CITY SANITATION PLAN FOR ROORKEE CITY

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

in

CONSERVATION OF RIVERS AND LAKES

By

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CANDIDATE'S DECLARATION

I hereby declare that the work which has been presented in the dissertation entitled "**CITY SANITATION PLAN FOR ROORKEE CITY** " in partial fulfillment of the requirements for the award of the degree of **Master of Technology in Conservation of Rivers and Lakes**, submitted in Alternate Hydro Energy Centre, Indian Institute of Technology, Roorkee, is an authentic record of my own work in the period from July 2011 to June 2012 under the supervision of Dr. Arun Kumar, Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee.

The matter embodied in the dissertation has not been submitted by me for the award of any other degree or diploma.

Place: Roorkee
Date: 15th JUNE, 2012

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CERTIFICATE

This is to certify that the above statement made by the candidate is correct to the best of my knowledge and belief.

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ABSTRACT

Urbanization in India is on a major growth trend. Roorkee town is growing also with cities into becoming from big towns. The services required to match this growth are not growing proportionately and often the available services are not appropriate and adequate and are being stretched too much to accommodate this growth. One of the key services for urban growth which is of major concern is safe water and sanitation.

The city sanitation plan (CSP) is a strategic planning processes for complete city wide sanitation plan covering all technical, administrative, social, financial, legal issues concern to solid as well as liquid and biomedical, toxic waste and generated in the city.

The total population of Roorkee city as per census 2011, residing in 20 wards, is 116,809. The demand for water supply up to year 2011 has been assumed as 18.13 MLD, wastewater as 14.87 MLD, municipal solid waste as 45 MT and bio-medical waste generated by health care units as 2000 kg daily. The projection population for Roorkee city for the year 2041 is estimated as 166,759.

Under the study field data regarding the water quality of the Solani river was assessed by taking samples from various locations the river. Quality of sewage water was assessed by taking samples from several locations in the city, such as industrial area and garage and sewer line and milk dairy also visit and take sample from the main landfill site for solid waste in the Saliyar village, visit the existing sewage pumping stations and natural ponds for collection waste water drainage inside city neighborhoods.

The CSP immediate and effective steps as well as remedies and solution to achieve environmental sanitation to every individual in the city for long term in sustainable manner may be achieved. It is an integrated and holistic planning process which will take in to account the entire cycle of sanitation-safe access, collection, treatment and disposal. There after plans will be developed individual such as to ensure

100 % sustainability and cost recovery. As the CSP is a complex phenomenon, which requires large amount of data to support the decision. In the process of planning and management of large data and maps, Geographical Information System (GIS) based planning tools play a very vital role, as maps and data can be stored, manipulated and analyzed for planning and decision making. It facilitates and also eases to assess the information spatially.

This work is a step to develop an environmentally sustainable appropriate sanitation plan for Roorkee town, Existing situation analysis for waste water disposal, solid waste management and water supply has been carried out for the city. It highlights the deficiencies in various existing and planned sanitation facilities for the city. The analysis also projects the future demand for water and sanitation services along with the possibility of resource mobilization, institutional development and implementation strategy for achieving city sanitation. The implementation of CSP may cost Rs 237 crore (US $2012 45 Million) and may be implemented 5 years

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^0C	:	Degree Centigrade
ADB	:	Asian Development Bank
AHEC	:	Alternate Hydro Energy Centre
BEG&C	:	Bengal Engineering Group and Center
BMW	:	Bio-Medical Waste
BOD	:	Biochemical Oxygen Demand
CBRI's	:	Central Building Research Institutes
COD	:	Chemical Oxygen Demand
CPCB	:	Central Pollution Control Board
CPHEEO	:	Central Public Health Environmental Engineering Organisation
CSP	:	City Sanitation Plan
CWTF	:	Common Waste Treatment Facility
DG	:	Diesel Generator
DO	:	Dissolved Oxygen
DPR	:	Detailed Project Report
EO	:	Executive Officer
GTZ	:	Gesellschaft für Technische Zusammenarbeit GmbH, Germany
HAD	:	Haridwar Development Authority
HCUs	:	Health Care Units
ID	:	Institutional Development
ID	:	Irrigation Department
IDS	:	Institutional Development Strategy
IEC	:	Information, Education and Communication
IITR	:	Indian Institute of Technology Roorkee
IRI	:	Irrigation Research Institute
ISBT	:	Inter State Bus Terminal
IUSP	:	Integrated Urban Sanitation Program
JNNURM	:	Jawaharlal Nehru National Urban Renewal Mission
KL	:	Kilo Liters
LPCD	:	Liters Per Capita per Day
LPM	:	Liter Per Minute

M&E	:	Monitoring and Evaluation
MDG	:	Millennium Development Goals
MLD	:	Million Liters Per Day
MNRE	:	Ministry of New and Renewable Energy Sources,Govt. of India
MoUD	:	Ministry of Urban Development, Govt. of India
MSW	:	Municipal Solid Waste
MT	:	Metric Tone
NEERI	:	National Environmental Engineering Research Institute
NH	:	National Highway
NIH	:	National Institution of Hydrology
NOG	:	Non Government organization
NP2	:	Non Pressure pipes
NPK	:	nitrogen(N), phosphorus(P), and potassium(K)
NRCD	:	National River Conservation Directorate
O&M	:	Operation and Maintenance
OHT	:	Over Head Tank
PHED	:	Public Health Engineering Department
PPP	:	Public Private Partnership
PWD	:	Public Works Department
RCC	:	Reinforced Cement Concrete
RDA	:	Roorkee Development Authority
RNPP	:	Roorkee Nager Palika Parishad
SFC	:	State Financial Commission
SPCB	:	State Pollution Control Board
SPS	:	Sewage Pumping Station
STP	:	Sewerage Treatment Plant
SWM	:	Solid Waste Management
UDA	:	Urban Development Authority
UDD	:	Urban Development Department
UFW	:	Unaccounted For Water
UJS	:	Uttarakhand Jal Sansthan
UJVNL	:	Uttrakhand Jal Vidyut Nigam Limited
ULB	:	Urban Local Bodies

UPCL	:	Uttrakhand Power Corporation Limited
UPJN	:	Uttarakhand Pey Jal Nigam
UPJN	:	Uttarakhand Pey Jal Nigam
WMC	:	Waste Management Coordinator
WSSCC	:	Water Supply and Sanitation Collaborative Council

CHAPTER 1

INTRODECTION

1.1 GENERAL

It is now well known that half of humanity living in urban areas. and this percentage is growing. As cities since ancient contributed in progress of civilization through its focus on culture, infrastructure, institutions. Also the cities became the best places to focus on economic opportunity and prosperity and prosperity. This is still positive aspects of city life attract people to urban areas and urges them to stay. As the cities provide substantial opportunities for the future. And will be the cities that have city sanitation plan more prosperous and beautiful and sophisticated vision of those that do not have a CSP.

1.2 WHAT IS CITY SANITATION PLAN

City Sanitation Plans are strategic planning processes for citywide sanitation sector development. Addressing technical and non-technical aspects of sanitation services, city sanitation plans include the vision, missions, and goals of sanitation development as well as strategies to meet these goals.

1.3 WHY CITY SANITATION PLAN IS NECESSARY

city sanitation plan is necessary for the city to become the city completely sanitized, healthy and liveable and ensure and sustain good public health and environmental outcomes for all its citizens, with particular focus on hygienic sanitation facilities and affordable for the poor in urban areas. to convert the city to the urban community-based and cities sterile and completely safe and suitable for living and the policy sets the following goals:

1). Generate awareness and behavior change.

2). Open defecation free cities.

3). Integrated citywide sanitation:

i). Re-orienting Institutions and mainstreaming sanitation.

ii). Sanitary and safe disposal: 100% of human excreta and liquid wastes must be disposed of safely.

iii). Proper Operations and maintenance (O&M) of all sanitary installations.

1.4 CITY SANITATION (MASTER) PLANS (CSP)

City sanitation (master) plans (CSP) sometimes also referred to as Municipal Sanitation Plans or Water and Sanitation Strategy Plans, are strategic planning processes for citywide sanitation sector development. To manage water resources, water safety plans (WSP) exist.

A citywide sanitation strategy includes the vision, missions, and goals of sanitation development as well as strategies to meet these goals. Each strategy is then translated into indicative programmes (and projects). The citywide sanitation strategy covers :

1.4.1. Technical Aspects,

Including strategies and programmers for the development of

1). Domestic wastewater services,

2). Solid waste management services

3). Micro drainage services.

1.4.2. Non-Technical Aspects,

Including strategies for the development of non-physical aspects such as

1). Community awareness and participation,

2). Policy and regulation.

3). Institutional capacity.

4). Private sector engagement.

5). NGO engagement.

6). Financing and tariffs.

7). Monitoring and evaluation.

1.5 THE COMPONENTS OF CITY SANITATION PLAN

The city sanitation plan identifies issues, priorities and actions along five sanitation components namely:

1). Water Supply,

2). Access to Toilets

3). Wastewater management,

4). Storm water drains

5). Solid Waste Management (SWM).

Apart from Technical Actions in these areas, the city sanitation plan also identifies issues and actions across cross-cutting aspects including:

1). Governance/Institutional Framework,

2). Capacity Development,

3). Awareness Generation and

4). Financial sustainability.

1.6 CITYWIDE STRATEGIC SANITATION PLANNING

Although each city is different, city sanitation services should be developed based on a common set of principles. Services must be comprehensive and continuously accessible to all residents. The entire city should have sanitation services suited to its needs, allowing all residents to enjoy the benefits of improved sanitation.

To meet the total sanitation principles, a city needs a strategic approach. It is the most general methods that can be used as a basis for a more strategic approach to the development of sanitation services in the city:

1). Enhance synergy among the actors in sanitation development, including municipal government agencies, the private sector, NGOs, and others.

2). Employ appropriate technologies that are suitable to user needs, while ensuring that they are relevant to the city's actual conditions, comply with technical standards, and prevent potential impacts .

3). Develop sanitation in all parts of the city (citywide), prioritizing poor residential areas where the health risks are highest.

4). Promote awareness of health and hygiene behavior while creating demand for better sanitation services .

5). Create opportunities and incentives for private sector initiatives in the development and operation of sanitation services

6). Foster better use of existing sanitation services, which becomes the basis for developing new services.

7). Encourage the development of community-based sanitation services, especially in areas where public and private services are difficult to establish.

8). Engage stakeholder groups, including women groups, in sanitation planning, in line with their respective capacities.

9). Create enabling institutional and regulatory frameworks to accelerate sanitation services development.

10). Increase funding from sources other than municipal government, such as from the national and provincial governments, donor agencies, the private sector and the public .

11). Adopt step-wise sanitation development as available resources allow.

1.7 JUSTIFICATION FOR SELECTION THE TOWN FOR PROJECT

There are many reasons to choose the city Roorkee It is the most important of these reasons, the following:

1). the spirit of it cultural, political, and blend multi-religion, and class distinct from the social and economic classes are representative of typical Indian cities: in fact all of the typical Asian cities.

2). it is not a heavily industrialized city; therefore the impacts of industrialization do not dominate the city's system but are among the several other contributory factors. In this respect too. the city is representative of a very large number of similar urban systems.

3). a major attraction and educational tourism. The city also has an active commercial movement.

4). experiencing growth in population and the increase in the number of residential buildings, economic, educational and hospital .

1.8 REQUIREMENT TO PREPARE EXECUTIVE SUMMARY AND CHECK LISTS OF ALL SCHEMES

The City Sanitation Plan (CSP), Feasibility Report of Sewerage Schemes and DPRs of all Schemes should contain an executive summary and a check list. There should also be an integrated executive summary and check list of the pollution abatement project as a whole.

Table 1.1: Check List of City Sanitation Plan for Roorkee.

S. No.	Parameters	Yes	No
1.	Has the available data of the polluted stretch of the river basin been collected?		✓
2.	Have the maps of the river basin and the city been prepared?		✓
1.	Has the city been selected after studying the status of water quality of the river in the entire stretch in the state?	✓	
2.	Has the problem of pollution with its causes been identified	✓	
3.	Have all the sources of pollution of river been identified	✓	
4.	Has the information of toilet facilities available in slums and elsewhere been collected	✓	
5.	Has the condition of ghats been ascertained?		✓
6.	Has the expected outcome of pollution abatement project been spelt out in terms of improvement of water quality and of environment in the city been spelt out?	✓	
7.	Has the present system of management of waste water and other works been studied	✓	
8.	Have areas requiring up gradation of existing system of waste water management been identified.	✓	
	Have areas where sewers to be laid been identified?	✓	
	Have drainage areas and sewage districts been identified?	✓	
	Has the need for following Schemes been examined?		
	(i) SWM	✓	
	(ii) Community toilet	✓	
	(iii) River front development	✓	
	(iv) Other non-pint sources of pollution	✓	
	Have agencies that will be assigned the preparation of Component Schemes been identified?	✓	
	Has executive summary been prepared?	✓	

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

The growth of civilization and subsequent needs for better living standard of human being has caused great impact on the environment. The various issues and challenges before the mankind for utilization of natural resources for a sustainable development have compelled to look back at various environmental problems at different levels. One of the major environmental problems is the pollution due to discharge of domestic and industrial effluent and disposal the solid waste. This has negative affects on the health of the community life as well as the beautiful appearance of the city .

Accordingly The review begins with a general overview of the city sanitation plan experience, Subsequently, the need for alternative technologies is examined. The review then explores the relationship between sanitation, the environment and public health, and issues solid waste and biomedical wastes generally.

2.2 CITY SANITATION PLAN

2.2.1 The Need For Alterative Sanitation Technologies

Austin and Duncker (2002) [2] Sanitation is an extremely complex issue. It is an issue that impacts on the daily lives of every human being inhabiting this planet, particularly in the developing countries where the level of service is either poor or nonexistent. There is no single solution that can be applied as a universal panacea and the situation will continue to worsen unless new approaches are adopted . and **Simpson-Hébert (1996)[28]** proposes a number of interrelated guiding principles, among which are the following:

1). The sanitation sector must continue to innovate low-cost facilities for people with different needs, from different climates, and with different customs.

2). There is a need in some societies to recycle human excreta as fertilizer.

3). Toilets are consumer products: their design and promotion should follow good marketing principles, including a range of options with attractive designs based

upon consumer preferences, and also be affordable and appropriate to local environmental conditions.

And based **Winblad (1996a & 1996b) [33],[34]** maintains that sanitation approaches based on flush toilets, sewers and central treatment plants cannot solve the sanitation problem. Nor can the problem in high-density urban areas be solved by systems based on various kinds of pit toilets. According to him, there exists an erroneous assumption that the basic problem is one of "sewage disposal", while in actual fact the problem is the disposal of human faeces and urine, not sewage. It is therefore proposed and says **Austin and Duncker (2002)[2]** Urine diversion sanitation technology is based on the concept of keeping these two substances separate. The main advantages of this approach are, firstly, that valuable nutrients such as nitrogen, phosphorus and potassium are found in urine, and secondly, the dangerous pathogens present in faces are more easily isolated from the environment . but **Dudley, E (1996) [11]** said the flush toilets conventional sanitation options, may be suited to certain situations, but in other circumstances where both water and space are scarce there is a clear need for permanent, expiable toilets which do not require water. Such circumstances are becoming increasingly common. When limits are placed on other variables, for example money and the depth of the water table, the circumstances where options such as sewers and pit toilets are viable become fewer, while the need for permanent, expiable, waterless toilets grows. And **EcoSanRes (2003)[13]** Even if the sanitation crisis can be communicated to and understood by more people, the need to find sustainable alternatives to conventional approaches for both developed and developing countries remains. Sanitation can no longer be a linear process where excreta are hidden in deep pits or flushed downstream to other communities and ecosystems. Sustainable and ecological sanitation requires a holistic approach.

2.2.2 The Environment And Public Health: The Argument For Ecological Sanitation

As a result of faulty sanitation systems design, their incomplete implementation, poor operation and improper use, human excreta are spread throughout the environment. Says **Simpson-Hébert (1997)[29]** Vast amounts of improperly managed faeces and untreated sewage contaminate the living environment of people, soils and bodies of water. and says **Kaseva, M E (1999)[20]** Environmental problems in turn undermine the

process of development, which is further hampered by rapid population growth. In all developing countries, especially in sub-Saharan Africa, the population growth in the urban areas alone is outstripping the capacity of these regions to provide for basic needs such as shelter, water and sanitation, and **Björklund, G (1997) [7]** Which is to say about the problem of pollution Water quality is deteriorating all over the world due to pollution. Some cities in the developing world treat only about 10 % of their sewage. And **DWAF (1999) [12]** Even in South Africa, reports have indicated that an alarming proportion of sewage waste in many towns and cities across the country does not reach treatment plants, but flows untreated into the rivers. This is regarded as one of the most pressing water quality problems in the country.

Esrey et al (1998) [16] point out that globally, sewage discharges from centralized, waterborne collection systems are a major component of water pollution, contributing to the nutrient overload of water bodies. Although waterborne systems are acceptable to the vast majority of people, they are technologically complex and require institutional capacity and skills that are not always available. Over 90 % of all sewage in developing countries is discharged completely untreated. So **Winblad and Kilama (1980) [35]** The success or failure of a sanitation system depends on the interaction of environmental, human and technical factors. The most important environmental aspects are climate, soil and groundwater; these vary from place to place and have a great influence on the choice of the most appropriate sanitation system. The technology selected should therefore be adapted to the local environmental conditions. And also says **Feachem and Cairncross (1978)** [17] It is better to protect the environment from faecal pollution than to undertake expensive measures to reduce pollution that has already taken place.

The approach to the sanitation challenge should therefore be ecologically sustainable, i.e. concerned with the protection of the environment. This means that sanitation systems should neither pollute ecosystems nor deplete scarce resources. **Simpson-Hébert (1997) [29].**

In many urban centers, the poorest groups face the most serious environmental hazards and are least able to avoid them or receive treatment to limit their health impact **Wall (1997)[32].** By early this century, more than half of the world's population is expected to be living in urban areas. By the year 2025, this urban population could rise to 60 %, comprising some 5 billion people. The rapid urban population growth is putting

severe strains on the water supply and sanitation services in most major conurbations, especially those in developing countries **Mara, D D, Ed (1996) [23].** In Africa today, over half the population is without access to safe drinking water and two-thirds lacks a sanitary means of excreta disposal. It is a situation in which the poor are adversely affected to a disproportionate degree **WSSCC (1998) [37]** (Water Supply and Sanitation Collaborative Council Working Group on Promotion of Sanitation (World Health Organization, Geneva).

