DISTRICT ENVIRONMENTAL PLAN
DEHRADUN

(As per the Hon'ble National Green Tribunal (NGT) vide order O.A. no. 360/2018 dated 26.09.2019)

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PREFACE

Hon'ble National Green Tribunal (NGT) vide order, dated 26/09/2019 in O.A. No. 360 of 2018 filed by Shree Nath Sharma Vs. Union of India and others directed that Central Pollution Control Board (CPCB) need to facilitate the District Magistrates in preparing the District Environmental Plan (DEP) by placing a model plan on its website. This model plan may be adopted as per local requirements by all districts under the supervision of the District Magistrate (DM). The said order also directs that the Department of Environment in respective states should collect district plans to prepare State Environment Plan (SEP), which shall be monitored by respective Chief Secretaries of the State by 15/12/2019. Based on State Environmental Plans, CPCB and Ministry of Environment, Forest & Climate Change (MoEFCC) shall prepare a National Environmental Plan (NEP), under the supervision of Chairman, CPCB and Secretary, MoEFCC.

There are diverse environmental issues that address our key responsibilities to the community and its surrounding environment. As a set of target, 14 areas by Hon'ble NGT and one more - plastic waste by Government of Uttarakhand were included under the district plan. These 14 areas were regarding compliance to the rules for solid waste including legacy waste, bio-medical waste, Construction & Demolition waste (C&D), Hazardous waste, Electronic waste (E-waste), Polluter stretches, Non-attainment cities, Industrial clusters, the status of Sewage Treatment Plants (STPs) and re-use of treated water, the status of Common Effluent Treatment Plants (CETPs) / Effluent Treatment Plants (ETPs), Groundwater extraction, contamination and re-charge, Air pollution including noise pollution, Illegal sand mining, and Rejuvenation of water bodies. In addition, plastic waste was also assessed based on consultative workshops with the state government including State Pollution Control Board (SPCB). The present environmental plan describes the status quo of 15 thematic areas and sets out strategies to mitigate their impact on different environmental parameters and human health. It briefly touches upon the basic need for bringing in mountain perspective in developmental planning. Implementation of this plan based on selected indicators may be helpful in resolving different environmental issues. Also, it will meet compliance of different departments within a district. It will also allow a variety of environmental opportunities associated with different activities to be further undertaken from a view point of sustainable development. We hope this document will act as a noble reference for various stakeholders interested in sustainable development planning for the district of Dehradun. Moreover, it will help to develop comprehensive understanding of the environmental planning process in view of socio-economic and financial situation of the district.

Date: July, 21, 2022 Principal Investigator, Co-Project Investigators & Project staff

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In the last but not least, our especial thanks go to Uttarakhand Pollution Control Board (UKPCB), Government of Uttarakhand for financial support (Letter No. UKPCB/HO/Gen.183-431/2020/2156-415, dated 05/08/2020) to conduct the study in the 13 districts as well as the state of Uttarakhand.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AMRUT	-Atal mission for Rejuvenation and Urban Transformation
APL	-Above Poverty Line
AR	-Assessment Report
As	-Arsenic
ASP	-Activated Sludge Process
ASSOCHAM	-Associated Chambers of Commerce and Industry of India
BHEL	-Bharat Heavy Electricals Limited
BMWMIS	-Biomedical Waste Management Information System
BOD	-Biological Oxygen Demand
BPL	-Below Poverty Line
C	-Carbon
C&D waste	-Construction and Demolition waste
CAAQMS	-Continuous Ambient Air Quality Monitoring Station
CACMP	-Catchment Area Conservation Programme
CAGR	-Compound Annual Growth Rate
CANTT	-Cantonment Board
CBG	-Compressed biogas plant
CBMWTF	-Common Bio-Medical Waste Treatment Facility
Cd	-Cadmium
CD	-Check Dam
CEMS	-Continuous Emission Monitoring System
CEPI	-Comprehensive Environmental Pollution Index
CETP	-Common Effluent Treatment Plant
CFL	-Compact Fluorescent Lamps
CGWB	-Central Ground Water Board
CH_4	-Methane
CHCs	-Community Health Care Centres
CK	-Chal Khal
CNG	-Compressed Natural Gas
CO	-Carbon monoxide
CO_2	-Carbon dioxide
COD	-Chemical Oxygen Demand
CPCB	-Central Pollution Control Board

CPHEEO	-Central Public Health and Environmental Engineering Organisation
Cr	-Chromium
CSCs	-Community Sanitary Complex
CT	-Contour Trench
Cu	-Copper
dB	-Decibels
DDT	-Di-chlorodiphenyltrichloroethane
DFO	-Divisional Forest Officer
DIPSR	-District Industrial Profile Survey Report
DM	-District Magistrate
DO	-Dissolved Oxygen
DPR	-District Project Report
EC	-Environmental Clearance
EEE	-Electronics and Electrical Equipment
ENVIS	-Environmental Information System
EPI	-Environmental Performance Index
ESIPL	-Eldeco SIIDCUL Industrial Park Limited
ESS	-Environment Surveillance squad
ETPs	-Effluent Treatment Plants
E-Waste	-Electronic Waste
F	-Fluoride
FPZ	-Flood Plain Zones
FSI	-Forest Survey of India
FSSM	-Faecal Sludge and Septage Management system
FSTP	-Faecal Sludge Treatment Plant
GBPNIHE	-G.B. Pant National Institute of Himalayan Environment
GDP	-Gross domestic product
GES	-Global Environmental Solution
GIS	-Geographical Information System
GPIs	-Grossly Polluting Industries
GPS	-Global Positioning System
HCFs	-Health Care Facilities
HCL	-Hindustan Computers Limited
ICT	-Information and Communication Technology

IEC	-Information, Education and Communication
IHHLs	-Individual Household Latrines
IIE	-Integrated Industrial Estate
INR	-Indian rupee
IPC	-Inter-Personal Communication
IPCC	-Intergovernmental Panel on Climate Change
IRAP	-Integrated Rural Area Programme
ISO	-International Organization for Standardization
ISWM	-Integrated Solid Waste Management
IWRM	-Integrated Water Resources Management
KFW	-Kreditanstalt Fuer Wiederaufbau
KLD	-Kilo Liters Per Day
LPG	-Liquefied Petroleum Gas
MBBR	-Moving Bed Biofilm Reactor
MDWS	-Ministry of Drinking Water and Sanitation
Mg	-Milligram
MGNREGA	-Mahatma Gandhi National Rural Employment Guarantee Act
MLD	-Millions of Litter Per Day
MMT	-Million Metric Tons
MoEF&CC	-Ministry of Environment, Forest &Climate Change
MoF	-Ministry of Finance
MoUHA	-Ministry of Urban & Housing Development
MPCC	-Medical Pollution Control Committee
MPN	-Most Probable Number
MRF	-Material Recovery Facility
MSMEs	-Micro, Small &Medium Enterprises
MSW	-Municipal Solid Waste
MTPD	-Metric Ton per Day
NA	-Not Applicable
NAAQS	-National Ambient Air Quality Standards
NACP	-National Clean Air Program
NAPCC	-National Action Plan on Climate Change
NASA	-National Aeronautics &Space Administration
NATCOM	-National Communication

NCEPC	-National Committee on Environment Planning &Co-ordination
NGOs	-Non-Governmental Organizations
NGT	-National Green Tribunal
NH	-National Highway
NIHL	-Noise induced Hearing Loss
NITI	-National Institution for Transforming India
NMHS	-National Mission of Himalayan Studies
NN	-Nagar Nigam
NP	-Nagar Panchayat
NPP	-Nagar Palika Parishad
NTFPs	-Non-Timber Forest Products
O&M	-Operation and Maintenance
OCEMS	-Online Continuous Effluent Monitoring System
ODF	-Open Defecation Free
OSHA	-Occupational Safety and Health Administrations
OSS	-On-site Sewage Systems
PAT	-Perform, Achieve &Trade
PCC	-Pollution Control Committee
pH	-Potential of Hydrogen
PHCs	-Primary Health Centre
PIBO	-Producer, Importer and Brand Owner
PM	-Particulate Matter
PPCP	-Polypropylene Copolymer
PPP	-Polluter Pays Principle
PRO	-Producer Responsibility Organization
PSUs	-Public-Sector Undertaking
PT	-Percolation Tank
PUC	-Pollution under Control
PWD	-Public Works Department
QPD	-Quintal Per Day
RBMs	-Riverbed Minerals
RoHS	-Restriction of Hazardous Substances
RSM	-Rural Sanitary Marts
RTO	-Regional Transport Officer

RTRWH	-Rooftop Rain Water Harvesting
SBC	-Soil Bowl Centrifuge
SBM-G	-Swachh Bharat Mission Gramin
SDGs	-Sustainable Developmental Goals
SIDCUL	-State Industrial Development Corporation of Uttarakhand Limited
SLWM	-Solid and Liquid Waste Management
SPCB	-State Pollution Control Board
SPM	-Suspended Particulate Matter
SSMG	-Sustainable Sand Management Guidelines
STP	-Sewage Treatment Plant
TKN	-Total Kjeldahl Nitrogen
TPD	-Tonne Per Day
TSDF	-Treatment Storage and Disposal Facilities
UKPCB	-Uttarakhand Pollution Control Board
ULBs	-Urban Local Bodies
UNDP	-United Nations Development Programme
UREDA	-Uttarakhand Renewable Energy Development Agency
WHO	-World Health Organization
ZED	-Zero Effect Zero Defect
ZLD	-Zero Liquid Discharge
µg	-Microgram

EXECUTIVE SUMMARY

The district of Dehradun is one of the most populous and developed region of the state. Its unique ecosystem provides ample natural resources, which caters the demand of lakhs of people and wildlife. However, developmental activities have pushed the natural resource base to its limit. Ever increasing waste, deteriorating air quality, water body pollution is pervasive in 11 municipalities of the district. Economic and population growth have been the factors that need consideration to explain the increasing biotic and abiotic stress imposed by human interferences on the natural environment.

In view of analysing the current status and furnishing a comprehensive plan to mitigate the environmental deterioration, GBPNIHE was assigned the task to prepare an 'Environment Plan for the District of Dehradun'. Detailed deliberations were carried out to devise the action plan focusing on explicit thematic areas which are as under:

- ***Waste Management Operations:*** Waste generation in the district is substantial in Nagar Nigam (NN) Dehradun when compared to other ULBs (). Source segregated waste is transported in different compartment vehicles.
- For waste processing and disposal, some ULBs have their own recovery facility and disposal ground and some of them (7 out of 11 ULBs) have linkage with Sheeshambada waste processing plant. Nagar Palika Parishad (NPP) Doiwala is working on a cluster based approach with NN Rishikesh.
- Plastic waste is segregated from the dry waste after secondary segregation. After compaction, it is either sold to local rag pickers or is channelized to authorised recycler. Dustbins have been provided in major tourist locations (NN Rishikesh and NPP Mussoorie) to prevent littering of plastic waste.
- Based on our estimation, the rise in population will increase the solid waste and plastic waste generation in the district. It will surpass 1200 MTPD and 350 MTPD respectively by 2040. Rapid urbanization, high tourist influx, change in habits and attitude of stakeholders would be the major factors for the projected rise.
- As the district hosts the capital city of the state, it needs to propagate state of art technologies in solid waste management.
- The data for domestic hazardous waste and e-waste were not available with the district. Some steps such as use of triple compartment vehicles, collection centre for e-waste, etc. have been taken in some ULBs of the district.

- More than 400 industries are generating hazardous waste in the district. Maximum quantity of this waste is incinerable and land fillable. All the industries have linkage with a Treatment, Storage and Disposal Facility (TSDF) named as Medical Pollution Control Committee (MPCC) at Roorkee. These industries are strictly being regulated by State Pollution Control Board.
- Based on our assessment, most of the ULBs of the district have above average performance in waste management practices. NN Dehradun, NN Rishikesh NPP Doiwala, and NPP Mussoorie are standout performers in the district.
- ***Bio-medical Waste Management:*** Maximum HCFs in the district are authorised by UKPCB. Medical Pollution Control Committee (MPCC), a CBWMTF/TSDF at Roorkee is tasked with lifting and processing biomedical waste generated in the HCFs of the district. Government health care facilities also have the facility of deep burial pits for biomedical waste disposal. Biomedical waste generated in households is not inventoried and exists as a part of mixed waste.
- ***Construction and Demolition*** **(**C&D) ***Waste Management:*** The quantity of C&D waste is determined in 4 out of 11 ULBs of the district. These four ULBs are: (NN Dehradun NPP Vikasnagar Cantonment Board (CB) Dehradun and CB Chakrata. Moreover, many have the ULBs started collecting C&D waste generated in their administrative area. C&D waste is either utilized locally or is kept in the solid waste disposal site of each ULB. In some ULBs, C&D waste is being sold to local residents on demand.
- ***Air Pollution***: Air quality monitoring stations have been installed in six different locations (3 each) of NN Dehradun and NN Rishikesh. To make people aware of the prevailing Air Quality Index (AQI), a real time monitoring station has been installed by UKPCB in collaboration with Doon University. These air quality data are displayed in 50 smart poles across the city.
- In view of high pollution levels obtained from the monitored data, NN Dehradun and NN Rishikesh were declared as non-attainment cities under National Clean Air Program.
- ***Non-Attainment City-Dehradun***: Natural dust and particulate laden smoke from diesel vehicles such as trucks, buses, auto-rickshaws have been primarily responsible for air pollution in the city. Industrial pollution is marginal in the district. Air quality parameters, especially PM_{10} and $PM_{2.5}$ values exceeded the permissible limits for the past five years. This has been a matter of concern. Action plan has been prepared as a part of National Clean Air Program (NCAP) and directions of Hon'ble NGT for improving air quality in the town and its vicinity

- ***Non-Attainment City-Rishikesh:*** Emissions from vehicles, diesel generator sets, fossil fuel burning, solid waste, etc. are the major sources of pollution in the city. Two major industries of red category are also operational in the outskirts of Rishikesh. Out of three monitoring stations, two have been in operation from the past two years. PM_{10} value is above the permissible limit in all the monitoring stations. Action plan is prepared as a part of National Clean Air Program (NCAP) and directions of Hon'ble NGT for improving air quality in the town and its vicinity.
- ***Noise Pollution***: Noise levels are measured in few locations of NN Dehradun. These locations fall under different zones such as commercial, industrial, residential, etc. Measured values indicate elevated noise levels in each location. A special monitoring drive is carried out to study the impact of fire crackers during Deepawali festivals in different locations of NN Dehradun and Rishikesh.
- ***Waste water Management***: At present, 13 STPs (8 in NN Dehradun and 5 in NPP Mussoorie) are operational in the district. One more STP is proposed in Kalagarh, NN Dehradun The coverage of scientific treatment of waste water is limited to only two ULBs of the district. Other ULBs use captive septic tanks for the disposal of waste water.
- ***Industrial Areas and Industrial Waste Water:*** Currently, more than 600 industrial units are operational in the district. Some of these industries exist in the industrial areas at different locations. As per Doon Valley Notification 1989, some designated industries are prohibited in NN Dehradun. Stack monitoring is performed in few industries to ascertain the air quality.
- 104 industries in the district have their own Effluent Treatment Plant (ETPs). Usually, these work on the principle of Zero Liquid Discharge (ZLD).
- ***River Polluter Stretches:*** As a part of River Suswa from Mothrowala to Raiwala (approx. 31 km) was declared as polluted river stretch of priority I. This was based on the data obtained from monitoring stations for the year 2016 and 2017. Waste water from seasonal streams (*nalas*) draining into Rispana and Bindal eventually join River Suswa. Industrial drains and illicit dumping of solid waste are some of the reasons for the poor environmental condition of River Suswa. Action plan has been prepared for restoration of this polluter stretch as directed by Hon'ble NGT.
- ***Water Resources Management:*** Dehradun valley is situated between the River Ganga and Yamuna. These two basins are separated by a ridge starting from Mussoorie and pass through Dehradun. Major rivers in the district include Rispana, Bindal, Suswa, Song, etc. Moreover, four major canal systems exist in the district which were built during the British period. They are being used for the purpose of irrigation and water supply.

- River Rispana caters the drinking water demand of thousands of residents in the city of Dehradun. It's over-exploitation and pollution have become a case of concern for the government. Taking stock of the situation and its direct consequences, a project named Mission Rispana has been launched in 2018. Forest department is assigned with the responsibility to revive the flow of the river. Restoration works include plantation works, construction of water ponds, etc.
- ***Mining Activity:*** Mining operations, specifically sand mining is one of the major sources of revenue for the state government. Mining activities are carried out in 2.77 km^2 area of the district. Permission for the same is given by the district authority. At present, two illegal lining sites (one each in River Dhaula and Kot Mot) have been identified in the district. Penalties are imposed as per Mines and Minerals (Development and Regulation) Act,1957 for these illegal mining activities.

The execution of this management plan in the district of Dehradun will require the integration and co-operation of the stakeholders at all levels, viz., public including natives, private organizations, local government, etc. This plan aims at reducing the ever increasing risks on the human health and environmental components with a target of sustainable development in the district.

INTRODUCTION

The link between environmental degradation, economical scarcity and poverty is straightforward. The world's poor are significantly prone to natural disasters pertaining to the fact that in many cases their livelihoods are directly dependent on natural resources. Human welfare is closely associated with the health of the environment. Around the world, 24% of deaths can be traced back to avoidable environmental factors according to the World Health Organization (WHO). People are in dire need of clean air to breathe, freshwater to drink and places to live that are free of toxic substances and hazards. The 2030 agenda for Sustainable Development Goals (SDGs) and its 17 SDGs adopted by world leaders defines a blueprint for future development trajectory to all nations with a focus on poverty eradicating, environmental sustainability, peace and harmony. To shed some light on the Himalayan context, the area is one of the most fragile mountainous regions of the world, hence they are very much susceptible to changes in environment and ecology. These mountains are the 'Water Towers' of Asia, as they are the origin of the major rivers in the Indian sub-continent. But for the past two decades, the area has become a global hotspot of environmental degradation and the indirect impact has been seen in the glaciological aspect of these mountains. Over a billion people worldwide and over 500 million in South Asia are reliant on the healthy aspect of this Himalayan Ecosystem. In India, it directly serves a national interest because of an imperishable ecosystem developed by them, which helps in realizing sustainable development in the Indo–Gangetic plains. A prerequisite for such sustainability is compliance in areas, which at once would apprise about the present environmental issues and a strategy to meet the targets for the future. Uttarakhand being a crucial chunk of the Himalayan Regime is utmost vulnerable to environment mediated risks. About three fourth of the state's population is rural, hence their livelihoods are almost totally dependent on natural resources. The traditional customs of the local people of Uttarakhand, which tend to be sustainable and in harmony with the natural ecosystem are often overlooked as every time reckless development of roads, infrastructure, environmental degradation takes precedence over the traditional ecological knowledge. The tragedy of ecological governance in most parts is that it remains trapped in Environment - Development Binary. In contrast, the people of Uttarkhand had in past shown with movements such as the Chipko Andolan, which sowed the germ of an idea of human well-being sensitive to forests, mountains and water bodies.

The art of cultivating balance between economic and sustainable development is known to many, but is implemented by few. We need to devise a strategy to break this trade off so that a mutually beneficial situation is achieved for the Environment and Society. Environment plan is a

prerequisite to understand how the Social, Political and Economic factors are affecting the environment considering development. Environment Planning begin in India in early 1970s after Human Environment Conference at Stockholm held by United Nations which led to the formation of National Committee on Environment Planning and Co-ordination (NCEPC). Subsequently, the Ministry of Environment and Forest was formed in mid 1980s by Government of India. Realizing that the conservation of nature and its sustainability is a basic requirement for sustaining healthy life on globe, the key purpose of this plan is to implement and devise programs intended to conserve and protect the environment.

FUNDAMENTAL PRINCIPLES OF ENVIRONMENT PROTECTION

(Judgments of the Hon'ble Supreme Court of India)

Sustainable Development

The Supreme court has recognized the principle of sustainable development as a basis for balancing ecological imperatives with development goals. In rural litigation and Entitlement Kendra, Dehradun Vs State of U.P., the Supreme court was hearing litigation for the problem of the mining activities in the limestone quarries in Dehradun-Mussoorie area. This was the first case of its kind in the country involving issues relating to environment and ecological balance and brought into sharp focus the conflict between development and conservation. In this Case the Supreme court emphasized the need for reconciling development and conservation in the larger interest of the country. Furthermore, it was realized that the necessary condition for achieving sustainable development is ecological security, economic efficiency and social equity.

Precautionary Principle

The emergence of precautionary principle marked a shift in the international environmental jurisprudence – a shift from assimilative capacity principle to precautionary principle. Basically, it is a principle which ensures that a substance or activity posing threat to the environment is prevented for adversely affecting it, even if there is no conclusive scientific proof lining that particular substance or activity to the environment damage. In Vellore Citizens Welfare Forum vs Union of India, it was alleged that the untreated effluent being discharged by tanneries in Tamil Nadu was entering into the river, agricultural fields and was significantly polluting the water. Justice Kuldip Singh (Known to be Green Judge) observed that "even otherwise once these principles are accepted as a part of the Customary International law, there would not be difficulty in accepting them as part of domestic law. It is almost accepted proposition of municipal law, that the rule of customary international law, which are not contrary to the municipal law shall be deemed to be incorporated in the domestic law and shall also be followed by the Courts of laws of

the country". As per this special principle, the burden is on the person wanting to change the status quo to show that the actions proposed will not have any adverse effect, the presumption operating in favor of environmental protection.

Polluter Pays Principle

Polluter Pays Principle has become a popular slogan in recent times. "If you make a mess, it's your duty to clean it up". It should be mentioned that in environmental law, this principle doesn't refer to" Fault". Instead it favors a curative approach which is concerned with repairing ecological damage. The Supreme Court held that as per the Polluter Pays principle "once the activity carried on is hazardous or inherently dangerous, the person carrying out such activity is liable to make good the loss caused to any other person by this activity irrespective of the fact whether he took reasonable care while carrying on his activity. The rule is premised on the very nature of the activity carried on". While applying the principle of polluter pays, the Supreme court later expressed the view that compensation to be awarded must have some correlation not only with the magnitude and capacity of the enterprise but also the harm caused by it.

Public Trust Doctrine

The public trust doctrine primarily rests on the principle that certain resources like air, sea waters and forests have such a great importance to the people as a whole that it would be wholly unjustified to make them a subject of private ownership. The said resources being a gift of nature, they should be made freely available to everyone irrespective of the social status. This doctrine came up for consideration in the M.C. Mehta vs Kamal Nath. A rather unusual situation had arisen in this case. The flow of river Beas was deliberately diverted because it used to flood Span Motels in the Kullu Manali valley in which a prominent politician's family had a direct interest. Though the Supreme court did not specifically refer to the Doctrine of Public Trust directly, in many cases they have given effect to this doctrine implicitly. Traditionally the Doctrine of Public Trust was applied only for protection of access to the common for public benefit, but now the Doctrine is being applied even to prevent over exploitation of the environment.

Public Liability Insurance

The Public Liability Insurance Act 1991, has been enacted with the objective of providing immediate relief to the victims of accidents that might occur while handling hazardous substances. The owner who has control over handling of hazardous substances is required under the act to pay specified amounts to the victims as interim relief based on "No-Fault" liability. The expression 'Handling' is defined widely to include manufacture, trade and transport of hazardous substances. Accidents by reason of war or radioactivity are excluded from the scope of the Act. The Principle

of absolute Liability was propounded in the case of MC Mehta vs Union of India with the primary question regarding the extent to which industries engaged in hazardous and inherently dangerous industries can be held liable. This Principle was further reaffirmed in the Indian Council for Enviro Legal Action vs Union of India in which it was held that industries will be absolutely liable to the harm caused to villages due to the pollution caused to the soil and underground water and hence are bound to take remedial measure to improve the situation.

ENVIRONMENT MANAGEMENT SYSTEM (ISO 14001:2015)

An Environment management system helps organizations identify, manage, monitor, and control their environmental issues in a Holistic manner. ISO 14001 is an internationally agreed standard that sets out the requirements for an environmental management system. It helps organizations improve their environmental performance through more efficient use of resources and reduction of waste. Other ISO standards that look at different types of management systems such as ISO 9001 for quality management and ISO 45001 for occupational health and safety, all use a High-level Structure, this means that ISO 14001 can be integrated easily into existing ISO management systems. ISO 14001 includes the need for continual improvement of an organizations systems and approach to environmental concerns. It is suitable for organizations of all types and sizes, be they private not-for-profit or governmental. It requires an organisation to consider all environmental issues relevant to the operations such as air pollution, water and sewage issues, waste management, soil contamination, climate change mitigation, resource use and efficiency.

DISTRICT PROFILE

Dehradun district is situated in the north-west corner of Uttarakhand state (Fig.1). It is located in the Shivalik range of the Himalaya on the western border of the state. The district is bounded by Uttarkashi district on the North, Tehri Garhwal and Pauri Garhwal districts on the east and Saharanpur district (UP) on the south. Its western boundary adjoins Sirmour district of Himachal Pradesh being separated by Rivers Tons and Yamuna. The district is well connected to other cities of the North India by rail, road and air. The capital of Uttarakhand, Dehradun is a gateway to some of the most popular hill stations in the country like Nainital, Mussoorie, etc. along with the pilgrimage sites of Haridwar and Rishikesh. Moreover, Dehradun is one of the “Counter Magnets” of the National Capital Region (NCR) being developed as an alternative growth to help ease the migration and population explosion in the Delhi Metropolitan area.

The history tells that for centuries the region formed as a part of the Garhwal kingdom with some intrusions from Rohillas and Gorkhas. In 1815, Gorkhas were ousted from Garhwal region and it

was annexed by the British. Since then, it has been a favoured tourist destination as it attracts explorers, pilgrims and enthusiasts from various walks of life to its scenic beauty. In addition, the abundance of special Basmati rice and Leechi gardens contributes in accomplishing the region to a promised land. Not only this, the city also boasts of its lush green tea gardens that sprawl up to 2000 km^2 of land.

