals and combating climate change. 3) To provide scientific advice and policy support to the central and state governments aiding informed decision making in forestry matters of national importance and international commitments. 4) To act as a repository of scientific knowledge related to forestry, environment and climate change, and disseminate such knowledge to various stakeholders. 5) To provide technical assistance and support to states, forest- based industries, tree growers, farmers and others for forest protection, afforestation, agro- forestry and allied activities. 6) To develop appropriate forest-based technologies, processes and products for sustainable resource use, 7) to provide livelihood support to forest dependent communities through transfer of scientific knowledge and appropriate forest-based technologies 8) To develop technically qualified human resources for forestry sector (ICFRE, 2021).

Forest Survey of India

Forest Survey of India (FSI) is a premier national organization under the union Ministry of Environment and Forests, responsible for the assessment and monitoring of the forest resources of the country regularly. The main objective of PISFR was to ascertain the availability of raw materials for establishment of wood-based industries in selected areas of the country. In its report in 1976, the National Commission on Agriculture (NCA) recommended the creation of a National Forest Survey Organization for a regular, periodic and comprehensive forest resources survey of the country leading to creation of FSI. After a critical review of activities undertaken by FSI, Government of India redefined the mandate of FSI in 1986 to make it more relevant to the rapidly changing needs and aspirations of the country (FSI, 2021).

Department of Forest Government of Rajasthan

The department is headed by Principle Chief Conservator of Forests & Head of Forest Force as the technical head and administratively lead by Principal Secretary to the Government of Rajasthan

Rajasthan State Biodiversity Board

The Convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992 and entered into force on 29 December 1993. After becoming a party to the Convention on Biological Diversity in 1994, the Government of India has taken many important steps to further strengthen the existing framework. The Biological Diversity Act, 2002 (No. 18 of 2003) was enacted by the Ministry of Law and Justice, Government of India after approval of the Parliament and the assent of the president on the 5th February 2003. This Act provides for the conservation of biological resources and their diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto. In exercise of the powers conferred under subsection (1) of Section 63 of the Biological Diversity Act, 2002, the Government of Rajasthan framed 'Rajasthan Biological Diversity Rules, 2010', vide notification dated 02 March 2010. As per provision of Section 22 of this Act, the State Government (s) shall establish State Biodiversity Board for this Act. Accordingly, the Government of Rajasthan has established the Rajasthan State Biodiversity Board, vide Government order number: F.4 (8) Forest/2005/Part 1 Jaipur dated: 14 September 2010 (GoR, 2021d).

Acts and rules:

Forest conservation Act, 1980

The Forest Conservation Act 1980 was enacted to help conserve the country’s forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of central government. To this end the act lays down the pre-requisites for the diversion of forest land for non-forest purposes. This act has been passed with a view to check deforestation which has been taking place in the country on a large scale and which had cause ecological imbalance and thus led to environmental deterioration. The president of India promulgated the forest (Conservation) Ordinance on 25 October 1980. It simply aims at putting restriction on the DE reservation of forests or use of forest-land for non-forest purposes. The Act is intended to serve a laudable purpose as is evident from the statement of objects and reasons of the Act, which reads:

Deforestation causes ecological imbalance and leads to environmental deterioration. Deforestation had been taking place on a large scale in the country and it had caused widespread concern. Intending to check further deforestation, the president promulgated on 25Th October, 1980 the forest (Conservation) Ordinance, and 1980 (GOI, 1980).

Indian Forest Act, 1927

The Indian Forest Act, 1927 consolidates the law relating to forests, the transit of forest-produce and the duty liable on timber and other forest-produce. The Indian Forest Act,1927 aimed to regulate the movement of forest produce, and duty leviable forest produce. It also explains the procedure to be followed for declaring an area as Reserved Forest, Protected Forest or a Village Forest. This act has details of what a forest offence is, what are the acts prohibited inside a Reserved Forest, and penalties leviable on violation of the provisions of the Act. After the Forest Act was enacted in 1865, it was amended twice (1878 and 1927) (GOI, 1927). This Act impacted the life of forest-dependent communities. The penalties and procedures given in this Act aimed to extend the state's control over forests as well as diminishing the status of people's rights to forest use. The village communities were alienated from their age-old symbiotic association with forests. Further amendments were also made to restrain the local use of forests mainly by forest-dependent communities. It was enacted to make forest laws more effective and to improve the previous forest laws.