Esrey and Andersson (1999) [15] Western sanitation solutions were designed and built on the twin premises that human excreta are waste products suitable only for disposal, and that the environment is capable of assimilating the waste. Times have changed and these premises are outdated. Current sanitation interventions contribute, either directly or indirectly, to many of the problems faced by society today.

Although conventional sewage systems transport excreta away from the toilet user, they fail to contain and sanities, instead releasing pathogens and nutrients into the downstream environment. This is considered the "linear pathogen flow" **Esrey et al (1998) [16].**

GTZ (2002) [18] Closed-loop wastewater management and sanitation helps restore the remarkable natural balance between the quantity of nutrients excreted by people each year and the quantity required to produce their food. Ideally, ecosan systems enable the almost complete recovery of all nutrients and trace elements from household wastewater and their reuse in agriculture. They help preserve soil fertility and safeguard long-term food security.

2.2.3 Ecosan Defined EcoSanRes (2003) [13].

Ecological sanitation can be viewed as a three-step process: containment, sanitization and recycling of human excreta. The objective is to protect human health and the environment while reducing the use of water in sanitation systems and recycling nutrients to help reduce the need for artificial fertilizers in agriculture. Ecosan represents a conceptual shift in the relationship between people and the environment, and is built on the necessary link between people and soil Figure 2.1.

Ecosan systems are designed around true containment of pathogens and provide two ways to render human excreta innocuous: dehydration and decomposition. The

preferred method will depend on climate, groundwater tables, amount of space and intended purpose for the sanitized excreta.

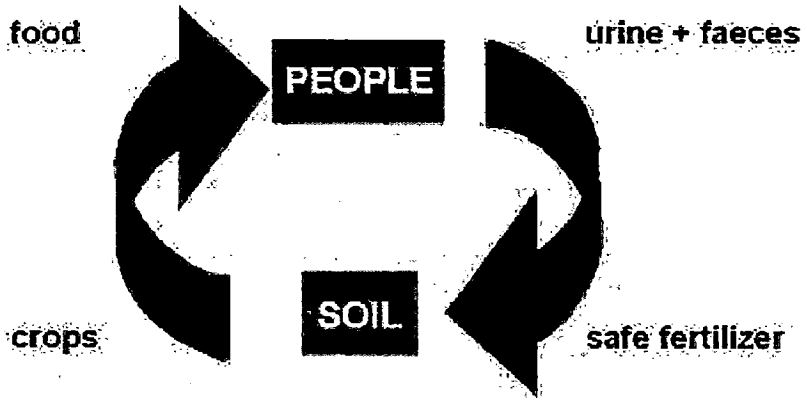


Figure 2.1: The concept of ecological sanitation EcoSanRes (2003)[13].

Soil composting toilets make use of the process of decomposition, a biological process carried out by bacteria, worms and other organisms to break down organic substances. In a composting environment, the competition between organisms for available carbon and nutrients continues until the pathogens are defeated by dominant soil bacteria.

Soil-composting toilets are constructed using shallow vaults where soil and ash are added after each use. The vaults are used alternately and, once sanitised and composted, the contents are removed and used in agriculture.

The ecological sanitation approach can be broadened to cover all organic material generated in households (kitchen and food wastes). If these organic materials are sorted within the home, rather than mixed with solid waste and dumped, they become valuable recyclable materials once composted. Greywater can be treated using biological systems such as evapotranspiration beds and constructed wetlands, an rainwater harvesting can be implemented to harness water for personal hygiene and irrigation. Figure 2.2 illustrates all the options in a fully functional ecosan household.

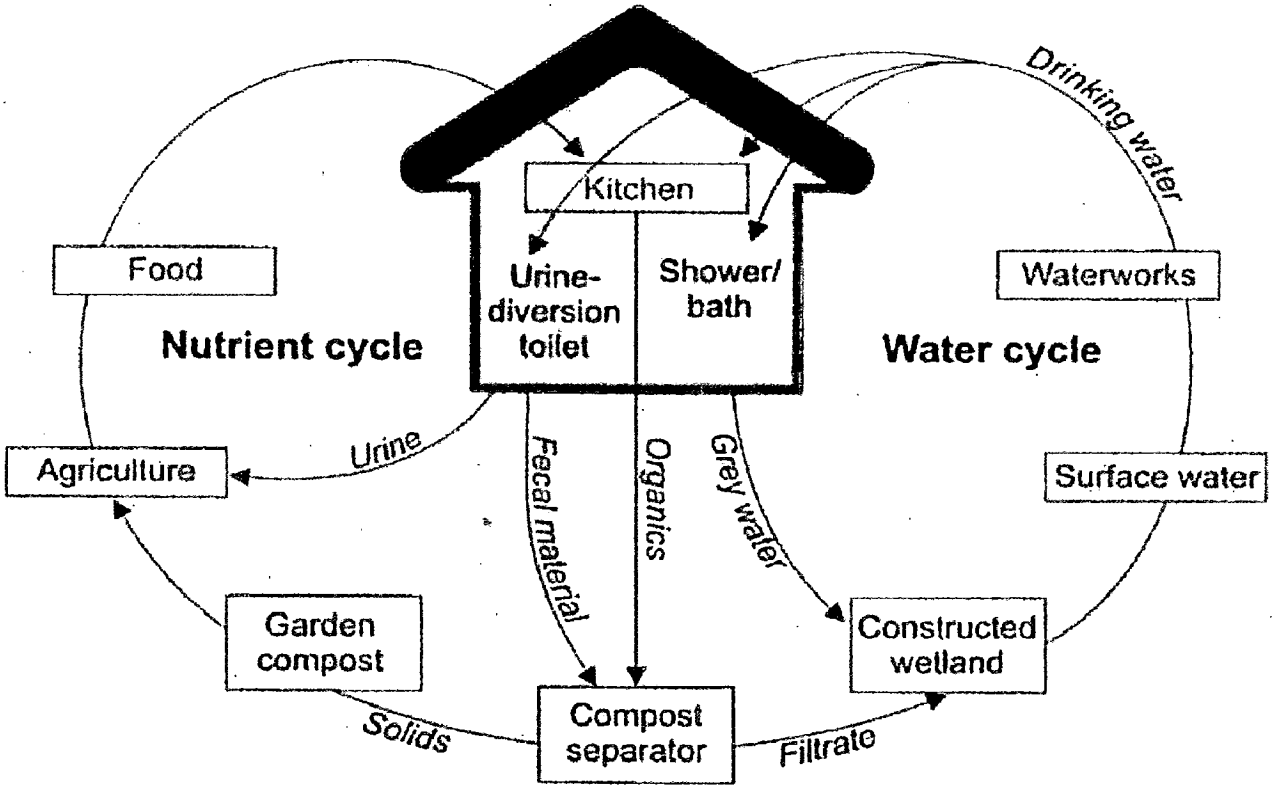


Figure 2.2: Complete household ecosan
(M. Oldenburg (Otterwasser) quoted in EcoSanRes 2003)[13]

2.3 SOLID WASTE

2.3.1 Characteristics of Municipal Solid Waste

Sample of city refuse from 33 Indian cities were collected in all the three seasons and analyzed by **Bhide et al. (1975) [5]**, both physically and chemically.

A). Physical Characteristics

The results of the physical analysis carried out by **Bbide et al. (1975)[5]** gives the value of various ingredients on the wet-weight basis . The plastic and the glass contents show a clear tendency of increase with the population. A higher population of the town is normally accompanied in India by an upward increase in standard of living; which is represented by any increase in the plastics and glass contents of the refuse. However, in both the cases the quantities do not exceed 1%. and the paper content, in general shows an increase in the value as the population of the town increases. The higher paper content in the larger towns should. also the amount of reclamation of compostable matter from the solid waste is not so much as in the case of smaller towns. The compostable matter

however, varies within a small range i.e. between 33 and 42%. The high organic content clearly. And necessitates a more frequent collection and removal of refuse from the collection point and also shows composting as a suitable method of its further utilization. The ash and fine earth contents show an opposite trend i.e. decrease in value with increase in population.

B). Chemical Characteristics

Information on the chemical composition of the components that constitute municipal solid waste is important in involving alterative processing and recovery options. According to **Bhide et al, (1975)[5]** in a large majority of the samples collected, the Organic content was found to be between 10 and 30% **[5]**. No specific trend could be observed in organic content values when grouped according to the population categories.

In large percentage of the samples the NPK values in the decomposable fraction of refuge ranged from 0.4 to 0.6%, 0.3 to 0.7% and 0.3 to 0.8% respectively. However, no specific trend could be observed in these values when placed in different population categories.

2.3.2 Density of Refuse

The density of refuse is mainly affected by its constitutes. A high organic content results in low density while a high inorganic content gives a high density. In most of the cities studied, densities much higher than those recorded in developed countries were recorded by **Bhide et al. (1975) [6]** mainly due to the corresponding high inorganic content. This was mainly due to inclusion of the street sweeping in the city refuse in India. In many of the cities proper dustbins are not provided with the result that the city refuse gets mixed up with dust and earthy matter. The higher density values also clearly indicate that compaction type of refuse transport vehicle may not find such a common application in India.

Density values in 85% of the samples ranged between 330 to 560 kg/m^3. The maximum value recorded was 685 kg/m^3while the minimum value recorded was 271 kg/m^3. Maximum density values were always recorded in rainy season essentially due to the high moisture content.

2.3.3 Quantity of Refuse

It is rather difficult to obtain an exact idea of the amount of refuse produced in a city due to salvage of reusable components at the source and the inefficient collection. All of the waste produced does not reach the disposal site. Hence, it is generally possible to measure only the quantities reaching the disposal site. These were accurately measured by weighing the trucks by . **Suess, Micheal J. Ed. 1985 [31]**. The total amount was divided by the contributing population to get the per capita value.

The maximum per capita value of 0.481 kg/day was recorded in a city, which employed private contractors who were paid on trip basis and hence to maximize earnings did larger number of trips. The lowest per capita value of 0.066 kg/day was noted in a city in which farmers from surrounding areas were observed to come early in the morning, collect and take away the refuse leaving very little for municipal agency to collect. Out of the 33 cities studied, 20 cities recorded per capita values ranging between 0.15-0.35 kg/day. Values above 0.35 kg/day and below 0.15 kg/day were rarely observed. The per capita values in the 6 cities having population exceeding 1 million, studied in this project, ranged between 0.21 to 0.32 kg/day.

Although a comfortable standard of living does not have to necessarily produce a high volume of solid waste. There does seem to be some relationship between affluence and waste generation. It can be suggested that developing countries have much smaller solid waste generation when compared to developed countries.

However, it IS not possible to give a general value of solid waste production rate in the absence of reliable data particularly in Indian context where the data collected from different sources have been found to vary up to the extent of 200% **Bhattacharya (1997) [4]** complied the total municipal waste produced in some of the major cities of India and abroad for the comparison .

Singh (1991)[30] complied per person per day solid waste generation rate for the period between 1971 to 1973 for different Indian Cities of varying Population and location.

An average based on data of 40 Indian cities was found to be 0.27kg/person/day. Solid waste generation rates observed in the cities of some of the neighbouring countries were also collected and complied by **Singh (1991)[30]** while a comparison of average solid waste generation rates for different countries could be made from. Large variation in data is apparent. One can conclude that for a particular situation, it is advisable to

make assessment of solid waste generated rate rather than adopting any of the reported values.

2.4 BIOMEDICAL WASTES

2.4.1 Hospital Waste Management

The actual biomedical waste management situation in the democratic developing country like India is grim. **Lakshmi (2003) [21]** , in the leading national newspaper of the country, reports that even though there are Rules stipulating the method of safe disposal of Bio-medical Waste (BMW), hospital waste generated by Government Hospitals is still largely being dumped in the open, waiting to be collected along with general waste. Health-care waste management in India is receiving greater attention due to recent regulations (the Biomedical Wastes Management & Handling) Rules, 1998). Hospitals are health institutions providing patient care services. It is the duty of hospitals and health care establishments to look after the public health. This may directly be through patient care or indirectly by ensuring a clean, healthy environment for their employees and the community. In the process of health care, waste is generated which usually includes sharps, human tissues or body parts and other infectious materials **(Baveja et al., 2000) [3]**, also referred to as "Hospital Solid Waste" and "Bio-medical Solid Waste" **(Manohar et al., 1998) [22]**.

The prevailing situation is analysed covering various issues like quantities and proportion of different constituents of wastes, handling, treatment and disposal methods in various health-care units (HCUs). The waste generation rate ranges between 0.5 and 2.0kg /bed/day. It is estimated that annually about 0.33 million tonnes of waste are generated in India **(Patil and Shekdar 2001) [25]**.

Patil.and Pokhrel (2004) [26] studied:

(i) to assess the waste handling and treatment system of hospital bio-medical solid waste and its mandatory compliance with Regulatory Notifications for Bio-medical Waste (Management and Handling) Rules, 1998, under the Environment (Protection Act 1986), Ministry of Environment and Forestry, Govt. of India, at the chosen KLE Society's J. N. Hospital and Medical Research Center, Belgaum, India and

(ii) to quantitatively estimate the amount of non-infectious and infectious waste generated in different wards/sections.

During the study, it was observed that:

(i) The personnel working under the occupier (who has control over the institution to take all steps to ensure biomedical waste is handled without any adverse effects to human health and the environment) were trained to take adequate precautionary measures in handling these bio-hazardous waste materials,

(ii) The process of segregation, collection, transport, storage and final disposal of infectious waste was done in compliance with the Standard Procedures,

(iii) The final disposal was by incineration in accordance to EPA Rules 1998,

(iv) The non-infectious waste was collected separately in different containers and treated as general waste, and

(v) on an average about 520 kg of non-infectious and 101 kg of infectious waste is generated per day (about 2.31 kg per day per bed, gross weight comprising both infectious and noninfectious waste). This hospital also extends its facility to the neighboring clinics and hospitals by treating their produced waste for incineration.

2.4.2 Hazards Of Health-Care Waste Management

Baveja et ai, (2000) [3] conducted a study for the municipalities for the Chennai and Bangalore; it was observed that while hospital waste was considered as a key problem by the municipalities, the staff was unaware of the application and implications of various hospital waste treatment technologies like incineration. It identified the need for installing appropriate hospital waste management systems, under non- training interventions. At present, there is no specific system ensuring separation of infectious and non-infectious waste at source. This results in mixing of infectious wastes with others which are normally disposed of along with municipal waste leading to various types of hazards **Patil and Pokhrel (2004)[26] .**

CHAPTER- 3

PRESENT STATUS OF AREA UNDER STUDY

3.1 AREA UNDER STUDY

3.1.1 General

Roorkee is a small town located in the foothills of Himalayas in the beautiful state of Uttranchal in north India. It is a part of the district of Haridwar which is merely 30 km distant away. It is about 175 kilometers north of the Indian capital, New Delhi and located between the rivers Ganga and Yamuna on the banks of the upper Ganga Canal. It is situated on National Highway NH.58 (Delhi-Haridwar) as well as on NH.73 (Haridwar-Panchkula) and is on Amristar-Howrah main rail route.

As of 2011 India census, Roorkee had a population of 116,809 Males constituted 54% of the population and females 46%. With a population of about 116,809 inhabitants, it is the third largest Municipal Council in the state of Uttarakhand, after Haridwar & Haldwani. Languages spoken are Hindi, Urdu and Punjabi.

3.1.2 History, Culture and Tourism Of The Town

Roorkee derives its name from Ruri, the wife of a Bargujar Rajput chieftain, and earlier it was even spelled as 'ruri ki'. Vernacular belief amongst villagers around Roorkee is that it got its name from "Roron ki" i.e a dwelling of Rors.

The Ganga Canal flowing through Roorkee was the brainchild of Sir Proby Cautley. Its construction began in 1840, and the canal was opened by Governor-General Lord Dalhousie in April 1854. Before 1840s, when the work on the Ganga Canal began under the aegis of Proby Cautley, according to an officer in British Army, Roorkee was a mere mud built village on the banks of the hill torrent, named Solani. Digging work on the Upper Ganga Canal formally began in April 1842, and soon this village started developing into a city. The canal was formally opened in April 8, 1854, irrigating over 767,000 acres (3,100 Sq.Km) in 5,000 villages.

Roorkee was the capital of a Moghul Mahal (similar to a present day Pargana) during the time of Akbar, as is referred in Ain-e-Akbari, authored by Abul Fazal. During the 18th century, it came under the rule of Landhaura state, till the death of its Bargujar king, Raja Ramdaval Dev in 1813 and later became a part of the territories of the British East India Company.

The municipality of Roorkee was created in 1868, when it was already home to the Bengal Sappers and Miners since 1853, and two artillery units were stationed here. Today, the Roorkee Cantonment has a large army base with headquarters for Bengal Engineering Group and Centre (BEG&C), also known as Bengal Sappers, established in 1803. Later in 1901, when the city had a population of 17,197, it was made headquarters of the Roorkee Tehsil, in Saharanpur district of the United Province of the British Raj; the tehsil included in it 426 villages (of the parganas of Jwalapur, Manglaur and Bhagwanpur) and six towns, most important among them being Haridwar and Manglaur. The Old Cemetery in the city is today a protected monument, by Archaeological Survey of India. Roorkee is also famous for the shrine of 13th century, Sufi saint Alauddin Sabir Kaliyari - the dargah is also known as Sarkar Sabir Pak – situated.

3.1.3 Geographical Location

Roorkee town is located at 29.87° North Latitude 77.88° East Longitude. It has an average elevation of 268 meters (879 feet). It is situated on National Highway NH.58 (Delhi-Haridwar) and NH.73 (Haridwar-Panchkula), and is on Amristar-Howrah main rail route. Roorkee is 175 km north of the Indian capital New Delhi and about 70 km from Dehradun the provisional capital of Uttarakhand and located between the rivers Ganga and Yamuna, close to the foot hills of Himalayas. The location of Roorkee is shown in Figure 3.1 and the town map shown in Figure 3.2.