Dehradun and Education is quite synonymous. The city has been known as *"School capital of India"* for its world class residential schools which attract students across the globe. Dehradun has some highly revered educational institutions such as Doon School, Welham Girls School, Rashtriya Indian Medical College, Forest Research Institute, the Zoological Survey of India. These all make Doon the *"Eton of the East"*.

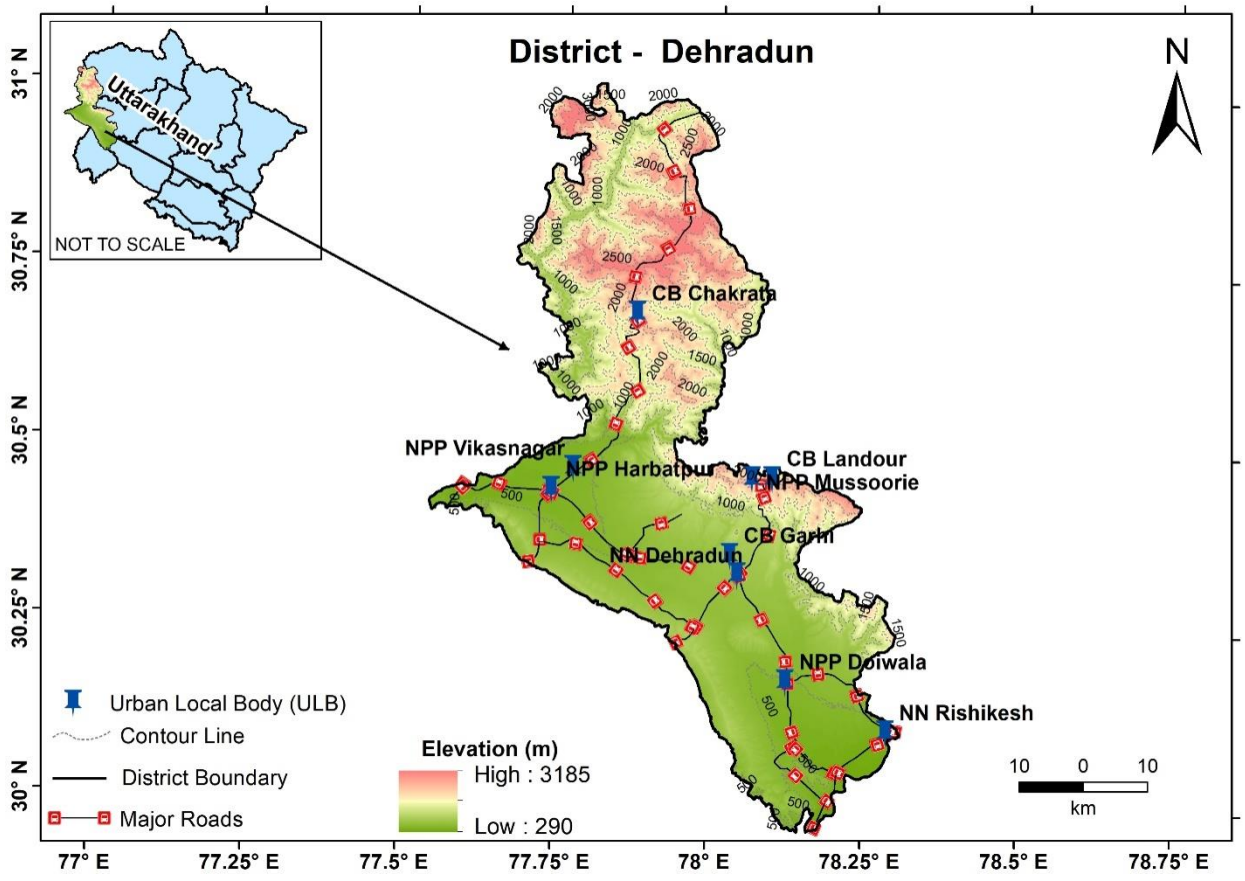


Fig. 1. Geographical location with topographical and road network in Dehradun district

District at a glance

Table 1 below represents the geographical aspect, population data and administrative setup of the district of Dehradun.

Table 1. District at a Glance

Geographical Location	
Latitude	$29^0$57'N - $31^0$2'N
Longitude	$77^0$35'E - $79^0$20'E
Geographical area (km^2)	3088
Average elevation of district headquarter (m asl)	640
Population Data (2011 census)	
Total population	1696694
Male population	892199
Female population	804495
Population density (population per km^2)	549
Population growth rate (%)	32.33
Overall literacy rate (%)	84.25
Male literacy (%)	89.40
Female literacy (%)	78.54
Sex ratio (female per thousand male)	902
Urban population (%)	55.52
Rural population (%)	44.48
Administrative Divisions	
Tehsils	07
Blocks	06
Nyay Panchayats	36
Village Panchayats	401
Census Villages	749
Census Town	05
Municipal Councils	02
Nagar Palika Parishad	04
Nagar Panchayats	01
Cantonment Boards	04

Source: *District Census Handbook 2011; District statistical report 2018, District at a Glance 2018-19, Dehradun*

Topography

The district is surrounded by the Himalayas in the north, the Shivalik Hills to the south, the river Ganges to the east and Yamuna river to the west. The capital city of Dehradun mainly lies in the Doon valley which is locally known as the Mussoorie Range. Mean sea level of the hilltop ranges from 1500 to 2700 meters and in the valley from 500m to 1200 m. Topography of the district is divided into two distinct tracts which consists of a succession of mountains (rough with steep slopes) and gorges (Table 2).

Table 2. Topography of the district

Name of Tract	Location	Region	Topography
Montane tract	Chakrata tehsil	Includes hilly areas of Jaunsar-Bhabar	Consists of ridge which separates the drainage area of Tons river on west from that of Yamuna river on the east.
Sub-Montane Tract	Below the Montane tract	Includes the famous Doon valley.	Bounded by Shivalik hills in the south and outer scrap of Himalayas in the north

Drainage System

The Holy Ganga and Yamuna originates in the Upper Himalayan region from Gangotri and Yamunotri forming a vast Indo-Gangetic fertile plain. Ganga enter in the west of Dehradun district at Tapovan and meander south-west to Haridwar while Yamuna enters the district in Jaunsar and flows southwards for about 32 km on the south east border of Dehradun district. From a point about midway between these two rivers runs a ridge which forms the watershed of the valley. Western part of the ridge is washed by tributaries of Yamuna and the eastern segment is drained by Suswa, a tributary of Ganga (Table 3).

Table 3. Drainage System of the district

S. No.	Name of the Rivers/ Streams	Total length in the District (km)	Place of Origin	Altitude at origin (m)
1	Yamuna	40	Yamunotri	3162
2	Ganga	18	Gangotri	3200
3	Tons	28	Mussoorie	1963
4	Assan	28	Malhan Range	718
5	Sorna	20	Misras Patti	985
6	Nimi	11	Kharakhet	834
7	Noon	13	Bakrana	1315
8	Jakhan	27	Raithwan gaun	1152
9	Song	39	Tega Kalhan	2378
10	Bindal	21	Rajpur	960
11	Sheetal Raw	19	Koti	1160
12	Chorkhala	14	Birsani	830
13	Sudhowla/Khala	10	Bidholi	823
14	Gulata	7.5	Bidholi	781
15	Narokhala	5	Tauli	698
16	Rispana	23	Tibanalapani	839
17	Chandrabhaga	21	Agarkhal	1361
18	Suswa	34	Mothrowala	578

Source: District Survey report Dehradun

Climate

The climate varies greatly from tropical to severe cold which is determined by the altitude of the area. There is temperature variation due to significant difference in elevation. In the hilly region,

the summer is pleasant. Nevertheless, the Doon valley often experiences intense heat although not up to such magnitude as in case of the plains of the surrounding districts. The district Dehradun experiences three seasons, i.e., cold winter season (Oct-Feb), hot or summer season (March-June) and wet monsoon season (July-Sep). During summer, average temperature ranges between 16ºC to 34ºC although winter seasonal variations is observed between 5ºC to 24ºC. Temperature sometimes falls down below freezing point not only at the high altitude but also at places in Dehradun amid snowfall events in higher altitudes.

Rainfall

The district receives an average annual rainfall of 2073.3 mm with relative humidity in monsoon season which, on an average, exceeds to 70%. Most of the rainfall is received during the period from June to September, wherein July and August are the wettest months. The region around Raipur gets the maximum rainfall, while the southern part receives the least rainfall in the district. About 87% of the annual rainfall is received during the period from June to September.

Fauna and Flora

Flora

Dehradun is distinguished from other districts in the state by the existence of very large forest chiefly stocked with Sal (Table 4). Additionally, Forests play an important role in the economy of the district.

Table 4. Forest cover of Dehradun district

District	Geographical Area (km^2)	Very dense	Moderately dense	Open Forest	Total	Percentage Change as of 2017 assessment
Dehradun	3,088	659.77	601.56	347.36	1,608.69	3.69 %

Different types of forests and varying species of shrubs and grasses, depending upon the aspect, altitude and soil condition are found in the district. The four major type of forests prevalent in different localities of Dehradun are as given in Table5.

Table 5. Type of forests in the district

S. No.	Forest Types	Major Localities
1.	Moist Shiwalik Sal Forests	Thano and Motichur forest ranges
2.	Moist Bhabar Doon Sal Forests	Barkot and Thano forest Range
3.	West Gangetic Moist Deciduous Forests	Barkot ,Motichur and Thano forest ranges
4.	Dry Shiwalik Sal Forests	Higher slopes of Shiwaliks

Fauna

Ecologically, the district of Dehradun is a unique due to its varied physiography and climatic conditions. The district is very rich in its biological diversity and faunal diversity in particular. Table 6 depicts some of the famous wildlife sanctuaries and national parks which is home to diverse range of flora and fauna.

Table 6. Ecological uniqueness of the district Dehradun

S. No.	Name	Area (km^2)	Prevalent Faunal Species
1.	Rajaji Tiger Reserve and National Park	820.42	Himalayan Bear, Samba Deer, Common Krait, Himalayan-Pied Kingfisher
2.	Assan Barrage Bird Sanctuary	04	Pintail, Gadwall, Red Crested Tufted Duck
3.	Benog Wildlife Sanctuary	11	Himalayan Goat, Leopard, Bear, Red-Billed Blue Magpie
4.	Jabarkhet Nature Reserve	-	Kaleej Pheasant, Lammergeyer Vultures, Himalayan Griffon
5.	Malsi Deer Park	-	Nilgai, Two-Horned Deer, Peacocks, Tigers

- Indicates nil

Land use Pattern

Increasing population pressure is putting tremendous pressure on the land use and land cover in district Dehradun. The major land use in the Dehradun district are vegetation cover area, agriculture area, built up area and barren land (Table 7). It has been observed that a certain percentage of barren land was converted into built-up area in past two decades.

Table 7. Land use pattern of Dehradun district

Land use	Area (km^2)	Total Area (%)
Vegetation cover	1897.82	61.47
Agricultural land	543.67	17.61
Built up area	210.54	6.82
Barren land	182.45	5.91
Sediment area	175.00	5.67
Water body	78.07	2.53

Source: Rawat and Puri, 2017

Culture and Tradition

Since the district is a major part of the Garhwal region, the area is greatly influenced by the Garhwali culture. The district is home to multi lingual society with Garhwali being the primary language spoken. Around 60% of the population follows Hinduism. Other prominent religions are Sikhism, Islam and Jainism.

Dehradun is famous for its diverse cultural activities as it is during these festivals that the cultural side of Dehradun becomes prominent. Some of the famous fairs and festivals celebrated in

Dehradun includes Jhanda Fair, Tapkeshwar Mela, Laxman Siddha Fair, Mahasu Devta's Fair, Shaheed Veer Kesri Chandra Fair, Hanol Mela and Shivratri Fair.

URBAN EXPANSION AND ITS IMPACT ON GREEN SPACES IN DEHRADUN

The current trend of urban growth in Dehradun has shown most obvious environmental impacts on the surrounding ecosystems, land use patterns, water resources and hence quality of life. According to the latest trends, the urban and built up areas has increased from 27.16 km^2 to 34.08 km^2 in the past decades. The study also shows that there is a remarkable urban sprawl in and around the city as almost 6.13 km^2 of agriculture land, fallow land and vacant land has been lost to built-up land in past 10 years. It has been also found that some kind of urbanization is undergoing in the protected area of the region.

In addition, the ambient air quality parameters like SPM, RSPM and SO_2 were found in high concentration and even crossed the maximum permissible limit of NAAQ in almost all sampling location while parameter NO_X was found under limit. Vehicular emission was found to be the prime reason for undesirable pollution levels. Given an excessively dense population, massive resource consumption, and very scarce land resources, these adverse factors have greatly impaired the city's capacity to meet the challenges presented by modern growth and expansion for which planning policies need to be devised for providing sustainable development.

As Dehradun is a well-renowned tourist spot, the number of tourists is increasing at an exponential rate and its projection up until the year 2025 is double as compared to that in late 90s. It implies that Dehradun is facing the challenge of tourist overburden, built-up (rapidly growing infrastructure) has been observed in all slope categories with almost 95% share of gentle and moderate slope class. Some fraction of the built-up was also observed on strong, extreme steep and very steep slope, Since the inclination angles of these slopes classes are very high with horizontal, they are more prone to landslides. Proper developmental plan of the city has become prerequisite for optimum use of land and sustainable tourism.

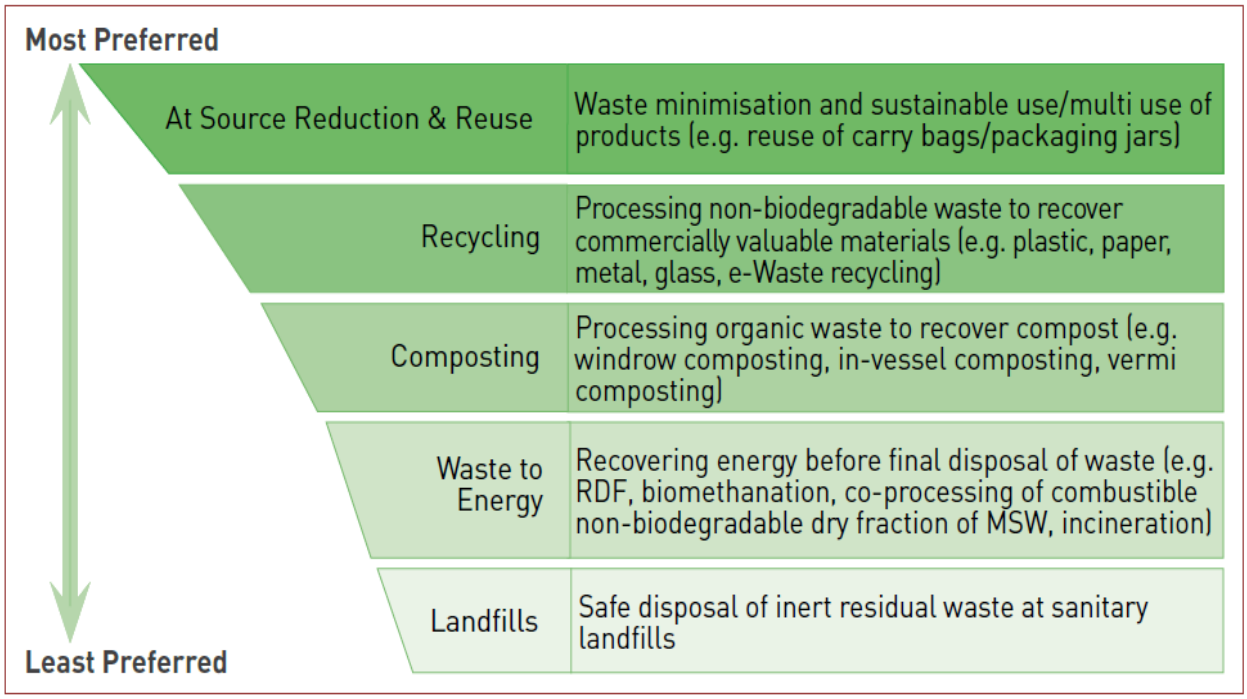
DATA AND IMPACT ANALYSIS

SOLID WASTE MANAGEMENT

Ministry of Environment, Forest and Climate Change (MoEF&CC) defines Municipal Solid Waste(MSW)as commercial and residential waste generated from a municipal area in either solid or semi-solid form excluding hazardous waste *(Industrial*), but including treated bio-medical waste. Predominantly, about *0.17 kg* of MSW is generated per capita per day in small towns compared to about *0.67 kg* per capita per day in cities. More than *70%* of waste in India is believed to be dumped in an unsatisfactory manner.

Integrated Solid Waste Management (ISWM)

It is based on the waste management hierarchy, with an aim to reduce the amount of waste being disposed of while maximizing resource recovery and efficiency (Fig 2). Based on this waste management hierarchy, an assessment of local needs and conditions should lead to the selection of an appropriate mix of process and technologies.



(Source: MoHUA, 2016)

Fig. 2. Waste management paradigm

Solid waste management in Dehradun district

Nagar Nigam Dehradun and Rishikesh account for more than 80% of the waste generated in the district. Wet waste forms larger faction of the solid waste in both urbanized and semi-urbanized areas (Table 8). On an average, more than half of the population is practising source segregation of waste. Many ULBs have collaborated with multiple private agencies/NGOs/international organization for waste management operations (Table 9).

Table 8. Inventory of total solid waste generation

Name of Urban Local Body (ULB)	Population (2011 census)	Number of wards	Solid Waste Generation (MTPD)			
			Dry	Wet	*Other Waste	Total
Nagar Nigam (NN) Dehradun	8,03,983	100	178.00	241.00	36.00	455.00
Nagar Nigam (NN) Rishikesh	1,06,320	40	25.00	55.00	--	80.00
Nagar Palika Parisad (NPP) Doiwala	55,719	20	12.00	8.50	9.50	30.00
Nagar Palika Parisad (NPP) Mussoorie	30,118	13	4.50	13.50	--	18.00
Nagar Palika Parisad (NPP) Vikasnagar	24,019	11	2.18	4.77	2.05	9.00
Nagar Palika Parisad (NPP) Herbertpur	9,782	09	2.48	2.30	--	4.78
Nagar Panchayat (NP) Selakui	16,880	09	3.00	7.00	--	10
Cantonment Board (CB) Dehradun	52,716	08	13.50	11.00	0.50	25.00
Cantonment Board (CB) Clement Town	22,557	07	4.00	6.00	--	10.00
Cantonment Board (CB) Chakrata	5,117	6	0.40	0.50	0.10	1.00
Cantonment Board (CB) Landour	3,543	06	1.00	0.50	--	1.50

(Source: District administration, Dehradun, 2021)

**Other waste may include sanitary waste, domestic hazardous waste, horticulture waste etc.*

Table 9. Waste management operation

Waste Management Operations	Outcome	
Segregation at source	***ULB***	***Source Segregation (%)***
	NN Dehradun	50
	NN Rishikesh	60
	NPP Doiwala	100
	NPP Mussoorie	80
	NPP Vikasnagar	70
	NPP Herbertpur	65
	NP Selakui	75
	CB Dehradun	60
	CB Clement Town	80
	CB Chakrata	100
	CB Landour	100

<table>
<tr><td>Door to door collection</td><td colspan="4">Except NPP Mussoorie (90%), All other ULBs have 100% coverage for Door to Door collection.</td></tr>
<tr><td>Sweeping</td><td colspan="4">• All ULBs are accomplishing 100% road sweeping.
• Sweeping is being accomplished manually in all ULBs, except NN Dehradun, which has 20% coverage of mechanical sweeping apart from manual sweeping.
• NN Rishikesh has authorised to use a mechanical sweeping machine which will be operational soon.</td></tr>
<tr><td rowspan="12">Segregated transport of waste (received from door to door collection)</td><td>ULB</td><td colspan="3">Transportation of waste in segregated manner (%)</td></tr>
<tr><td>NN Dehradun</td><td colspan="3">50</td></tr>
<tr><td>NN Rishikesh</td><td colspan="3">60</td></tr>
<tr><td>NPP Doiwala</td><td colspan="3">100</td></tr>
<tr><td>NPP Mussoorie</td><td colspan="3">80</td></tr>
<tr><td>NPP Vikasnagar</td><td colspan="3">70</td></tr>
<tr><td>NPP Herbertpur</td><td colspan="3">65</td></tr>
<tr><td>NP Selakui</td><td colspan="3">75</td></tr>
<tr><td>CB Dehradun</td><td colspan="3">60</td></tr>
<tr><td>CB Clement Town</td><td colspan="3">80</td></tr>
<tr><td>CB Chakrata</td><td colspan="3">100</td></tr>
<tr><td>CB Landour</td><td colspan="3">100</td></tr>
<tr><td colspan="4">Collected segregated waste is transported in multiple compartment vehicles and rest (i.e. unsegregated waste) is transported in a combined manner.</td></tr>
<tr><td rowspan="14">Material Recovery Facility (MRF) operation</td><td>ULB</td><td colspan="3">Type and Number of MRFs</td></tr>
<tr><td></td><td>Automated</td><td>Semi-Automated</td><td>*SLRM</td></tr>
<tr><td>NN Dehradun</td><td>(01)
Sheeshambada</td><td>(05)
• Nathuwala
• Harawala
• Remaining 03 in different wards of Nagar Nigam</td><td></td></tr>
<tr><td>NN Rishikesh</td><td>-</td><td>(01)</td><td></td></tr>
<tr><td>NPP Doiwala</td><td>(01)</td><td>-</td><td>-</td></tr>
<tr><td>NPP Mussoorie</td><td>-</td><td>(01)</td><td>-</td></tr>
<tr><td>NPP Vikasnagar</td><td></td><td>(01)</td><td></td></tr>
<tr><td>NPP Herbertpur</td><td></td><td></td><td>(01)</td></tr>
<tr><td>NP Selakui</td><td></td><td></td><td>(01)</td></tr>
<tr><td>CB Dehradun</td><td>(02)</td><td>-</td><td>-</td></tr>
<tr><td>CB Clement Town</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>CB Chakrata</td><td>-</td><td>-</td><td>(01)</td></tr>
<tr><td>CB Landour</td><td></td><td></td><td>(01)</td></tr>
<tr><td>Total</td><td>04</td><td>08</td><td>04</td></tr>
<tr><td>Involvement of Non-</td><td>ULB</td><td colspan="3">Name & Number of private</td></tr>
</table>

Governmental Organizations(NGOs)/ private agencies/International organizations		***agencies/NGOs/International organizations***
	NN Dehradun	(05) • Feedback Foundation • Sunlight Waste Management Pvt. Ltd. • Econ Waste Management Solution Pvt. Ltd. • Waste Worriers Organization • Chennai Waste Management
	NN Rishikesh	(04) • Rishikesh Waste Management • Rollz India (for waste remediation) • UNDP • GIZ
	NPP Doiwala	(01) Zero Waste Incorporation
	NPP Mussoorie	(01) Keeping the Environment Ecologically Natural (KEEN) Organisation
	NPP Vikasnagar	(01) Zero Waste Incorporation
	NPP Herbertpur	-
	NP Selakui	-
	CB Dehradun	(01) Patheya
	CB Clement Town	(01) SARC Security Service
	CB Chakrata	-
	CB Landour	(01) Mithilesh Sahoo and Sons
	Total	***15***
Authorization and issuance of Identity cards to waste pickers/sanitation workers	***ULB***	***Number***
	NN Dehradun	3256
	NN Rishikesh	385
	NPP Doiwala	135
	NPP Mussoorie	44
	NPP Vikasnagar	25
	NPP Herbertpur	34
	NP Selakui	34
	CB Clement Town	80
	CB Dehradun	116
	CB Chakrata	24
	CB Landour	15
Direct linkage with Treatment Storage and Disposal Facilities (TSDF) / Bio-Medical Waste Treatment Facility (CBMWTF)	Nagar Nigam Rishikesh has linkage with TSDF named Medical Pollution Control Committee (MPCC),Roorkee.	

**SLRM-Solid Liquid Resource Management*

Availability of infrastructure for waste management

The district has almost 100% coverage for door to door collection which has robust transportation infrastructure. This includes handcarts, collection trolleys, compaction vehicles, multiple compartment vehicles, e-rickshaws, etc. Transfer stations or secondary segregation sheds have been developed for secondary segregation of waste (Table 10). Wet waste after segregation is composted in both centralized and decentralized manner (Table 11). Many ULBs channelize their waste (directly or after secondary segregation) to Sheeshambada waste processing plant for further processing. The ULBs which do not have linkage with Sheeshambada waste processing plant are either well equipped with waste management infrastructure including automated/semi-automated MRFs, trenching ground, etc.

Table 10. Existing infrastructure for waste management operations

Name of ULB	Inventory of infrastructure involved in waste management operation					
	Waste collection trolleys/ hand carts	Mini collection trucks / tractors/ others	Composting units/ on-site composting facilities	MRF (available / not available)	Landfills (dumping ground/ trenching ground/ sanitary landfills)	Remarks
NN Dehradun	120	37	• Windrow composting in Sheeshambada waste processing plant. • 10 composting units and 04 composters in Nathuwala	Available	Sanitary landfill	• NN Deharadun is having 03 waste transfer centres (Dharan-01 and Kargi Chowk-02). • Twin compartment vehicles (with a bag/buckets attached for other waste) are used for the transportation of source segregated waste. • Waste is processed scientifically at Sheeshambada waste processing plant.
NN Rishikesh	04	22	24	Available	Trenching ground	• Multiple compartment (Dry, Wet and DH Waste) vehicles are deployed for the transportation of source segregated waste. Extra bag/buckets are also attached for other waste. • The ULB is using backpacks and rickshaws(if feasible) for D2D collection in narrow streets.