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

It recognizes the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited by them and provides a framework for according the same (GOI, 2006)

Rajasthan Forest Act, 1953

An Act to consolidate the law relating to forests the transit of forest produce and the duty leviable on timber and other forest produce. Be it enacted by the Rajasthan State Legislature as follows: received the assent of the President on 3'1st of March, 1953, published in the Rajasthan Gazette No. 10 Part. lV A, dated the 18th April, 1953 (GoR, 1953).

Rajasthan State Forest Policy, 2010

The Rajasthan government has proposed a new draft forest policy that will drive the management and protection of forest in the largest state of India in the next 10 years. The policy aims to have measures to increase forest area under protected area network, control mining activities, strengthen biodiversity conservation, increase afforestation and ensure proper management of grasslands. The forest policy proposes to create a "secret fund to deal with organized forest crimes and illegal mining and be used to award whistle-blowers/informers." While promising strict action against illegal mining, it emphasized that mining will be permitted in the forest areas only after proper clearance.

The main aim of the Rajasthan Forest policy is to: Conserve and enhance environmental resources; Assure environmental sustainability of key economic sector; Improve environmental governance and build capacity (GoR, 2010).

Table 10.1 Regulations regarding forest conservation

Law	Description	Requirement
Forest (Conservation) Act, 1980	The Forest (Conservation) Act prohibits the use of forest land for non-forest purposes without the approval of Ministry of Environment and Forests (MoEF), Government of India	Not applicable; none of the components of the subproject are located in forest.
Rajasthan Forest Act, 1953 and Rajasthan Forest Rules, 1962	This Act makes the basis for declaration of Reserved Forests, constitution of village forest committees, management of reserved forests and penalties and procedures.	Not applicable

The following inferences can be drawn a) Conservation of forest is a national problem so it must be tackled with perfect coordination between forest department and other departments; b) People's participation (especially that of tribal/indigenous people) in the conservation of forests is of vital importance. So, they must be involved in this national task; c) The cutting of trees in the forests needs to be in a controlled manner along with planting and proper management of the forests; d) Afforestation or special programme like Van Mahotsava should be launched on grand scale; f) Plantation forestry with proper joint forest management plan can be useful; g) Community forest management can be benefitted and can help restore the forest land.

10.2 Present Scenario and Gap Identification

Data provided by Forest Department

The total area under forest is reported to be 72174.09 hectors, which is 14.28 per cent of total geographical area of the district. The total number of forest block in district is 421. Out of 72174.09 hectares of forest 24936.37hectares are reserved forest, 33968.35 hectares are protected forest, and 13269.371 hectares are under unclassified forest. The forest coverage in the district is more the State average of about 9 per cent under forest. If compared to the 13 per cent of forest area of national average, the district comes out to be equal of the national average.

Table 10.2 Total Forest Area in Alwar Forest Division

Reserved Forest		Protected forest		Unclassifed Forest		Total Forest Land	
No. of Forest Block	Area	No. of Forest Block	Area	No. of Forest Block	Area	No. of Forest Block	Area
29	24936.37	245	33968.35	147	13269.37	421	72174.091

Table 10.3 Forest Cover in Alwar District (area in Sq. Kms.)

Geographical Area	ISFR 2019 Assessment			% of GA	Change w.r.t	Scrub
	Very Dense Forest	**Moderately Dense Forest**	**Open Forest (OF)**			
8380	59	334.96	802.7	14.28	-0.34	245.66

Table 10.4 Activity by Forest Department

Sl. No.	Action Area	Unit	Data
1	Total Forest Area in the District	Hectares	72174.091
2	Afforestation	Hectare	7220.139
3	Development of Urban Forest	Hectare	2.49
4	Reclaiming of Degraded Forest Land	Hectare	2625.096
5	Road Side Plantation	Rkm	100 Plant
6	Forestry activities to increase	Nos.	
7	Any other activity (District Specific)		

Table 10.5 Range-wise Forest area in Alwar Forest Division

Sl. No.	Name of Range	Associated Panchayat	Forest Area in Ha.			
			Reserved Forest	Protected Forest	Unclassified Forest	Total
1	Alwar		7894.45	2077.15	2196.02	12167.62
2	Thanagazi		4200.88	4081.82	122.80	8405.50
3	Rajgarh		4619.39	11476.12	3156.41	19251.92
4	Laxmangarh		1348.87	2249.53	3204.47	6802.87
5	Kishangarhbas		2465.00	6390.33	2971.35	11826.68
6	Behror		1160.94	2143.42	1338.30	4642.66
7	Tijara		3246.84	5549.03	280.97	9076.84
	Total		**24936.37**	**33967.40**	**13270.32**	**72174.09**

The important trees found in the district are Dhok, Babool, Kumtha, Kair, Hingotia, Khejra, Shisham, Neem etc. The main type of grasses is Bharut, Doob, Baru lapla and Munj, etc. Wild animals like hyena, wolf, jackal, fox, bush rat, striped in a languor can be easily spotted in the hilly tract of the district. The common mongoose and hedgehog are also seen in the entire area of the district. The main threats to the forest land are Illegal mining and Encroachments. Afforestation activities are regularly prepared and implement in the district.