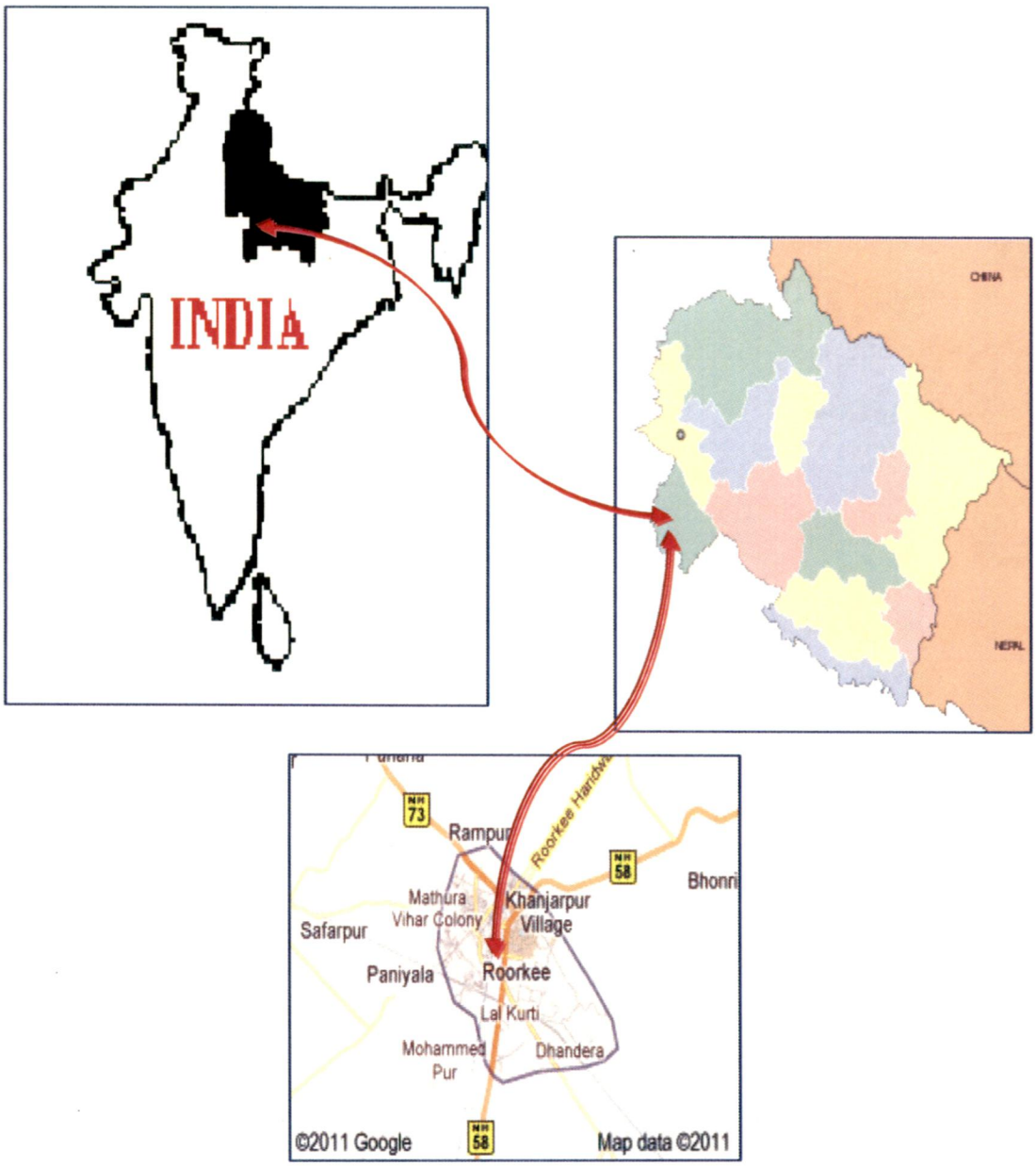


Figure 3.1 : Location of Roorkee

3.1.4 Climate[8]

1). District Haridwar moderate subtropical to humid climate with three distinct seasons viz. summer followed by rainy and winter seasons. Temperature begins to rise from March (29.10°C) and reaches to its maximum in May (39.20°C), with the commencement of monsoon season by mid-June, the temperature begins to fall. During the winter season in the month of November to February the temperature ranges between 10.50°C and 6.10°C.

2). The relative humidity is highest in monsoon season (85% in the morning and 79% in the evening). The lowest humidity is observed during the month of April and May i.e. 24% (in evening) and 40% in May (in morning).

3). The average normal annual rainfall in Hardwar district is 1174.3 mm, out of which 84% is received during monsoon season and only 16% occurs during non-monsoon period. The district receives heaviest rainfall in northern part. The rainfall gradually decreases towards south. To study the recent trend of rainfall distribution over the district, monthly rainfall during monsoon has been given in Table 3.1. The monthly distribution of rainfall during the monsoon season over the district shows that July and August are the wettest month in the district having a rainfall 329.3mm and 393.8 mm, respectively. The rainfall during the month of July and August is more or less the same. The monsoons retreat in the first fortnight of October giving a meager rainfall of about 31mm to 34 mm. Maximum rainfall occurs in the foothills of Himalayas and gradually decreases towards south.

Table 3.1: Monthly and annual normal rainfall in district Haridwar (mm)

Month	Rainfall in (mm)	
	Haridwar	Roorkee
January	48.1	43.3
February	45.8	41.1
March	24.5	26.9
April	9.8	11.4
May	19.9	18.9
June	108.9	99
July	360.1	329.3
August	393.8	299.3
September	192.2	182
October	34.3	31.5
November	5.4	4.7
December	15.4	14.9
Annual rainfall	**1256.2**	**1102**

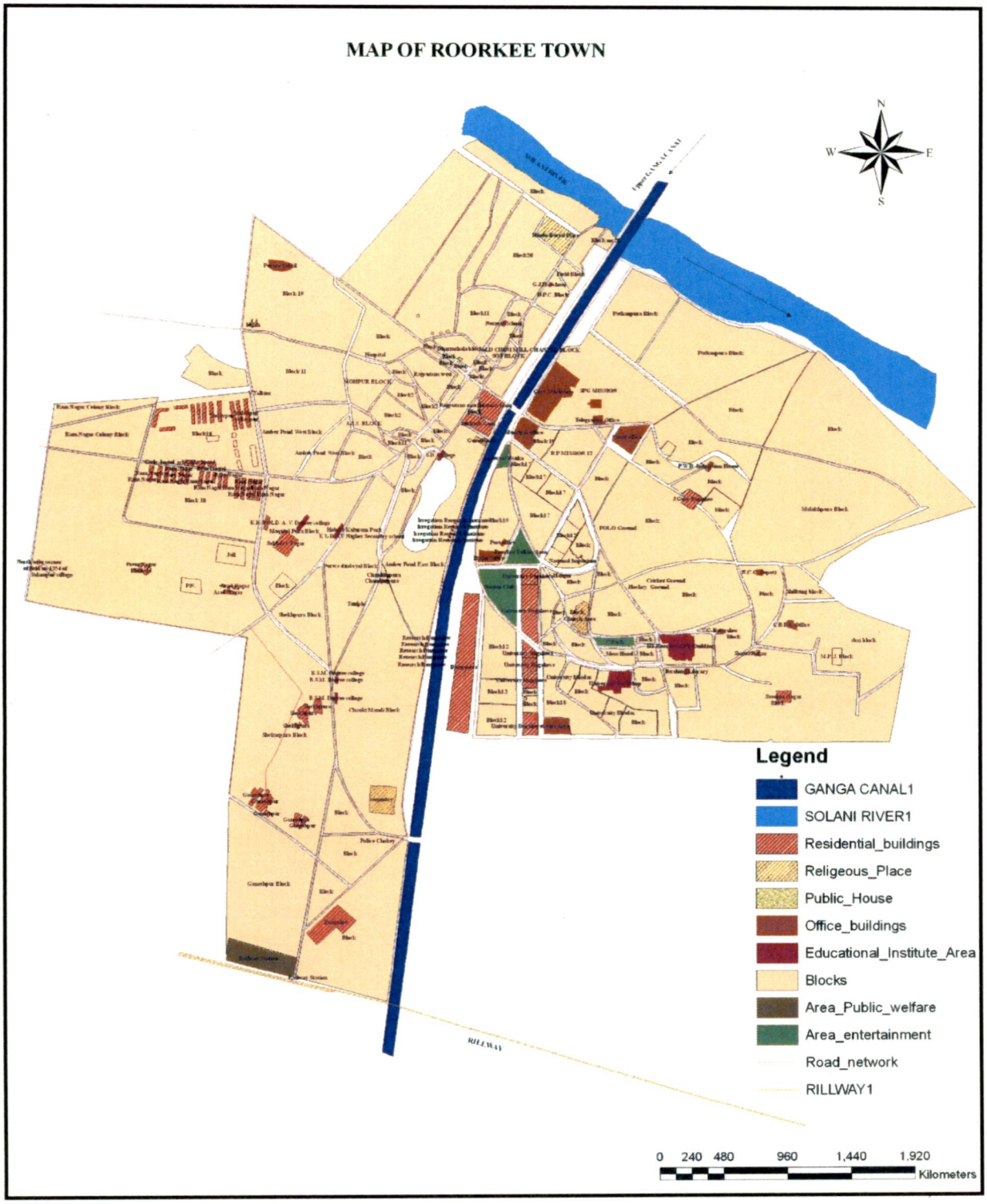


Figure 3.2 : Map of Roorkee town

3.1.5 Topography[8]

1). The town has a gently sloping topography, with slope from south to north towards River Solani, However the Ganga Canal slopes towards the southwest. The difference in the highest and lowest ground level of the town is of the order of 18.5 meters. Depth of Subsoil water in this area varies from 6.0 meters to 10.0 meters, with average depth of 8.0 meters. The town lies in the Tarai belt and has tropical climate.

2). Geologically the area may be divided into three zones viz. Siwaliks, Bhabar and Gangetic Alluvial Plains from North to South. Siwalik Range This forms the outermost part of Himalaya and comprise Tertiary Group of rocks. In Bhagwanpur block only Upper and Middle Siwaliks are exposed. The Upper Siwaliks is constituted of boulders, pebbles, sand and clay. The boulders and pebbles are mostly of quartzites. Middle Siwaliks comprises mainly grey micaceous sandstone and siltstone. also Older Alluvium (Piedmont Plains or Bhabar). The Piedmont Plains are formed along the foothills of Siwaliks. It is formed by flooding hill torrents and nallahs (locally termed as 'Rao'). Alluvial fans in the piedmont zones are wider and longer when formed along mature streams. The Older Alluvium consist of polycyclic sequence of brown to grey silt, clay with boulders and pebbles, and Gangetic Alluvial Plains. The region south of the piedmont plains occupied by Gangetic Alluvial Plains, forms major part of the Bhagwanpur block. Lithologically, the alluvium is formed of unconsolidated to semi-consolidated deposits of sand, silt, clay and kankar.

3). Due to the fragile eco-system and geo-dynamic terrain, Uttarakhand State is highly vulnerable to natural disasters like earthquakes, landslides, forest fires, and cloud burst etc. According to hazard zoning in the Vulnerability Atlas of India, the whole of Uttarakhand falls under "very high" to "high" category earthquake zone. The problems of landslides, subsidence, and erosion are quite common in the hilly regions of the State due to combination of several factors like geological movements, structure, lithology, water seepage, soil cover, vegetal cover, weather, and climatic changes.

3.1.6 Economic Development [19]

Located close to the national capital Delhi and Haridwar and with its salubrious climate and natural beauty, Roorkee is an educational and institutional centre. Roorkee finds its importance by being the host of many prominent institutions and organizations. The city has contributed to the national development by producing the finest quality engineers from the renowned University of Roorkee, now called the Indian Institute of Technology, Roorkee. It is also the home of various government research institutes as Central Building Research Institute (CBRI), Irrigation Research Institute (IRI) and the National Institute of Hydrology (NIH). It also has an army base of Bengal Engineering Group & Centre (BEG&C).

Commercial and Industrial Growth

1). **Commercial growth**

The first permanent market called Main Bazaar was built in 1830. This was constructed by the material left over from the building of Ganges Canal (Nevill 1921). Main Bazaar has two chowks (squares). After the establishment of railway station in 1880, the growth of the market extended along the station road connecting the Anaj Mandi (grain market) and the railway station. In 1947 the Amber Talab area shops and the subzimandi came into existence. A few shops were also constructed along the right bank of the canal for the rehabilitation of refugees.

2). **Industrial development**

The establishment of Government Workshop in 1843. Heralded industrial development in Roorkee. With the initiation of Thomason College of Civil Engineering In 1847 several new industries came in existence for manufacturing surveying, drawing and mathematical instruments. Independence has inspired a quantum leap in the industrialization of Roorkee. A 'Quality Marketing Scheme' was introduced in 1954 to ensure adequate quality of the products. An industrial estate was set up in 1965 on a 10 acre near Rarnnagar colony. By 1967 the estate had been fully developed and occupied.

Manufacture of drawing. Surveying and mathematical instruments forms the most prominent of the industrial activity of Roorkee but is slowly giving way 10 units manufacturing electronic microprocessor-based instruments.

3.1.7 Health, Recreational Facilities

The first official medical facility in Roorkee was established In 1850 in the form of Ganges canal Dispensary. University Hospital and CBRI's Employee's State Insurance Dispensary were established Figure 3.3.

During the last decade (1980-1990) there has been substantial qualitative well as quantitative improvement in health care larger number of doctors. encompassing broader spectrum of medical disciplines are now available The Civil Hospital has been shifted to a new building and renamed Jagdish Narayan Sinha Civil Hospital. The number of medical practitioners of all levels nursing homes. And maternity centers have also increased considerably Table 3.2.

In its efforts towards maintaining a healthy environment .Municipal Board has been regularly conducting sanitation programs. The Municipal Board has also been organizing camps for administering vaccines for various diseases. During 1988 and 98 the vaccines administered against Cholera were 777. 1956 and 69 respectively and against BCG 442.283 and 337 respectively. No death was recorded due to these diseases (MB 1990).

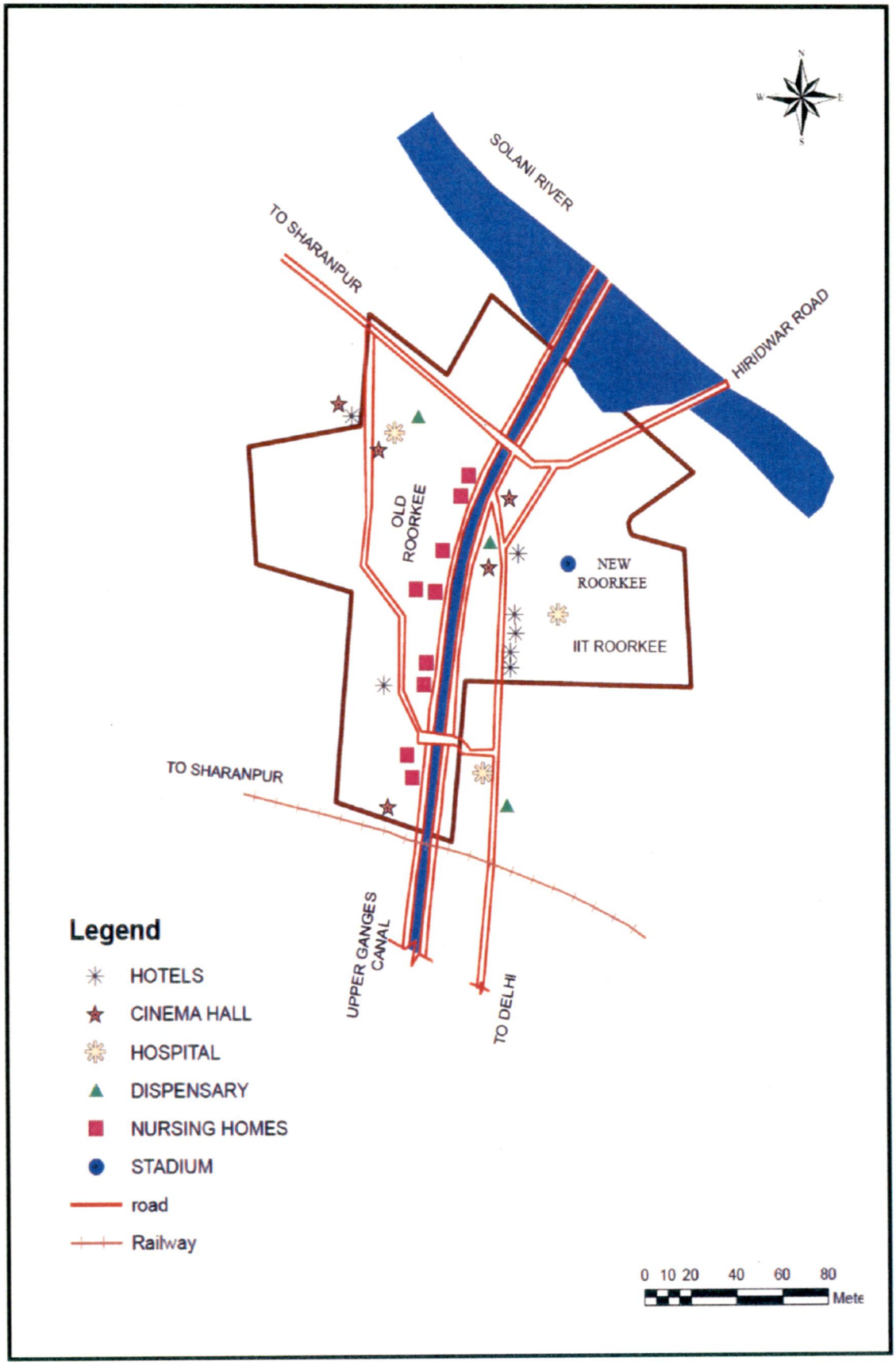


Figure 3.3:- Health and recreational facilities in Roorkee

Table 3.2: Existing medical facilities in Roorkee

S.No	MEDICAL FACILITES	NO
1.	Doctors (MBBS)	61
2.	Doctors (MAMS)	12
3.	Dentist	5
4.	Surgeons	5
5.	Bone specialists	4
6.	Eye specialists	3
7.	ENT surgeon	1
8.	Gynecologists	7
9.	Anesthesiologist	1
10.	Cardiologists	3
11.	Child specialist	6
12.	General physicians	17
13.	Pathologists	4
14.	Radiologists	5
15.	Hospitals	3
16.	Dispensary	2
17.	Nursing homes	14
18.	Beds (Total)	500
19.	Medical stores	35

3.1.8 Education Facilities

Before the foundation of Thomason College of Civil Engineering In 1847. there were only maktabs or paths alas (primary schools) in Roorkee to impart education. In 1851. with the establishment of Tehsil School. Vernacular education was started. This was followed by an Anglo-Vernacular school in 1856. Municipal and mission schools were added in 1871. The first girls' school was started by the Arya Samaj in 1907 (Nevill 1921).