NPP Doiwala	04	01	09	Available	--	• Twin compartment vehicles (with a bag/buckets attached for other waste) are used for the transportation of source segregated waste. • NPP Doiwala is planning to work with Rishikesh Cluster for scientific management and disposal of waste.
NPP Mussoorie	--	14	08	Available	Temporary dumping ground.	• Due to rough terrain, only backpacks/gunny bags are preferred by waste pickers for D2D collection of waste. • Multiple compartment vehicles are being used for the transportation of primarily segregated waste. • A waste transfer point is established for secondary segregation of waste.
NPP Vikasnagar	20	13	04	Available	--	• Twin compartment vehicles (with a bag/buckets attached for other waste) are used for the transportation of source segregated waste. • Secondary segregation of waste is carried out at a designated MRF.
NPP Herbertpur	03	06	--	Not available	--	• Twin compartments vehicles are used for the transportation of segregated waste • Secondary segregation of waste is carried out in two transfer points. (one at Dehradun road and other on Ponta Sahib Road).
NP Selakui	05	05	--	Not available	--	• Twin compartment vehicles (with a bag/buckets attached for other waste) are used for the transportation of source segregated waste • Currently, no facility is available for Scientific management/processing of waste.
CB Dehradun	10	08	10	Available	Dumping ground	• Twin compartments vehicles are used for the transportation of segregated waste. • Two MRFs are available for processing of collected waste.

CB Clement Town	02	08	--	Not Available	Not available	• Twin compartment vehicles (with a bag/buckets attached for other waste) are used for the transportation of source segregated waste. • Collected waste is further segregated at a temporary location. Leftover waste is channelized to Sheeshambada waste processing plant.
CB Chakrata	01	01	02	Not available	Trenching ground	• Twin compartments vehicles are used for the transportation of segregated waste. • Waste is further segregated manually at a designated place.
CB Landour	--	01	--	Not available	--	• Twin compartments vehicles are used for the transportation of segregated waste.

Table 11. Methods of treatment, disposal and recovery

Name of ULB	**Wet waste management** ***(centralised/ decentralized or on-site composting)***	**Dry waste management** ***(waste to energy/ recycling/ incineration/ dumping in trenching ground/ sanitary landfill)***	**Remediation of old dump site**
NN Dehradun	• Wet waste is processed through mechanized windrow composting in Sheeshambada waste processing plant. • 10 centralized composting pits and 04 composters are available in Nathuwala for wet waste composting (Wet Waste processing of few wards is performed in this facility).	• 05 private agencies/NGOs are working in the ULB for managing the dry waste. • Waste is scientifically processed through mechanization in Sheeshambada waste processing plant.	• There is an old dump site with approximately 07 lakhs MT of legacy waste. • A DPR has been prepared for its early remediation.
NN Rishikesh	• Total 24 decentralized composting pits are available in the ULB. • 05 composting pits are under construction in a land near to the trenching ground.	• After secondary segregation, the reusable and recyclable waste is channelized through the private agencies working in collaboration with the ULB. • Leftover waste is disposed of at trenching ground. • Organizations such as UNDP and GIZ conducts regular awareness programs and IEC activities.	• Rollz India organization has undertaken work to remediate an old dump site with almost 271.91 MT of legacy waste.
NPP Doiwala	• Wet waste is processed in 09 composting pits which are constructed near disposal site.	• After secondary segregation, the reusable and recyclable waste is channelized through Zero Waste Organization.	DPR has been prepared to remediate the only old dumpsite in Nagar Palika Doiwala.

	• With the help of SHGs, the ULB is pushing for home composting.	• Leftover waste is channelized to trenching ground at Rishikesh.	
NPP Mussoorie	08 decentralized composting pits are available for wet waste processing.	• Waste is secondarily segregated at waste transfer point (at Broom hill estate) near to the MRF. Thereafter, the reusable and recyclable waste is channelized through KEEN Organization. • Leftover waste is sent for further processing at Sheeshambada waste processing plant.	Remediation and beautification work has been started. Almost 75% is completed.
NPP Vikasnagar	Total of 04 centralized composting pits are available near to the MRF in the ULB.	• After secondary segregation, the reusable and recyclable waste is channelized through Zero Waste Organization. • Mixed waste (30 % of total waste) is channelized to Sheeshambada waste processing plant.	No old dumpsite exists within the ULB
NPP Herbertpur	Due to land issues, no composting pits are available in the ULB.	• Two transfer stations are available for secondary segregation of waste. • Leftover waste is further channelized to Sheeshambada waste processing plant.	No old dumpsite exists within the ULB
NP Selakui	• Selakui is newly formed municipal body and is yet to start its waste management operations. • At present , all the generated waste is channelized to Sheeshambada waste processing plant.		
CB Dehradun	• Total 10 centralized composting pits area available near to the trenching ground.	• Recyclable waste (after secondary segregation at MRF) is sent to Aakanksha Enterprise, New Delhi. • Leftover waste is disposed of at dumping ground.	At present 02 old dumpsite exists, remediation for which has been started (60- 70% work is completed).
CB Clement Town	• No composting pits are available within the ULB for wet waste processing. • Generated wet waste is managed in Sheeshambada waste processing plant.	• Waste is manually segregated at a temporary location. Recyclable/Reusable waste is sold to local rag pickers. • Leftover waste is channelized to the Sheeshambada waste processing plant.	No old dumpsite exists within the ULB
CB Chakrata	Two composting pits are constructed close to trenching ground.	• Dry waste is manually segregated near to the trenching ground and thereafter it is sold to the Waste Warriors Organization. • Leftover waste is dumped in trenching ground.	Remediation of an old dumpsite is under process.
CB Landour	• No composting pits are available within the ULB for wet waste processing. • Generated wet waste is managed in Sheeshambada waste processing plant.	• Waste is manually segregated at temporary location. Some amount of recyclable/reusable is sold to the local rag pickers. • Leftover waste is channelized to the Sheeshambada waste processing plant.	No old dumpsite exists within the ULB.

Gap identification and proposed policies

Partial source segregation of waste has hampered the waste processing capably of individual MRFs and Sheeshambada waste management plant. Moreover, some ULBs are still lacking basic infrastructure for waste management. They are relying on traditional waste management practices which may decrease waste recovery efficiency and could prove hazardous for waste handlers (Table 12). The ULBs have undertook some measures to revamp their waste management operations. These include waste to energy plant at Sheshambada Waste processing plant, cluster based approach for waste management, etc. (Table 13).

Table 12. Gap identification

Name of ULB	Observed shortcomings	Remarks
NN Dehradun	Partial source segregation of waste	Only 50% households are practising segregation at source.
	Limited coverage of mechanical sweeping	80% of the roads in the ULB are swept manually.
	Lack of public participation	This may be attributed to lack of awareness and existing social taboos associated with waste.
NN Rishikesh	Partial source segregation of waste	60% of the households are practising source segregation despite having robust coverage for door to door collection.
	No coverage for mechanical sweeping of roads.	Recently, UKPCB has authorised one mechanical sweeping machine. Its coverage area is yet unknown.
NPP Vikasnagar	Waste disposal	ULB is channelizing its leftover waste (after processing) to Sheeshambada waste management plant. Due to high waste generation, it may require a disposal facility in near future.
NPP Herbertpur	Partial source segregation	NPP Herbertpur achieved 65% source segregation. After collection it is again segregated manually in transfer station.
	No infrastructure for wet waste management.	Earlier, two composting pits were used for wet waste processing. At present , they are not operational.
	Absence of automated/semi-automated waste recovery facility	No mechanized waste processing infrastructure is available in ULB.
	Lack of linkage with recyclers	ULB has not established linkage with authorised recycler/local rag pickers to channelize its segregated waste in transfer station.
	No linkage with private firms / NGOs	ULB is not assisted by any private firm for handling waste management operations.

CB Dehradun	Partial Source segregation	60% of the waste is segregated at source.
CB Clement Town	Lack of wet waste composting facility.	No wet waste composting facility is available in ULB.
	Undesignated secondary segregation point	Waste is segregated at a temporary location.
	Absence of automated/semi-automated waste recovery facility	Waste after manual segregation is channelized to Sheeshambada waste processing plant.
	Lack of linkage with recyclers	Waste is sold through informal networks to local rag pickers.
	Waste Disposal	Despite having substantial waste generation, there is no separate waste disposal facility .
** A common gap that has been identified in the waste management operations of the ULBs in the district having lack of direct linkage with Treatment Storage and Disposal Facility (TSDF)/ Common Biomedical Waste Treatment Facility (CBMWTF) for the disposal of domestic hazardous waste, sanitary waste and biomedical waste.		

Table 13. Proposed policies and budget requirements put forward by different stakeholders in the district

ULB	Proposed Policy	Current status and Budget requirement
NN Dehradun	Revamping Solid Waste Management	• A waste to energy plant has been proposed at the Sheeshambada waste processing plant. • A DPR has been prepared for the remediation of legacy waste at an old dump site.
NN Rishikesh		• NN Rishikesh and NPP Doiwala will be working in a cluster based waste management system namely *Rishikesh Cluster. • A waste processing plant will be constructed on 10 hectares' land sanctioned in NN Rishikesh. • Both ULBs have also undertaken the task to remediate the old dump sites.
NPP Doiwala		
NPP Mussoorie		• Remediation and beautification of old dump sites is under process. It is expected to be completed within one year.
NPP Herbertpur		• DPRs have been prepared by both ULBs for establishing individual Material Recovery Facility. • NP Selakui is a newly formed ULB. It is working on preparing a road map for effective waste management operations in the district.
NP Selakui		

**Rishikesh Cluster also includes Muni ki Reti, Narendra Nagar and Swargasharam.*

Vegetation suitable for reclamation of dumping sites

Besides having aesthetic value, vegetation (natural or planted) on a landfill site has an important role to play in soil formation, removal of contaminants and erosion control (Sadowsky, 1999). Moreover, vegetation may also be used in leachate treatment. Sometimes, vegetation over landfill sites may show signs of damage due to presence of landfill gas (LFG) in the root zone. In view of reconstruction of a suitable medium for landfill, afforestation, plantation, or re-vegetation might provide a capping that is deep and as favourable as to root growth to achieve desired plants' performance in getting over these degradations. In this context, locally available species could be hardened and resistant in reclaiming the waste dump problem (Table 14).

Table 14. Suggested vegetation for reclaiming landfill sites in Dehradun district

Botanical Name	Local and English Name	Assimilating capacity	Altitude (m)	Site/ Location
Mangifera indica	Mango	Absorb dust particles	100-1200	Shukla et al. 2019
***Populus nigra* L.**	Popular	Accumulation of Cd, Pb, As, and Ni	100-1800	Houda et al. 2016
***Populus alba* L.**	Black popular	Accumulation of Cd and Pb	100-1400	Houda et al. 2016
***Cassia fistula* L.**	Amaltas	Absorbs Arsenic and Fluoride from wastewater	100-1500	Houda et al. 2016
***Delonix regia* (Bojer ex Hook.) Raf.**	Gulmohar	Accumulation of (Cd, Pb, Zn and Cu)	250-1250	Ukpebor et al. 2010
***Cynodon dactylon* (L.) Persoon**	Doob	Absorbs Arsenic and Fluoride from wastewater	400-2500	Kumar et al. 2011

Sheeshambada solid waste processing plant

Located in outskirts of the city of Dehradun, Sheeshambada waste processing plant is based on Integrated Solid waste management approach. It is operational from past four years. This plant is based on Built, Operated and Transfer (BOT) model under which a concession agreement has been signed with Dehradun Waste Management Pvt. for a period of 15 years. The plant is well equipped with modern facilities for processing the solid waste and ensuring its scientific disposal (Table 15; Fig. 4). Landscaping, development of green belt, etc. has been done in the premises of the waste processing plant for aesthetical and beautification purpose (Fig. 3).

Table 15. Infrastructure available for waste processing and disposal

Total Area (Processing and landfill)	**8.23 ha**
Processing and Disposal Facilities	Waste processing shed
	Weigh Bridge with capacity of 60 tonne
	Trommel machines
	Mechanized windrow composting system

	Shredding facility for refuse derived fuel
	Leachate storage and treatment facility
	Scientific Landfill (1.4 ha)
Supporting Infrastructure	Security Rooms
	Internal Approach RCC Roads
	Administrative and Laboratory building
	Cafeteria
	Changing rooms and toilets

Waste management operations at Sheeshambada solid waste processing plant

Sheeshambada waste processing plant receives mixed waste from 7 ULBs of Dehradun district. On an average, about 450 MTPD waste is received at the waste processing plant. It is then segregated through mechanical sorting by Trommel machine in waste processing shed (Fig. 4). After segregating, the bio-degradable material is shifted to Windrow platform for composting operations. The compost thus formed is sold to private parties (KRIBHCO, Patanjali) and local farmers. The segregated dry waste is either channelized to authorised recyclers or is kept as RDF depending upon its chemical properties. The authority is planning to start its waste to energy plant to produce electricity from the RDF. Sanitary landfill, which is used for waste disposal is equipped with liner system, leachate collection facility, gas collection facility, environment monitoring system, etc.

Fig. 3. Green Spaces and landscaping at Sheeshambada waste processing plant

Fig. 4. Waste processing shed and various waste management operations

Projected population and Solid waste generation in Dehradun district

Projecting waste quantities in a near future is as difficult as predicting changes in waste composition for a locality or town. Storage methods, salvaging activities, exposure to the weather, handling methods and decomposition, all have their effects on changes in waste bulk density. Generally, lower is the level of economic development, greater will be the change between waste generation and disposal.

In the present context, population Census data for the year 2001 and 2011 is taken for population forecast. Decadal population and subsequent waste generation projection is done based on following presumptions:

- Arithmetic increase method is used for the decadal population forecast, hence the rate of change of population with time is assumed constant.
- In view of changing waste paradigm and floating population, 1.5% yearly growth in per capita waste generation is assumed.

- Analysis includes population and waste generation estimations with projected decadal change for only urban local bodies and does not include peri-urban and rural areas (Table 16 and 17; Fig. 5 and 6).

Table 16. Projected population and waste generation

Name of ULBs	Projected Population			Existing/ Projected Solid Waste Generation (MT/Day)		
	2021	2031	2041	2021	2031	2041
NN Dehradun	1072966	1341949	1610932	455.00	654.42	903.44
NN Rishikesh	153100	199880	246660	80.00	120.11	170.45
NPP Doiwala	103395	151071	198747	30.00	50.41	76.26
NPP Mussoorie	34161	38204	42247	18.00	23.15	29.44
NPP Vikasnagar	34116	44213	54310	9.00	13.41	18.95
NPP Herbertpur	10321	10860	11399	4.78	5.78	6.98
NP Selakui	20256	23632	27008	10.00	13.42	17.63
CB Dehradun	75330	97944	120558	25.00	37.38	52.91
CB Clement Town	25480	28403	31326	10.00	12.82	16.26
CB Chakrata	6738	8359	9980	1.00	1.43	1.96
CB Landour	3836	4129	4422	1.50	1.86	2.29
			Total	**644.28**	**934.19**	**1296.58**

Table 17. Projected decadal change in solid waste generation

Name of ULBs	% Rate of Growth (2021-2031)	% Rate of Growth (2031-2041)
NN Dehradun	4.38	3.81
NN Rishikesh	5.01	4.19
NPP Doiwala	6.80	5.13
NPP Mussoorie	2.86	2.72
NPP Vikasnagar	4.90	4.13
NPP Herbertpur	2.10	2.07
NP Selakui	3.42	3.14
CB Dehradun	4.95	4.16
CB Clement Town	2.82	2.68
CB Chakrata	4.27	3.73
CB Landour	2.38	2.32

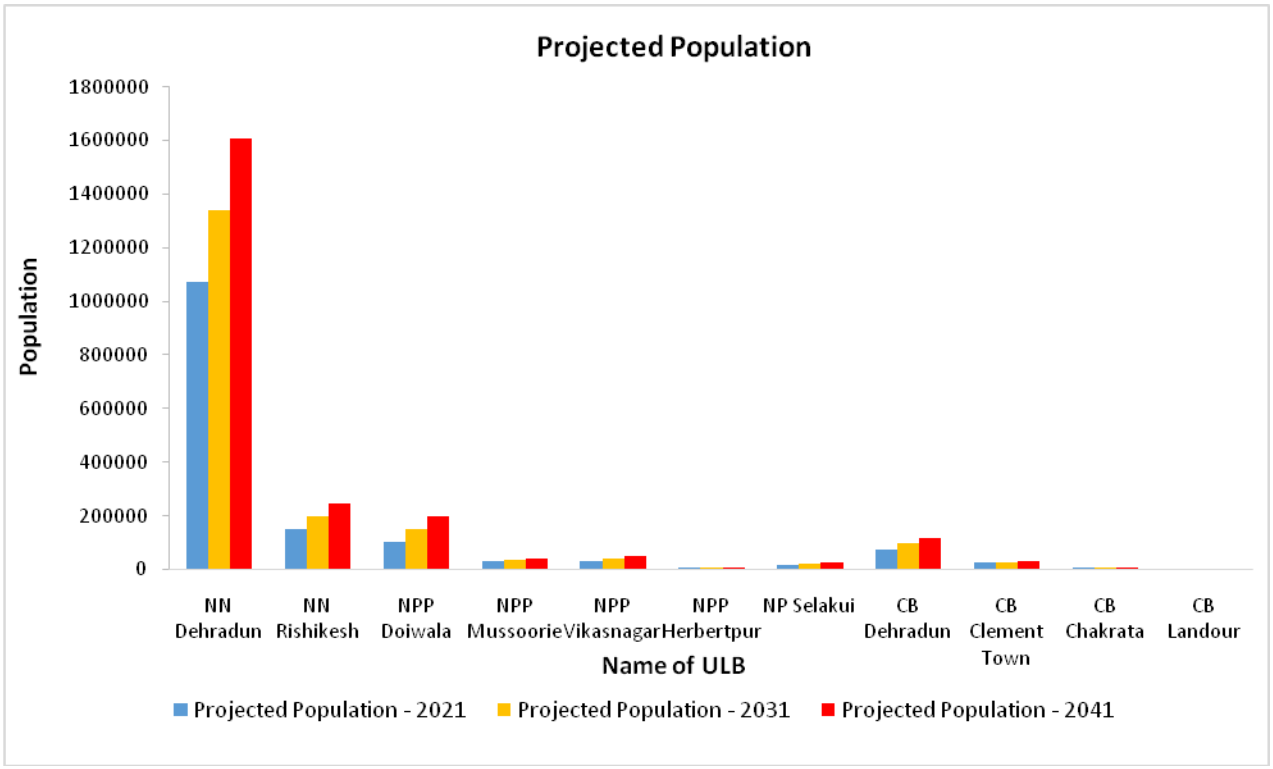


Fig. 5. Graphical representation of projected population

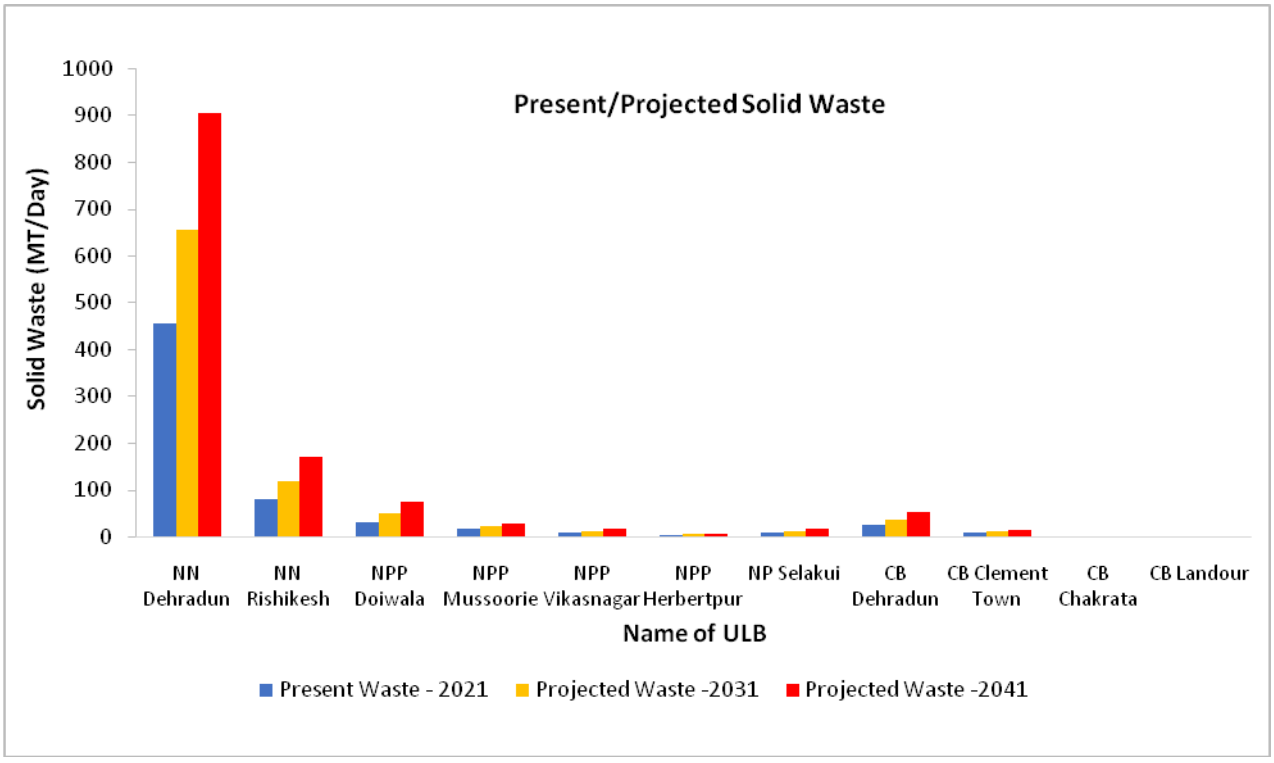


Fig. 6. ULB wise distribution of projected solid waste

Inferences drawn from the projection of waste

- Solid waste generation is projected with exponential rise in the district. It may surpass 1200 MT per day by 2040.
- Waste generation in Nagar Nigam Dehradun will surpass 900 MTPD in two decades. To handle such large quantity of waste, its waste management infrastructure needs to be well equipped.
- Nagar Nigam Rishikesh will also witness rise in waste generation and will surpass 150 MT in coming decades. Its cluster based waste management operations could be challenged in coming decades.
- Increased urbanization will change the waste composition in the district. The quantity of wet waste may decrease. However, there would be increase in e-waste, hazardous waste generation, plastic waste, etc.
- Waste quantity in other ULBs will also surge in coming decades. They need develop self-reliant strategies for solid waste management.

Rural solid waste management

The domestic waste generated in rural households of India is increasingly becoming an issue of serious concern. As reported by the Ministry of Drinking Water and Sanitation (MDWS) about 0.3 to 0.4 million metric tonnes of solid waste is generated in rural India every day. With the objective of achieving ODF plus status and improving cleanliness, hygiene and the general quality of life in rural areas, the aspects of Solid and Liquid Waste Management (SLWM) assume greater significance. Most of the solid waste generated in rural areas can be reused after generation because the generation rate of rural areas is much less as compared to urban areas.

Current standpoint about rural waste management in India

- According to 2011 census, 68.84% of the total population in India live in rural areas which generate almost 0.3-0.4 million metric tonnes of waste per day.
- Due to lack of commercial development, rural solid waste contains only domestic waste (92.4%) as a major contributor to the total waste generation.
- Rural community produces comparatively more biodegradable waste (63.5%) compared to non-biodegradable waste (36%).
- About 78% of the rural population use open dumping as storage and collection of solid waste.

PLASTIC WASTE MANAGEMENT

Plastic waste is defined as the accumulation of plastic objects (e.g. plastic bottles, bags, etc.) in the environment that adversely affects the wildlife and humans. Its broad range of application is in packaging films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, households and industrial products, building materials, etc. The ongoing pandemic has caused a rapid growth in the generation of plastic waste for the medical, packaging and other services *(like PPE kit, gloves, face shield, packaged food, etc.).*

Plastic products have become an integral part in our daily life pertaining to the fact that its production has crossed 150 million tons per year globally *(CPCB, 2013).* India generates 15 million tons of plastic waste every year but only one fourth is recycled due to lack of a functioning solid waste management system. This leads to burden on the landfills and poor socio-economic conditions of the waste pickers, mostly women *(UNDP, 2018-2024).*

India is committed to take action for mitigation of pollution caused by littered Single Use Plastics. In the 4th United Nations Environment Assembly held in 2019, India has piloted a resolution on addressing single–use plastic products pollution, recognizing the urgent need for global community to focus on this very important burning issue. The adoption of this resolution at UNEP was a significant step.

Plastic Waste Management Amendment Rules, 2021

Keeping in view the adverse impacts of littered plastic on both terrestrial and aquatic ecosystems, the MOEF&CC has notified the Plastic Waste Management Amendment Rules, 2021, which prohibits identified single use plastic items. Such plastic have low utility and high littering potential by 2022. Salient features of this amendment are as follows:

- The manufacture, import, stocking, distribution, sale and use of single-use plastic, including polystyrene and expanded polystyrene, commodities shall be prohibited with effect from the 1st July, 2022.
- In order to stop littering due to light weight plastic carry bags, with effect from 30th September, 2021, the thickness of plastic carry bags has been increased from 50 microns to 75 microns and up to 125 microns with effect from 31st December, 2022. This will allow reuse of plastic carry due to increase in thickness.
- The plastic packaging waste, which is not covered under the phase out of identified single use plastic items, shall be collected and managed in an environmentally sustainable way through extended producer's responsibility of the Producer, Importer and Brand Owner (PIBO). For

effective implementation of Extended Producer Responsibility, the guidelines for extended producer responsibility being brought out and have been given legal force through Plastic Waste Management Amendment Rules, 2021.

- The State government and concerned Central Ministries and associated departments have also been requested to develop a comprehensive Action plan for elimination of single use plastics and effective implementation of Plastic Waste Management Rules, 2016 and its execution in a time bound manner.
- Directions under Section 5 of Environment (Protection) Act, 1986, have been issued to all state for setting up for institutional mechanism for strengthening enforcement of Plastic Waste Management rules, 2016.

Current scenario of plastic waste in Dehradun district

Almost 15% part of the dry waste generated in the district of Dehradun is plastic waste. Major chunk of this waste is generated in N.N. Dehradun which is densely populated and highly urbanized. Other ULBs have minimal contribution towards overall plastic waste generation in the district (Table.18). Compacting and bailing operations are performed in ULBs with automated/semi-automated MRF (Table 19). ULBs have either established linkage with authorized recyclers or informal association with waste pickers or both to channelize the generated plastic waste.