Table 10.6 Commonly found Wild life in Alwar District (as per 2020-21 Census data)

S. No.	Common Name	Zoological Name	Count
Carnivores			
1	Jackal	Canis aureus	686
2	Jungal Cat	Felis chaus	22
3	Fox	Vulpes Bengalensis	19
		Total	**727**
Herbivore			
4	Black buck	Antelope cervicapra	0
5	Nilgai	Boselaphus tragocamhis	1161
6	Chinkara	gozella bennettii	0
7	Wild Pig	sus scrofa	467
8	Indian crested porcupin	hystrix indica	81
		Total	**1709**
Birds			
9	Peacock	Pavo cristatus	1847
		Total	**1847**

Total 13 nurseries are established in 7 ranges by the department of forest. These nurseries have a total 1,59,0000 plant raising capacity.

Table 10.7 List of Nurseries in Alwar Division

Name of Nrusery	Name of Range	Associated Phanchyat	Permanent/ Temporary	Plant raising Capacity
Nayabas	Alwar	-	Permanent	200000
Mungaska	Alwar	-	Permanent	200000
Behror	Behror	-	Permanent	100000
Neemrana	Behror	-	Permanent	60000
Kanpura	Behror	-	Permanent	100000
Gunj	Kishangarhbas	-	Permanent	100000
Kotkasim	Kishangarhbas	-	Permanent	50000
Tijara	Tijara	-	Permanent	30000
Srinagar	Rajgarh	-	Permanent	350000
Mahalbagh	Rajgarh	-	Permanent	100000
Burja	Laxmangarh	-	Permanent	50000
Ghata	Thanagazi	-	Permanent	200000
Pratapgarh	Thanagazi	-	Permanent	50000
			Total Capacity :-	**1590000**

Total 13 nurseries are established by the forest department, where seedling of plant is done. During 2020-2021 a total number of 4,86,100 plants are prepared in these nurseries.

Table 10.8 Number of Plant Seedlings raised in Nurseries during 2020-21

S. No.	Name of Nursery	Name of Range	Number of Plants (in Lakhs)		
			For Local Distribution	For Department use	Total
1	Nayabas	Alwar	95000	0	95000
2	Mungaska	Alwar	50000	0	50000
3	Behror	Behror	25000	200	25200
4	Neemrana	Behror	25000	1500	26500
5	Kanpura	Behror	20000	1000	21000
6	Gunj	Kishangarhbas	25000	0	25000
7	Kotkasim	Kishangarhbas	25000	0	25000
8	Tijara	Tijara	30000	0	30000
9	Srinagar	Rajgarh	25000	0	25000
10	Mahalbagh	Rajgarh	25000	0	25000
11	Burja	Laxmangarh	15000	0	15000
12	Ghata	Thanagazi	20000	55000	75000
13	Pratapgarh	Thanagazi	25000	23400	48400
		Total	**405000**	**81100**	**486100**

Table 10.9 Range-wise running plantation under different schemes from the year 2015-16 to 2021-22

Name of Range	Name of Scheme	Allotted Plantation works		No. of Plants planted/to be planted.	
		Number of works	Area in Ha.	Planted	To be planted
Alwar	NABARD	5	250	105000	0
Alwar	CAMPA	2	100	70000	0
Behror	NABARD	4	200	55000	0
Behror	CAMPA	10	657.55	388300	0
Kishangarhbas	NABARD	12	600	225000	0
Kishangarhbas	CAMPA	25	1051.731	651225	0
Laxmangarh	NABARD	1	50	25000	0
Laxmangarh	CAMPA	10	475	145000	0
Rajgarh	NABARD	13	675	220000	0
Rajgarh	CAMPA	21	1014.52	333772	3000
Rajgarh	State Plan	5	307.232	153616	0
Thanagazi	NABARD	7	325	125000	0
Thanagazi	CAMPA	22	1225.106	596781	0
Tijara	CAMPA	3	150	30000	0
Tijara	NABARD	1	50	10000	0
Tijara	Gadoj Majri-NH	1	89	62300	0
	Total	**142**	**7220.139**	**3195994**	**3000**

For Alwar district, 7 departments are benefited for afforestation where forest department distribute plant. A total of 2,44,532 units of plant are distributed.