A steady progress has been maintained in providing more avenues of education. As already discussed, the establishment of University of Roorkee as a major engineering university after independence has given a great impetus to post-school education in

Roorkee. The educational institutions functioning at present in Roorkee are enumerated in Table 3.3.

Table 3.3: Institutions of higher education in Roorkee.

S.No	Level	Numbers
1.	University	1
2.	Degree College (Arts/science)	3
3.	Polytechnic	1
4.	Higher Secondary / Intermediate schools	5
5.	Secondary / Matriculation schools	8
6.	Junior Secondary & Middle Schools	12

3.1.9 Infrastructure

1). **Transportation[19]**

Roorkee is located on National Highway NH.58 (Delhi-Haridwar /Dehra Dun-Shri Badrinath-Mana Pass) and NH.73 (Panchkula/Chandigarh-Yamuna Nagar-Roorkee). Roorkee comes under Northern Railway and is well -connected by trains (Shatabdi, Jan-Shatabdi, Mail/Express and Shuttle/Passenger) with a number of important Indian cities including Delhi, Mumbai, Kolkata, Chennai, Ahemedabad, Jaipur, Lucknow, Bhopal, Gwalior, Agra, Ujjain, Indore, Dhanbad, Patna, Jammu, Puri, Amritsar, Dehra Dun etc.

2). **Road network.[24]**

The study area has national highway, Pucca road, Kutcha road, foot path and railway line Figure 3.4. The railway line is passing through Sahipur Salehpur, Dhandera, Roorkee city, Padale Guzar, and Mohanpur Mohammadpur habitations. National highway Delhi-Roorkee-Dehradun and Roorkee-Hardwar are passing through the area and connecting some habitations. All the habitations do not have Pucca roads. From the data, it is evident that road connectivity is essentially required in all the habitations. Some habitations need additional roads while in other habitations existing Kutcha road needs to be converted into Pucca roads.

3). **Power supply[19]**

Hydro power is the main source of energy in Uttarakhand. Uttarakhand Jal Vidyut Nigam Limited (UJVNL) is responsible for power generation and Uttarakhand Power Corporation Limited (UPCL) is responsible for power transmission and distribution in the State. Power is supplied from the central grid by overhead cables carried on metal and concrete poles, mainly located in public areas alongside roads. The power supply is erratic and there are frequent outages in warmer months, and large fluctuations in voltage.

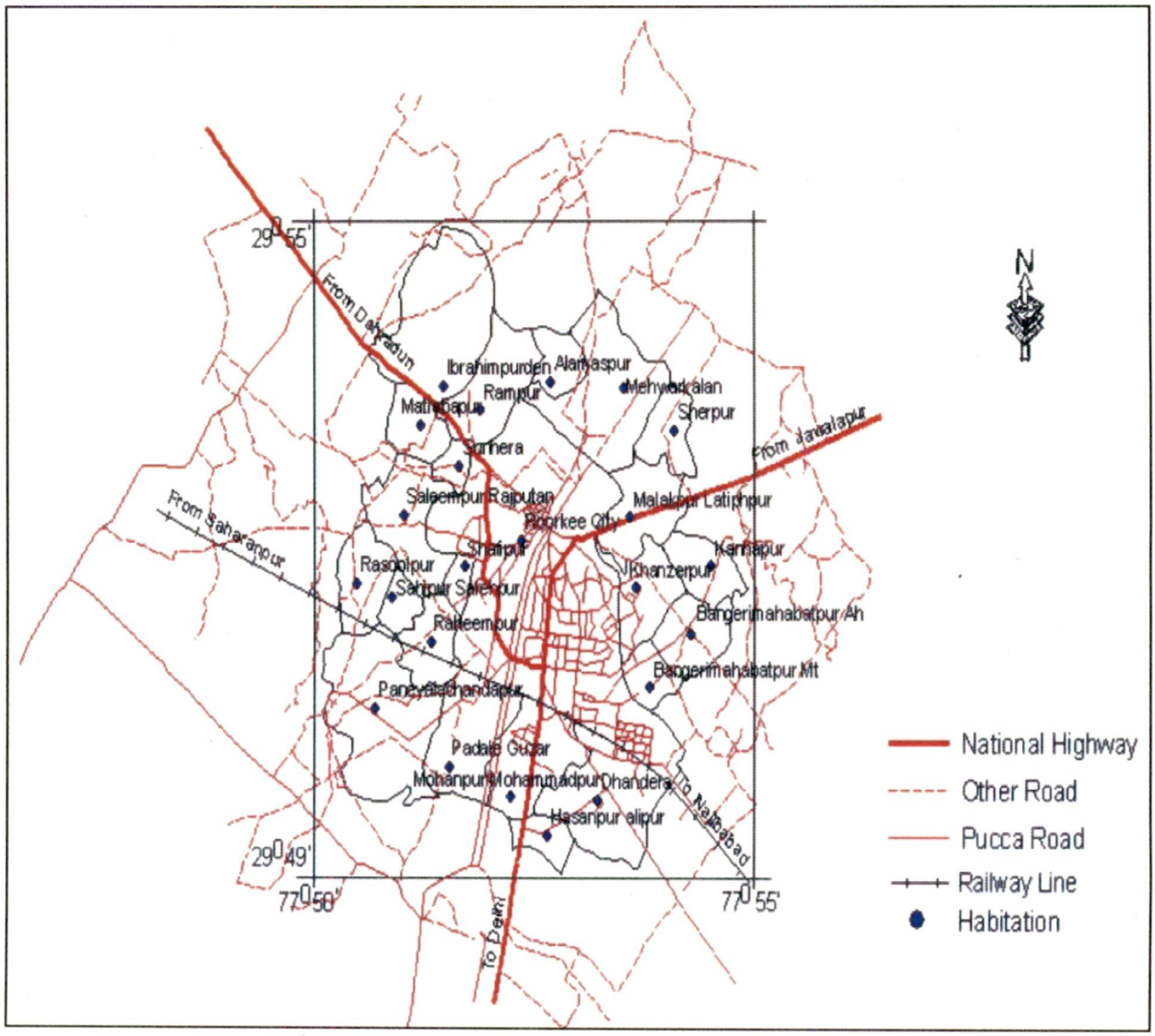


Figure 3.4: Road Network Map in Roorkee [24]

3.2 POPULATION ESTIMATES AND PROJECTIONS

3.2.1 General

In order to come up with sanitation strategies, it is useful to know population at a disaggregate level (sub-ward level), particularly if decentralized (neighborhood level/campus level/etc.) sanitation solutions need to be developed.

3.2.2 Objectives of Projecting Population

In the context of the City Sanitation Plan, population estimation and projection are being carried out with the following objectives:

1). To take informed strategic decisions on provision of sanitation infrastructure and services for the city as a whole and for different parts of the city.

2). In taking strategic decisions, to strive for a reasonable balance between the risks of adequacy and viability in the future.

3.2.3 Population Growth in Roorkee from 1961 to 2011

The population of Roorkee municipality as per 2011census is 1,16,809. In 1961 the population of Roorkee was 33,561 . Population data for the past 10 decades has been collected from government department like Roorkee Municipality and census department.

Though the population is available since 1901, data of only the last six decades were considered in the analysis, as it is felt the urbanization has really started with after independence. The Figure 3.5 shows trends in population growth rate of the Roorkee town. And also the Table 3.4 shows ward-wise details of census-2011 of Roorkee town and Figure 3.6 shown the words of Roorkee town.

Figure 3.5: Trends in population growth rate.

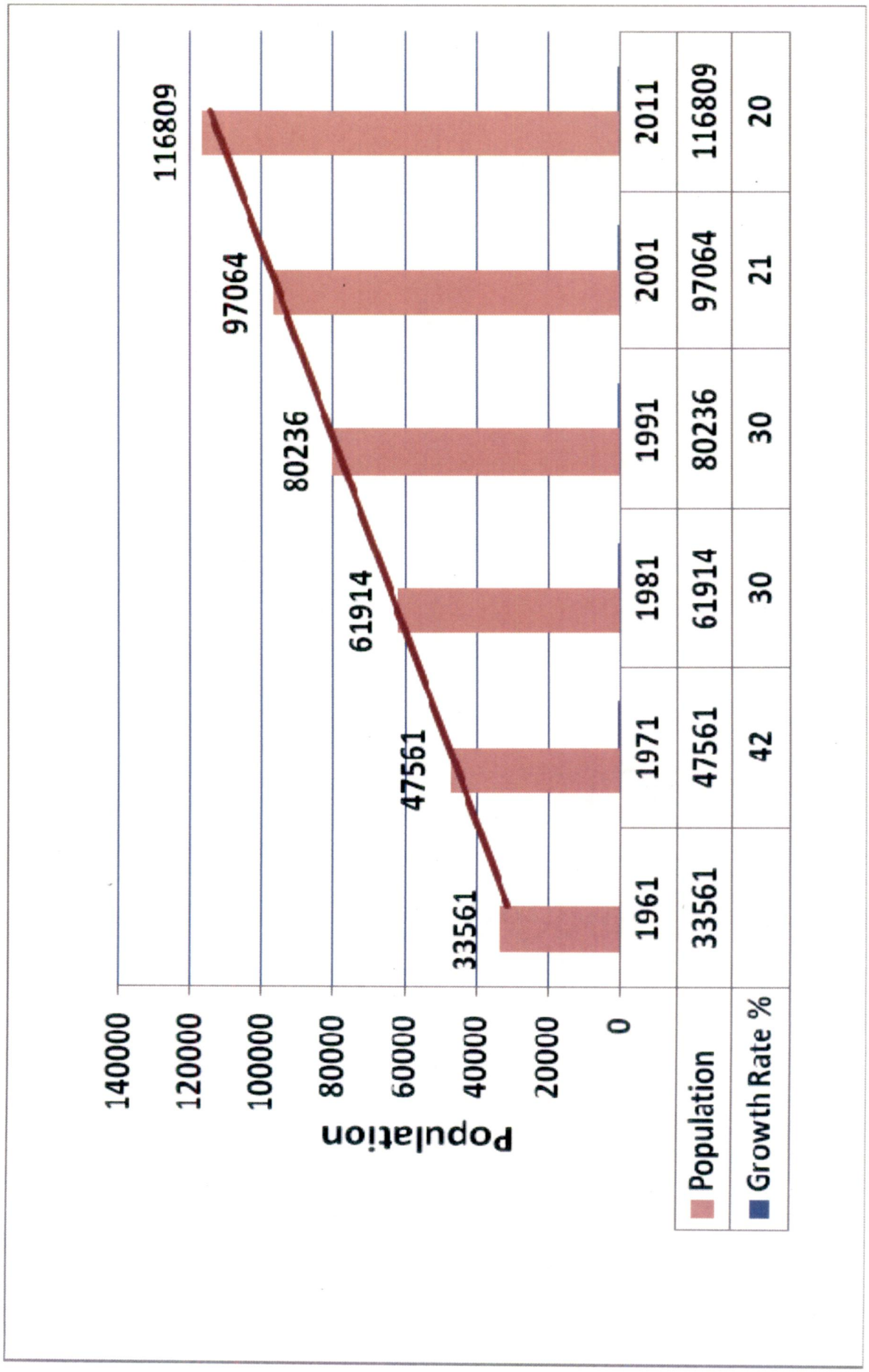


Table 3.4:- : Ward-wise details of census-2011 of Roorkee.[9]

Ward No.	Ward Name	Area of ward (km^2)	Density of population no/km^2	Population 2011		
				Total Person	Male	Female
1	Chau Mandi	0.5014	15652	7848	4095	3753
2	West Ambar Talab (Northern Area)	0.1641	41779	6856	3588	3268
3	Shekhpuri	0.4703	19047	8958	4746	4212
4	Eastern Walli	0.8417	12154	10230	5362	4868
5	Easernt Deen Dyal	0.1502	23009	3456	1765	1691
6	Eastern Amber Talab	0.1255	38781	4867	2528	2339
7	I.I.T Roorkee	1.0239	8997	9212	6499	2713
8	C.B.R.I	0.7545	4689	3538	1814	1724
9	Sot	0.2348	16623	3903	2102	1801
10	Civil Lines (Northern Area)	0.9998	10149	10147	5307	4840
11	West Ambar Talab (Western Area)	0.2807	11493	3226	1660	1566
12	Civil Lines (Southern Area)	0.4831	7328	3540	1832	1708
13	West Ambar Talab (Middle Area)	0.2352	21437	5042	2567	2475
14	Civil Lines (Middle Area)	0.342	8070	2760	1438	1322
15	Ram Nagar (Southern Area)	0.3175	14775	4691	2585	2106
16	Mahigran	0.3217	32717	10525	5459	5066
17	Rajputana West	0.1622	20536	3331	1729	1602
18	Ram Nagar (Northern Area)	0.2332	15669	3654	1864	1790
19	Old Tehsil	0.2894	20007	5790	3013	2777
20	Satti Mohalla	0.211	24810	5235	2749	2486
	Total	**8.1422**		**116809**	**62702**	**54107**

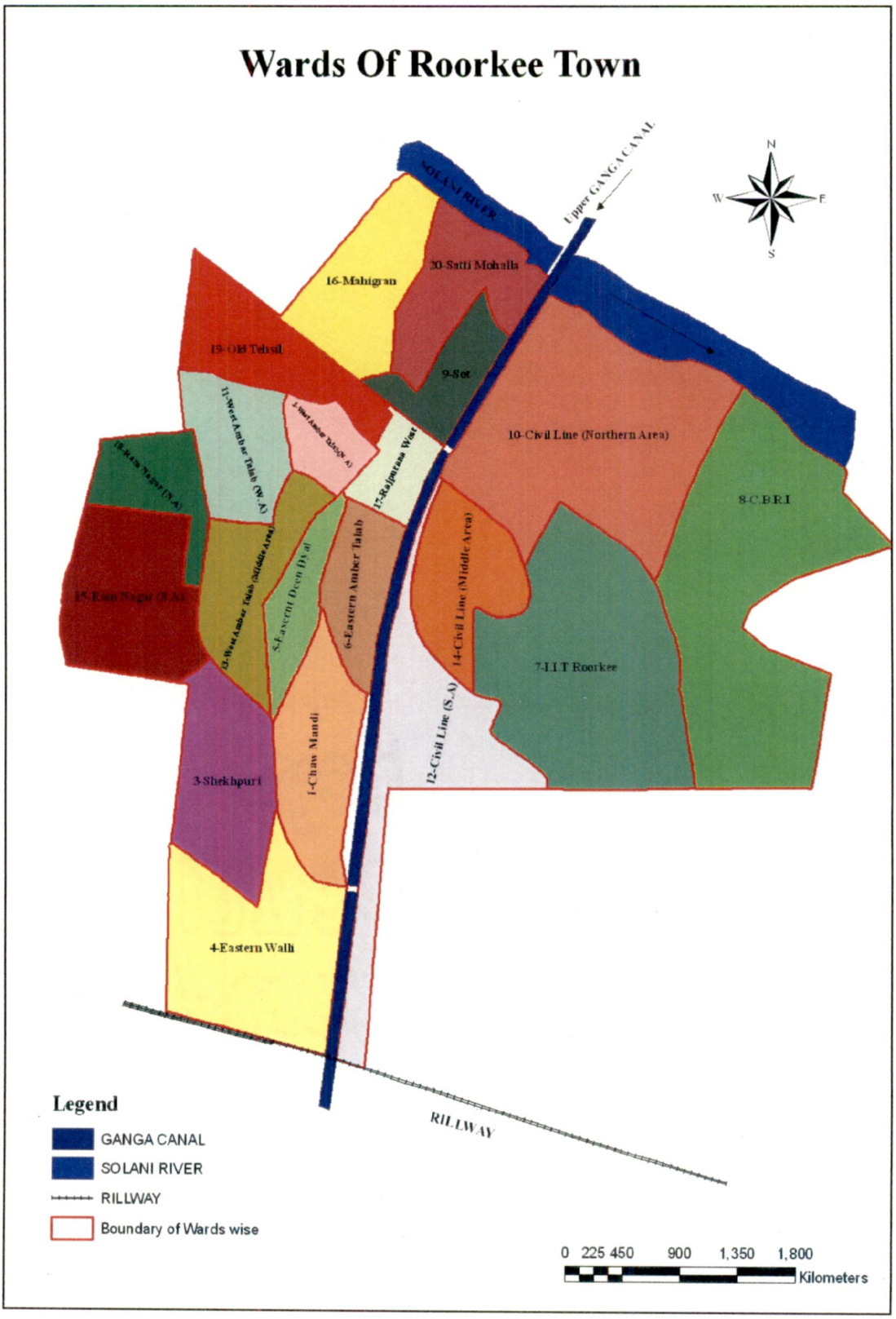


Figure 3.6: Wards of Roorkee.