Table 18. Inventory of Plastic waste generation

Name of Urban Local Body	Population (2011 census)	Number of Wards	Estimated Quantity of Plastic Waste Generated (MT/Day)
NN Dehradun	8,03,983	100	28
NN Rishikesh	1,06,320	40	2.6
NPP Doiwala	55,719	20	0.15
NPP Mussoorie	30,118	13	3.5
NPP Vikasnagar	24,019	11	0.5
NPP Herbertpur	9,782	09	0.03
NP Selakui	16,880	09	0.3
CB Dehradun	52,716	08	1.5
CB Clement Town	22,557	07	1.0
CB Chakrata	5,117	06	0.1
CB Landour	3,543	06	0.5

Source: District administration, Dehradun 2022

Table 19. Present Infrastructure for Plastic Waste Management Operations

Name of ULB	Inventory of infrastructure available for plastic waste management operation		
	Availability of plastic compactor	**Linkage with plastic waste recyclers**	**Remarks**
NN Dehradun	Available	Except NPP Herbertpur, NP Selakui, CB Clement town and CB Landour, all other ULBs have linkage with recyclers to channelize their plastic waste.	• Plastic waste after compaction and bailing operation is sent to authorised recycler. • Some ULBs are selling their waste to the local rage pickers or directing it to the Sheshambada Waste Processing Plant, Dehradun.
NN Rishikesh	Available		
NPP Doiwala	Available		
NPP Mussoorie	Available		
NPP Vikasnagar	Available		
NPP Herbertpur	Not Available		
NP Selakui	Not Available		
CB Dehradun	Available		
CB Clement Town	Not Available		
CB Chakrata	Not Available		
CB Landour	Not Available		

Gaps identified in the management of plastic waste in the district

Some ULBs do not have basic infrastructure to manage its plastic waste. Plastic waste forms a major part of the waste which is found littered in the streets. There is a lack of policy framework to tackle the issue of growing plastic waste locally.

Estimated future population and plastic waste generation in Dehradun district

Plastic waste in India has increased steadily over the past 50 years. It is expected to double over the next 20 years. Its growth rate in India is considered to be the highest in the world.

Projecting waste quantities in coming future is a difficult task. It is because of its changing composition over the seasons and periods due to ever changing dietary habits, economic conditions of the people and pandemic situation like COVID-19 in the concerned region. Crop harvesting season with adequate availability of a variety of food also affect the plastic generation. Lower is the level of economic development, greater will be the change between plastic waste generation and disposal. Moreover, COVID-19 like pandemic situation also caused remarkably plastic waste generation for creating medical tools and devices. These could be syringes, insulin pens, intravenous line (IV), surgical gloves, catheters, inflatable splits, etc.

Census population data for the year 2001 and 2011 is taken for population forecast. Decadal population and subsequent waste forecasts done is based on following presumptions:

- Arithmetic increase method is used for the decadal population forecast, hence the rate of change of population with time is assumed constant.
- The per capita generation of plastic waste was estimated to be 11 kg/annum (*Centre for Science and Environment, 2019*).
- It is assumed that 70% of the total plastic waste consumed is discarded as waste (CPCB, 2013).
- 16 % yearly growth in per capita plastic waste consumption has been taken keeping in mind the changing waste paradigm and floating population *(Centre for Science and Environment,2019).*
- This analysis included population and waste generation estimations with projected decadal changes for only urban local bodies and did not include peri-urban and rural areas (Table 20 and 21; Fig. 7).

Table 20. Projected population and estimated plastic waste generation

Name of ULBs	Projected Population			Existing / Projected Plastic Waste Generation (MT/Day)		
	2021	2031	2041	2021	2031	2041
NN Dehradun	1072966	1341949	1610932	28.00	91.05	284.18
NN Rishikesh	153100	199880	246660	2.60	8.83	28.32
NPP Doiwala	103395	151071	198747	0.15	0.57	1.95
NPP Mussoorie	34161	38204	42247	3.50	10.18	29.26
NPP Vikasnagar	34116	44213	54310	0.50	1.68	5.38
NPP Herbertpur	10321	10860	11399	0.03	0.08	0.22
NP Selakui	20256	23632	27008	0.30	0.91	2.70
CB Dehradun	75330	97944	120558	1.50	5.07	16.23
CB Clement Town	25480	28403	31326	1	2.90	8.31
CB Chakrata	6738	8359	9980	0.1	0.32	1.00
CB Landour	3836	4129	4422	0.5	1.40	3.90
Total				38.18	122.99	381.45

Table 21. Projected decadal changes in waste generation

Name of ULBs	% Rate of Growth (2021-2031)	% Rate of Growth (2031-2041)
NN Dehradun	22.52	21.21
NN Rishikesh	23.94	22.09
NPP Doiwala	27.99	24.21
NPP Mussoorie	19.08	18.75

NPP Vikasnagar	23.69	21.94
NPP Herbertpur	17.36	17.29
NP Selakui	20.33	19.71
CB Dehradun	23.81	22.00
CB Clement Town	18.98	18.68
CB Chakrata	22.25	21.04
CB Landour	17.99	17.84

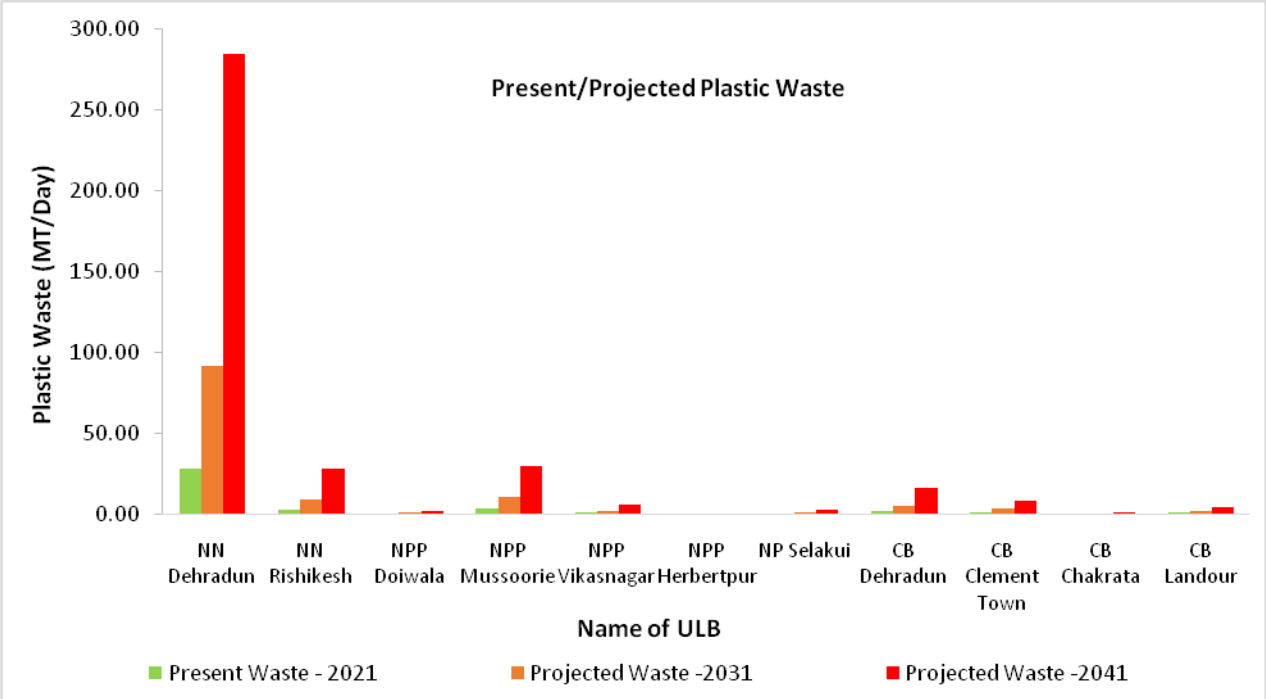


Fig. 7. Projected plastic waste generation

Inferences drawn from plastic waste projection

- Plastic waste generation in the district is likely to surpass 100 MTPD by next decade and about 350 MTPD by 2040.
- Nagar Nigam Dehradun would be the major contributor towards daily plastic waste generated in the district.
- With increasing urbanization, the proportion of plastic waste in dry waste will also rise. This means that it will become necessary for ULBs to transform waste processing techniques and machinery accordingly.

BIO-MEDICAL WASTE MANAGEMENT

According to latest bio-medical waste management rules (published in 2016 and amended in 2019), biomedical waste is defined as such waste that is generated during diagnosis, treatment or immunization of human beings or animals, or in research activities pertaining thereto or in the production or testing of biological experiments. The fact sheet of WHO states that 20% of the total waste generated by health care activities is hazardous. All the biomedical waste generated is essential to be properly collected, segregated, stored, transported, treated and disposed of in a safe manner to prevent spreading infectious diseases. The health system of Uttarakhand constitutes a large network of health care facilities based on three-tier system that comprises of District level health care facilities (District hospitals, Base hospitals, etc.), Community Health-care Centres (CHCs), and Primary Health-care Centres (PHCs). Biomedical waste generation has shown a wide variation in Uttarakhand due to its typical physiographical conditions and changing density of population. Handling and disposal of biomedical waste is done as per BMW rules, 2016 (Fig. 8).

Source: *CPCB, 2020*

Fig. 8. Segregation of Biomedical waste as per BMW rules, 2016

Importance of bio-medical waste management in the wake of pandemic

Due to the onset of COVID pandemic, bio-medical waste generation increased worldwide. Similar trend was also observed in our country from 2019 to 2021. The daily bio-medical waste generation increased from 619 MTPD to 800 MTPD in India (CPCB, 2021) and from 3.8 MTPD to 6.26 MTPD in Uttarakhand state (ENVIS, 2020).

At present, the bio-medical waste is being generated not only from the health care facilities but also from the quarantine centres and residential areas where patients were in a home isolation. Bio-medical waste ought to be segregated in the households as well as from the municipal solid waste. Thus, it has to be properly disposed of to get rid of the risks of infection among the workers handling the municipal solid waste in urban local bodies.

Biomedical waste management in Dehradun district

The district of Dehradun has highest number of Health-Care Facilities (HCFs) in Uttarakhand. More than 90% of them meets the consent conditions and authorization of UKPCB. Much of the bio-medical waste is lifted to CBMWTF named Medical Pollution Control Committee(MPCC), Roorkee (Table 22). Some HCFs are also using deep burial method for biomedical waste disposal.

Table 22. Inventory of current healthcare infrastructure and current status of bio-medical waste Management

S. No.	Parameter	Outcome	
1.	Health-care facilities in the district.	*Facility*	*Numbers*
		Bedded HCFs	291
		Non-bedded HCFs	1146
		Total	1437
2.	*Miscellaneous health care facilities in the district.	*Facility*	*Numbers*
		Veterinary Hospitals	32
		Pathology Labs	48
		Dental Clinics	140
		Blood Banks	01
		Bio-Research Labs	89
		Total	309
3.	Number of health care facilities authorised by SPCB/ PCC.	1390	
4.	Total Bio-Medical Waste (BMW) generation in the district.	1710.84 kg/day	
5.	Daily Bio-Medical Waste (BMW) lifting by Common Bio-Medical Waste Treatment Facility (CBMWTF).	1656.93 kg/day	
6.	Segregation of BMW as per	All the healthcare facilities of the district properly	

	guidelines of BMW Rules, 2016.	segregate their bio-medical waste into separate colour-coded bins as per BMW Rules, 2016.
7.	Linkage with Common Bio-Medical Waste Treatment Facility (CBMWTF)	• 929 Health care facilities are linked to Medical Pollution Control Committee (MPCC), Roorkee, Haridwar. • NN Rishikesh has also established linkage with CBMWTF for bio-medical waste management (generated from domestic households.
8.	Other disposal method of BMW used by the district	Deep Burial Method– 220 Nos.
9.	The capacity of the Common Bio-Medical Waste Treatment Facility (CBMWTF)	MPCC receives bio-medical waste of entire Region of Garhwal; therefore, capacity is assessed with respect to total waste received from other districts.
10.	District level monitoring committee	Already established under the chairmanship of the District Magistrate.
11.	Adequacy of facilities to treat biomedical waste	Facilities for bio-medical waste management seems adequate

*Miscellaneous HCFs belong to the category of Non-bedded HCFs (*Sources: UKPCB, 2022*)

- Bar code tracking and GPS tracking of vehicles is carried out by CBMWTF for effective bio-medical waste management.
- Routine inspection of CBMWTF is being done by the head office and regional office, UKPCB.

CONSTRUCTION & DEMOLITION WASTE MANAGEMENT

Construction and Demolition (C&D) waste is produced in the construction, remodelling, repair and demolition of residential/ commercial buildings and other structures and pavements. C&D waste mainly consists of concrete, bricks, sanitary ware, glass, steel, plastic, etc. (Table 23). According to a general estimate, 40% of the total C&D waste originates from renovation work, while 50% from the demolition work and remaining 10% from new construction work (CPCB, 2020) (Table 24).

Implementation of 3R principles in C&D waste management

Construction and demolition waste is inert in nature. It does not create chemical or bio-chemical pollution. Hence in view of its management, maximum emphasis should be given on 3R Principle. The concept of 3R, which refers to Reduce, Reuse and Recycle particularly in the context of production and consumption is well known today. Waste reduction is presumed to be optimal measure for C&D waste management due to its minimal adverse impact on environment. Applicable building materials can be reused for original activity or to fulfil any other purpose. Steel, doors and windows, wood, bricks and other construction items can be easily taken out and again put to reuse without much processing. The last but not least step is to recycle the C&D waste considered fit for recycling. This is usually done by converting the waste into recycled sand and aggregates that have various construction applications. This principle can be applied to the entire life cycle of products and services - starting from design and extraction of raw materials from collection to transport, and then manufacturing, practicing scientific disposal. Hence, it is evident that application of 3R principle would help reduce the C&D waste in the construction industry.

Present state of affairs

- According to a report by Transparency Market Research (2016), the volume of construction waste generated worldwide every year will nearly double to 2.2 billion tonnes by 2025 (CWM, 2020).
- Our country generates 150 million tonnes/year C&D waste but the official recycling capacity is a meagre 6500 tonnes/day or just about 1% *(as per building material promotion council* (CWM, 2020).

Table 23. Characteristics of C&D waste in India

Type of Debris	Percentage (%)
Wood	42.4
Drywall	27.3

Concrete	12.0
Brick and Other mixed debris	7.3
Cardboard	5.4
Metals	1.8
Asphalt	1.4
Plastic & Foam	1.4
Other packaging	0.6
Textiles	0.4

(Source: District Administration, 2020)

Table 24. Thumb rule for estimation of C&D waste generation for India

Range	Type of construction
40-60 kg/m^2	New construction
40-50 kg/m^2	Building repair
300-500 kg/m^2	Demolition of building

C&D waste management in Dehradun district

C&D waste is collected and quantified in major cities of the district. No separate streamline exists specifically for C&D waste. C&D waste is disposed or kept at same location where solid waste is stored for processing or disposal (Table 25). Collected waste is sold on demand to local residents of the district.

Table 25. Current status related to C&D waste generation

Sl. No.	Action Areas	Outcomes/Remarks	
1.	Quantity of C&D waste generated (*MTPD)*	Name of ULB	Estimated Quantity
		NN Dehradun	8
		NPP Vikasnagar	2.05
		CB Dehradun	0.5
		CB Chakrata	0.1
		Total	**10.65**
		Other ULBs are yet to initiate the quantification of C&D waste. Some of them may not even require as C&D waste quantity is presumed to be minimal.	
2.	Collection of C&D waste	Collection is initiated by following ULBs: • NN Dehradun • NN Rishikesh • NPP Doiwala • NPP Vikasnagar • CB Dehradun • CB Chakrata	
3.	Establishment of deposition point/dumping zone	The ULBs that have initiated collection of C&D waste are disposing it near to the facility where its solid waste is processed.	

4.	Establishment of linkage with any C&D waste recycling facility	No C&D waste recycling facility exists in the district. Moreover none of the ULBs have established linkage with any C&D waste recycling facility outside the district or state.
5.	Implementation of by-laws	Except NPP Herbartpur, CB Clement town, NPP Landour and NP Selakui, all other ULBs have implemented by-laws related to C&D waste management.

Gaps identified in the management of C&D waste

There is no mechanism to quantify C&D waste in some ULBs of the district. There aren't any collection centres specifically designate for C&D waste. NN Dehradun has emerged as major hub for development activities but it still lacks robust policy framework in view of C&D waste management.

C&D waste management in rural areas

In the rural areas of Dehradun district, construction work is observed to be limited. Therefore, minimal amount of C&D waste is generated which mainly consists of the soil excavated from the foundation trenches and stones from the hill slopes. This excavated soil is reused either in filling the plinth and trenches or many times used in the low-lying areas. Stones obtained from the hill slopes are used in masonry work. There is an issue of improper dumping of muck dumping along the river banks or seasonal streams (khads) or construction of roads. These issues need to be addressed within a strategy for managing construction and demolition waste.

HAZARDOUS WASTE MANAGEMENT

Hazardous waste is any waste which because of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger or is likely to cause danger to health or environment (whether alone or in contact with other wastes or substances). State Pollution Control Board (SPCB) is responsible for tabulation of hazardous waste generating units and quantification of waste generated in respective state. Hazardous industrial wastes in India can be categorized broadly into two categories as under:

- Hazardous wastes generated from various industries in India.
- Hazardous industrial wastes transported to India from the western countries for re-processing and recycling.

Present state of affairs

- Hazardous and other wastes (Management and Transboundary Movement) rules, 2016 govern the collection, transfer, Processing, treatment and disposal of hazardous waste.
- The rules were amended on March 2019 keeping in consideration the ease of doing business, boosting make in India initiative by simplifying the procedures, while at the same time upholding the principles of sustainable development.
- According to CPCB Report (2019-20), there are 69,308 hazardous waste generating units in India having authorized annual capacity to generate about 39.46 Million Metric Tonnes (MMT) of hazardous waste. However, about 8.78 MMT hazardous waste was generated during 2019-20, based on the annual returns submitted by such units (CPCB, 2020) (Table 26).

Table 26. Hazardous waste generation in India

Type of hazardous waste	Quantity/Year (MMT)	% of total waste
Land-fillable	2.13	24.29
Incinerable	0.40	4.52
Recyclable	2.07	23.59
Utilizable	4.18	47.60

(Source: CPCB, 2020)

Hazardous waste management in Dehradun district

The data for hazardous waste generated in the industries is available in the district of Dehradun. Incinerable and Land fillable type forms major part of hazardous waste generated in the industries (Table 27).The hazardous waste generated in domestic households or other commercial establishments in not quantified in the district. However, some ULBs have provided a dedicated compartment/bag in transportation vehicle to collect hazardous waste. Only NN Rishikesh having

direct linkage with TSDF (MPCC, Roorkee) (Table 28). Industrial processes are the main source of hazardous waste in the district. Much of the hazardous waste generated is quantifiable and is managed according to hazardous and other wastes (Management and Transboundary Movement) rules, 2016. However, hazardous waste generated in domestic households along with verification of records with respect to generators needs consideration (Table 28).

Table 27. Inventory of hazardous waste in Dehradun district

Sl. No.	Parameters	Present status			
1.	Quantity of hazardous waste generated in the district (in MT/annum)	Incinerable	Landfillable	Recyclable/ Reusable	Total
		156.321	145.143	48.621	350.085
2.	Number of hazardous wastes generating industries in the district	416			
3.	Industry authorized by UPCB/ PCC	359			

Table 28. Current status related to hazardous waste management

Sl. No.	Action areas	Outcome and Remarks
1.	No. of captive/ common Treatment Storage and Disposal Facility (TSDF) in the district.	Currently, there is no captive or common TSDF in the district for the treatment of hazardous waste. The hazardous waste generating in the district is sent to TSDFs available outside the district.
2.	Linkage with common TSDF/ CBMWTF	Currently, the hazardous waste generating industries of the district have linkage with the following TSDF/ CBMWTF - 01 (Medical Pollution Control Committee (MPCC), Roorkee, Haridwar, Uttarakhand).
3.	Display board of hazardous waste generation in front of gates of respective industries	200 industries have installed display board regarding hazardous waste.
4.	Number of ULBs directly linked with common TSDFs	Only NN Rishikesh having directly linkage with common TSDFs.
5.	Contaminated sites/ probable contaminated sites within the district	One site is identified in NP Selakui.
6.	Regulation of industries & facilities generating hazardous waste	Industries generating hazardous waste are strictly regulated by SPCB.

ELECTRONIC WASTE MANAGEMENT

The discarded and end-of-life electronics products ranging from computers, equipment used in Information and Communication Technology (ICT), home appliances, audio and video products and all of their peripherals are known as Electronic waste (E-waste). Computer devices contributes to almost two third of electronic waste in India (Table 29). It is categorised into 21 types under two broad categories:

- Information technology and communication equipment.
- Consumer electrical and electronics.

The ill effects of e-waste could be on soil through leaching of hazardous contents from landfills; in water due to recycling process *(if not carried our properly)*, through inhalation of gases during recycling, contact of the skin of the workers with hazardous substances and contact during acid treatment used in recovery process (EEMI, 2018).

Government of India has notified E-waste Management Rules 2016, which are expanded to manufacturer, dealer, re-furbisher and Producer Responsibility Organization (PRO) of components, consumables, spares and parts of Electronics and Electrical Equipment (EEE) in addition to equipment as listed in Schedule I appended with the rules. Moreover, Compact Fluorescent Lamps (CFL) and other mercury containing lamps are also brought under the provisions of these Rules**.** Amendments were further made on March, 2019 with the objective of channelizing the E-waste generated in the country towards dismantlers and recyclers in order to formalise the e-waste recycling sector.

Table 29. Bifurcation of E-waste based on electronic appliances

Types of waste	Contribution (%)
Computer devices	70
Telecom sector	12
Medical equipment	7
Electric equipment	8
Others	3

Source: *ASSOCHAM, 2020*

Worldwide scenario

- Electronics and Electrical Equipment (EEE) are manufactured and disposed worldwide. In 2016, 44.7 Million Metric Tonnes (MMT) of E-waste was generated worldwide *(equivalent to 6.1kg/inhabitant)*. Following the current growth rate of rising E-waste, it is estimated that by 2021, quantity has already risen to 52.2 MMT or 6.8 kg/inhabitant.

- Out of the total E-waste produced in 2016, only 20% (8.9 MT) is documented to be collected properly and recycled, while there is no record of the remaining E-waste. The quantity of E-waste generated worldwide is expected to grow at a rate of 3.15% (CAGR).

Indian scenario

- According to Central Pollution Control Board (CPCB), India generated more than 10 Lakh tonnes of E-waste in 2019-20. Against this, the E-waste dismantling capacity has not been increase from 7.82 lakh tonnes since 2017-18.
- In 2018, the Ministry of Environment had told the tribunal that 95% of E-waste in India is recycled by the informal sector and scrap dealers unscientifically dispose of it by burning or dissolving it in acids.
- India has emerged as fifth largest E-waste producer in world. City-wise, Mumbai tops the list in producing electronic waste, followed by New Delhi, Bangalore and Chennai.
- The government offices, public and private sector companies generate nearly 75% of E-waste; with the contribution of individual household only being 16%.
- India's first E-waste clinic for segregating, processing and disposal of waste from household and commercial units has been set-up in Bhopal, Madhya Pradesh.

E-waste management in Dehradundistrict

Some ULBs are using multiple compartment vehicles which includes one separate compartment for e-waste collection.Collection centres have been established in some ULBs, However the quantity of waste received is very less as segregation at source is not optimum (Table 30). Local residents prefer to sell their E-waste to local rag pickers in hope of better prices.

Table 30. Current standpoints regarding E-waste generation and collection

Sl. No.	Parameter	Outcome & Remarks	
1.	Quantity of E-waste generated per annum (MT)*(As per SPCB)*	Uttarakhand	16260
		Dehradun	Not Estimated
2.	Toll-free number in the district for the citizens to deposit e-waste	Initiated	
3.	Collection centre established by ULBs in the district	Collection centres are established by following ULBs: • NN Dehradun • NN Rishikesh • Keshavpuri - NPP Doiwala	
		NPP Mussoorie and C.B. Clement Dehradun have initiated e-waste collection.At present, they are not receiving any waste of this category.	

4.	Number of authorized E-waste recyclers/ dismantlers in the State	Currently, five authorized recyclers/dismantlers are available in the district namely: • *Attero Recycling Pvt. Ltd. Raipur, Bhagwanpur* • *Bharat Oil & Waste Management, Mukhimpur, Laksar* • *Resource E-Waste Solution Pvt. Ltd. Bahadrabad* • *Scarto Metal Recycle Plant, Mewar Khurd, Roorkee* • *Anmol Paryavaran Sarakshan Samiti, Daulatpur Budhwa Shahid, Banjarewala*
5.	Linkage with any E-waste recycling facility	• Not initiated by any ULB. However, NN Rishikesh, NPP Mussoorie, CB Dehradun are selling their e-waste to local rag pickers. • District administration have linkage with the authorised e-waste recycling facility to deposit e-waste generated from the government offices.
6.	Control over illegal trading or processing of e-waste in the district	Partially controlled

Gap identified in E-waste management

Coverage area of e-waste related management services is very less in the district. Only 07 out of 11 ULBs have taken some measures for e-waste management be it segregation, collection, facilitating toll free number, etc. E-waste generated from the residential areas is usually mixed with municipal solid waste and thus it is not being treated properly. Moreover, the public is not completely aware about health hazard related with unscientific handling of E-waste.