Table 10.10 Distribution of Plants to different Ranges of Alwar District

Sl. No.	Department	Alwar	Behror	Tijara	Kishangarhbas	Rajgarh	Laxmangarh	Thanagazi	Total
1	Distribution	58551	42043	18500	27000	57593	15845	25000	244532
	Total	58551	42043	18500	27000	57593	15845	25000	244532

Different plantation scheme under Farm forestry, tall plant, and NAREGA are implemented.

Table 10.11 Distribution of Plants under different schemes

Scheme	Target	Achievement
Farm Forestry	40148	35982
Tall Plant	62956	62319
NAREGA	0	0
Total	**103104**	**98301**

Sariska Tiger Reserve

Sariska Tiger Reserve is a tiger reserve in Alwar district, Rajasthan, India. It stretches over an area of 881 km^2 (340 sq mi) comprising scrub-thorn arid forests, dry deciduous forests, grasslands, and rocky hills. It was given the status of a tiger reserve making it a part of India's Project Tiger in 1978. The wildlife sanctuary was declared a national park in 1982, with a total area of about 273.8 $km^{2.}$

The dominant tree in the forests is dhok (Anogeissus pendula). Other trees include the salar (Boswellia serrata), kadaya (Sterculia urens), dhak (Butea monosperma), gol (Lannea coromandelica), ber (Ziziphus mauritiana) and khair (Acacia catechu). Bargad (Ficus benghalensis), arjun (Terminalia arjuna), gugal (Commiphora wightii) or bamboo. Shrubs are numerous, such as kair (Capparis decidua), adusta (Adhatoda vesica) and jhar ber (Ziziphus nummularia).

Apart from the Bengal tiger, the reserve harbours many wildlife species including Indian leopard, jungle cat, caracal, striped hyena, golden jackal, chital, sambar deer, nilgai, wild boar, small Indian civet, Javan mongoose, ruddy mongoose, honey badger, Rhesus macaque and Northern plains gray langur and Indian hare. Bird species present include grey partridge, white-throated kingfisher, Indian peafowl, bush quail, sandgrouse, treepie, golden-backed woodpecker, crested serpent eagle and the Indian eagle-owl. As of October 2018, there were 18 tigers including five cubs. By 2020, the tiger population in the reserve has risen to 20 (Wikipedia, 2021).

10.3 Action Plan

The following steps should be taken for the conservation of forests:

A. Regulated and Planned Cutting of Trees: One of the main reasons of deforestation is commercial felling of trees. According to an estimate, about 1,600 million cubic metres of wood have been used for various purposes in the world. Although trees are considered as perennial resource, when exploited on a very large scale, their revival cannot be possible.

Therefore, cutting should be regulated by adopting methods like:

(i) Clear cutting, (ii) Selective cutting, and (iii) Shelter wood cutting.

The clear-cutting method is useful for those areas where the same types of trees are available over a large area. In that case, trees of same age group can be cut down in a selected area and then marked for replantation. In selective cutting only mature trees are selected for cutting. This process is to be followed in rotation. Shelter wood cutting is where first of all useless trees having been cut down followed by medium and best quality timber trees. The time gap between these cuttings is helpful in re-growth of trees. In regulated cutting only one-tenth of the forest area is selected for use and rotational system is always followed for their protection. The forest can be managed in such a way that a timber crop may be harvested indefinitely year after year without being depleted. This technique is called the ‘sustained yield’ method adopted by many countries of the world

B. Control over Forest Fire: Destruction or loss of forest by fire is fairly common; because trees are highly exposed to fire and once started it becomes difficult to control. Sometimes, the fire starts by natural process, i.e., by lightning or by friction between trees during speedy winds, while in most cases it is started by man either intentionally or unintentionally. In order to save forests from fire it is necessary to adopt latest techniques of firefighting. Some of the fire suppression techniques are to develop three metre wide five lanes around the periphery of the fire, back-fires, arrangement of water spray, fire retardant chemicals should be sprayed from back tank and if possible, by helicopters. There must be a trained staff of firefighters to control the fire.

C. Reforestation and Afforestation: The sustained yield concept dictates that whenever timber is removed, either by block cutting or by selective cutting, the denuded area must be reforested. This may be done by natural or artificial methods. Similarly, any forested land which has been destroyed by fire or mining activities should be reforested. In rugged terrain aerial seeding is the method of choice. Besides all this, fresh afforestation programmes should be started. New plantations will not only increase the forest cover but also help in making up the eco-balance. For afforestation, selection of trees should be done according to local geographical conditions and care must be taken during initial growth of the trees.