3.2.4 Design Periods

Based on the "Guidelines for Preparation of Project Reports under National River Conservation Plan and National Ganga River Basin Authority" prepared by the Alternate Hydro Energy Centre, IIT Roorkee. sewerage scheme involves the laying of underground sewer pipes and construction of costly treatment units. which cannot be replaced or increased in their capacities easily or conveniently at a later date. In order to avoid such complications, the future expansions of the city and consequent increase in the sewage quantity should be forecasted to serve the community satisfactorily for a reasonable years. As well as on the solid waste plan for Roorkee city.

The Table 3.5 shows the design period for each item that was on the basis of determining the duration of the scheme.

Table 3.5:- Design periods.[1]

S.No	Component	Design Period (years)	Year
Sewerage Schemes			
1	Sewerage Network and Pumping stations Civil Works and land acquisition for STP	30	2041
2	Pumps and Machineries	15	2026
3	STP	10	2021
Solid Waste Management			
4	Short-term plan	5	2016
5	Medium-term plan	15	2026
6	Long-term plan	30	2041

3.2.5 Population Projection For 2016 to 2041.

The population for 2016 was projected from the Census figures for the period 1961 to 2011 using standard statistical methods mentioned in Table 3.6. The results are tabulated below.

Table 3.6:- Population projection by statistical methods.

No.	Year	Arithmetic Increase Method	Incremental Increase Method	Geometrical Increase Method	Line of Best fit	Semi log method
1	2016	125134	125673	129775	140120	125200
2	2021	133459	134895	144181	158489	133500
3	2026	141784	144477	160186	179267	141800
4	2041	166759	175375	219670	259418	166800

3.2.6 Projections Of Water Demand and Sewage Generation and Solid Waste

As per recommendations of Section 2.2.8.3 of the CPHEEO Manual, ward level water demand and sewage generation has been projected considering 150 lpcd for residential and non-residential requirements. This figure includes retail, non-domestic consumption such as commercial development, but does not include non-residential bulk consumers like large-scale industries, industrial estates, large institutions, etc. It also doesn't include UFW (Unaccounted For Water). It is assumed that end of pipe consumption is 135 lpcd plus 15% loss. Eighty percent of this quantity is taken as sewage generation Plus two percent of infiltration . The actual rate of generation of solid waste has been taken at 385 grams/capita/day.

Table 3.7: Summary of projected city level infrastructure demand.

Year	2016	2021	2026	2041
Population	125134	133459	141784	166759
Water Demand at Consumer End (MLD)	19.43	20.72	22.01	25.89
Sewage Generation (MLD)	15.93	16.99	18.05	21.23
Solid Waste Generation (Metric Tone)	48.18	51.38	54.59	64.20

Table 3.8:- Projected ward level infrastructure demand for 2016

Ward No.	Ward Name	2016			
		Population	Water Demand (MLD)	Sewage Generation (MLD)	Solid Waste Generation (Metric Tonne)
1	Chaw Mandi	8408	1.31	1.07	3.24
2	West Ambar Talab (Northern Area)	7345	1.14	0.94	2.83
3	Shekhpuri	9596	1.49	1.22	3.69
4	Eastern Walli	10959	1.70	1.40	4.22
5	Easernt Deen Dyal	3703	0.57	0.47	1.43
6	Eastern Amber Talab	5214	0.81	0.66	2.01
7	I.I.T Roorkee	9868	1.53	1.26	3.80
8	C.B.R.I	3790	0.59	0.48	1.46
9	Sot	4182	0.65	0.53	1.61
10	Civil Line (Northern Area)	10871	1.69	1.38	4.19
11	West Ambar Talab (Western Area)	3456	0.54	0.44	1.33
12	Civil Line (Southern Area)	3792	0.59	0.48	1.46
13	West Ambar Talab (Middle Area)	5402	0.84	0.69	2.08
14	Civil Line (Middle Area)	2957	0.46	0.38	1.14
15	Ram Nagar (Southern Area)	5025	0.78	0.64	1.93
16	Mahigran	11275	1.75	1.44	4.34
17	Rajputana West	3569	0.55	0.45	1.37
18	Ram Nagar (Northern Area)	3914	0.61	0.50	1.51
19	Old Tehsil	6202	0.96	0.79	2.39
20	Satti Mohalla	5608	0.87	0.71	2.16
TOTAL		**125134**	**19.43**	**15.93**	**48.18**

Table 3.9:- Projected ward level infrastructure demand for 2021

Ward No.	Ward Name	2021			
		Population	Water Demand (MLD)	Sewage Generation (MLD)	Solid Waste Generation (Metric Tonne)
1	Chaw Mandi	8967	1.39	1.14	3.45
2	West Ambar Talab (Northern Area)	7833	1.22	1.00	3.02
3	Shekhpuri	10235	1.59	1.30	3.94
4	Eastern Walli	11689	1.81	1.49	4.50
5	Easernt Deen Dyal	3949	0.61	0.50	1.52
6	Eastern Amber Talab	5561	0.86	0.71	2.14
7	I.I.T Roorkee	10525	1.63	1.34	4.05
8	C.B.R.I	4042	0.63	0.51	1.56
9	Sot	4459	0.69	0.57	1.72
10	Civil Line (Northern Area)	11594	1.80	1.48	4.46
11	West Ambar Talab (Western Area)	3686	0.57	0.47	1.42
12	Civil Line (Southern Area)	4044	0.63	0.51	1.56
13	West Ambar Talab (Middle Area)	5760	0.89	0.73	2.22
14	Civil Line (Middle Area)	3153	0.49	0.40	1.21
15	Ram Nagar (Southern Area)	5359	0.83	0.68	2.06
16	Mahigran	12026	1.87	1.53	4.63
17	Rajputana West	3805	0.59	0.48	1.47
18	Ram Nagar (Northern Area)	4175	0.65	0.53	1.61
19	Old Tehsil	6615	1.03	0.84	2.55
20	Satti Mohalla	5982	0.93	0.76	2.30
TOTAL		**133459**	**20.72**	**16.99**	**51.38**

Table 3.10:- Projected ward level infrastructure demand for 2026

Ward No.	Ward Name	2026			
		Population	Water Demand (MLD)	Sewage Generation (MLD)	Solid Waste Generation (Metric Tonne)
1	Chaw Mandi	9527	1.48	1.21	3.67
2	West Ambar Talab (Northern Area)	8322	1.29	1.06	3.20
3	Shekhpuri	10873	1.69	1.38	4.19
4	Eastern Walli	12418	1.93	1.58	4.78
5	Easernt Deen Dyal	4195	0.65	0.53	1.62
6	Eastern Amber Talab	5908	0.92	0.75	2.27
7	I.I.T Roorkee	11181	1.74	1.42	4.30
8	C.B.R.I	4295	0.67	0.55	1.65
9	Sot	4738	0.74	0.60	1.82
10	Civil Line (Northern Area)	12317	1.91	1.57	4.74
11	West Ambar Talab (Western Area)	3916	0.61	0.50	1.51
12	Civil Line (Southern Area)	4297	0.67	0.55	1.65
13	West Ambar Talab (Middle Area)	6120	0.95	0.78	2.36
14	Civil Line (Middle Area)	3350	0.52	0.43	1.29
15	Ram Nagar (Southern Area)	5693	0.88	0.72	2.19
16	Mahigran	12776	1.98	1.63	4.92
17	Rajputana West	4043	0.63	0.51	1.56
18	Ram Nagar (Northern Area)	4435	0.69	0.56	1.71
19	Old Tehsil	7027	1.09	0.89	2.71
20	Satti Mohalla	6355	0.99	0.81	2.45
TOTAL		**141784**	**22.01**	**18.05**	**54.59**

Table 3.11:- Projected ward level infrastructure demand for 2041.

Ward No.	Ward Name	2041			
		Population	Water Demand (MLD)	Sewage Generation (MLD)	Solid Waste Generation (Metric Tonne)
1	Chaw Mandi	11205	1.74	1.43	4.31
2	West Ambar Talab (Northern Area)	9787	1.52	1.25	3.77
3	Shekhpuri	12788	1.99	1.63	4.92
4	Eastern Walli	14606	2.27	1.86	5.62
5	Easernt Deen Dyal	4934	0.77	0.63	1.90
6	Eastern Amber Talab	6948	1.08	0.88	2.68
7	I.I.T Roorkee	13151	2.04	1.67	5.06
8	C.B.R.I	5051	0.78	0.64	1.94
9	Sot	5572	0.87	0.71	2.15
10	Civil Line (Northern Area)	14488	2.25	1.84	5.58
11	West Ambar Talab (Western Area)	4605	0.71	0.59	1.77
12	Civil Line (Southern Area)	5053	0.78	0.64	1.95
13	West Ambar Talab (Middle Area)	7197	1.12	0.92	2.77
14	Civil Line (Middle Area)	3940	0.61	0.50	1.52
15	Ram Nagar (Southern Area)	6696	1.04	0.85	2.58
16	Mahigran	15027	2.33	1.91	5.79
17	Rajputana West	4754	0.74	0.61	1.83
18	Ram Nagar (Northern Area)	5216	0.81	0.66	2.01
19	Old Tehsil	8265	1.28	1.05	3.18
20	Satti Mohalla	7475	1.16	0.95	2.88
TOTAL		**166759**	**25.89**	**21.23**	**64.20**

3.3 SANITATION EXISTING SITUATION ANALYSIS

3.3.1 WATER SUPPLY

3.3.1.1 General

The use of improved sources of drinking-water is high globally, with 87% of the world population and 84% of the people in developing regions getting their drinking-water from such sources. Even so, 884 million people in the world still do not get their drinking-water from improved sources, almost all of them in developing regions.

However, the current rate of progress, the world is expected to exceed the MDG target of halving the proportion of the population without sustainable access to safe drinking-water.

Global estimates of access and use hinge significantly on progress made in large, populous countries.

India and China are home to more than a third of the world population. Both countries have made considerable progress. These two countries together account for a 47% share, of the 1.8 billion people that gained access to improved drinking-water sources between 1990 and 2008. This share is almost equally distributed between the two countries. Obviously, these two countries heavily influence the global trend. Therefore, the ability to reach the MDG target is highly dependent on the performance of these two countries.

In India, 88% of the population of 1.2 billion use drinking-water from such sources, as compared to 72% in 1990. Table 3.12 below shows the proportion of the population using improved water sources in urban and rural areas from 1990 to 2008 in India.[36]

Table 3.12: Progress on drinking-water and estimates for 1990, 2000 and 2008 in India.[36]

Year				1990	2000	2008
Population (thousand)				862,162	1,042,590	1,181,412
Percentage urban population				26	28	29
USE OF DRINKING-WATER SOURCES (PERCENTAGE OF POPULATION)	Urban	Improved	Total improved	90	93	96
			Piped	52	50	48
			Other improved	38	43	48
		Unimproved		10	7	4
	Rural	Improved	Total improved	66	76	84
			Piped	8	9	11
			Other improved	58	67	73
		Unimproved		34	24	16
	Total	Improved	Total improved	72	81	88
			Piped	19	20	22
			Other improved	53	61	66
		Unimproved		28	19	12
Number of people who gained access to improved sources of drinking-water 1990-2008 (thousand)				418,886		

3.3.1.2 Source of Water Supply:

Main source of water in the city ground water. Where there is a number of 17 tube wells distributed over the whole city and that the discharge of 21.41 MLD for a period of 16 hours per day as shown in the Table 3.13.

These wells feeds the city Roorkee by pumped the water to overhead tanks number 5 as shown in the Table 3.14 and distributed to the city's drinking water network. Figure 3.8 shows locations and distribution of tube wells and overhead tank (OHT) in Roorkee city.

Table 3.13: List of tube wells and discharge

S. No	ZONE	TUBE WELLS	NAME OF TUBE WELL	Municipal office [9] DISCHARGE (LPM)	UJS Office[10] DISCHARGE (LPM)
1	CIVIL LINES ZONE -1	TW NO -01	GANDHI VATIKA NO 01	1000	1000
2		TW NO -02	GANDHI VATIKA NO 02	1200	1200
3		TW NO -03	CIVIL LINES NEELAM TALKIES	1800	1800
4		TW NO -04	NAGAR PALIKA CAMPUS	0	0
5		TW NO -05	ADDERSH NAGAR	1800	1800
			∑ (LPM)	**5800**	**5800**
			∑(MLD)	**5.57**	**5.57**
6	RAM NAGAR ZONE II	TW NO -6	RAMNAGR NO 01	1500	1500
7		TW NO -7	RAMNAGR NO 02	1000	1000
8		TW NO -8	RAMNAGR NO 04 NEW	1800	1800
9		TW NO -9	RAMNAGR GOAL CHAKKER	1800	1800
			∑ (LPM)	**6100**	**6100**
			∑(MLD)	**5.86**	**5.86**
	AVAS VIKAS ZONE III	TW NO -10	AVAS VIKAS-1 (not working)	0	600
10		TW NO -17	AVAS VIKAS-2 new (2010)	1800	1800
			∑ (LPM)	**1800**	**2400**
			∑(MLD)	**1.73**	**2.30**
11	MAQTOOLPURI ZONE IV	TW NO -11	PASSIAN	1500	1800
12		TW NO -12	CHANDERPURI	1800	1000
13		TW NO -13	MAQTOOLPURI	1105	1100
14		TW NO -14	PADDAO	1800	1800
			∑ (LPM)	**6205**	**5700**
			∑(MLD)	**5.95**	**5.47**
15	SOT MOHLLA ZONE V	TW NO -15	SABJI MANDI	600	600
			∑ (LPM)	**600**	**600**
			∑(MLD)	**0.58**	**0.58**
16	GANESHPUR ZONE VI	TW NO -16	GANESH PUR	1800	1800
			∑ (LPM)	**1800**	**1800**
			∑(MLD)	**1.73**	**1.73**
TOTAL DISCHARGE OF TUBE WELLS (LPM)				**22305**	**22400**
TOTAL DISCHARGE OF TUBE WELLS (MLD)				**21.41**	**21.50**

Water products for tube wells have been taken as 16 hr per day.

Table 3.14:- Details of overhead tank in Roorkee city.[9]

No.	ZONE	NUMBER OF OVERHED TANK	CAPACITY(KL)
1	CIVIL LINES	1 NOS OHT	1700
2	CIVIL LINES	1 NOS OHT	450
3	RAM NAGAR	1 NOS OHT	2500
4	AVAS VIKAS	1 NOS OHT	750
5	MAQTOOLPURI	1 NOS OHT	450
		Total capacity (KL)	**5850**

3.3.1.3 Network of Water Supply :

The distribution system in city needs improvement. Main issues are that numbers of connection is not increasing due to excess use of ground water, low pressure and unreliable service, low utilization due to old and leaky system. Where divided the network of water supply in city to 6 zones as shown in Figure 3.9.

The total existing length of distribution network in the city is about 86.09 km and this network distribution includes both slum and non slum areas. The following Table 3.15 illustrates the broad overview of water supply facilities in the city.

Table 3.15: Existing water supply facilities in Roorkee city.[9]

.No.	Description	Urban	Total
1.	Power Load (HP)	643.00	643.00
2.	Total no. of Tube wells	17	17
3.	Automatic operation of no. tube wells	17	17
4.	Existing length of maintenance schemes (Km)	86.09	86.09
	A- supply main	3.09	3.09
	B- Distribution	83.00	83.00

.No.	Description	Urban	Total
5.	Amount of water produced(MLD)	21.41	21.41
	A- gravity	0.00	0.00
	B- pumping	21.41	21.41
6.	Number of reservoirs	5	5
	A- Reservoir	0	0
	B- Vertical Reservoir	5	5
7.	Benefited population	124820	124820
8.	No. of benefited families	20675	20675
9.	Number of public stand post	275	275
10.	No. of private water connections	10865	10865
	Domestic Measured	0	0
	With out water meter	10198	10198
	Total	10198	10198
	Non domestic Measured	0	0
	Not measured	667	667
	Total	667	667

3.3.1.4 Water Supply and Demand:

The minimum per capita water supply recommended by CPHEEO for cities with population of one lac and above is 150-200 lpcd for domestic and non-domestic needs. After consultation with officials in municipal office it has been decided that the per capita water supply for Roorkee should be kept 135 lpcd plus 15% loss, and 16 hours pumping per day.

By anticipating the amount of water demand for the city in the years 2016 2021 2026 2041 and compared the available water from tube wells located in each zones of Roorkee, Observed a shortfall in the amount of water that must be supplied to meet the demands of the city In the coming years. and the (Table 3.16) and (Figure 3.10) below illustrates the difference between the water demand and the water produced from wells in city. and the (Table 3.17) and (Figure 3.11) showing the storage capacity difference at Roorkee in different zones.

3.3.1.5 Key Issues

The total water supplied is about 21.41 MLD. but availability of water is adequate to 2021, Distribution system needs improvement. Low pressure and unreliable service, low utilization due to old and leaky system, Inadequate funds for O&M. And the need is felt to expand distribution as demand is high.

The piped water supply of Roorkee City was started about 30 years ago. as the distribution network covers 60% of the city area. The leakage (UFW - unaccounted-for water) is estimated to be 30 percent due to old and leaky pipelines.

The most significant drawback of Roorkee water supply is the huge amount of water wastage and negligible revenue collection from public utilities (for example parks and fire fighting etc.) and stand posts which takes away about 10 percent of water.