AIR AND NOISE POLLUTION MANAGEMENT

Air pollution management

The ambient air that is the atmospheric air in its natural form consists of nearly 99.9% of Nitrogen, Oxygen, Water vapors, Carbon dioxide and some other gases like helium, argon, methane etc. surrounds the earth and forms its atmosphere. Any undesirable change in the composition of ambient air is called air pollution. The undesirable substances can be in solid, liquid and gaseous forms and when present in sufficient concentration for a sufficient time under certain conditions can endanger human health and welfare of plants and animals. According to 'Global Air Report - 2020, Air pollution has now become the biggest health risk in India. Most of the cities in our country (majority of them are from the region of Indo-Gangetic plains) are facing the problem of air pollution which has led to increase in cases of breathing discomfort and other related diseases. To tackle the problem of air pollution in our cities, Government of India has taken many steps, one of them being National Clean Air Program (NCAP) 2019. Under this programme, 122 cities in the country are identified as non-attainment cities, which include three cities from the Uttarakhand *(Dehradun, Rishikesh and Kashipur)*. These cities have fallen short of the National Ambient Air Quality Standards (NAAQS) for over five years. Goal ofNational Clean Air Program (NCAP) is to meet the prescribed annual average ambient air quality standards at all locations in the country in a stipulated timeframe. The tentative national level target of 20% to 30% reduction of $PM_{2.5}$ and PM_{10} concentration by 2024 is proposed under the NCAP taking 2017 as the base year for the comparison of concentration.The ambient air quality standards as set by Central Pollution Control board are mentioned (Table 31).

Table 31. National ambient air quality standards in India

Pollutants	**Time weighted average**	**Concentration in ambient air**	
		Industrial, residential, rural and other areas	Ecologically sensitive area (notified by central government)
Sulphur Dioxide (SO_2), µg/m3	Annual* 24 hours**	50 80	20 80
Nitrogen Dioxide (NO_2), µg/m^3	Annual* 24 hours**	40 80	30 80
Particulate Matter (size less than 10 µm) or PM_{10} µg/m^3	Annual* 24 hours**	60 100	60 100
Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$ µg/m^3	Annual* 24 hours**	40 60	40 60
Ozone (O_3) µg/m^3	8 hours* 1 hour**	100 180	100 180

Lead (Pb) µg/m	Annual* 24 hours**	0.50 1.0	0.50 1.0
Carbon Monoxide (CO) mg/m^3	8 hours* 1 hour**	02 04	02 04
Ammonia (NH_3) µg/m^3	Annual* 24 hours**	100 400	100 400
Benzene (C^6H^6) µg/m^3	Annual*	5	5
Benzo (a) Pyrene (BaP)-particulate phase only, ng/m^3	Annual*	1	1
Arsenic(As), ng/m^3	Annual*	6	6
Nickel (Ni), ng/m^3	Annual*	20	20

Source: National Ambient Air Quality Standards, Central Pollution Control Board Notification in the Gazette of India, Extraordinary, New Delhi, 18th November, 2009.

** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.*

*** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time, they may exceed the limits but not on two consecutive days of monitoring.*

Air quality monitoring in Dehradun district

Air quality monitoring stations are established in Nagar Nigam Dehradun and Rishikesh under National Air Quality Monitoring Programme(NAMP) funded by CPCB and under National Clean Air programme (NCAP) funded by UKPCB. These cities have also been declared as non-attainment city under NCAP. Air quality data for these cities is available in the website of UKPCB and is also mentioned in Table38 and 40. Recently, a Continuous Air Quality Monitoring Station (CAQMS) is installed in Mothrowala which is operationalized by UKPCB and Doon University. The air quality data of premises of Doon University in Mothrowala is displayed in 50 smart poles across the city.

Noise pollution management

Noise pollution may be defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms. According to World Health Organization (WHO) sound levels less than 70 dB are not damaging to living organisms and exposure of noise level beyond 85 dB constantly for more than 8 hours may be hazardous and leads to loss of hearing (Table 32). Although noise pollution is not a big issue in the district but proper monitoring is required to maintain noise level within the desirable limits.

Table 32. Permissible noise level standards

Area code	Category of area/zone	Limits in dB(A) L_{eq}	
		Day time	Night time
A	Industrial zones	75	70
B	Commercial zones	65	55
C	Residential zones	55	45
D	Silence zones	50	40

Source- Noise Pollution (Regulation and Control) Rules, 2000

- Day time shall mean from 6.00 a.m. to 10.00 p.m.
- Night time shall mean from 10.00 p.m. to 6.00 a.m.
- Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority
- Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.
- dB(A) L_{eq} denotes the time weighted average of the level of sound in decibels on scale 'A' which is relatable to human hearing.
- "Decibel" is a unit in which noise is measured.
- "A", in dB(A) L_{eq}, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.
- L_{eq}: It is an energy mean of the noise level over a specified period.

Noise pollution in Dehradun district

Noise level measuring devices are available with competent authority i.e. UKPCB. At present, noise levels are measured only at different locations of NN Dehradun (Occasionally in NN Rishikesh) (Table 35). These locations include residential, commercial and silent zones. Average noise level data shows elevated values for the past five years in each location (Table 34).

To examine the impact of fire crackers on noise levels, a special monitoring drive is organized during pre-Deepawali and Deepawali day at various locations in NN Dehradun and NN Rishikesh (Table 35). As far as noise pollution due to vehicles is concerned, the state transport department has some set of responsibilities which includes ban of multi-toned horn, implementation of noise control measures, etc.(Table36).

Table 33. Current status related to noise pollution management

Sl.No.	Parameters	Current Status
1.	Number of noise level measuring devices available with various agencies in the district.	03
2.	Number of complaints received by SPCB related to noise pollution in past 1 year.	04 complaints were registered. All of them were redressed.
3.	Implementation of ambient noise standards in residential and silent zones.	Occasionally done.
4.	Capability to conduct noise level monitoring by State agency/ District authorities	Available with the competent authority.
5.	Noise monitoring study in district	Noise level monitoring is carried out monthly.
6.	Setting up of sign boards	Not installed.
7.	Routine monitoring of ambient noise level at various locations	Initiated a few locations in NN Dehradun.

8.	Responsibility of departments regarding vehicular noise pollution	• To adhere with noise levels guidelines coming under Motor Vehicles Act,1998 • State Transport Department is responsible for execution of noise standards and implementation of Noise control measures.

Table 34. Noise level monitoring carried out during (2017-2022)

Monitoring locations	**Zone**	**Average $L_{equivalent}$ dB(A)**					
		***2022**	**2021**	**2020**	**2019**	**2018**	**2017**
Survey Chowk	Commercial	78.4	67.83	68.83	73.00	73.24	74.59
Doon Hospital	Silence	75.6	64.00	58.83	54.47	48.88	53.40
Clock Tower	Commercial	80.4	68.33	70.00	72.00	74.03	73.69
Gandhi Park	Silence	73.4	58.00	55.50	57.08	53.00	54.70
Race Course	Residential	70.7	55.67	51.25	55.58	53.57	55.31
CMI Hospital Chowk	Commercial	77.9	65.67	67.42	71.50	73.15	73.17
Nehru Colony	Residential	64.2	56.33	54.17	54.75	52.58	59.94

**Data Updated till March'22*

Table 35. Noise level monitoring carried out during Deepawali festival (2021)

Monitoring locations	**Average $L_{equivalent}$ dB(A)**	
	Pre Deepawali, (29.10.2021)	**Post Deepawali (01.11.2021)**
Dila Ram Chowk, Dehradun	60.67	61.06
Doon Hospital,Dehradun	42.47	43.84
Nehru Colony,Dehradun	47.97	51.06
Nirmal Ashram, Rishikesh	54.13	56.92
Government Hospital, Rishikesh	40.66	47.69
Awas Vikas Colony, Rishikesh	46.49	53.16

Table 36. Responsibility of various departments to mitigate noise pollution

Responsibility	**Department Responsible**
Ban on use of multi-toned horn or any other device giving an unduly harsh, shrill, loud or alarming noise(Nothing contained in this policy shall prevent the use on vehicles used as an ambulance, vehicles used by Police Officers, Fire Fighters, Operators of construction equipment vehicles or the officers of motor vehicle departments).	State Transport Department
Execution of noise standards and implementation of noise control measures.	State Transport Department

NON-ATTAINMENT CITIES IN DEHRADUN DISTRICT

Noticing unprecedented levels of air pollution in the country, the government of India launched National Clean Air Programme (NCAP) in 2019. This national level strategy aims to mitigate air pollution across the country in a time bound manner. The main target is to achieve 20% to 30% reduction in Particulate matter concentration by 2024 keeping 2017 as a base year for the comparison of concentration. This goal is primarily set for non-attainment cities, which can be defined as the cities that have fallen short of National Ambient Air Quality Standards (NAAQS) (Table 31) for over five years. The city of Dehradun and Rishikesh have been identified as non-attainment cities in the district.

Non-attainment city: Dehradun

Three decades ago, the issue of deteriorating air quality in the city of Dehradun was discussed in the context of limestone mining. It was finally banned in 1986 by Hon'ble Supreme Court. Following the orders, Government of India restricted developmental activities in Doon Valley Notification,1989.

Series of studies in recent times which includes: Pollution Control Research Institute (PCRI), BHEL Haridwar Report - 2017, Greenpeace Report- Apocalypse 2017, Central Pollution Control Board (CPCB) Report on air quality index of 273 cities,2018 have found that the levels ofPM_{10} and $PM_{2.5}$ were much higher than the permissible limits. In view of above developments, the city of Dehradun was declared as non-attainment city. A comprehensive plan was then developed to maintain permissible air quality standards under the mandate of National Clean Air Programme(NCAP).

Reasons for air pollution in Dehradun city

High levels of air pollution in Dehradun city can be attributed to natural dust and particulate-laden smoke from diesel fuelled vehicles, especially vikrams, trucks, buses and three-wheelers. Unlike other cities, industrial pollution is not a major reason for deteriorating air quality in Dehradun. This pertains to the fact that since 1989 (under Doon Valley Notifications, 1989), Red category industries are prohibited in Doon Valley. The city of Dehradun is also prone to temperature inversions, a phenomenon which affects air quality as it changes the dynamics of air movement.

Status of annual ambient air quality in Dehradun

Three manual air quality stations and one real time air quality monitoring station (installed in February, 2022 by UKPCB in collaboration with Doon University) are available to ascertain the air quality level in the city (Table 37). $PM_{2.5}$ measurements have started from January'19. The

annual air quality levels (for particulate matter and SO_2) measured in different monitoring stations have been exceeding the prescribed standards from past five years (Table 38).

Table 37. Air quality monitoring in Dehradun district

Action areas	Outcomes
Number of manual air quality monitoring stations in the district	Three permanent air quality monitoring stations are located in following locations: 1. Clock Tower 2. Raipur Road 3. Himalayan Drug, ISBT
Number of automatic air quality monitoring stations in the district	One real time air quality monitoring station has been installed at Mothrowala.
Availability of air quality monitoring data	Air quality data is regularly updated in the website of Uttarakhand State Pollution Control Board (UKPCB).

Table 38. Ambient air quality characteristics (2017-2022) in Dehradun

Year	Dehradun											
	Clock Tower				Raipur Road				Himalayan Drug, ISBT			
	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO2 ($\mu g/m3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO2 ($\mu g/m3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO2 ($\mu g/m3$)
2022	154.4	84.95	20.22	25.12	151.36	82.08	18.61	23.53	160.06	85.80	22.24	25.45
2021	153.6	89.75	21.46	25.55	134.85	80.55	20.36	24.71	151.34	91.89	22.12	25.42
2020	136.9	83.71	21.51	25.45	80.31	67.90	20.97	22.93	143.85	84.27	21.72	25.57
2019	171.3	93.83	24.90	28.82	123.66	72.54	23.17	27.67	205.17	106.71	25.72	29.23
2018	175.9	-	24.6	28.33	161.39	-	24.13	27.83	264.80	-	25.78	28.35
2017	190.4	-	24.98	28.5	223.71	-	25.84	28.85	302.35	-	26.67	29.68

Non-attainment city: Rishikesh

Popularly known as the '" Yoga Capital of India", the city of Rishikesh is located in the Himalayan foothills, on the banks of River Ganga. Rishikesh witness huge tourist influx throughout the year. This pertains to the spiritual experiences and serenity offered by the place. Moreover, adventure sport activities are also prominent in the city. This however, may have increased the burden on the ecological services offered by the place. Indirect impact can be seen on the deteriorating air quality in the city due to which it was declared as non-attainment city under National Clean Air Programme(NCAP). This was also established by the air quality data monitored by CPCB for a period of five years (2012-2017) which recorded significantly high values of PM_{10}.

Identified sources of air pollution in Rishikesh

Emission from vehicles, re-suspension of road dust, diesel generator sets, construction activities, burning of fossil fuels and solid waste, etc. are identified as major sources of air pollution on the city. Besides, two major industries (IDPL and Hindustan National Glass Industries Ltd.) are also

operational in the outskirts of the city. Emissions from brick kilns located around Rishikesh could also be one reason for deteriorating air quality.

The baseline emissions from traffic being too high because of rapid economic growth counter balance the control measures. At the beginning of 2011, heavy smog covering the Rishikesh region arose public concern about air pollution.

Status of annual ambient air quality in Rishikesh

Three manual air quality monitoring stations are established in different locations to ascertain the values of air quality parameters in the city (Table 39). Two of them have become operational in recent times. Not much data is available, however it can be inferred that the particulate matter values are exceeding the permissible limits (Table 40).

Table 39. Air quality monitoring in Dehradun district

Action Area	Outcomes
Number of manual air quality monitoring stations in the district	Three permanent air quality monitoring stations located at the Rishikesh. 1. Nagar Nigam (Rishikesh) 2.SPS Hospital (Rishikesh) 3.Natraj Hotel (Rishikesh) *(Monitoring stations in SPS Hospital and Natraj Hotel, Rishikesh have been setup in 2021-22).*
Number of automatic air quality monitoring stations in the district	Not initiated
Availability of air quality monitoring data	Air quality data is regularly updated in the website of Uttarakhand State Pollution Control Board (UKPCB).

Table 40. Ambient air quality characteristics (2017-2022) in Rishikesh.

Year	Rishikesh											
	Nagar Nigam				SPS Hospital				Natraj Hotel			
	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO2 ($\mu g/m3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO2 ($\mu g/m3$)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO2 ($\mu g/m3$)
***2022**	137.47	73.81	20.80	26.22	137.77	74.96	20.83	26.32	139.98	79.21	20.58	26.30
2021	128.66	73.35	19.94	25.00	132.90	79.30	20.14	25.01	-	-	-	-
2020	108.18		18.66	23.24	-	-	-	-	-	-	-	-
2019	136.31		22.31	27.06	-	-	-	-	-	-	-	-
2018	129.33		20.22	24.11	-	-	-	-	-	-	-	-
2017	128.71		21.77	26.73	-	-	-	-	-	-	-	-

**Data is averaged upto May'22*

WASTE WATER MANAGEMENT AND SEWAGE TREATMENT PLANT

Domestic sewage is the type of waste water that is produced by a community of people and is characterized by volume of flow, physical condition, chemical and toxic constitute and its bacteriologic status. Around 80% of water supply flows back into the ecosystem as wastewater, this can be a critical environmental and health hazard if not treated properly.

Currently, India has the capacity to treat approximately 37% of its wastewater, or 22,963 million litres per day (MLD), against a daily sewage generation of approximately 61,754 MLD according to the 2015 report of the Central Pollution Control Board (CPCB). Moreover, most sewage treatment plants do not function at maximum capacity and do not conform to the standards prescribed (Table 41).

Piped sewerage system connects only 31.7 per cent of the total urban households with individual household latrines. More than half of the urban population in the State relies on On-Site Sanitation (OSS) systems such as septic tanks *(53.1 percent)* for the collection of faecal sludge and wastewater. Further, some individual households in the state discharge the waste from their toilets directly into open drains.

Table 41. Current Scenario related to STPs (MLD) in Uttarakhand

Number of STPs Installed in Uttarakhand	**71**
Total Sewage Generation (MLD)	627
Installed Capacity (MLD)	448.18
Operational Treatment Capacity (MLD)	345
Actual Utilization (MLD)	187 *(42% of installed capacity, 54% of Operational capacity)*
80 % of the state's total sewage treatment plant capacity caters to Dehradun and Haridwar (Plain areas).	

*(**Source:** ENVIS Centre on hygiene, sanitation, sewage treatment systems and technology)*

Sewage management in Dehradun district

Sewage Treatment Plants are available in two ULBs i.e. Nagar Nigam Dehradun and Nagar Palika Mussoorie. One of them is the most populous areas in the district and other is a major tourist hub. Total 13 STPs of varying capacities are currently operational in the district. (Table 42).

Table 42. Inventory of sewage treatment facilities in district

Sl. No.	Location	Installed STP capacity (MLD)	Operational capacity (MLD)
1.	Lakkarghat, Dehradun	26.00	12.30
2.	Mothrowala - I, Dehradun	20.00	13.52

3.	Mothrowala- II, Dehradun	20.00	11.00
4.	Kargi, Dehradun	68.00	13.00
5.	Vijay Colony, Dehradun	0.42	0.30
6.	Salawala, Dehradun	0.71	0.35
7.	Indira Nagar, Dehradun	5.00	5.00
8.	Jakhan Rajpur road, Dehradun	1.0	0.14
9.	Bhattafall, Mussoorie	3.12	0.80
10.	Happy Valley, Mussoorie	1.20	0.20
11.	Landour South, Mussoorie	1.30	0.10
12.	Landour North, Mussoorie	0.80	0.035
13.	Kulri Bazar, Mussoorie	0.90	0.35
STPs under construction in the district			
14.	Kolagarh, Dehradun	3.00	--

Liquid waste management in rural areas

Since the water supply for domestic purposed in rural areas has improved considerably over the years, the quantity of wastewater that is disposed as also increases. Hence effective wastewater management systems need to be introduced in the rural areas to mitigate the problem of contamination in the majority of rural areas, untreated wastewater is discharged directly into the local surroundings and water bodies. This leads to contamination of surface as well as sub-surface water, having negative effects on the environment and human health.

Current standpoint about rural waste water management in India

- With Population growth and rapid industrialization, wastewater management has become a serious issue. Rural India with old or without any infrastructure has reached to a tipping point.
- India has the highest number of people who don't have access to clean drinking water. Even abundance of water in certain places do not guarantee access to safe, reliable, drinking water.
- United Nations Sustainable Development goal 6 focuses on access to clean water and sanitation for all. The goal of the initiative is to sensitize communities to the advantages of hygiene and sanitation.

Policies for rural waste management in India

Various interventions are made under Swachh Bharat Mission (SBM-G) to mitigate the ecological and health related impacts of liquid waste in rural areas. These include infrastructure development financial compensation, awareness programs etc. targeting remotest of the village (Table 43).

Table 43. Policies undertaken for waste water management in rural India

Current Policy	Sponsoring agency	Remarks
Construction and Usage ofIndividual Household Latrines (IHHLs)	Under Swachh Bharat Mission-Gramin (SBM-G)	There are various models of toilets available based on safe sanitation technologies like Twin pit, Septic tank, Bio toilets etc.

Availability of Sanitation Material through Rural Sanitary marts (RSM), Self-help groups (SHGs)	Under Swachh Bharat Mission-Gramin (SBM-G)	To provide material, services and guidance needed for constructing different types of latrines and other sanitary facilities for clean environment,
Community Sanitary Complex (CSCs)	Under Swachh Bharat Mission-Gramin (SBM-G)	Such complexes comprise of appropriated number of toilet seats ,bathing cubicles etc.(Only where there is lack of space in the village for construction of household toilets.)
Financial Assistance	Under Swachh Bharat Mission-Gramin (SBM-G)	Up to Rs.12000 is provided to BPL (below poverty line) households and identified APL (Above poverty line) households for construction of one unit of IHHL. It is not the cost of the toilet but an incentive amount.
Mensural Health Management	Under Swachh Bharat Mission-Gramin (SBM-G)	It is aimed at making behavioural change in woman and adolescence girls using a clean menstrual management material to absorb or collect blood that can be changed in privacy as often as necessary for the duration of the menstruation period, and having access to facilities to dispose of used menstrual management materials.

INDUSTRIAL AREAS AND INDUSTRIAL WASTE WATER MANAGEMENT

The Ministry of Environment, Forest and Climate Change (MoEF&CC) has developed the criteria for categorization of industrial sectors based on the Pollution Index, which is a function of the emissions (air pollutants), effluents (water pollutants), hazardous waste generated and consumption of resources.

Moreover, Central Pollution Control Board (CPCB) developed Comprehensive Environment Pollution index (CEPI) to find out the index value to characterise quality of the environment. Monitoring is carried out by CPCB through recognized environmental laboratory periodically and CEPI is assessed based on the recorded monitoring data (Table 45). The evaluated CEPI reflects the environmental quality of the industrial areas and serve as a standard to assess the progress achieved in the implementation of action plans. Table 44 describes number of industries in the district of Dehradun based on Pollution Index.

Table 44. Based on Pollution Index (Categorization of industries based on range indices)

Pollution Index of industrial sectors	Category
60 and above	Red
Between 41 and 59	Orange
Between 21 and 40	Green
Up to 20	White*

**A new category of white industries, which is practically non-polluting, does not require Environmental Clearance (EC) and Consent and will help in getting finance from lending institutions.*

Table 45. Based on CEPI Score

CEPI score	Category
Exceeding 70	Industrial cluster is treated as critically polluted.
Between 60-70	Industrial cluster is treated as severally polluted.

Table 46. Inventory of industries in Dehradun district

Category	Number of industries
Red	45
Orange	209
Green	401
White	-
Total	**655**

** The number of industries keeps changing monthly, quarterly or yearly based on the authorisation received by UKPCB.*

Industrial aspect of Dehradun district

Industrial areas are prominent in the outskirts of the NN Dehradun. One of the industrial areas is located in NPP Vikasnagar (Table 47). Air quality monitoring, specifically for industrial areas is absent in the district. However, stack monitoring is observed in some industries in NNDehradun (Table 48). Groundwater quality parameters analysed in Industrial area Selaqui (in the year 2020) adheres to the permissible standards (Table 50).

Table 47. Industrial areas in the district

Industrial areas in the district		
Name	**Number of industrial units**	**Type of enterprise (public/private)**
UPSIDC Industrial Area, Selaqui,Dehradun	132	Private enterprise
Mohabewala Industrial Area, Saharanpur Road,Dehradun	13	
Lal Tappar, Dehradun	16	
Industrial Area, Vikasnagar	31	
Industrial Estate, Langha Road, Dehradun	09	
Rani Pokhri Industrial Area, Dehradun	03	
UPSIDC Industrial Area, Patelnagar	13	

Table 48. Prominent sources of pollution

Parameter	Outcome/Remark
Related to air pollution	
Air quality monitoring in Industrial areas of the district	Not initiated in any Industrial area
Stack monitoring in Industries	06 Industries in Dehradun
Related to water pollution	
The number of Industrial Nalas/Drains meeting the river	NIL
Number of Nalas/Drains tapped	NIL
Surface water quality and groundwater quality in industrial areas	Groundwater data for two locations is available
Related to Hazardous waste	
Number of industries generating hazardous waste	416

Information related to Industrial waste water

Effluent Treatment Plants are available in Industries which generate waste water (Table 49). They work on the principle of Zero Liquid Discharge(ZLD). All the industrial units discharging waste water are adhering to the set norms.

Table 49. Current status related to industrial waste water

Parameters	Outcome/Remark
Total quantity of industrial waste water generated (MLD)	714
Quantity of treated industrial waste water discharged in water bodies.	NIL
Quantity of untreated/partially treated industrial waste water discharged in water bodies	NIL
Industries having ETPs	104 (all of them operate on ZLD)
Number of industries meeting standards	104
Number of industries where environment compensation was imposed by SPCB	NIL

Table 50. Groundwater quality data for the year 2020

Parameters	Groundwater stations		Acceptable limits (as per IS:10500-2012	Permissible limits (As per IS:10500-2012
	Groundwater Selaqui, Industrial area 1, Uttarakhand	Groundwater Selaqui, Industrial area 2, Uttarakhand		
pH	7.58	7.34	*6.5-8.5*	*No Relaxation*
Total dissolved solids (mg/l)	82	136	*500*	*2000*
Chloride (mg/l)	17	14	*250*	*1000*
Calcium (mg/l)	46	56	-	*No Relaxation*
Fluoride (mg/l)	*BDL	BDL	*1*	*1.5*
Magnesium (mg/L)	36	41	*NA*	*NA*
Total Iron (mg/l)	BDL	BDL	*0.3*	*1*
Total Hardness (mg/l)	82	97	*200*	*600*
Nitrite (mg/l)	BDL	BDL	*NA*	*NA*

**BDL stands for Below Detection Limit*

IDENTIFICATION OF POLLUTER STRETCHES

The polluted locations in a continuous sequence are defined as polluted river stretches and are categorized in five priority classes based on Biological Oxygen Demand (BOD) concentration (Table 51). The Central Pollution Control Board (CPCB) in 2018 identified 351 Polluted river stretches in India. The national-level assessment of water quality for identification of Polluted river stretches has found that there are 31 states and Union territories having rivers and streams not meeting water quality criteria. Currently, 9 rivers are monitored in Uttarakhand at 28 different locations. It is prerequisite to maintain water quality in accordance to the criteria set out as per designated best use (Table 52).

Table 51. Criteria for prioritization

Priority area	**BOD level (mg/l)**
Priority I	> 30
Priority II	20-30
Priority III	10-20
Priority IV	6-10
Priority V	3-6

Source: *CPCB, 2018*

Table 52. Water quality standards for different purposes

Designated best use	**Class**	**Criteria**	
		Parameters	**Prescribed value**
Drinking water source without conventional treatment but after disinfection	A	pH	6.5- 8.5
		DO	6 mg/l or more
		BOD	2 mg/l or less
		Total Coliforms (MPN/100ml)	50 or less
Outdoor bathing (organized)	B	pH	6.5-8.5
		DO	5mg/l or more
		BOD	3 mg/l or less
		Total Coliforms	500 or less
		(MPN/100ml)	
Drinking water source after conventional treatment and disinfection	C	pH	6-9
		DO	4 mg/l or more
		BOD	3mg/l or less
		Total Coliforms (MPN/100ml)	5000 or less
Propagation of wildlife and fisheries	D	pH	6.5-8.5
		DO	4gm/l or more
		BOD	2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal.	E	pH	6.0-8.5
		Electrical conductivity	2250
		Sodium absorption ratio	Max.26
		Boron Max.	2mg/l
	Below -E	Not meeting any of the above standards	

Polluter stretch: River Suswa

River Suswa originates in the middle of a clayey depression which is located towards the east of the Asarori-Dehradun Road. It drains the eastern part of Dehradun city and is one the major drinking water source for various villages in Dehradun and wild animals in Rajaji National Park.Dehradun and Doiwala are two major urban settlement located in the catchment of River Suswa. Apart from these, numerous small villages are also situated on the banks of this river.