D. Check over Forest Clearance for Agricultural and other purposes: Most of the present-day agricultural land was once forested and then cleared for the use of agriculture. But now it has reached the stage where further clearance will be dangerous for the entire ecosystem. Similarly, for the development of villages, towns and cities, forest lands have been cleared and this process continues to this day causing loss of forest cover. This also should be checked and green belts around cities should be developed.

E. Protection of Forest: The existing forests should be protected. Apart from commercial cutting, unorganized grazing is also one of the reasons. There are several forest diseases resulting from parasitic fungi, rusts, mistletoes, viruses and nematodes which cause the destruction of trees. The forests should be protected either by use of chemical spray, antibiotics or by development of disease resistant strains of trees.

F. Proper Utilization of Forest Products and Forests: Generally, forests have been cut for logs and rest of the tree – stump, limbs, branches and foliage, etc., are left out in the forest as worthless debris. Further waste occurs at the saw-mill. There is a need to use all this waste material. Now several uses have been developed and products like waterproof glues, board, etc., can be obtained.

G. Role of Government in Forest Conservation: Although the government of every country is very particular about conservation of its forest resources and has several rules and laws for the protection of forests but, they are not implemented in an effective manner. Both national and provincial governments can take some steps in this direction, such as: (i) passing acts for the conservation of forests, (ii) Survey of the forest resources, (iii) Categorization of forest areas and proper delimitation of reserved forest areas, (iv) Find out the areas where reforestation can be done, (v) Regulate the commercial use of forest products, (vi) Protect forest from fire, mining and other natural calamities, (vii) Develop national parks, (viii) Encourage forests developmental activities like social forestry, agro-forestry, etc., and (ix) Prepare master plans.

H. Forest Management: Management of forest resources is the key to all conservation efforts. In forest management, the following aspects should be taken into consideration: (i) Survey of forest, (ii) Categorization of forest. (iii) Economic use of forest, (iv) Administrative setting for forest management, (v) Training programmes for persons engaged in forest conservation activities, (vi) Use of forest land as tourist centers, (vii) Social and agro-forestry, (viii) Development of new techniques for the conservation of forests, (ix) Research for efficient use and conservation of forest, and (x) Policy decisions and their proper implementation. In brief, conservation of forest resources can be done by cooperative efforts of the government, non-government organizations and the public through a proper management system.

I. Similarly, forests can easily be used or developed as tourist centers. By using them as tourist centers the country can earn substantial foreign exchange. This practice has been adopted by many countries, both developed and developing.

J. The concepts of 'national park' and 'game sanctuary' have now become popular and every state has developed its unique forest area as a 'national park'. In India alone, there are as many as 21 national parks. This scheme is a good method of forest conservation.

10.4 Summary

Forest preservation is the act of planting and keeping up forested regions for the advantage and sustainability of people in the future. The protection of forest likewise stands and focuses on a speedy change in the structure of trees species and age appropriation. Forest preservation includes the upkeep of the regular assets inside forest that are useful to the two- people and the climate.

In any case, presently forest cover is depleting quickly because of numerous reasons like a development of agribusiness, other land utilization, urbanization, development of roads, illegal mining, and encroachments, comprises the greatest and extreme danger to the forest causing genuine natural harm. In this manner, there is need of public mindfulness.

Summary of present status, future projection and action plan for forest conservation and management Alwar district:

Table 10.12 Action Plan for Forest Conservation for Alwar District

Name of District	Present scenario	Action plan for future
Alwar	The total area under forest- 72174.091 hectors Percent of total geographical area of the district- 14.28 % The total number of forest block in district is 421. Out of 72174.091hectares of forest: Reserved forest:24936.37 hectares, Protected forest: 33968.35Hectare Unclassified: 13269.371	• Enforcement of acts/rules and regulation of forest conservation • Development of Urban Forest • Reclaiming of Degraded Forest Land • Road side plantation • Commercialization of forest produces. • Development of forest as a tourist centers and other recreational activities. • Management and monitoring of forest in the area

In this way, we can conclude that, individuals as well as governments can do their part in protecting the forests of the world. Knowledge about the importance of forest needs to be spread so that people become aware of the danger to everyone and everything on the earth by deforestation. People's participation in the conservation of forests is of vital importance.

Finally, it is necessary to add that the methods, strategies and measures mentioned here for the conservation of forests are very simple so that every individual could follow them and act at their own level in order to achieve the goal of conservation of forests. If we do not start and act now, it might get too late for the cause of conservation of forests.

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