Figure 3.7: Existing situation pumping hand of water supply

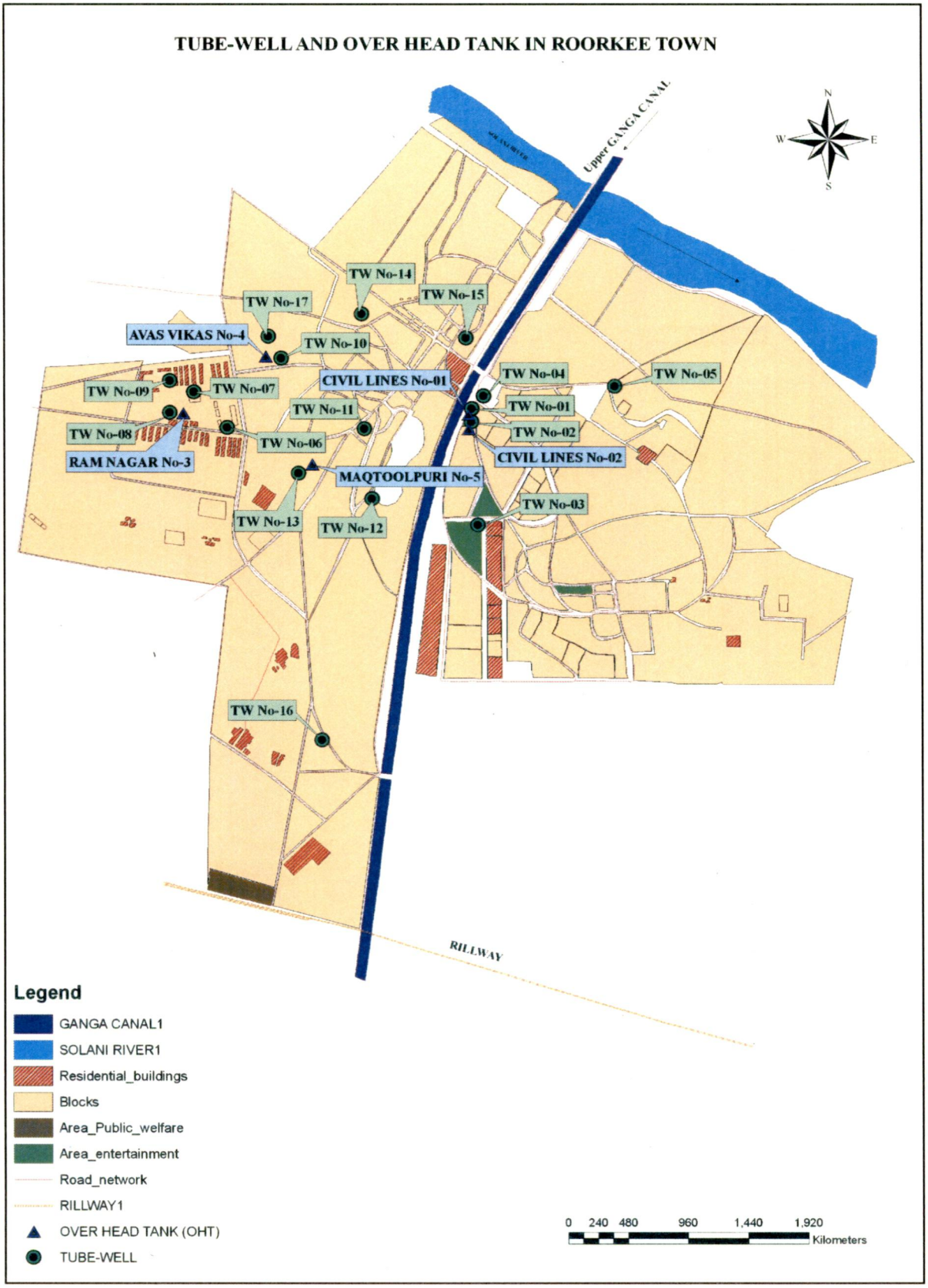


Figure 3.8: Locations and distribution of tube wells and overhead tank (OHT) in Roorkee town.

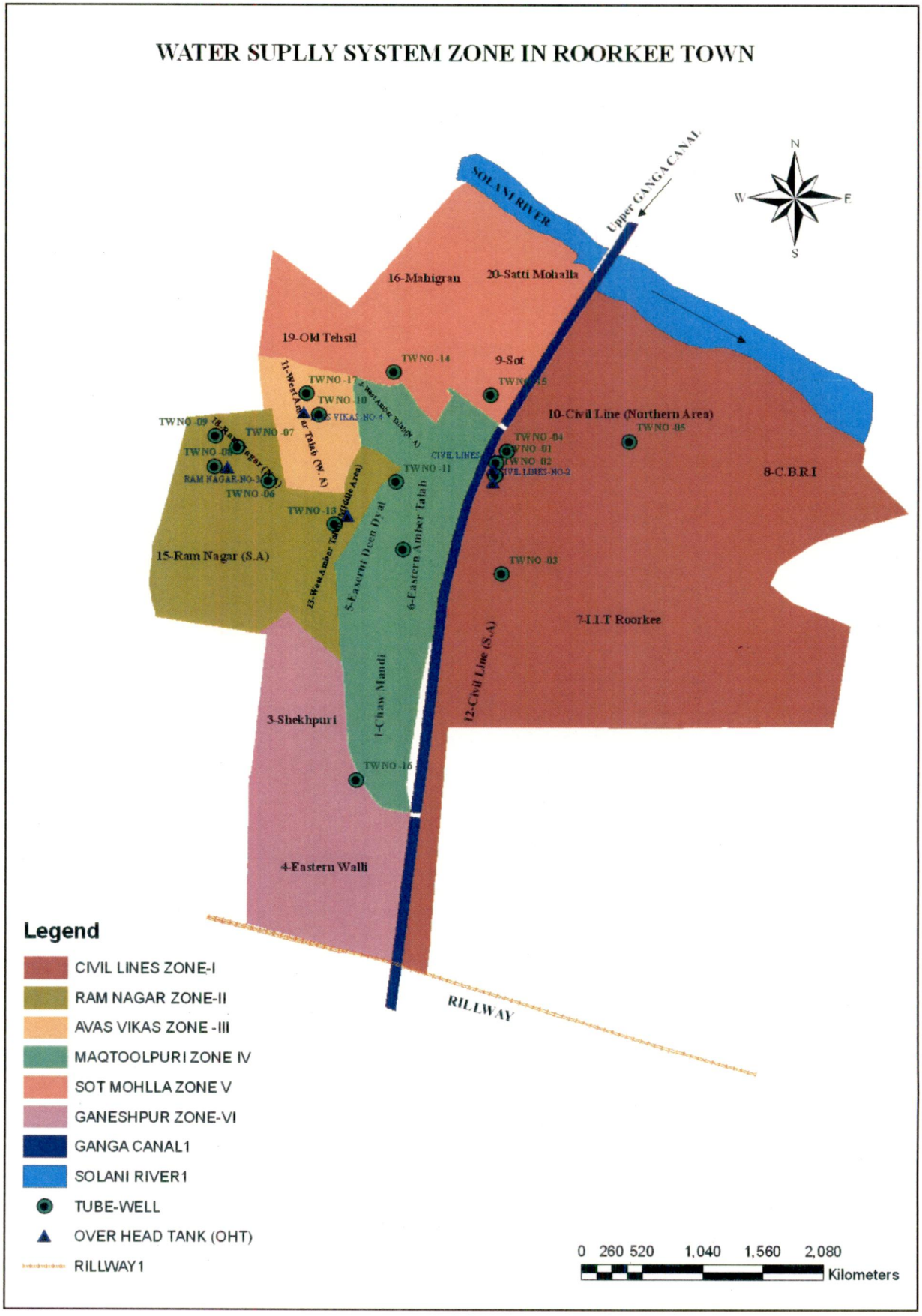


Figure 3.9: Water supply system zone in Roorkee town.

Table 3.16: Demand and production difference at Roorkee in different zones.

S.NO.	NAME OF ZONE	POPULATION 2011	POPULATION 2016	POPULATION 2021	POPULATION 2026	POPULATION 2041	WATER DEMAND (MLD)				WATER AVAILABLE (MLD)	SHORT FALL(-) / SURPLUS (+) IN (MLD)			
							2016	2021	2026	2041		2016	2021	2026	2041
1	CIVIL LINES ZONE -1	29197	31278	33359	35440	41683	4.86	5.18	5.50	6.47	5.57	0.71	0.39	0.07	-0.90
2	RAM NAGAR ZONE II	13387	14341	15295	16248	19110	2.23	2.37	2.52	2.97	5.86	3.63	3.49	3.34	2.89
3	AVAS VIKAS ZONE III	3226	3456	3686	3916	4605	0.54	0.57	0.61	0.71	1.73	1.19	1.16	1.12	1.02
4	MAQTOOLPURI ZONE IV	26358	28238	30115	31994	37629	4.38	4.68	4.97	5.84	5.95	1.57	1.27	0.98	0.11
5	SOT MOHLLA ZONE V	25453	27267	29082	30895	36338	4.23	4.51	4.80	5.64	0.58	-3.65	-3.93	-4.22	-5.06
6	GANESHPUR ZONE VI	19188	20555	21923	23290	27394	3.19	3.40	3.62	4.25	1.73	-1.46	-1.67	-1.89	-2.52
	Total	**116809**	**125134**	**133459**	**141784**	**166759**	**19.43**	**20.72**	**22.01**	**25.89**	**20.26**	**1.99**	**0.70**	**-0.59**	**-4.47**

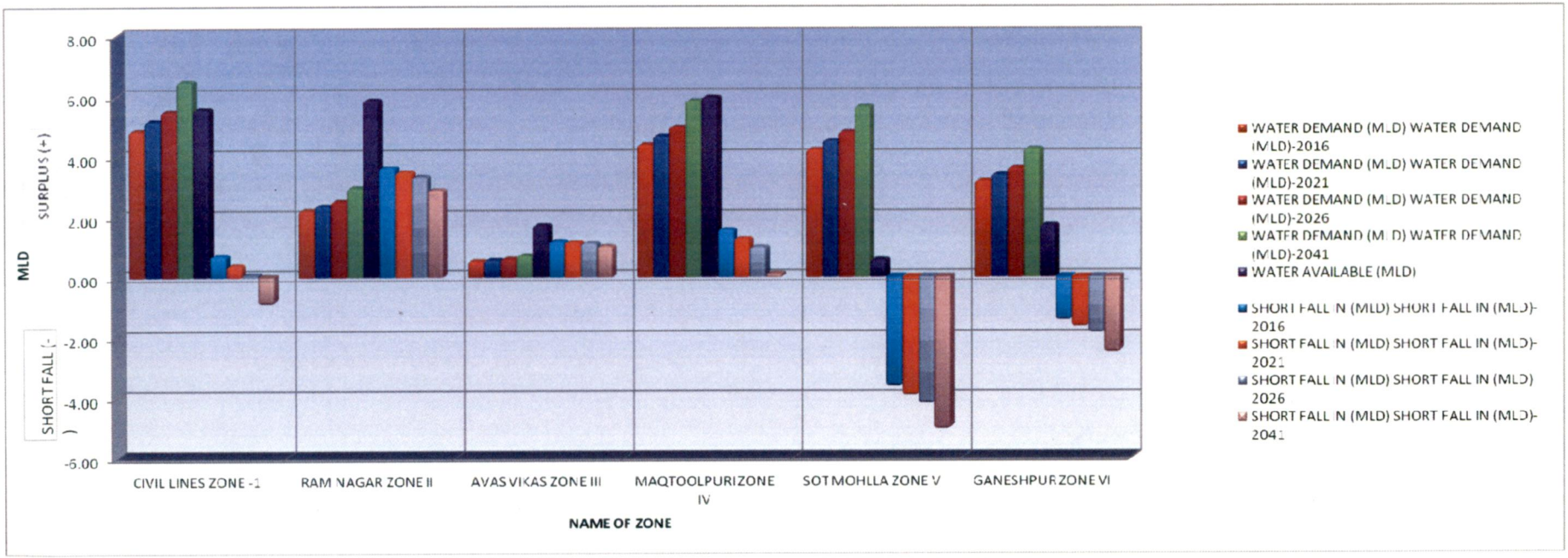


Figure 3.10: Demand and production difference at Roorkee in different zones.

Table 3.17: Storage capacity difference at Roorkee in different zones.

S.NO.	NAME OF ZONE	POPULATION 2011	POPULATION 2016	POPULATION 2021	POPULATION 2026	POPULATION 2041	WATER DEMAND (MLD)				STORAGE CAPACITY		
							2016	2021	2026	2041	DEMAND 2026 (KL)	AVAILABLE (KL)	SHORTFALL(-)/SURPLUS(+) IN 2026 (KL)
1	CIVIL LINES ZONE -I	29197	31278	33359	35440	41683	4.86	5.18	5.50	6.47	2292	2150	-142
2	RAM NAGAR ZONE II	13387	14341	15295	16248	19110	2.23	2.37	2.52	2.97	1051	2500	1449
3	AVAS VIKAS ZONE III	3226	3456	3686	3916	4605	0.54	0.57	0.61	0.71	253	750	497
4	MAQTOOLPURI ZONE IV	26358	28238	30115	31994	37629	4.38	4.68	4.97	5.84	2070	450	-1620
5	SOT MOHLLA ZONE V	25453	27267	29082	30895	36338	4.23	4.51	4.80	5.64	1999	0	-1999
6	GANESHPUR ZONE VI	19188	20555	21923	23290	27394	3.19	3.40	3.62	4.25	1507	0	-1507
	Total	**116809**	**125134**	**133459**	**141784**	**166759**	**19.43**	**20.72**	**22.01**	**25.89**	**9172**	**5850**	**-3322**

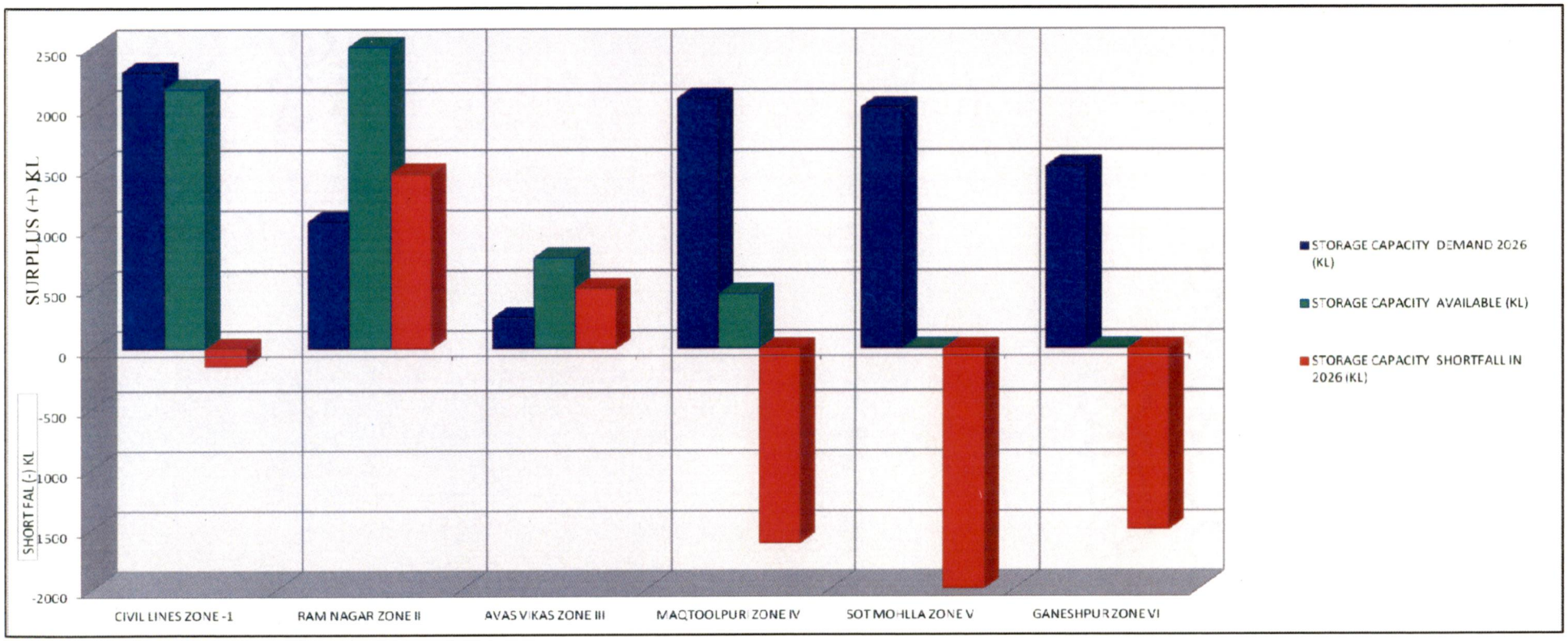


Figure 3.11: Storage capacity difference at Roorkee in different zones.

3.3.2 TOILETS

3.3.2.1 Open Defecation

By far the great majority of people practicing open defecation live in rural areas, but this number is declining.

However, partly because of rapid increases in the urban population, a growing number of people in urban areas defecate in the open.

The proportion of the world population that practices open defecation declined by almost one third from 25% in 1990 to 17% in 2008. A decline in open defecation rates was recorded in all regions.

However, India remains at the forefront of the world according to what is shown in Figure 3.12. Therefore, it is necessary to focus on reducing this problem.[36]

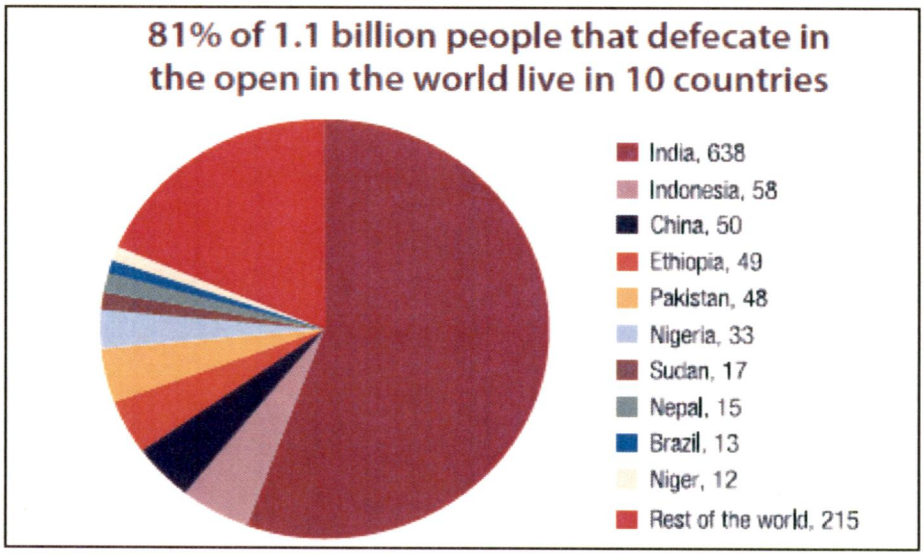


Fig 3.12: Distribution of 1.1 billion people who practice open defecation, 2008, population in (million).[36]

3.3.2.2 Toilet Facilities.

Availability of toilets is an important indicator in the field of sanitation of the city. Provide sufficient latrines and clean for the citizens primary responsibility of the Roorkee municipal. In addition to individual toilets.