Two rivers: Rispana and Bindal which carries abundant municipal drainage from Dehradun city meets River Suswa at Mothrowala. About 20 km downstream of Mothrowala, River Suswa joins River Song (which originates from adjoining Tehri district) and thereafter it is recognized as River Song. After travelling about 11km, it joins River Ganga near Birla Guest House, upstream of Raiwala.Based on the water quality data for the years 2016 and 2017, its stretch from Mothrowala to Raiwala (approximately 31 km) has been identified as polluted stretch of priority I.

Sources of pollution in polluted stretch of river Suswa

The Polluted stretch starts from Mothrowala, where River Suswa confluences with river Rispana and Bindal.These two rivers carry the pollution load of Dehradun city. This majorly includes waste water from municipal drains and households of the city (Table 53). Hazardous waste from the industries located in the catchment of this polluter stretch could also be one reason for the unhealthy state of River Suswa.

Table 53. Identification of sources of pollution in the polluter stretch

Potential source of pollution	Remarks	
Municipal sewage	Rivers carrying municipal drains	Rispana and Bindal
	No. of nalas draining into river Rispana and Bindal (they eventually joins river Suswa)	• Wastewater from about 177 nalas and 2901 household's flows into River Rispana • At Mothrowala, river Suswa is joined by several drains including river Song. A total of 51 drains flows towards this catchment.
	Estimated amount of municipal wastewater drained in river Rispana and Bindal.	• Estimated 9.38 MLD municipal wastewater flows into River Rispana. • Estimated 18.14 MLD municipal wastewater is flowing into river Bindal.
Industrial pollution	• Two Grossly Polluting Industries (GPIs) are located in the catchment of river Suswa and Song. • Approximately 3.9 MT per annum hazardous waste is generated from the industries located in the catchment of river Suswa.	
Unscientific solid waste disposal	Illicit dumping of waste,particularly in rural areas could be one reason for the deteriorated water quality.	
Apart from this,agriculture runoff is also cited as major source of pollution in river Suswa.		

Water quality characteristics of river Suswa

Surface water quality is regularly monitored at two monitoring stations; one at Mothrowala (at the confluence of river Rispana and Bindal with Suswa) and another at the upstream of Raiwala (Just before the confluence of river Song with river Ganga). River water quality data for two locations (one at Mothrawala and other just after the confluence of River Songs and River Ganga) is provided in Table 54. BOD content has remained at elevated levels in Mothrowala monitoring station.

Table 54. Surface water quality characteristics of river Suswa at different monitoring stations in Dehradun.

Year	Name of monitoring location	pH	BOD (mg/l)	COD (mg/l)	DO (mg/l)	Conductivity (umho/cm)	TDS (mg/l)
2021	Suswa river at Mothrawala, (Suswa (D/S) Mathurawala), Dehradun, Uttarakhand	7.562	26.4	88	3.12	≥1600	≥1600
	River Ganga after confluence of river Song near Satyanarayan temple D/S Raiwala, Dehradun	7.93	1.52	6.4	9.4	69	105.6
2020	Suswa River at Mothrawala, (Suswa (D/S) Mathurawala), Dehradun, Uttarakhand	7.78	28.17	112.5	5.38	≥1600	≥1600
	River Ganga after confluence of river Song near Satyanarayan temple D/S Raiwala, Dehradun	7.89	1.23	5.58	9.4	51.52	95.83
2019	Suswa river at Mothrawala, (Suswa (D/S) Mathurawala), Dehradun, Uttarakhand	7.78	27.3	117.7	2.8	7.9	≥1600
	River Ganga after confluence of river Song near Satyanarayan Temple D/S Raiwala, Dehradun	7.9	1.03	5.67	9.15	98.18	201.67
2018	Suswa river at Mothrawala, (Suswa (D/S) Mathurawala), Dehradun, Uttarakhand	7.88	33.17	134	2.42	422.83	≥1600
	River Ganga after confluence of river Song near Satyanarayan temple D/S Raiwala, Dehradun	7.68	1.05	5.67	8.87	127.75	211.67

Source: UKPCB

GROUND WATER EXTRACTION/CONTAMINATION AND RE-CHARGE

Groundwater is found underground in the cracks and spaces in soil, sand and rock. Over 70% of the earth's surface is covered in water but of that water, just 1% is readily available for human use, out of which ,99% is stored beneath our feet as groundwater *(The Groundwater Foundation, 2021).*

Ground water extraction:

Over 80-85% of our country population depends on groundwater for drinking water. Groundwater is also one of our most important sources of water for irrigation. Due to overuse and leverage of high amount of groundwater water table decreasing with rapid rate and it will very harmful for mankind

Ground water contamination

Groundwater contamination occurs when man-made products (such as, gasoline, oil, road salts and chemicals) get into the groundwater and makes it unsafe and unfit for any kind of use for humans and as well as other animals *(The Groundwater Foundation, 2021*). Unfortunately, groundwater is susceptible to pollutants. Hazardous materials from the land surface can move through the soil and end up in the groundwater. For example, pesticides and fertilizers can find their way into groundwater supplies over time. Also, groundwater is contaminated by the untreated waste from septic tanks and toxic chemicals from underground storage tanks and leaky landfills.

Groundwater recharge

Groundwater recharge is a hydrologic process, when water (rain, snow-melt etc.) moves downward from surface to groundwater. Mostly groundwater recharged by naturally but due to high amount of groundwater extraction, water table is falling down day by day. Saving groundwater is very important for mankind as it is the major sources of drinking water and agricultural irrigation water (The Groundwater Foundation, 2021). A comparison of depth to water level of August 2019 with decadal mean of august (2009-2018) indicates that there is decline of more than 4m in the groundwater level in state of Uttarakhand (CGWB,2019-20). Therefore, some artificial methods (Rainwater harvesting, Injection wells) are applied nowadays to save groundwater.

Water resources in Dehradun district

The District of Dehradun has extensive river network. Out of all the rivers found in the district,the easterly flowing rivers join river Ganga and the westerly flowing rivers join river Yamuna. Artificial waterbodies include Asan barrage, Dakpathar barrage etc. (Table 55).

Table 55. Water resources in Dehradun district

Sl. No.	Water resources	Remarks			
1.	Rivers	**Name**	**Place of origin**	**Altitude (m asl)**	**Length within the district (km)**
		Yamuna	Yamunotri	3162	40
		Ganga	Gangotri	3200	18
		Tons	Mussoorie	1963	28
		Assan	Malhan Rang	718	28
		Sorna	Misras Patti	985	20
		Nimi	Kharakhet	834	11
		Noon	Bakrana	1315	13
		Jakhan	Raithwan Gaun	1152	27
		Song	Tega Kalhan	2378	39
		Bindal	Rajpur	960	21
		Sheetal Raw	Koti	1160	19
		Chorkhala	Birsani	830	14
		Sudhowala khala / Darer	Bidholi	823	10
		Gulata		781	7.5
		Narokhala	Tauli	698	5
		Rispana	Tibanalapani	839	23
		Chandrabhaga	Agrakhal	1361	21
		Suswa	Mothrowala	578	34

3.	Artificial Waterbodies	**Name**	**Latitude**	**Longitude**	**Surface area (ha)**	**Altitude (m asl)**
		Asan Barrage	30°25’57’’N	77°40’12’’ E	108.75	396
		Asan (Near Kunja Vill.)	30°25’56’’N	77°39’58’’E	5.00	
		Asan (Near Gmvn)	30°26’23’’N	77°39’58’’E		
		Nakuronda Swamp	30°14’10’’N	78°08’05’’E	0.29	512
		Dakpathar Barrage	30°30’04’’N	77°47’49’’E	70.00	480
		Virbhadra Barrage	30°04’34’’N	78°17’14’’E	72.66	340

Table 56. Pollution control in water resources

Sl. No.	Parameters	Current status
1.	Open defecation in River/ Nala/ Khad	Partially controlled
3.	Control measures for idol immersion	Measure taken
4.	Nalas/ Drains meeting rivers	N/A
7.	Encroachments near flood plains	Not monitored yet.
8.	Protection of Flood Plain Zones (FPZs)	No work has been started yet but the district administration is planning to demarcate FPZ.

Table 57. Information of groundwater in the district

Sl. No.	Parameters	Current Status
1.	Estimated numbers of bore-wells/ hand pumps	--
2.	Groundwater polluted area in the district	None
3.	Adequacy of groundwater availability	Adequate
4.	Access to surface water and groundwater quality data at DM office	N/A
5.	Is there any action plan available for this district	N/A

Current standpoint regarding water resources management in Dehradun district

Present state of affairs

- Common water sources used for water supply schemes over the district are:
  1. *Deep Tubewells*
  2. *Rivulets/Naulas/Gadheras*
  3. *Springs*
  4. *Khadins / Nadins/ Tankas/ Ponds / Wells/ Ooranis*
  5. *Stream*
- Rivulets/ Naulas/ Gadheras(36.7%)followed byDeep tube-well (29.3%) and Springs(18.8%) are tapped for water schemesin Dehradin district.
- The Chakrata block has the highest water dependencyon Springs, approx.27% of total water supply schemes is directly dependent on Springs.

Source: Water at a Glance, GBPNIHE2019

Artificial recharge of groundwater

The district of Dehradun is divided into three hydrogeological units namely Himalayan Mountain belt, Siwalik zone and Doon Gravels. Groundwater occurs under different conditions in these three units. The groundwater development is going on a faster rate which demands sustainable practices. Doon gravels are highly receptive to the artificially recharged water. Artificial recharge potential for the region has been investigated to cater the growing domestic and irrigation water demand (Table 58). This could be further developed scientifically in a phased manner for future needs.

Table 58. Scope of artificial recharge in Dehradun district

District	Area (km^2)	Area identified for Artificial Recharge (AR) (km^2)	Volume of unsaturated zone (MCM)	Available sub-surface space for AR (MCM)	Water required for AR (MCM)	Surplus available for recharge (MCM)
Dehradun	3088	772	1544	232	308	1931

The structures suitable in high reaches and foothill zones could be check dams, gully plug etc. In the valley portion rain water may be harvested for the use other than drinking. Roof top harvesting

and recharge well are suitable in the plain areas of the valley. Keeping in mind the future scenario, the state government has undertaken development of artificial recharge structures under different programs. (Table 59).

Table 59. Artificial recharge and RTRWH structure constructed in Dehradun district under Catchment Area Conservation Program (CACMP)

District	Number of structures					Cost (in lakhs)					Total cost (in lakhs)
	CD	CK	RTRWH	PT	CT	CD	CK	RTRWH	PT	CT	
Dehradun	38	0	20	0	1675	3.8	0	7.3	0	0.1	11.2

CT-Contour Trench, CK- Chal Khal, RTRWH- Rooftop Rain Water Harvesting, CD- Check Dam, PT- Percolation Tank, NA- Data Not Available

Table 60. Artificial recharge and cost estimate in Dehradun district

District	**Structures proposed**					**Unit cost estimate (in lakhs)**					**Cost (in lakhs)**					**Total cost (in lakhs)**
	RTRWH	CD	PT	CK	CT	RTRWH	CD	PT	CK	CT	RTRWH	CD	PT	CK	CT	
Dehradun	250	150	30	100	200	0.5	0.3	0.07	0.15	0.015	125	45	2.1	15	3	190.1

CT-Contour Trench, CK- Chal Khal, RTRWH- Rooftop rainwater harvesting, CD- Check Dam, PT- Percolation Tank, NA- Data not available

REJUVENATION OF WATER BODIES

Most of India's major water resources *(underground waterways, lakes, rivers and reservoirs)* have to depend on monsoon rains to replenish/recover them. Nearly 600 million Indians faced high to extreme water stress and about 2 lakh people died every year due to inadequate access to safe water. The NITI Aayog in 2018 released the results of a study warning that India is facing its "worst water crisis" in history and that demand for potable water will outstrip supply by 2030, if concrete steps are not taken. If matters are to continue, there will be a 6% loss in the country's GDP by 2050. Due the high amount of water extraction and mismanagement of water resources are causing drought and sudden flood in several part of our country. Rejuvenation of water bodies also play a vital role to improve the water quality and storage of surface runoff water. For these reasons we must need to store, manage and rejuvenate the existing water bodies. We can use several government policies/schemes like Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), Atal Bhujal Mission, etc. to restore and rejuvenate the water bodies. The Water Stress Index 2019 by London-based Verisk Maplecroft ranks India as the 46th highest risk country *(Verisk Maplecroft, 2019)*. India is also 13th on the Aqueduct's Water Risk Atlas and listed as one of the world's ***"extremely water-stressed countries"*** *(World Resources Institute, 2019).*

Table 61. Present scenario in the district

Name of department	Work undertaken	Work performed
Dehradun Forest Division	Construction Activities	No data available yet
	Number of Ponds	
	Chal-Khal	
	Check Dam	
	Contour Trenches	
	Dry Water Source	
	Water-Holes	
	Perculation Tank	
	Water Harvesting Tank	
Total		

Mission Rispana-2018

The Rispana River System

The Rispana river is a perennial river which originates from Lal Tippa hills of Mussorie (at about 2279 m asl). It flows both ways as on the surface and underground and plays a vital role in maintaining the groundwater level in the city. Adjoining Rispana, there is another river named Bindal which also flows through the city of Dehradun and joins river Rispana at Mothrowala.

Confluence of these rivers forms river Suswa, which further meets the river Song and finally drains into river Ganga near Satyanarayana (between Rishikesh and Haridwar).

Mission Rispana

The river Rispana has been the lifeline of Dehradun city of Uttarakhand since ancient times. Rapid increasing in population and urbanization in last few decades has turned the river into a polluted stream with ephemeral characteristics. Many unauthorised dwelling in the form of slums near the river banks has further deteriorated the water quality of this river. The river and its surrounding areas have become a safe haven for the people to throw garbage which has severely disturbed river profile and has hampered riverine ecology. These activities have further elevated the ever-growing water crisis in the city of Dehradun, especially in summer season.

In view of the above conditions, the Government of Uttarakhand launched an active campaign to revive the flow of river Rispana. The forest department was tasked with the opportunity to implement social, environmental and engineering measures to rejuvenate this waterbody. This came to be known as Mission Rispana. Since then, some actions such as demarcating suitable sites for plantation, construction of water ponds etc., have been taken for reviving the flow of river and improving its ecology. Some other activities have also been envisaged by the forest department under this mission.

Table 62. Work done/Proposed for Mission Rispana

S.No	Work done			Future work to be done
	Location near Rispana river	**Total area (ha)**	**Total no. of plantations**	• About 2.5 lakhs trees are to be planted from the mouth of rispana to mothrowala.where it meets the river bindal. • Interception and diversion works to avoid the direct sewer outfall.
1	Police Station	0.16	320	
2	Mothrowala	3.00	6000 (3500*)	
3	Indresh Hospital	0.10	200	
4	Firing Range	0.20	300	
Total		**3.46**	**10320**	

*Miyawaki technique (Dense afforestation techniques in a very small place).

Fig. 9. Various rejuvenation works being performed under Mission Rispana

ILLEGAL SAND MINING

The Mines and Minerals (Development and Regulation) Act, 1957 has empowered state governments to make rules to prevent illegal mining, transportation and storage of minerals. However, still large numbers of illegal mining cases are registered in the country and in some cases; many of the officers even lost their lives while executing their duties to curb illegal mining. Ministry of Environment, Forest & Climate Change (MoEF&CC) put forward the Sustainable Sand Management Guidelines (SSMG) 2016, which focus on the management of sand mining in India but there is a need to revamp the existing system for effective enforcement of regulatory provisions and their monitoring. Recently, in 2020, new set of guidelines have been put forward by (MoEF&CC) in 2020, which focuses on the effective monitoring of sand mining (from the identification of sand mineral sources to its dispatch and end-use by consumers and general public) and uniform protocol for the whole country. Also, states are advised to conduct river audits and monitoring of mining activities with night vision drones and other modern surveillance equipment.

Sand being an important economic resource and the second most used mineral after water is one of the main ingredients of concrete and mortar. Besides its economic importance, it also constitutes an important abiotic component in the aquatic ecosystem like rivers. As our country has seen growth in the infrastructure sector in the recent decade, the demand for sand increased by manifolds. Further, with the announcement of the national infrastructure pipeline project, the demand for sand is going to increase exponentially in the near future. In recent years, Uttarakhand has also seen an increase in riverbed quarrying operations. With the establishment of the stone crusher industry especially in the southern Terai and Bhabar region of the state, the scale and intensity of River-Bed Mining (RBM) excavation has further increased in the past few decades. Uncontrolled and illegal mining of river bed minerals like sand has led to the loss of revenue to the state, degradation of aquatic and riparian habitat (through large changes in the channel morphology) and geology of adjoining groundwater systems.

Mining activities in the district

Sand mining activities are common in the large river flood plains of the district. Mining licence is provided by district authority for certain period of time. Cases of illegal sand mining have been reported and subsequent penalties are imposed (Table 63). All the legal mining sites adhere to the consent conditions and environment clearance conditions of competent authority (Table 65).

Table 63. Prevalent mining activities

Total area of district (km^2)	**3144**	
Type of mining activity	River-bed mining (mainly sand) is prevalent in the district.	
Total no of sand mining sites in the district	08	
Total mining area (km^2)	2.77	
Number of mining licenses given by the district authority	08 (mentioned in Table no.)	
Illegal mining areas identified in the district	**Name**	**Area (m^2)**
	Dhaula River, Timli Range	840
	Kot Mot River, Chauharpur Range	816
	Total	5166
Action against illegal mining activities in the district (in the financial year 2020-21)	37	
Penalties charged for the illegal mining activities/ earnings from mining royalty	During the financial year 2020-21, INR 10.16 lakh has been imposed against 37 cases of illegal mining activities in the district.	

Source: *Geology and Mining Unit, Dehradun*

Table 64. Details of mining sites

Sl. No.	Name of lessee	Place of mining	Area (km^2)	Duration of operation	Expected royalty (INR)
1	Sh. Akshay Bhatt, S/o Khushiram Bhatt	Vill. - Jokala, Tehsil - Kalsi	0.038	18.04.2017 to 17.04.2022	1,02,43,233
2	Sh. Gambhir Singh, S/o Shayam Singh	Vill. - Basaan, Tehsil - Kalsi	0.026	07.06.2017 to 06.06.2022	39,66,888
3	Sh. Digvijay Singh, S/o Shoorveer Singh	Vill. - Basaan, Tehsil - Kalsi	0.026	18.06.2020 to 17.06.2021	70,62,155
4	Sh. Janak Singh Rawat, S/o Sunadar Singh Rawat	Vill. - Nawabgarh, Tehsil - Vikasnagar	0.017	13.10.2020 to 12.10.2025	30,94,407
5	Garhwal Mandal Vikas Nigam (GMVN)	Vill – Rampur Khurd, Tehsil -Vikasnagar	0.514	01.10.2020 to 30.06.2021	2,81,75,000
6	Garhwal Mandal Vikas Nigam (GMVN)	Vill.– 1) Dakpathar, 2) Nawabgarh, 3) Mandi Gang Mewa and 4) Bhimawala, Tehsil - Vikasnagar	1.239	01.10.2020 to 30.06.2021	6,44,00,000
7	Garhwal Mandal Vikas Nigam (GMVN)	Vill- Dhakrani and Mandi Gang Mewa Tehsil - Vikasnagar	68.364	01.10.2020 to 30.06.2021	4,83,00,000
8	Uttarakhand Van Vikas Nigam (UVVN)	Vill- Ranjawala, Tehsil - Vikasnagar	23.75	25.11.2020 to 25.11.2025	1,51,20,000

Total	277.21		18,03,61,683.00 (approx. 18 crore)

Source: *Geology and Mining Unit, Dehradun*

Table 65. Compliance with environmental standards

Mining areas meeting environmental clearance conditions	08
Mining areas meeting consent conditions of UKPCB	08
Mining operations were suspended for violations of environmental norms	Nil
Pollutions related complaints against mining operations in past one year	Nil

ASSESSMENT OF URBAN LOCAL BODIES IN DEHRADUN DISTRICT

In order to push the Urban Local Bodies (ULBs) to adopt effective waste management, an assessment of their waste management operations has been carried out (Table 66 and 67). The main objective of this assessment is to let ULBs know their present status regarding various waste management operations in solid waste management, bio-medical waste management, C&D waste management, etc. Based on the adopted methodology, few inferences have been drawn to let administration know about their performance in various indicators.

Table 66. Assessment of urban local bodies in Dehradun district

Area of concerns	Max. points	Urban Local Bodies										
		NN Dehradun	NN Rishikesh	NPP Doiwala	NPP Mussoorie	NPP Vikasnagar	NPP Herbertpur	NP Selakui	CB Dehradun	CB Clement Town	CB Chakrata	CB Landour
Solid Waste Management												
Segregation	**4**	2	2	4	3	2	2	3	2	3	4	4
Collection	**4**	4	4	4	4	4	4	4	4	4	4	4
Segregated waste transport	**4**	1	1	2	1	1	1	1	1	1	2	2
Wet waste processing	**2**	2	2	2	2	2	0	0	2	0	2	0
Dry waste processing	**4**	4	2	2	2	4	0	0	4	0	2	0
Disposal	**2**	2	2	2	2	2	2	2	2	2	1	2
Inclusion of informal sector	**1**	1	1	1	1	1	0	0	1	1	0	1
Bio-medical Waste Management												
Linkage with common bio-medical waste treatment and disposal facility	**1**	0	1	0	0	0	0	0	0	0	0	0
Hazardous Waste Management												
Linkage with treatment, storage and disposal facilities	**1**	0	0	0	0	0	0	0	0	0	0	0
C&D Waste management												
C&D waste processing	**1**	0	0	0	0	0	0	0	0	0	0	0
E-waste management	**2**	1	1	1	1	0	0	0	0	1	0	0
General Information												
Innovation and use of indigenous techniques	**2**	1	2	1	2	1	0	0	0	0	0	0
Enforcement of by-laws and Waste Management Rules, 2016	**2**	2	2	2	2	2	2	2	2	2	2	2
Total	**30**	**20**	**20**	**21**	**20**	**19**	**11**	**12**	**18**	**14**	**17**	**15**

Table 67. Final assessment of ULBs in Dehradun district

Name of ULB	Score (out of 30)	Performance (%)
NN Dehradun	20	66.67
NN Rishikesh	20	66.67
NPP Doiwala	21	70
NPP Mussoorie	20	66.67
NPP Vikasnagar	19	63.33
NPP Herbertpur	11	36.67
NP Selakui	12	40
CB Dehradun	18	60
CB Clement Town	14	46.67
CB Chakrata	17	56.67
CB Landour	15	50

Observations from data assessment

- The district has performed satisfactory in the evaluation criteria for waste management operations.
- Nagar Palika Doiwala is the best performer amongst all the ULBs of the district. Effective source segregation has been the key to its performance.
- Nagar Nigam Dehradun, Rishikesh and Nagar Palika Mussoorie are also among the best performers in the district. Waste processing plant at Sheeshambada has been the key for waste management operations in Nagar Nigam Dehradun.
- Nagar Nigam Rishikesh and Nagar Palika Mussoorie have employed indigenous techniques for waste management. They have also propagated the concept of circular economy.
- ULBs such as Nagar Palika Herbertpur and Nagar Panchayat Selaqui doesn't have necessary infrastructure either for wet waste management or dry waste management.
- Linkages with either CBMWTF or TSDF is missing in many ULBs of the district.

ACTION PLAN

Action plan for solid waste management

Focus areas

- *Secondary garbage bins in tourist hotspots.*
- *Battery powered waste collection vehicles.*
- *Portable compactor transfer station for NN Dehradun.*
- *Framing anti-littering regulations.*

The district of Dehradun has all modern amenities required for effective solid waste management. Many ULBs have outsourced their waste management operations to private agencies be it door to door collection, waste transportation or recovery. However, rapid development and population growth could test the waste management operation capabilities of the ULBs. This plan addresses each ULB individually and highlights the action points that require the collaboration and expertise of all stakeholders. Each action point is in compliance with the guidelines of Solid Waste Management Rules, 2016.These must be addressed in a timeframe of 5-10 years considering the financial constraints (Table 68).

Table 68. Action plan for solid waste management

Action point	Concerning ULB	Purpose	Strategy/Approach	Stakeholders responsible
Quantification and segregation of other waste such as sanitary waste,horticulture waste, toxic waste, etc.	• NN Rishikesh • NPP Mussorie • NPP Herbertpur • NP Selakui • CB Clement town	• Determining waste composition in the region. • Ascertaining the need of equipment's machinery for waste processing operations accordingly. • Reducing health risk associated with handling of toxic waste.	• Appropriate sampling mechanism as per municipal solid waste management manual, Swachh Bharat Mission. This will help in getting informal estimate of waste composition in the region. • Multiple compartment vehicle can be used for waste collection and transportation.	• Nagar Nigam/Nagar Palika/NagarPanchayat • Private agencies working with ULBs for waste management.
Segregated waste transport	All ULBs	• To reduce open dumping of waste. • Reduction of historical waste.	• Optimizing waste management Infrastructure (collection trucks, trolleys). • Man power optimization at recovery facility. • Use of twin compartment vehicles	• Nagar Nigam/Nagar Palika/Nagar Panchayat • Private agencies working with ULBs for waste management
Wet waste management	• NPP Herbertpur • NP Selakui • CB Clement town	• Initiating scientific solid waste management. • Eliminating the expense of fertilizer. • Promoting eco-friendly organic fertilizers	• Home compositing • Constructing decentralized composting pits. • Constructing composting pits in dumping site or trenching ground.	• Nagar Nigam/Nagar Palika/Nagar Panchayat • Local residents

Scientific dry waste management	• NPP Herbertpur • NP Selakui	• Higher waste Recovery	• Establishing automated/semi-automated material recovery facility • Establishing linkage with recyclers	• Nagar Palika/Nagar Panchayat
Designated waste disposal site as per SWM rules,2016	• NPP Mussorie	• Reducing local dump sites and heaps of historical waste. • To manage floating waste generated due to heavy tourist influx.	• Site selection criteria based on factors such as groundwater depth, slope, soil properties, etc. • Fast tracking transfer of land and other legal formalities.	Nagar Palika
Remediation of dump sites	• NN Dehradun • NN Rishikesh • CB Dehradun	• To mitigate environmental impact of waste (Methane emission). • Resource recovery of excavated waste.	• Landfill mining • Rehabilitation through Phytoremediation.	Nagar Palika
Regular waste audit	• All ULBs	• To determine changes in waste composition. • Ensuring that the ULBs are adhering to MSW rules, 2016.	• A team of expert must be devised to monitor changing waste paradigm in the district.	NagarNigam/Nagar Panchayat/Sanitary Inspectors
Identification of bulk waste generators	• NN Dehradun • NN Rishikesh	• Ensuring compliance as per guidelines of SWM rules,2016 • To reduce the waste quantity, specially wet waste (wet waste needs to be processed within the premises by bulk waste generators).	• Issuing Public Notice informing the ULB about the provisions of SWM Rules, 2016 regarding bulk waste generators. • Field survey by ULB to • identify individual bulk waste generator. • A pilot project must be started to train bulk waste generators regarding waste management operations and responsibilities.	Nagar Nigam
Community participation for waste management	All ULBs	• Social and Behavioural Change Communication • Cleanliness drive campaigns throughout the district	• Information, Education and Communication (IEC) activities in educational institutions. • Inter-Personal Communication(IPC): School children and Sanitation workers to spread awareness amongst people regarding waste management.	District administration

Establishment of Green Protocol	All ULBs	• To prevent use of disposables and using alternatives like glass/stainless steel etc. • To bring generation of non-biodegradable waste close to zero.	• By encouraging Green Protocol in local schools, public functions, IEC campaigns, sports events, annual temple festivals and other gatherings.	District administration

Wet Waste Management through composting – A study by GBPNIHE

The role of compost, organic fertiliser derived from waste, has been overshadowed by the excessive use of pesticides and chemical fertilisers in agricultural practices. The lack of compost used in farm fields and the dependence on chemical fertilisers have had a number of negative impacts, such as deteriorating soil conditions, deficient or excess nutrients, insect outbreaks and solidified soil. However, organic waste generated in daily life can help recover soil fertility if it is used to produce compost (Kuniyal et al, 2005 a & b).

Composting involves the breakdown of organic waste in the presence of microorganisms, heat and moisture. Effective microbial composting includes three types of microorganism namely bacteria, fungi and actinomycetes that act upon waste to convert it into sugars, starch and organic acids. It is a self-reliant method of composting with little or no use of technology (Fig. 9).

Microbial Bio-composting at Municipal level

A site was selected to construct an open below earth surface MBC pit (size 3x1x1 m) (Kuniyal and Thakur, 2013-14). Its roof top was covered with multi-layered ultraviolet (UV) resistant polyethylene sheet *(rainfall areas)* and UV treated fibre sheet *(Snowfall areas).* It was required to turn up the waste in an interval of 15 days for sufficient aeration (Fig. 9). It was noticed that 500 kg of waste produced almost 167 kg compost (almost 1/3rd). Moreover, yield per hectare of garlic from the compost produced also showed desirable results.

Fig. 10. Structure and design of microbial composting pit

Phytoremediation as a mitigation measure *(for treatment of solid waste)*

Natural or planted vegetation on landfill has an important role in erosion control and removal of contaminants, besides imparting aesthetic value. Moreover, it may also be used in leachate treatment. Phytoremediation is a promising, plant-based technology in which the plants and their associated microbes are utilized to absorb and clean up environmental contamination through engineered constructed systems. The ultimate aim is to either remove the pollutant from the contaminated media or to alter the chemical and physical nature of the contaminant so that it eliminates the risk to human health and the environment. Several plants are being identified to be used in phytoremediation task (Table 69).

Table 69. Phytoremediation as a mitigation measures

Botanical Name	Local and English Name	Assimilating capacity	Altitude (m)	Site/ Location
Mangifera indica	Mango	Absorb dust particles	100-1200	Shukla et al. 2019
***Populus nigra* L.**	Popular	Accumulation of Cd, Pb, As, and Ni	100-1800	Houda et al. 2016
***Populus alba* L.**	Black popular	Accumulation of Cd and Pb	100-1400	Houda et al. 2016
***Cassia fistula* L.**	Amaltas	Absorbs Arsenic and Fluoride from wastewater	100-1500	Houda et al. 2016
***Delonix regia* (Bojer ex Hook.) Raf.**	Gulmohar	Accumulation of (Cd, Pb, Zn and Cu)	250-1250	Ukpebor et al. 2010
***Cynodon dactylon* (L.) Persoon**	Doob	Absorbs Arsenic and Fluoride from wastewater	400-2500	Kumar et al. 2011

Action plan for rural waste management in India

The Government of India as well as state government is looking up at every Gram Panchayats (GPs) to come up with a working system to manage solid waste. At the moment there are Gram Panchayats in Tamil Nadu, Andhra Pradesh, West Bengal, Gujarat and Chhattisgarh which have created a robust and sustainable system to manage solid waste.

Owing to increase in tourist activities, numerous resorts and homestays have come up in the outskirts of the cities which generally comes under the village administration. Traditional waste management techniques are used in these areas which could be catastrophic to the environment. However, based on practical models, some policies have been propagated by both central and state government for solid waste management in rural areas (Table 70).

Table 70. Policies undertaken for rural waste management in India

Current policy	Sponsoring agency	Remarks
Decentralized waste management	Under Swachh Bharat Mission-Gramin (SBM-G)	Decentralized systems such as household compost and biogas plants shall be encouraged.
Community Sanitary Complex(CSC)	Under Swachh Bharat Mission-Gramin (SBM-G)	Such complexes comprise an appropriate number of toilet seats, bathing cubicles etc. (Only where there is a lack of space in the village for the construction of household toilets).
Cluster approach to solid waste management	Rurban Mission of Ministry of Rural Development	It aims at developing infrastructure and livelihood opportunities in a cluster of GPs that demonstrate economic growth potentials.
Community participation throughInformation, Education and Communication (IEC) activities	National Institute of Rural Development and Panchayati Raj	All the stakeholders need to plan for a series of IEC campaigns to educate the residents on how proper segregation at the household levels eases the entire process of managing waste at subsequent stages.

Action plan for plastic waste management

Plastic waste causes a plethora of problems when it leaks into the environment. Stranded single use plastics create visual pollution. There is evidence that the toxic chemicals added during the manufacture of plastic, transfers to animal tissue, eventually entering the human food chain. Moreover, by clogging sewers and providing breeding grounds for mosquitoes and pests, plastic bags can increase the transmission of vector-borne diseases like malaria, cholera.

Focus areas

- *Separate framework for plastic waste management in tourist hubs.*
- *Prioritizing plastic waste management in Plain regions, where its quantity is substantial.*
- *Emphasis on Extended Producers Responsibility.*

Plastic waste forms a major chunk of dry waste in the district and its processing is part of solid waste management practices. There is no separate policy framework of plastic waste management in the district. Different strategies need to be devised for dealing with plastic waste, especially in tourist hubs of hilly region. Action plan below addresses some key points which are prerequisite for sound plastic waste management (Table 71). These must be acted upon in a timeframe of 5-10 years considering the financial constraints.

Table 71. Action Plan for Plastic waste management

Action Point	Purpose	Strategy/Approach	Stakeholder Responsible
Source segregation	• To ensure better efficiency in waste processing • Higher recovery of resources.	• ULBs should distribute separate bins to households, street vendors and other shopkeepers. • Distribution of separate bins to every households and shopkeepers in rural areas under Swachh Bharat Mission Gramin should be ensured. • Mass awareness programmes regarding source segregation with the inclusion of institutions such as schools and colleges.	All ULBs, District Panchayati raj Officer (DPRO), Village Panchayats
Effective Collection and segregated waste transport	• To reduce open dumping of waste • To reduce monkey menace (which is a huge issue in the urban areas of the state) • To ensure optimum utilisation of manpower • To ensure compliance with plastic waste management rules	• Training waste pickers and providing them proper equipment suitable as per the topography of the area for door to door collection in urban areas. • Establishing plastic waste collection centres in rural areas where door to door collection is not possible. • Provision of separate vehicles is done for dry and wet waste to ensure utilisation of manpower. • ULBs can establish linkage with the NGOs working in this field for effective waste collection in the urban areas.	All ULBs, District Panchayati Raj Officer (DPRO), Village Panchayats

	2016		
Linkage of ULBs & other collection centres with recyclers/ cement plants/ Public works department	• To avoid open dumping of plastic waste. • To ensure reuse and recycle of plastic waste.	• Plastic waste collection centre to be started in rural areas should also be linked with recyclers. • Plastic waste can be used in road construction for this; ULBs should coordinate with the construction agencies such as Public Works Department.	All ULBs
Implementation of extended producer responsibility (EPR) through producer/Brand owner	To reduce the workload of ULBs	ULBs can ask the manufacturers collectively or individually in line with the principle of extended producer responsibility (EPR) to provide the required finance to establish plastic waste collection centres.	All ULBs
Community participation for waste management	Social and Behavioural Change Communication Cleanliness drive campaigns throughout the district	• Information, Education and Communication (IEC) activities in Educational institutions. • Inter-personal communication (IPC): School children and Sanitation workers to spread awareness amongst people regarding waste management	District Administration
Establishment of Green Protocol	• To prevent use of disposables and using alternatives like glass/Stainless steel etc. • To bring generation of non-biodegradable waste close to zero.	By encouraging Green protocol in local schools, public functions, IEC campaigns, sports events, annual temple festivals and other gatherings.	District Administration

Action plan for bio-medical waste management

More than 1000 HCFs are available in the district which generates ample amount of biomedical waste as well as solid waste. Linkage with CBMWTF has ensured that maximum bio-medical waste gets scientific treatment. Deep burial pits are also one option for waste disposal. Bio-medical waste generated from households is still not quantified nor managed in compliance with the Bio-medical Waste Management Rules, 2016.

Focus areas

- *Ensuring both; segregation of solid waste from bio-medical waste and segregation of bio-medical waste in different bags.*
- *Robust training of health care workers regarding bio-medical waste management.*
- *Routine inspection of CBMWTF.*

With the onset of the pandemic, it has become clear that a proper healthcare system is need of the hour. It also provides the opportunity to improve bio-medical waste management in the district. Moreover, during outbreaks such as covid-19, materials or substances which carry infection (fomites) acts as key vehicle for the transmission of the disease. Streamlining the bio-medical waste may help in reducing the infection and its transmission. This action plan provides holistic approach, which includes governance, infrastructure, training and immunization, services etc. to tackle the unprecedented growth in biomedical waste. Immediate action is required in some of the areas such as segregation and tracking of the waste generated etc. while other action points must be executed in due course of time (Table 72).

Table 72. Action plan for bio-medical waste management

Action areas	Purpose	Stakeholders
Governance		
Authorisation of all HCFs (Allopathic, AYUSH etc.) by Uttarakhand State Pollution Control Board (UKPCB).	Compliance with the Bio-medical Waste Management Rules, 2016.	UKPCB
Linkage of district level hospitals and Community Health Centres (CHCs) with Common Bio-Medical waste treatment facility (CBMWTF).	Proper disposal of bio-medical waste as specified under Bio-medical Waste Management Rules, 2016.	Health department
Linkage of ULBs with CBMWTF.	To ensure segregation of bio-medical waste from municipal solid waste and thus its proper disposal as per Bio-medical Waste Management Rules, 2016.	All ULBs
Fixation of rates for lifting bio-medical waste by CBMWTF.	Ensuring consonance between both parties i.e. the officials of HCFs and CBMWTF.	• Health department • Operators of CBMWTF

Sharing of responsibility between officials of HCFs and CBMWTF.	This is required to avoid any disagreement or dispute.	• Health department • Operators of CBMWTF
Monitoring and inspection of deep burial pits	Compliance with the Bio-medical Waste Management Rules, 2016.	Health department
Implementation of Kayakalp initiative	To promote cleanliness, hygiene and infection control practices in public healthcare facilities.	Health department
Training and Immunisation		
District and State level orientation programs for healthcare workers to sensitize them about effective bio-medical waste management.	To ensure proper handling and segregation of biomedical waste in HCFs	Health department
• **Setting up of bio-medical waste database at state level (specifically for primary health-care facilities)** • **Training on Bio-Medical Waste Management Information System (BMWMIS) to all data entry operators and pharmacists.**	To keep records of biomedical waste generated in every HCF of the district (especially in PHCs at rural areas).	Health department
Immunisation (Tetanus and complete doses of Hepatitis-B) of all hospital staff involved in bio-medical waste management.	To avoid any kind of infection while handling Biomedical waste.	Health department
Services		
Establishing bins and bags at each generation points in HCFs with IEC posters displayed.	• To ensure segregation at each generation point and avoid mixing with MSW. • To spread awareness amongst the people related to bio-medical waste management.	Health department
Timely replacement of bags, BMW transfer to collection shed and then prompt lifting to bio-medical waste treatment facility from the shed.	To ensure timely disposal of bio-medical waste.	Health department and UKPCB.
Information		
Development of an IT-enabled data management system to keep inventory of waste collection, consumables supply, training programs etc. in HCFs (including PHCs in the district)	To ensure transparency in the biomedical waste management system up to primary level.	Health Department
Display details regarding authorisation, treatment and annual report of all Health-care facilities on website.	To make the information open source and ensure transparency.	Health Department and UKPCB.

Action plan for C&D waste management

Urban areas of the district have started quantification of C&D waste. Collection works are also initiated but it may need some augmentation in near future.

Focus areas

- *Promoting local use of C&D waste.*
- *A separate framework for C&D waste management*
- *C&D waste processing plant.*

Increased construction activities in and around the district of Dehradun will lead to increment in C&D waste. The district will require infrastructure to manage such surge in C&D waste generation. Hence, some basic facilities need to be developed to manage its growth. The action plan provides below provide a sustainable approach for the management of the C&D waste in compliance with the latest C&D Waste Management Rules, 2016 (Table 73).

Table 73. Action plan for C&D waste management

Action points	Purpose	Strategy/Approach	Stakeholder responsible
Setting up of C&D waste dumping site for local construction activities and road construction debris.	To ensure compliance with C&D Waste Management Rules, 2016.	• Transition points must be defined to deposit C&D waste. • Establishment of dumping zone such that it also caters for C&D waste of peri-urban areas and nearby villages. • Proper collection and transportation systems should be set up to aid processing. Illegal dumping practices should be discouraged by imposing penalties on open dumping.	• All ULBs • Public Works Department (PWD)
Quantification of C&D waste generated	To keep account of C&D waste generated or dumped based on area and type of buildings demolished.	Giving demolition permits to waste generators rather than reconstruction permits.	• All ULBs • Public Works Department (PWD)

Setting up of C&D waste processing plant	For stacking, crushing, processing and manufacturing of various C&D products.	C&D waste processing plant should be setup in proximity to the urban areas of the district.	• Nagar Nigam/Nagar Palika • District administration
Arrangement of size grading	To facilitate reuse of C&D Waste.	This can be done by erecting sturdy metallic screens of different sizes at an angle and putting the waste over them with the help of front-end loader.	• All ULBs • Public Works Department (PWD)
Involvement of private enterprise	Assortment and transportation of C&D waste	Public private partnership schemes must be encouraged	ULBs
Coordination and collaboration amongst different departments.	To take care of C&D waste in addition to other municipal garbage, if there is no consolidated solid waste management department.	Close coordination between Sanitary department, Municipal Engineering department and Town Planning department is required for efficient management of C&D Waste management.	• All ULBs • Public Works Department (PWD)
Framing by-laws for C&D waste management.	To ensure compliance with C&D Waste Management Rules, 2016.	• By-laws must be framed by each ULBs as per C&D waste management rule for proper disposal of C&D waste in the district. • Provision of heavy fines should be done under these by-laws for illegal dumping of demolition waste such as excavated earth material on the banks of river or on the hill slopes.	• All ULBs and District Panchayati Raj officer (DPRO) • Public Works Department (PWD)
Plantation in old dumpsites.	Established the slope at old dumping zones.	Plantation at old dumping zone should be done with the help of community participation to stabilize the slope over there.	• All ULBs and District Panchayati Raj officer (DPRO) • Public Works Department (PWD)

Action plan for hazardous waste management

There are substantial hazardous waste generating industries in the district. The waste generated is more of land fillable and incinerable type which could be hazardous to the environment. Domestic hazardous waste is not segregated effectively nor quantified which means it may have been ending up in solid waste collected from each household. Necessary actions include providing separate bins, monthly quantification of hazardous waste, collaboration between stakeholders, etc.

Focus areas

- *Separate dustbins for hazardous waste generated in households.*
- *Quantification of domestic hazardous waste*
- *Regular inspection of hazardous waste generating industries*
- *Cluster based approach to collect and redirect hazardous waste to TSDF*

This action plan provides some other key areas in which the district needs to work to achieve effective hazardous waste management complying with latest Hazardous Waste Management Rules, 2016 (Table 74).

Table 74. Action plan for hazardous waste

Action Point	Purpose	Strategy/Approach	Stakeholder responsible
Linkage of ULBs with common Treatment, Storage and Disposal Facilities (TSDF) or disposal facility	To ensure segregation of domestic hazardous waste from municipal solid waste and its proper disposal.	• All the ULBs of the district should establish linkage with nearby common TSDF or disposal facility to ensure proper disposal of hazardous waste to avoid its dumping in the landfill site. • One collection facility should be setup in the district to collect domestic hazardous waste from the rural areas of the district.	All ULBs & District Panchayati Raj Officer (DPRO)
Training of sanitation workers regarding segregation of domestic hazardous waste	To ensure segregation of domestic hazardous waste from municipal solid waste	Training programme should be organised at district/ state level for handling and segregation of domestic hazardous waste so that sanitation workers should not catch any kind of infection during its handing and its proper segregation could be possible.	State government and District administration
IT enabled systems for inventorization of the hazardous waste m	To ensure compliance to Hazardous Waste Management Rule, 2016.	State pollution control board should inventories the generation, collection, and disposal of both domestic and industrial hazardous waste on its website so that complete transparency is maintained in the management of hazardous waste in the district.	State Pollution Control Board

Action plan for E-waste management

Few ULBs have taken some crucial steps such as establishment of collection centers and setting up of toll free number for e-waste management in the district. However, many ULBs are still devoid of management services related to e-waste. This may be due to lack of awareness amongst local residents as well as district administration.

Focus areas

- *To stop unregulated backyard operations of e-waste.*
- *Cluster based management of e-waste.*
- *Regular awareness programs and IEC activities.*

E-waste needs to be streamlined in the current waste management operation, moreover a detailed framework must be developed for its management. This action plan discusses key areas where intervention is needed to achieve effective waste management in compliance with E-waste Management Rules, 2016 (Table 75).

Table 75. Action plan for E-waste

Action points	Strategy/Approach	Stakeholder responsible	Purpose
Establishing E-waste collection centres	• Collection centre should be established for all ULBs in such a way that they could also cater the collection from nearby rural areas. • A Toll-free Number must be issued for the collection of E-waste.	• All ULBs • UKPCB	• To ensure proper segregation of E-waste from municipal solid waste • Capacity building of stakeholders to promote effective E-waste management.
Authorization of E-waste pickers	Identity cards should be issued to all the waste pickers.	District administration and ULBs	To avoid illegal trading and processing of E-waste.
Linkage of ULBs with authorized recyclers/ dismantlers	All the ULBs in the district should establish linkage with any of the five authorized E-waste recyclers.	All ULBs	To ensure proper recycling if possible and if not then proper disposal as per E-waste Management Rules, 2016.
Market survey for identification of brand/ producers/bulk consumers. physical verification of a manufacturer.	Regular Auditing of an area by a survey team.	• District administration • UKPCB	To ensure compliance with E-waste Management Rules, 2016.
District level awareness campaign	• Promoting Information, Education & Communication	District administration	Promoting behavioural change in public.

	(IEC) activities in educational institutions (Schools, Colleges etc.) • Promoting awareness programmes under Digital India Initiative (Initiated by Ministry of Electronics and Information Technology) about alternate methods of disposing E-waste.		
Extended Producer Responsibility (EPR)	• Random sampling of electrical and electronic equipment's placed on market to monitor and verify the compliance of Restriction of Hazardous Substances(RoHS) provisions as per the guidelines of Central Pollution Control Board (CPCB). • "E-waste Return" Programme should be initiated to incentivize people and bring about behaviour change.	State government and UKPCB	• Proper collection and disposal of E-waste • Channelization of e-waste generated from *the "end-of-life"* products to ensure environmental sound management.

Action plan for air and noise pollution

Air pollution is one of the major issues in the district, particularly in NN Dehradun and NN Rishikesh. Monitoring stations (both manual and automatic) have been installed to regularly check the air quality. The recorded data shows elevated levels of particulate matter in both ULBs. These cities have been also declared as non-attainment cities. Different departments need to undertake the responsibilities ensued to them under air action Plan for both cities. Moreover, UKPCB must start recognizing the areas which may develop as the hotbeds of air pollution in near future. This action plan focusses on areas, which requires collaborative efforts from different departments to mitigate air pollution in the district (Table 76).

Focus areas

- *Adhering to the air action plans prepared by UKPCB*
- *Expanding the monitoring stations is per-urban areas.*

As of now, Noise levels are only monitored in NN Dehradun and occasionally in NN Rishikesh. The district administration has the capacity to deal with noise pollution Collaborative efforts by different departments would be beneficial in near future (Table 77).

Table 76. Action plan for air quality management

Action areas	Purpose	Strategies/Approach	Stakeholders
Air quality monitoring	To identify the hotspots within the district and further development of mitigation measures for those areas.	Ambient air quality monitoring stations can be installed in all the urban centres and other identified areas such as construction sites after manual air quality monitoring.	Uttarakhand state pollution control board (UKPCB)
Vehicular traffic management	To reduce emissions caused by vehicles.	• Checking adulteration of fuel • Promoting intercity and intra-city public transportation with green fuel alternatives such e-buses & rickshaws etc. • Paving of road shoulders especially in urban areas.	• Department of Police • Transport department • Public works department
Encouraging CNG and battery operated public transport vehicles	Supporting the applicability of Electric and hybrid buses in following areas: • School buses • City buses • Tourism	• District administration	• To reduce local air pollution • Higher efficiency of electric propulsion system.

	Company vehicles		
Dust control measures	Following dust abatement measures need to be taken for mitigating its impact on health of an individual and environment: • Sprinkling of water/fine spray to suppress dust re-suspension • Management of transport vehicles by Pollution Under Control (PUC) compliance. • Dry sweeping of work areas to be discouraged. • Development of green buffer for construction activities site (preferably shrubs and trees that have low uptake of water.	• District administration	• To control dust at source and prevent it from becoming airborne, since suppression is virtually impossible once it has become airborne.
Mainstreaming and integrating existing policies and programmes of the National Action Plan on Climate Change (NAPCC) and other initiatives of government of India in reference to climate change	By mainstreaming the initiatives under eight national missions of NAPCC namely: • National Solar Mission • National Mission for Enhanced Energy Efficiency • National Mission on Sustainable Habitat • National Water Mission • National mission for sustaining Himalayan ecosystem • National mission for a Green India. • National mission for sustainable agriculture. • National Mission on Strategic Knowledge for Climate Change	District administration	For an accelerated implementation of time-bond plans through collaborations.
District level action plan for air pollution	To improve existing air quality.	A district level task force with some experts can be formed for air quality management in the district.	District administration
Awareness on air quality	To promote awareness among the masses regarding	Mass awareness can be promoted with IEC	District administration

	the issue.	activities by involving institutions such as schools and colleges for this purpose.	
Complaint redressal system	To sort out grievances registered by citizens	Online complaint registration and redressal system should be formed at the district level to register complaints regarding air pollution issues.	• UKPCB • District administration

Table 77. Action plan for noise pollution management

Action areas	Purpose	Strategies/Approach	Stakeholders
Noise level monitoring	To recognize the current situation of noise levels in the district and identify the hotspots	Noise monitoring studies need to be done in the district especially within the urban centres within the district by manual monitoring. In the areas identified as hotspots, continuous monitoring stations should be set up.	Uttarakhand state pollution control board (UKPCB)
Traffic management	To ensure noise level within permissible limits	Signboards should be placed at sensitive locations in the towns within the districts and if required silent zones should be established Green belts can be formed along the roads in the urban areas to reduce noise levels.	• District Administration • Public Works department and ULBs
Complaint redressing system	To sort out grievances registered by citizens	Online complaint registration and redressal system for noise pollution should be made which can be used by citizens, Traffic police, ULBs, and state pollution control board.	District administration
Mass awareness	To promote awareness among the masses regarding the issue	Mass awareness campaigns must be organized with the help of IEC activities by taking the help of institutions such as schools and colleges for this purpose	District administration

Action plan for non-attainment cities: Dehradun and Rishikesh

Setting up of a steering committee to achieve target deadlines has been the core strategy to improve the air quality in all NN Dehradun and NN Rishikesh and its vicinity. The recommended actions can be designated as either policy, regulatory or implementation (Table 78 and 79).