However, it is clear that there is significantly shortened by the municipality of Roorkee in this field. Saluting available only number 4 public toilet and a number of 10 general urinals in the city with a population of 116,809 according to Census 2011.[9]

The process of defecation is concentrated in the open spaces on the banks of the River solani. Another area of concern is the lack of facilities for children as well as physically handicapped persons. The open defecation has a serious effect on the health of the people and society in general and the image of the city as well. Some of the reasons for the open defecation are

1). Inadequate number of community toilet facility
2). Lower socio economic strata people find financial constraint and cannot build their own toilets.
3). Lack of space to construct toilets especially in the slum area.
4). No separate provision for children and physically challenged as well as women.
5). The floating population who are not aware about the facility.
6). Children don't hesitate to practice open defecation which later becomes a habit.
7). Mentality or notions of some of the rural or peri-urban people for defecating in open.

3.3.3 SEWERAGE

3.3.3.1 General .

Improved sanitation facilities are used by less than two thirds of the world population. Virtually the entire population of the developed regions uses improved facilities, but in developing regions only around half the population uses improved sanitation.

even with the increase between 1990 and 2008 in the proportion of the population using improved sanitation facilities in China (from 41% to 55%) and India (from 18% to 31%), the world is not on track to meet the sanitation target. This is despite the fact that 475 million people gained access to improved sanitation in these two countries alone, a 38% share of the 1.3 billion people that gained access globally.

Table 3.18 below shows the proportion of the population using improved sanitation facilities in urban and rural areas from 1990 to 2008 in India.[36]

Data has been used by collecting through field visits and discussing with responsible personal at the department of water supply network in municipal office Roorkee city.[9] and Uttarakhand peyjal sansathan for development and construction Nigam (ADB supported schemes) Dehradun.[10]

Table 3.18:- Progress on sanitation and estimates for 1990, 2000 and 2008 in India. [36]

Year				1990	2000	2008
Population (thousand)				862,162	1,042,590	1,181,412
Percentage urban population				26	28	29
USE OF SANITATION FACILITIES (PERCENTAGE OF POPULATION)	Urban	Unimproved	Shared	19	20	21
			Unimproved facilities	4	6	7
			Open Defecation	28	22	18
		improved		49	52	54
	Rural	Unimproved	Shared	1	3	4
			Unimproved facilities	2	4	6
			Open Defecation	90	79	69
		Improved		7	14	21
	Total	Unimproved	Shared	6	8	9
			Unimproved facilities	2	4	6
			Open Defecation	74	63	54
		Improved		18	25	31
Number of people who gained access to improved sanitation 1990-2008 (thousand)				211,049		

The municipality of Roorkee provides a network of sewer lines but it does not cover the all areas. This covers only about 60% of town area, mainly in central/core portion of the town. that too has outlived its life as most of the sewer collection lines are about 30 years old. Approximately total no of existing household connections to sewer network is 4,491 nos. and Houses of 40% of the city area are provided with own septic tanks and soak pits. The out let of majority of these septic tanks are connected to the open drains within city area. Also no scientific sewage treatment plant exists.

3.3.3.2 Sewerage System of Roorkee Town .

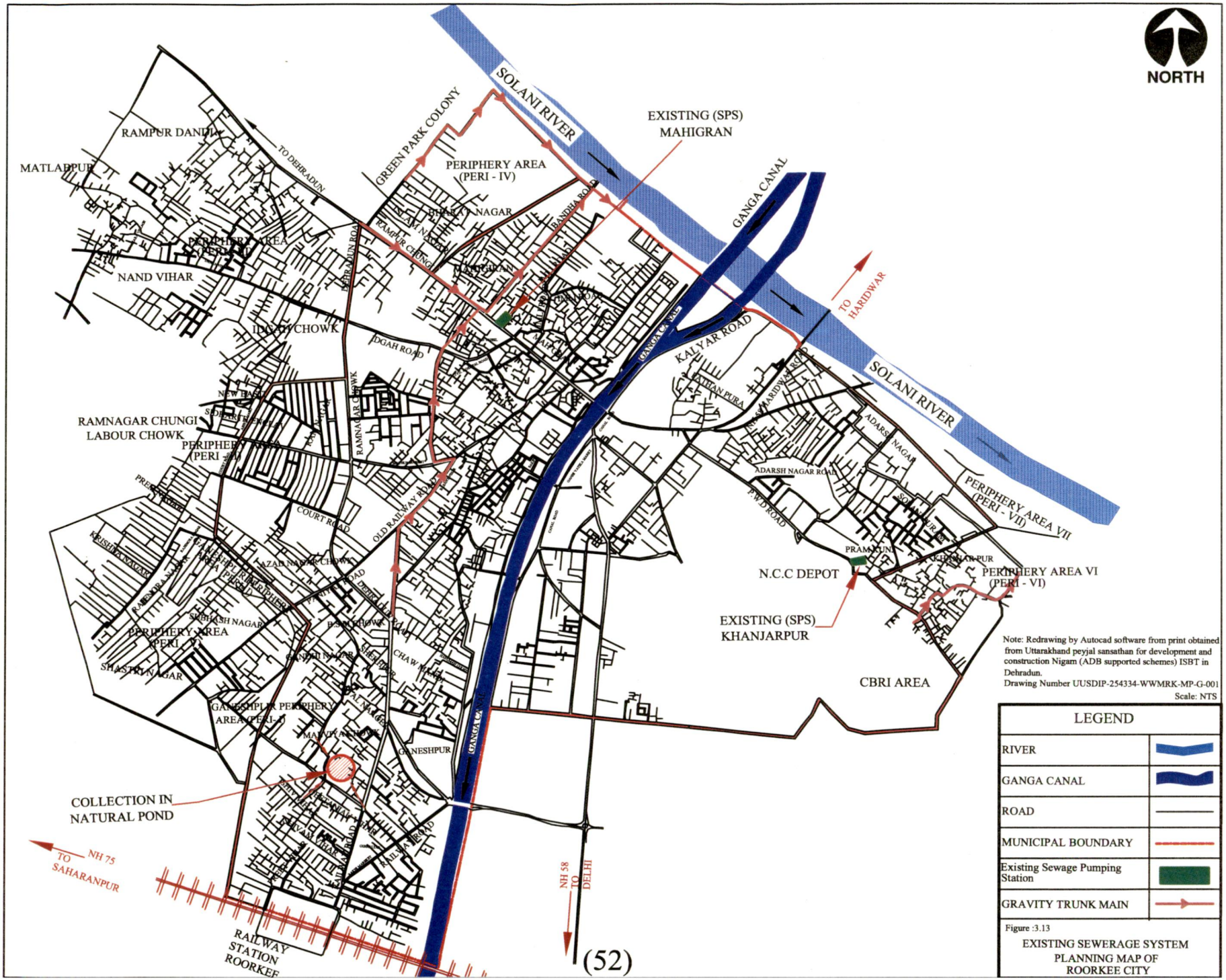
The first sewerage scheme for Roorkee may prepared in 1963-64, casting Rs 29.41 lac, for a design population 60,000 for the year 1991 excluding it Roorkee, CBRI and Cantonment area the scheme comprised of laying of RCC NP2 pipes from 150 mm to 525 mm diameter for length of about 22 km. two pumping station, rising main and sewage farm (150 acre) near Ibrahimpur village. And the second sewerage scheme was prepared in 1983-84. casting Rs 29.9 lac and there after the sewerage system was upgraded from time to time see Map of existing sewage network in Figure 3.13. The operation and maintenance of existing sewerage system was under municipal council Roorkee and presently it is under Uttarakhand peyjal sansthan as per the records available with jal sansthan. The existing sewerage network of sewer is 43.2 km length comprising. Branch sewer line of 150mm to 250 mm diameter and length 37.2 km also comprising trunk sewer line of 300mm to 600 mm diameter and length 6.0 km also 4491 sewer connection and about 3500 manholes and 24 number of main Nalas connection to sewer line and 150 drains connected to sewer line. Two sewage pumping station.

The present in Roorkee disposal waste water to the solani river without treatment because no sewage treatment plant in the city.

There are 2 major pumping stations of capacity 95 MLD. In the past the emphasis was for the provision of drinking water supply only to both urban & rural areas. As a result, growth in sewerage facilities has not been commensurate with the sewage generation. Even today, only about 25000 population about 4492 families (21.5% of the population of Roorkee) is served by the sewerage system. For the purposes of sewerage and drainage.

Roorkee can be divided into two zones. Area east of Ganga Canal. Area west of Ganga Canal. see Figure 3.14.

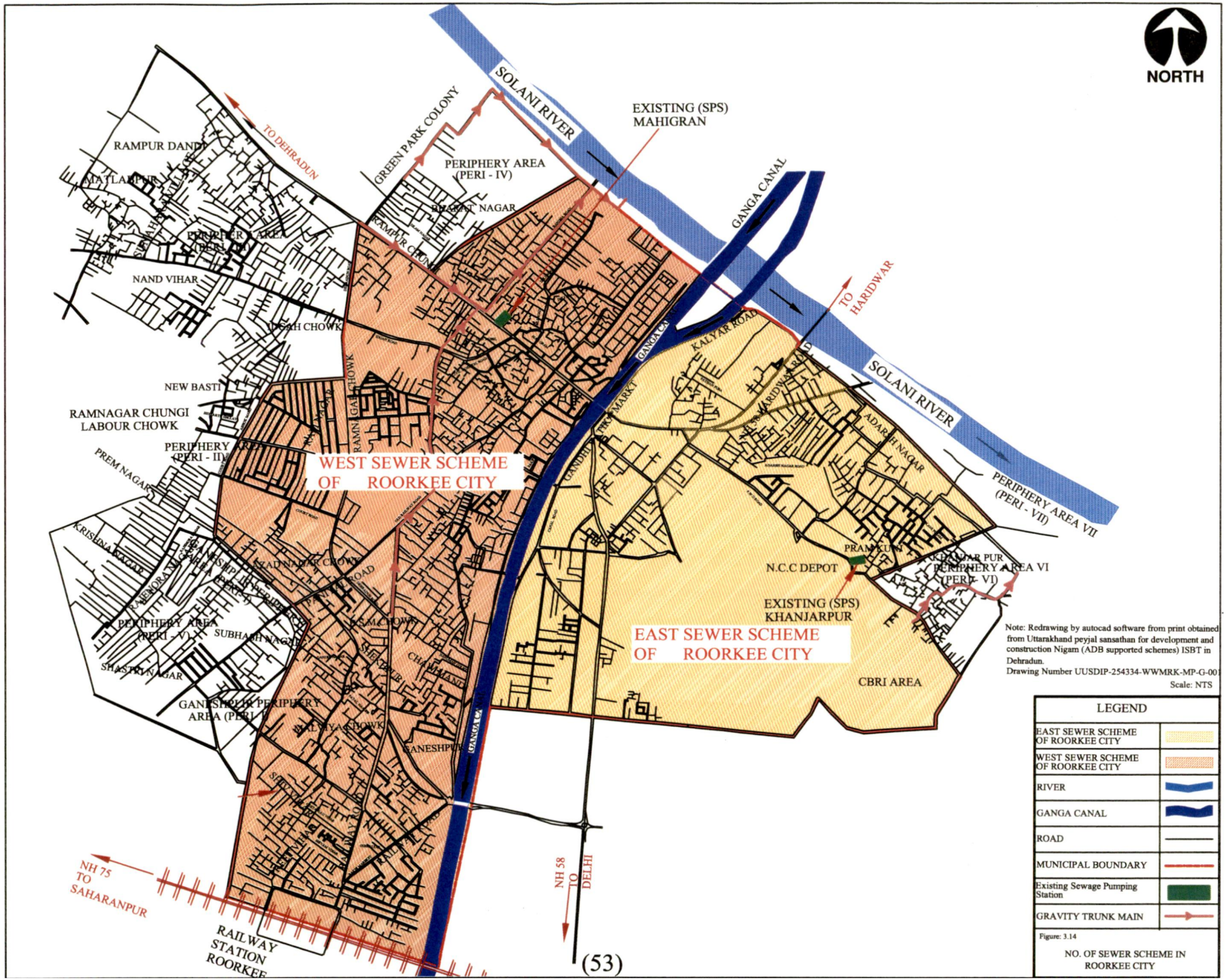
Besides this, There are areas outside the boundaries of Roorkee, but the sewage discharged in the city, so the total amount sewage discharge the city Roorkee included this area.



Note: Redrawing by Autocad software from print obtained from Uttarakhand peyjal sansathan for development and construction Nigam (ADB supported schemes) ISBT in Dehradun.
Drawing Number UUSDIP-254334-WWMRK-MP-G-001
Scale: NTS

LEGEND	
RIVER	
GANGA CANAL	
ROAD	
MUNICIPAL BOUNDARY	
Existing Sewage Pumping Station	
GRAVITY TRUNK MAIN	

Figure :3.13
EXISTING SEWERAGE SYSTEM
PLANNING MAP OF
ROORKEE CITY


NORTH
SOLANI RIVER
EXISTING (SPS)
MAHIGRAN
GANGA CANAL
TO DEHRADUN
TO HARIDWAR
GREEN PARK COLONY
PERIPHERY AREA
(PERI - IV)
RAMPUR DANDI
MATLAMPUR
NAND VIHAR
UDAAH CHOWK
NEW BASTI
RAMNAGAR CHUNGI
LABOUR CHOWK
PERIPHERY AREA
(PERI - II)
PREM NAGAR
KRISHNA NAGAR
PERIPHERY AREA
(PERI - V)
SUBHASH NAGAR
SHASTRI NAGAR
GANESHPUR PERIPHERY
AREA (PERI - I)
WEST SEWER SCHEME
OF ROORKEE CITY
EAST SEWER SCHEME
OF ROORKEE CITY
KALYAR ROAD
ADARSH NAGAR
PERIPHERY AREA VII
(PERI - VII)
N.C.C DEPOT
EXISTING (SPS)
KHANJARPUR
PERIPHERY AREA VI
(PERI - VI)
CBRI AREA
NH 75
TO
SAHARANPUR
RAILWAY
STATION
ROORKEE
NH 58
TO
DELHI
Note: Redrawing by autocad software from print obtained from Uttarakhand peyjal sansathan for development and construction Nigam (ADB supported schemes) ISBT in Dehradun.
Drawing Number UUSDIP-254334-WWMRK-MP-G-001
Scale: NTS
LEGEND
EAST SEWER SCHEME OF ROORKEE CITY
WEST SEWER SCHEME OF ROORKEE CITY
RIVER
GANGA CANAL
ROAD
MUNICIPAL BOUNDARY
Existing Sewage Pumping Station
GRAVITY TRUNK MAIN
Figure: 3.14
NO. OF SEWER SCHEME IN ROORKEE CITY

3.3.3.3 Condition Assessment of Existing Sewer System

The condition assessment of existing sewer system in Roorkee and of the work began preliminary field visit to various location in the town. And through field visits to the Uttarakhand peyjal sansathan for development and construction Nigam (ADB supported schemes) ISBT in Dehradun, obtained the data for sewer system and pumping station and sewage treatment plant for Roorkee town and municipal Offices of Roorkee.

1). **Western Zone (Area west of Ganga Canal).**

i). **Soot, Satti and Mahigran** – sewerage network exists in about 50% are and the newly developed areas near Solani River do not have any sewerage network the existing sewerage network is more than 30 year old. Sewage flow is draining through the surface drains to Solani River as it is visible in photograph give below Figure: 3.15.

ii). **Purani tehsil area**- main sewer line in purgni tehsil area is damaged and connected to main nallah through this area as the main sewer line down stream through Kabristan to mahigran sewage pumping station is not working.

some part of sewerage flow from magtoolpuri ,chawmandi Amber Talab drains through this main sewer line and remaining part over flow through sewerage manhole to surface drains and then to existing nallah and finally to Solani River .

Sewer lines are also very old and chocked due to fall of part the solid waste in nala , as shown in photograph give below Figure: 3.16.

iii). **Central Area of the Western Zone** – there are in sanjay colony and Magtoolpurin area the diameter of downstream pipe size is smaller than the diameter of up stream sewer line.

Many household have connected their house sewers to the surface drains. Due to this the surface drains are carrying sewerage flow and sewer lines are running dry during peak hours.

In Magtoolpuri Mohalla area the existing sewer line are approximately 25 year old (1984-85) and fully chocked as shown in photograph give below Figure: 3.17

In chotturam quarters the existing sewer lines are also very old and many manholes are in dilapidated condition and also there are complaints about water

supply contamination in area, sewer lines are fully chocked due to damage caused due to dumping of solid waste into damaged manholes.

iv). **Ramsnagar area** – Main sewer line from Ramnagar area is damaged and is connected directly to nallah which is flowing along Dehradun road in front of vaishali Figure: 3.18 as the main sewer line downstream through Dehradun road to puranitehsil area is choked and is abandoned. It is observed that the invert level of nallah at discharge point is higher than invert level of sewer line due to which the upstream sewer line and manhole are filled up to invert of the nallah before discharging sewage into nallh.

v). **Ganeshpur area** – There exist no sewer pipe line in this area, and therefore all households have connected their house sewer to surface drains. Sewage flow from Ganeshpure area flow to wards shouts direction and collected in the in vacant space of railway line near Roorkee railway station creating sewage pool in the area as shown in photograph give below Figure: 3.19.

vi). **Shekapuri**– No system of sewer lines in some neighbourhoods in the area where the discharge of sewage water on the surface as shown in photograph give below Figure: 3.20.

Are collected wastewater in two areas surrounding their homes without a pumping station the sewage dormant and these may cause health risks to the health of the population and the following images illustrate the size of the problem as shown in photograph give below Figure: (3.21, 3.22, 3.23, 3.24, 3.25).