Table 78. Action plan for non-attainment city: Dehradun

Source group	Action points	Stakeholders responsible
Vehicular Pollution	• Restriction on plying and phasing out of 15 years old commercial diesel driven vehicles. • Introduction of cleaner fuels (CNG/LPG) for commercial vehicles. Promotion and operationalization of E-rickshaw. • Integration of all pollution check centres with single web-based software for ensuring control and monitoring of polluting vehicles. • Periodic calibration test of vehicular emission monitoring instrument. • Battery operated vehicles and e-rickshaws to be introduced.	Transport department and Traffic Police Transport department
Road dust	• Development of green belt in along the roads, open areas, gardens, parks/ community places, schools & housing societies. • Installation of vacuum road sweeping machines &small vacuum cleaning machines for smaller roads	Municipal Corporation and Development authority
C&D waste	• Transportation of municipal solid wastes, construction materials and debris in covered system Enforcement of Construction and Demolition Rules 2016. • Water sprinkling, curtains, barriers and dust suppression unit to be used during all construction and demolition activities including covering the construction sites.	District administration and Municipal Corporation Municipal Corporation and Development authority
Strengthening of AAQ monitoring	Installation of Infra-red cameras at major traffic junctions to detect polluting vehicles	UKPCB Nagar Nigam Transport department

Table 79. Action plan for non-attainment city: Rishikesh

Source group	Action points	Stakeholders responsible
Vehicular pollution	• Restriction on plying and phasing out of 15 years old commercial diesel driven vehicles. • Introduction of cleaner fuels (CNG/LPG) for commercial vehicles. Promotion and operationalization of E-rickshaw. • Integration of all pollution check centres with single web-based software for ensuring control and monitoring of polluting vehicles. • Periodic calibration test of vehicular emission monitoring instrument.	Transport department and Traffic Police
Road dust	• Development of green belt in along the roads, open areas, gardens, parks/ community places, schools & housing societies. • Construction of concrete pavements along the roads. • Water spraying on roads through tankers.	Municipal Corporation and Development authority
Bio-mass and garbage burning	• Restriction on open burning of municipal solid waste, Biomass, plastic, horticulture waste etc • Ensuring promotion & use of cleaner fuel for commercial purposes like local Dhaba/ eateries.	Nagar Nigam and Development authority
Industrial Emissions	• Installation and operation of advance air pollution control systems and continuous ambient air quality monitoring system at M/s Hindustan National Glass Industries Ltd, Rishikesh. • Restriction of new industries which are based on solid fuel like wood and coke.	UKPCB Industrial Department
Strengthening of AAQ monitoring	• Installation of Continuous Ambient Air Quality Monitoring Stations (CAAQMS). • Increasing Number of manual ambient air quality station. • Installation of Infra-red cameras at major traffic junctions to detect polluting vehicles	UKPCB Nagar Nigam Transport department
Public Awareness	• Involvement of schools and other academic institution in awareness program. • Issue of advisory to public for prevention and control of air pollution, vehicle fitness, maintenance and minimise use of personal vehicles etc. • Issuing advisory to public for maintenance and minimise use of personal vehicle	UKPCB Nagar Nigam Transport department

Action plan for waste water management (STPs)

Except NN Dehradun and NPP Mussoorie, scientific waste water treatment facility is not available in any other ULBs of the district. Other ULBs still rely on conventional treatment methods for waste water disposal. Decentralized waste water management and co-treatment method could be one solution for scientific disposal of waste water in the district.

Focus Areas

- *Decentralized waste water management.*
- *Preparation of city sanitation plan*

This action plan focusses on addressing concerns of each ULB pertaining to the policies and design sanctioned by the respective administration (Table 80).

Table 80. Action plan for waste water management

Action areas	Concerning ULB	Strategy/Approach	Stakeholder responsible
Decentralized waste water management under Atal mission for Rejuvenation and Urban transformation(AMRUT) by Faecal Sludge and Septage Management System (FSSM)	As per feasibility analysis	• In line with National FSSM policy, each state is expected to develop and issue an FSSM implementation strategy and plan guideline. This may be integrated with overall city land use planning. • Capacity building and training on FSSM (at City level) to build their personnel capacities and organizational systems for delivery of sanitation services.	Ministry of Housing and Urban development Government of India
City sanitation plan under National Urban Sanitation Policy	All ULBs	• Enhance synergy among municipal government agencies, the private sector, NGOs and others. • Increase funding from sources other than municipal government (such as from the national and provincial governments, donor agencies, the private sector)	Ministry of Housing and Urban Development, Government of India
Automation of all water infrastructures including valves and pipelines	All ULBs	• Integration of new age technologies with real time data tracking.	Jal Sansthan /Jal Nigam
Integrated Urban Water management	All ULBs	• Promoting simultaneous planning of urban infrastructures with decentralised approach for new interventions in parallel to the existing centralised systems.	Jal Sansthan /Jal Nigam

Action Plan for rejuvenation of polluted stretch river Suswa

The action plan below (Table 81) highlights the action points related to solid waste management, effluent management (sewage and industrial waste water discharge), ground water management, etc. Rejuvenation of river Suswa will require collaboration among different departments such as UKPCB, Uttarakhand Payjal Nigam, NN Dehradun, NPP Doiwala, Irrigation department etc.

Table 81. Action plan for river Suswa polluter stretch

Action points	Stakeholders responsible
Industrial Effluent Management	
Routine/surprise Inspection of GPIs (Gross polluting industries) and Red category industries for ensuring Compliance of effluent discharge standards as prescribed under Environment (Protection) rules, 1986, as amended	• Special Environmental Surveillance Task Force • Uttarakhand pollution control board (UKPCB)
Strengthening of Environment Surveillance squad (ESS)	UKPCB
Monitoring of Drains carrying industrial wastewater	UKPCB
Sewage Management	
A. Upper catchment of River Suswa (Before Mothrawala):	
Tapping of 177 nos. of nalas/drain and 2901 nos. open household outlets on both banks of river Rispana.	Uttarakhand Payjal Nigam
Carrier line of 30.88 Km and appurtenant works.	
Diversion structure of Bindal river to 68 MLD STP.	
Interception and diversion of all drains	
Installation of STPs for treatment of domestic /commercial waste water in the district.	
B. Mothrawala to Shyampur Area:	
Interception anddiversion of 3- drains namely - Nala Sapera Basti; Nala Near Rajiv Gandhi International Stadium; and Nala Shyampur near Polytechnic	Uttarakhand Payjal Nigam
Installation of 3-Nos. of STPs at - Nala Near Rajiv Gandhi International Stadium; and Nala Shyampur near Polytechnic.	
Operation and Maintenance of 3 Nos. of STPs for 15 years; Operation and Maintenance of 3 Nos. I&D Works for 15 years; Land acquisition	
Monitoring of STPs outlet effluent quality w.r.t. STPs effluent discharge norms prescribed under E(P) Rules, 1986 as amended.	
Solid Waste Management	
Solid Waste management as per action plan provided in Table 68	Nagar Nigam Dehradun and Nagar Palika Doiwala
Groundwater Quality	
Groundwater quality monitoring at silent points in the catchment of river Suswa during summer (May-June) and winter (December-January).	Uttarakhand pollution control board (UKPCB)
Flood Plain zone	
Flood plain zoning of Suswa river.	Irrigation department
Regulation restricted activities in flood plain zones **Prohibition on illegal disposal of waste and removal of encroachment**	• Irrigation department • District Administration

from river banks	
Environmental Flow	
Maintaining environment flow (a minimum of 15% discharge in lean period) in river Ganga and its major tributaries	Uttarakhand Jal Vidyut Nigam Ltd.
Green Development	
Training works to prevent soil erosion at Suswa river and its catchment	Forest department

Source: UKPCB

Phytoremediation as a mitigation measure (for rejuvenation of polluter stretches) in Dehradun

Aquatic plants, demonstrate a high potential to purify river water, Industrial wastewater effluents and contaminated water (Samal et al., 2019). The tolerant plants, planted in the riverbank, can purify the river water by absorption, adsorption, accumulation and degradation of contaminants. These plants exhibited significant capacity to remove nutrients such as total Nitrogen and Phosphorus from water bodies (Tong, et al 2003). The plant roots provide strong and extensive rhizosphere systems, which facilitate the growth of bacteria and other microorganisms (Steenhoudt, et al., 2000; Zimmels, et al. 2008). These microorganisms play a significant role in the removal of organic and inorganic contaminants from wastewater and contaminated water by degradation of organic chemicals and accumulation of nutrients and other metal contaminants. This phytoremediation process can be applied along either the riverbank or wastewater/storm water discharge point. The technique has low cost and wider community acceptance, irrespective of geographical locations (Table 82).

Table 82. Phytoremediation as a mitigation measures (for polluter stretches)

Botanical name	Local name	Assimilating capacity	Altitude (m)	Remarks
***Pontederia cordata* L.**	Pickerel weed	Removal of nutrients and organic matter by aquatic plants and aeration. *P. cordata* has a strong impact on water purification even without concurrent aeration.	< 1000	Anawar et al. 2020
***Ipomoea aquatic* Forssk.**	Water spinach	Removal of TN and TP, *Ipomoea aquatica* has thriving roots and high growth rates and has high capacities to absorb nitrogen, phosphorus, and other nutrients or pollutants		Tang et al. 2020
Persicaria lapathifolia (L.) Delarbre	Spotted lady's thumb	Removal of BOD, COD, nutrient, metal		Rudin et al. 2016
***Canna indica* L.**	Indian shot	Ecological floating bed for removal of nutrients		Barya, 2020
***Iris pseudacorus* L.**	Yellow iris	Ecological floating bed for removal of nutrients		
***Accords calamus* L**	sweet flag	Ecological floating bed for removal of nutrients		
***Typha domingensis* Pers.**	Southern cattail	Decrease in BOD, COD and total organic carbon (TOC) was observed.		Gomber et al. 2013
***Leptochloa fusca* (Lam.) N.Snow**	Bearded sprangletop	Decrease in BOD, COD.		
Brassica juncea (L.) Czern.	Sarso	Used to remove As, Pb, and Cd concentration in contaminated soil		Ahmad et al. 2021

Action plan for water resources management and ground water extraction/contamination

Water Resources and Groundwater management requires an integrated approach from different departments such as the District administration, Panchayati Raj, Jal Sansthan, Jal Nigam, Payjal Nigam, Forest Department etc. Each department is expected to work in tandem with each other to achieve effective management of resources, be it land or water. The action plan focuses on the areas, which form the prerequisite for effective water resource management. Each action point is in compliance with the guidelines under Water (prevention and control of pollution act, 1974), (Amendment) Rules 2021 of water resource management act, 1986. The current action points must be addressed in a timeframe of 5-10 year considering the financial constraints (Table 83 & 84).

Focus areas

- *Mapping of water scarce areas*
- *Encouraging the use of organic fertilizers*
- *Crop diversification*

Table 83. Water Resources management

Action points	Purpose	Strategy/Approach
***Integrated water resources management* (IWRM) at River basin level**	To achieve water security for all purposes,managing risks and to mitigate disasters.	By considering basin/sub basin as a basic unit for planning and management.
River Basin Master Plan	Periodic review of hydrological conditions prevailing over a basin identification of protected areas.	By analysing river basin characteristics
Mapping of water scarce areas in a district	To get estimate of vulnerable areas in the district.	• By using modern mapping tools such as Geographical Information System (GIS) and Remote sensing • By setting up an interdisciplinary framework consisting of Local institution and empowered government agency
Assessment of water Resources in various river basin	• To collect reliable data. • To assess water resources potential and analysing water requirements for various uses.	Using Modern technology and Hydrological modelling
Public awareness and use of low cost technologies	For better water application efficiency	Using field application methods such as drip irrigation/micro sprinkler irrigation systems in water scarce areas. This can be achieved by bringing government subsidies in this area as the local people needs incentives to up bring this modern technology.

Integrated Rural area Programme*(IRAP)*	• For constant interactive relationships between different departments • Location specific programmes can be drawn up locally under this overall programme.	By bringing together all the programmes of different ministries as well as rural employment and development programme into one for effective collaboration and planning.

Table 84. Groundwater management

Action points	Purpose	Strategy/Approach
Multidisciplinary approach (nexus between groundwater, agricultural policy, urban infrastructure and energy consumption)	For groundwater sustainability	By integrated vision and coordination amongst different departments.
Mapping of aquifer at micro level	• To quantify the available ground water resources • To formulate plan appropriate to the scale of demands and aquifer characteristics.	By Maintaining an Aquifer information and Management system
Artificial recharge of groundwater	• To ensure sustainability of ground water resources • To ensure the quality of recharge to prevent possible contamination	• By demarcating groundwater recharge zones by identifying critical natural recharge areas of an aquifer and those areas that require special attention with regard to recharge of groundwater. • By using broad leaf plants to improve the moisture content in the soil and thereby increasing the groundwater level and water holding capacity of soil. • Improving the scale of work done through various schemes such as MNREGA which will help develop indigenous recharge methods (such as Chal-khal).
Identification of non-point sources of Pollution (pollution resulting from land runoff, precipitation, drainage, seepage, etc.)	Non-point source pollution is a leading cause of deteriorating water quality as when the runoff moves ,it picks up and carries away natural and human-made pollutants finally depositing them in lakes, rivers and groundwater.	• Controlling soil erosion by planting more trees and covering bare soil with vegetation. • Constructing wetlands.
Mitigating groundwater contamination	• To ensure the ground water quality of an area. • To reduce health hazards caused due to contaminated water.	• Reducing the use of pesticides and fertilizers. • Encouraging Organic farming in the area by organising various Information,Education and Communication (IEC) campaigns.

Action plan for rejuvenation of water bodies

The prime focus of Mission Rispana, an ongoing rejuvenation work, has been plantation activities. But to revive the flow and its ecology, it needs river basin management, mass awareness activities, etc. This action plan will further help the organizations/departments blend their restoration methods with scientific rationale to achieve the desired results (Table 85)

Table 85. Action plan for rejuvenation of water bodies

Action points	Strategy/Approach	Purpose
River Catchment/Basin Management	Participatory and self-management institutional framework for administering the catchment with a combination of engineering, social and scientific management.	• Reducing levels of potential contaminants in raw water. • Distribution of water and prioritization of water uses under stressed conditions.
Plantation in Flood Plain Zones (FPZ)	Vegetation that acts as natural resistant to soil disturbances and standing water must be encouraged.	• To reduce shoreline erosion • Particular type of plants acts as natural barriers to dissipate waves and back-lying areas from flooding.
Prohibition of disposal of municipal plastic waste and Biomedical waste (specially in flood plain zones)	• Awareness and behavioural change activities. • Provisions of heavy fine for those found throwing garbage in rivers.	• To maintain ecological balance of the water body • To prevent pollution activities nearby river basin.
Spring-shed and Stream shed management	• By constructing loose boulder, check dams. • Encouraging Information, Education and Communication(IEC) activities in local institutions (schools, colleges etc.)	• To improve water resource sustainability • To enhance water discharge from springs and rivers
Convergence activities	By making use of social media platforms.	Ensuring Community participation

**Key points for the action areas in this thematic are influenced by rejuvenation activities carries out for Kosi river(Almora), Bhela river(Kashipur) and Heval River (Pauri Garhwal)*

Action plan for mining activity management

Major river systems offer a good scope of sand mining in the district of Dehradun. It has been a major source of revenue for the district. Many newspaper agencies and environmentalists have highlighted illegal mining activities in the district. These activities hamper river profile and damages the river bed. Moreover, these activities also destroy the ecology of the areas close to the river and could prove dangerous in monsoon season, when water discharge is usually maximum.

Focus areas

- *Identification of illegal mining hotbeds*
- *Geo-scientific considerations for sand mining as per framed by Geographical Survey of India.*
- *Robust complaint redressal system.*
- *Revisiting the dredging policies.*

The action plan provided below mainly emphasize on areas, which includes monitoring of the mining operation by using the latest technologies, regular audit of the mining sites and other guidelines as per the Sustainable Sand Mining Guidelines, 2016 (Table 86).

Table 86. Mining activity management plan

Action areas	Purpose	Strategies/ Approach	Stakeholders
Monitoring of mining activity	To ensure sustainable mining activity within the district.	• A district-level task force should be formed to monitor mining activities and to conduct river audits and surveillance. • For the rivers marking the boundaries with other districts, a combined task force should be formed to monitor mining activity in the river.	District administration
System for online purchase and sale of Sand and other RBMs	To ensure compliance to Enforcement and Monitoring Guidelines for Sand Mining, 2020.	An online system should be made at the state or district level for e-auctioning the mines to ensure transparency in the system.	State Government and District administration
Identification illegal mining hotspots.	To have check on the mining activities in the district.	The district task force should identify the possible hotspots for illegal mining through surveillance and patrolling.	District administration
Community participation	• To understand local community's willingness in curbing illegal mining from the area. • To have local check on the illegal mining activities in the district.	A toll-free number must be issued for citizens in the district to register any complaint against any illegal mining practices as identified by them in their vicinity	District administration

CONCLUSION

Anthropogenic pressure due to urban sprawl and ongoing developmental activities have exacerbated the already existing environmental issues in the district. Nagar Nigam Dehradun, which accounts for more than 70% of the population, has been facing the environmental problems relating to waste management, air pollution, contamination of water in river streams, etc. About 70.62% (455 out of 644.28 MTPD) of waste in the district is generated in Nagar Nigam Dehradun. Waste generated from other ULBs is also substantial considering their population size. Source segregation, collection, compartmentalized transport and waste recovery operations in the district are performed in the ULBs with collaborative efforts from private agencies/NGOs/International organizations. Fifteen such organizations are currently working in the district. Centralized approach for waste management is prevalent in the district where Nagar Nigam Dehradun and Nagar Nigam Rishikesh are the two major hubs for waste management operations. After performing primary waste management operations, 6 out of 11 ULBs are channelizing their waste for further processing to Sheeshambada waste management plant. Nagar Palika Doiwala is working with Rishikesh cluster which includes 3 more ULBs from other districts (NPP Narendra Nagar, NPP Muni Ki Reti and NP Swargashram).

At present, Nagar Nigam Dehradun has 20% of its coverage for mechanical sweeping. Nagar Nigam Rishikesh has been authorised to use one mechanical sweeping which is expected to be operational soon. Of the total dry waste generated in the district, 15.5% (38.18 out of 246.06 MTPD) is plastic waste. After primary waste management operations and compaction, it is either sold to local rag pickers or is transported to the authorised waste recycling facility. As per analysis, the solid waste and plastic waste generation is projected to be around 1296.5 and 381.4 MTPD respectively by the year 2041. This means that the infrastructural carrying capacity for waste management needs to develop accordingly. Otherwise, it would be a difficult task if alike measures could not be taken up to minimise the waste by volume as well as weight under waste to energy initiatives. Each ULB needs to come up with self-reliant approach and circular economy model to accommodate the escalating solid waste generation. Streamlining the local rag pickers in the current waste management practices, secondary garbage bins in tourist hotspots, battery powered collection vehicles, public participation etc., are some of the approaches to achieve sustainable waste management. Plastic waste management will require separate policy framework and infrastructure in each ULB. Apart from solid waste, hazardous waste and e-waste are also prevalent in the district. About 350.08 MT of hazardous waste is generated from about 416

industries in the district. Only 13% (48.62 out of 350.08) is recyclable and rest is either incinerable or land fillable. These industries transport their hazardous waste to TSDF namely Medical Pollution Control Committee (MPCC), Roorkee. Suitable domestic hazardous waste, and its quantity are not determined in any of the ULB. There is a need to ensure proper management of hazardous waste with adequate facilities except for a black box that is attached in the waste transport vehicle. Cluster based approach to collect and direct domestic hazardous waste to TSDF could be one of the small steps towards its management. Collection centres for e-waste have been established in Nagar Nigam Dehradun, Nagar Nigam Rishikesh and Nagar Palika Doiwala. Some of the ULBs have initiated collection but they are not receiving any waste from domestic households. This is the fact that they get better prices for their e-waste raw material from local rag pickers. District administration has established linkage with authorised e-waste recyclers and dismantlers to dispose of the e-waste generated or e-waste lying idle in government offices. So the ULBs need to make sure under the purview of district administration that there should be no unregulated or unauthorised backyard operations of e-waste in the district. Schemes such as e-waste Return Programme need to be initiated on priority to incentivize people and to bring about their behaviour change. Around 10.65 MT C&D waste is generated per day from Nagar Nigam Dehradun, Nagar Palika Vikasnagar, Cantt Board Dehradun and Cantt Board Chakrata. C&D waste from other ULBs is not yet quantified. However, many of them have initiated collection of C&D waste. Collected waste is either stored near solid waste processing facility/MRF, or used locally for land filling, or is sold on demand to local residents. With infrastructure development and growing demand for construction materials, the district might require one C&D waste processing plant in near future. Around 96% (1656.93 out of 1710 kg) of biomedical waste is generated in about 1473 HCFs in the district, which is transported to Medical Pollution Control Committee (MPCC), a CBMWTF/TSDF at Roorkee. Deep burial pits are also being used in the district for biomedical waste disposal. Domestic biomedical waste is not inventorized in the ULBs and exists in mixed waste form. Management of biomedical waste has become very important considering its massive generation during pandemic. The ULBs must ensure segregation of domestic biomedical waste under secondary segregation facility. Population having more than 1 lakh need to ensure linkage with CBMWTF for biomedical waste management. Robust training should be provided to healthcare workers for scientific handling of biomedical waste in HCFs. Air pollution is one of the major environmental concern in the district especially in Nagar Nigam at Dehradun and Rishikesh. These two Nagar Nigam have been designated as Non-attainment cities under National Clean Air Programme (NCAP). In Nagar Nigam Dehradun, diesel fuelled vehicles especially auto-rickshaws (*Vikrams*), trucks, and buses are major causes of air pollution.

Although, some natural phenomena such as temperature inversion has also been playing its own role in determining the concentration of ambient air pollution in the region. Three manual monitoring stations and one automatic air quality monitoring stations are installed to ascertain the air quality status in the city. Air quality, as observed from the monitored data, remains above the permissible limits. Emission from vehicles, road dust, diesel generators, red category industries (two of them are operational in outskirts of the city) are the major sources of air pollution at Rishikesh. Air quality data are obtained by manual air quality monitoring stations in three different locations of the city. Two of them (one at SPS Hospital and another at Natraj Hotel) have been installed recently in the year 2021.All the three locations have elevated levels of air pollution as particulate matter especially PM_{10} is above permissible limit in all the monitored data. As per the directions of Hon'ble NGT, an action plan has been prepared by UKPCB for reducing pollution levels in these cities. The action plan includes short term, intermediate and long term plans for mitigating air pollution. As many as 3 noise level measuring devices are available with various agencies in the district. Noise pollution levels are measured in 7 locations of Nagar Nigam Dehradun which includes areas in commercial (Survey Chowk, Clock Tower and CMI Hospital Chowk), silence (Doon Hospital and Gandhi Park) and residential (Race Course and Nehru Colony) zones. Average noise levels are above the permissible limit in all the locations. A special noise level measuring drive is carried out during Deepawali festival in few locations of Nagar Nigam Dehradun and Rishikesh to study the impact of fire crackers on noise pollution. Traffic management, implementation of noise control measures, and setting up of sign boards have been the steps which might help in reducing noise pollution in crowded areas of the district. Total 13 STPs with installed capacity of 148.45 MLD are available in the district. However, these STPs cater the demand of only two ULBs, i.e., Nagar Nigam Dehradun and Nagar Palika Mussoorie. One more STP with estimated installed capacity of 3 MLD is proposed at Kolagarh, Dehradun. Other ULBs still rely on the conventional method of waste water disposal which includes captive septic tanks. Decentralized waste water management can be a solution for scientific waste water management. This also goes hand in hand together with the AMRUT mission of government of India. About 655 Industries are currently operational in the district out of which more than 60% (401) belong to green category. Moreover, 7 industrial areas (private enterprise) exist in the district which consists of almost 217 industries. Major pollution activities are not paid much attention in the district except for stack monitoring in some industries, ground water monitoring in two locations (in Selakui Industrial Area), etc. As per the data obtained, 714 MLD of industrial waste water is generated in the district. No untreated industrial waste water discharge has been reported so far. More than 104 industries have their own effluent treatment plants which operate

on the mechanism of Zero Liquid Discharge. Based on the monitored data for the year 2016 and 2017, a 31km stretch of River Suswa from Mothrowala to Raiwala was declared as polluted river stretch of Priority I, which depicts high BOD level. Pollution loads from River Rispana and Bindal have been one of the causes for the poor water quality of River Suswa. This can be attributed to the fact that wastewater from around 177 streams (*Nalas*) and 2901 households drains into Rispana. Estimated 9.38 MLD from Rispana and 18.14 MLD wastewater from Bindal ends up in River Suswa, which joins these rivers at Mothrowala, the starting point of Polluter stretch. It has been said that no untreated industrial waste water ends up in river bodies, but hazardous waste generating for the industries near the catchment of River Suswa could also be one of the reasons for its poor condition. In view of above conditions, an Action plan has been prepared by UKPCB for restoration of each polluter stretch. This is done after the Hon'ble NGT took cognisance of the issue. It is expected to rejuvenate the river in terms of meeting the water quality criteria for Class B, i.e., suitable for outdoor bathing. However, based on monitored data, the BOD levels at the upstream near Mothrowala remains substantially high. Hence goals can be met only for irrigation purpose, industrial cooling, etc., which means "Class E Designated Best Use". The Doon valley, stretching about 70 km is drained by major river systems from all sides. Rispana, Bindal, Song, Suswa, etc, are some of the rivers that drain the district and cater for irrigation and water supply demand. Some artificial water bodies such as Asan Barrage, Dakpathar Barrage, etc. are also located in the district. Since 2018, a major rejuvenation project, namely, Mission Rispana is underway in the district. Forest department has been given responsibility to undertake works to restore the water quality of the river. Works performed till date includes plantation works in an area of around 3.46 hectare in 4 locations near River Rispana, construction of water ponds, etc. Forthcoming works includes plantation of about 2.5 lakh trees in the catchment of the river. Currently, there are 8 mining sites operational in the district as per geology and mining unit. These are sand mining sites mainly in Kalsi and Vikasnagar areas of the district. These sites meet the requisite environment clearance conditions. Royalty of almost INR 18 cr. is expected from these sites. Two illegal sand mining sites (one each in River Dhaula and Kot Mot) were identified by the department. Actions have been taken again illegal mining activities for which penalties amounting to 10.16 lakh have been imposed. Illegal mining activities disturb the riverine ecology. The riverbeds are adversely affected due to incessant dredging. Hotspots of illegal mining activities need to be identified and the mining operations need to be supervised by modern surveillance equipment.

Without proper environment planning, it might become difficult to make urban development in the district sustainable. Efficient and judicious use of available natural resources, assets, and infrastructure are the needs of the hour.

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