2). **Eastern Zone (Area East of Ganga Canal)**

i). Sewage from Eastern area is collected in Existing SPS near Khanjapur village from where the sewage is pumped to western side of the canal to irrigation colony, from where again the sewage drains to existing nallah to wards Solani River. If the existing (SPS) at Khanjarpur is not working. Than the sewage flows directly in to near by open drain and flows in the nallah through Khanjarpure village and finally discharges into Solani creating unhygienic condition in the village.

The existing sewerage network is choked at many places as visible in figure (3.26).

3). Existing Pumping Stations

Table 3.19:- Details of Existing Pumping Stations.[10]

S.No	Location	Year of construction	No of pumps	Head (m)	Discharge LPM	Remarks
1	Main sewage pumping station (SPS) at Maghigran	1970	5	27	6800+25000+ 32000	Presently not in operation. The condition of pump house is not good required rehabilitation.
2	Intermediate sewage pumping station (SPS)at Khanjarpur	1985	2	23	2000	Presently it is working.

Figure 3.15: Sewage flow is draining through the surface.

Figure 3.16: Solid waste in sewer line.

Figure 3.17: Sewer line is very old and choked.

Figure 3.18: Main sewer line from Ramnagar area.

Figure 3.19: Vacant space for sewage pool in the area near Roorkee railway station.

Figure 3.20: Sewage flow is draining through the surface.

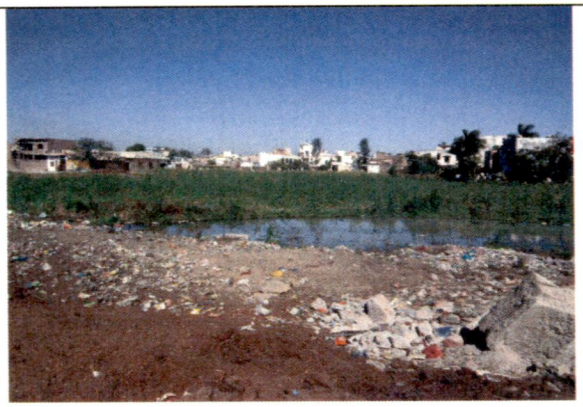


Figure 3.21: Vacant space for sewage pool in the area(1).

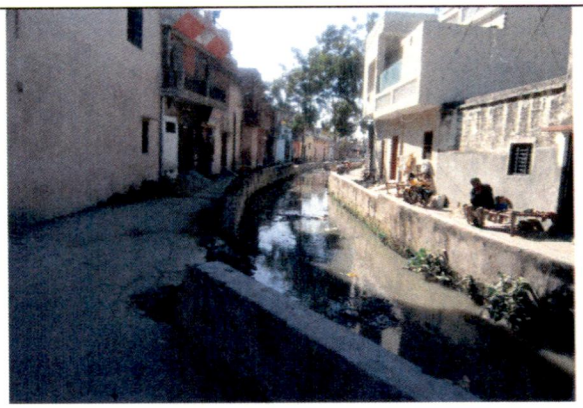


Figure 3.22: Discharge sewer line into sewage pool in the area (1).

Figure 3.23: Discharge sewer line into sewage pool in the area (1).

Figure 3.24: Vacant space for sewage pool in the area(2).

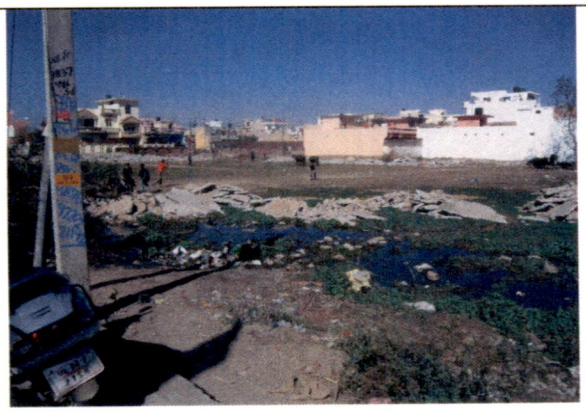


Figure 3.25: Vacant space for sewage pool in the area(2).

Figure 3.26: Sewage flow is draining through the surface.

Figure 3.27: Pumping station for waste water

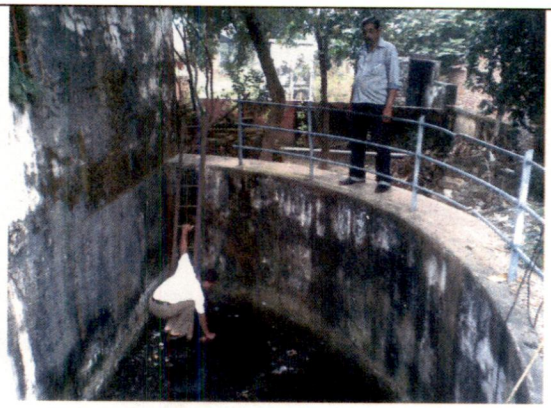


Figure 3.28: Pumping station for waste water

3.3.3.4 Source of Sewerage.

The source of sewer is mostly from domestic households but the waste generated from industries also flow into sewers. The present arrangements do not segregate industrial effluents from domestic sewerage for sewerage treatment plants.

3.3.3.5 Sewerage Generation and Collection.

The following Table 3.20 shows the amount of sewage generated from each ward during the year 2011, as well as the map showing the location of this ward Figure (3.29).

Table 3.20: Sewage generated from each ward during the year 2011.

Ward No.	Ward Name	2011		
		Population	Water Demand (MLD)	Sewage Generation (MLD)
1	Chaw Mandi	7848	1.22	1.00
2	West Ambar Talab (Northern Area)	6856	1.06	0.87
3	Shekhpuri	8958	1.39	1.14
4	Eastern Walli	10230	1.59	1.30
5	Easernt Deen Dyal	3456	0.54	0.44
6	Eastern Amber Talab	4867	0.76	0.62
7	I.I.T Roorkee	9212	1.43	1.17
8	C.B.R.I	3538	0.55	0.45
9	Sot	3903	0.61	0.50
10	Civil Line (Northern Area)	10147	1.58	1.29
11	West Ambar Talab (Western Area)	3226	0.50	0.41
12	Civil Line (Southern Area)	3540	0.55	0.45
13	West Ambar Talab (Middle Area)	5042	0.78	0.64
14	Civil Line (Middle Area)	2760	0.43	0.35
15	Ram Nagar (Southern Area)	4691	0.73	0.60
16	Mahigran	10525	1.63	1.34
17	Rajputana West	3331	0.52	0.42
18	Ram Nagar (Northern Area)	3654	0.57	0.47
19	Old Tehsil	5790	0.90	0.74
20	Satti Mohalla	5235	0.81	0.67
TOTAL		116809	**18.13**	**14.87**

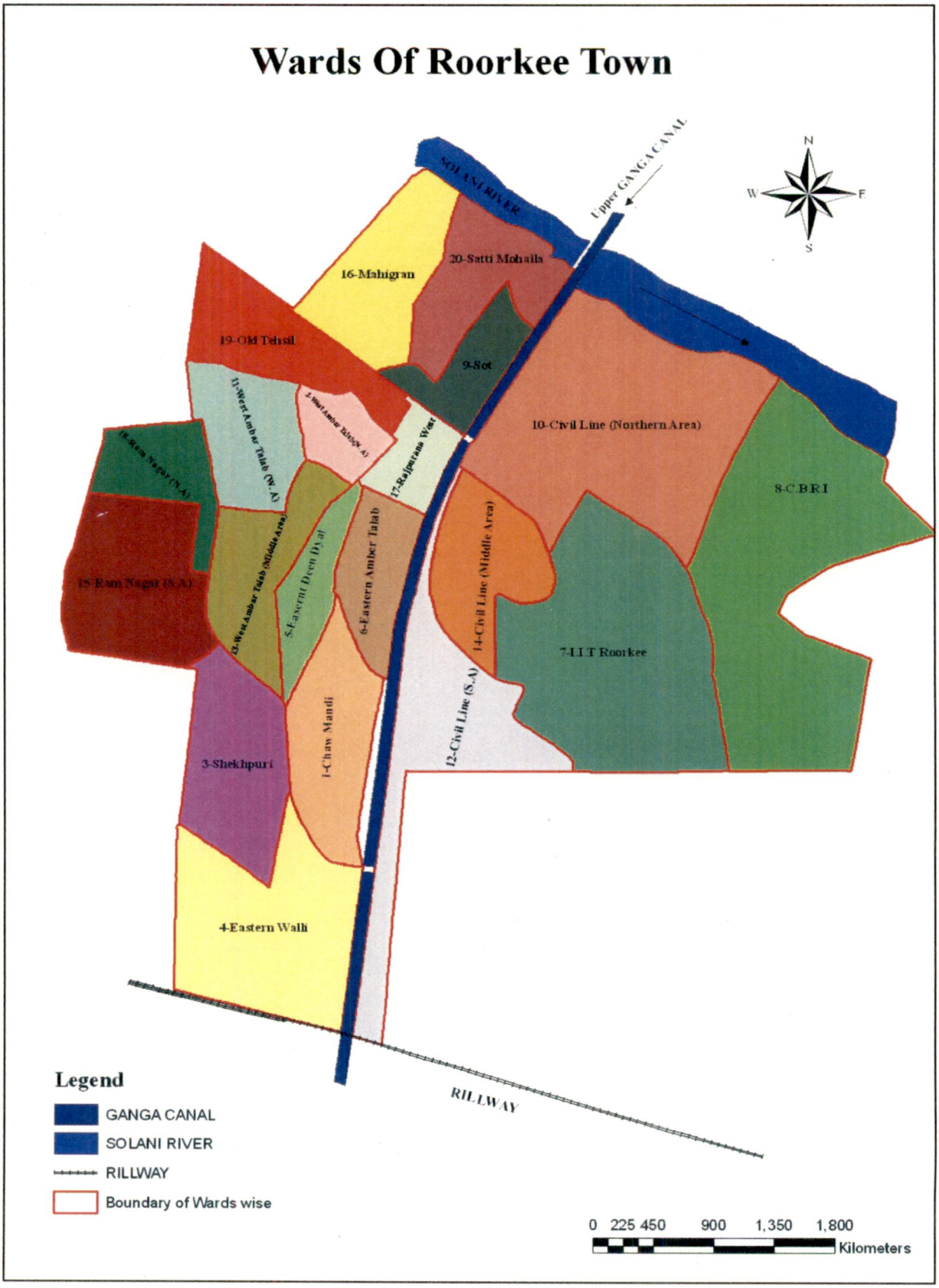


Figure 3.29: Wards of Roorkee.

3.3.3.6 Sampling Location

For the examination of different physic-chemical and biological parameters. samples were collected from different places in Roorkee. Sampling locations for different place are shown in the Figure: 3.3 The total six number of samples. taken from sewer line (wastewater) on June 3 and 4, 2012 The day was dry during peak summer with normal temperature varying between 41 to 28 degree celsius.

These samples were grab Samples and have been taken for physic-chemical and biological Examination in 500 ml Plastic bottles and were tested in AHEC, Indian Institute of Technology Roorkee, Roorkee. The examination of different physic-chemical and biological was carried out on the same day of sample collection.

All samples were analyzed for physic-chemical and biological parameters (COD, BOD, TSS, Fecal coli form density, pH).

1). Waste water characteristics

Waste water characteristics are given in Table 3.21 as show below.

Table 3.21: Sample of waste water sewer lines.

No	Parameters	Units	Location					
			W1	W2	E1	Ind	MD	MC
1	Discharge Q	(m3/sec)	0.154	0.056	0.072	0.043	0.033	0.034
2	Biochemical Oxygen Demand (BOD)	Mg/l	225	289	150	100	580	585
3	Chemical Oxygen Demand (COD)	Mg/l	477	523	339	183	1000	1026
4	PH		6.9	7.1	7.1	6.9	7.1	7.6
5	Total Solid (T.S)	Mg/l	2500	900	700	600	700	1300
6	Suspended solids (TSS)	Mg/l	1000	400	300	200	300	500

No	Parameters	Units	Location					
			W1	W2	E1	Ind	MD	MC
7	Fecal coliform density	MPN Per100 ml	2400	2400	460	43	460	39

2). Analysis

Samples were collected from different places in Roorkee town. At few location value of BOD and COD are much high that the domestic sewage which is primarily due to the reasons that sewage is being generated from Garage mechanical (MC) and milk dairy (MD). The BOD value becomes high at these location due to lot of organic matter like dead plant, domestic kitchen waste and animal dung, .etc mix up with domestic sewage. COD value are also high due to presence of large amount of non biodegradable waste like grease, oil, varieties of metal, mineral ions and cleaning solvents.

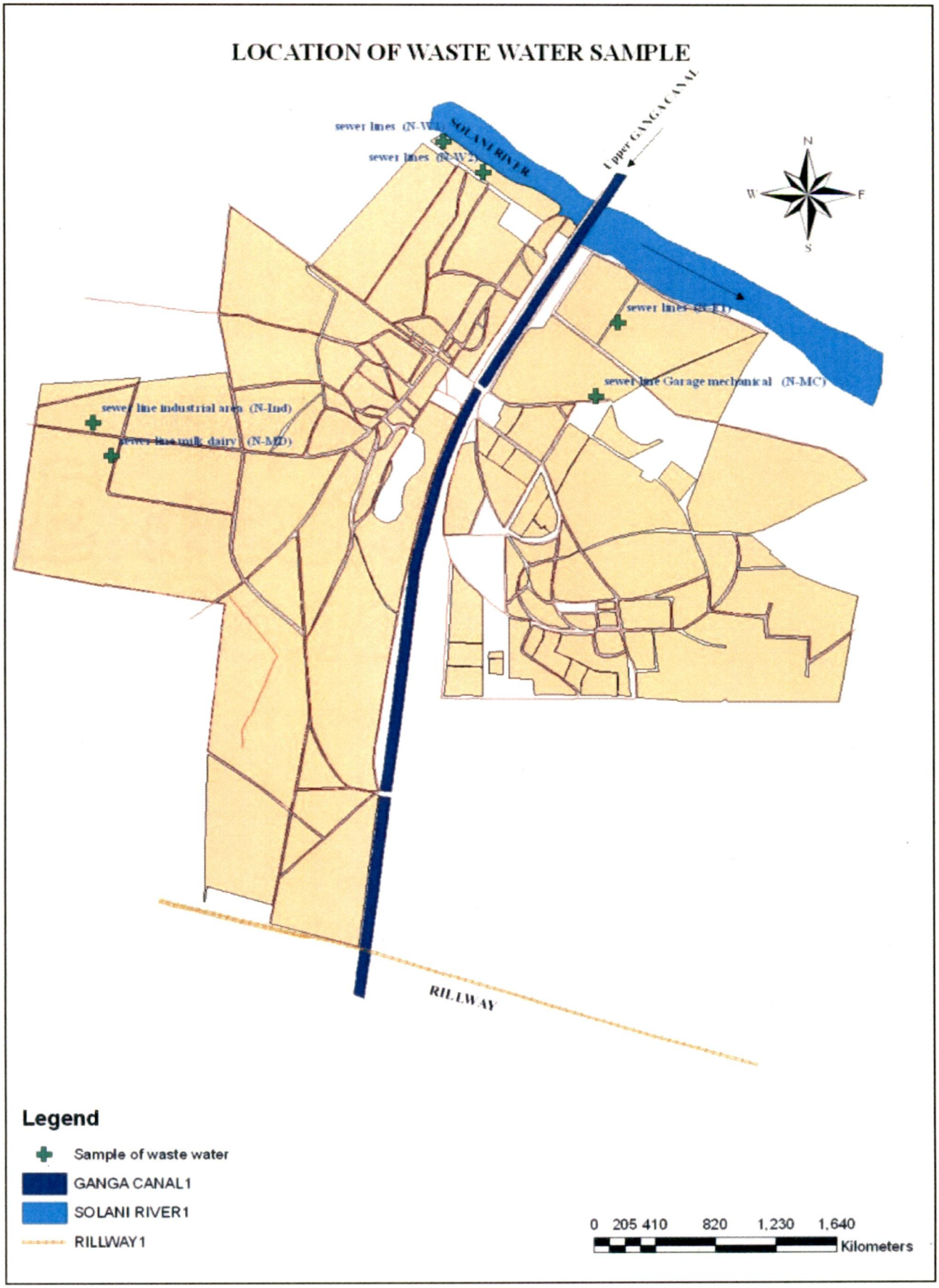


Figure 3.30: Locations of waste water sample

Figure 3.31: Sewer Line (W1)

Figure 3.32: Sewer Line (W2)

Figure 3.33: Collected of samples from location (E1)

Figure 3.34: Collected of samples from location (Ind)

Figure 3.35: Samples in Ecology Lab

3.3.3.7 Key Issues.

The existing sewerage system has already completed it design period of 30y and is outlived .though some sewer lines are fond in good condition size the Sewer lines is not adequate to carry the flow beyond. And Therefore. It would be required to replace the existing sewers with new sewers of required sizes.

The existing sewerage network in eastern part east of Ganga Canal of the town would need to be completely abandoned because of difficulties in integrating the New system with existing old system as presently the sewerage is collected in Khanjarpur (SPS) and pumped toward western part of town, whereas in the New sewerage planning it is proposed to collect the entire sewage by gravity towards (SPS) proposed near Khanjapur village towards Solani River.

Most of existing manhole are filled with sewage because of under capacity of existing sewer line as it has completed its design period, and also silting in sewers.

Many manholes are in dilapidated condition, inside of manhole the bricks are falling down due to damage in plastering etc. Benching inside the manhole also not seen during condition assessment. The size of some of the existing manhole are not as per standard design. And most of the existing lateral sewers and mains are blocked and sewer lines are damaged to connect with surface drains for direct discharge of sewage to open drains due to which drainage system is not working satisfactorily.

3.3.4 STORM WATER DRAINS

Presently the storm water drain and sewage drains are together. also drainage condition of the Roorkee town is not functioning properly. Surface drains are filled with sewage and garbage and due to which during rainy season street are flooded and low lying area are inundated. Where the section is not designed as per the required discharge. And unhygienic conditions prevail in the low lying area as well as pollution of ground and surface water sources. Southwest portion of the town does not have any sewerage system and all the surface and main drain / nallah are flowing full with sewage, garbage etc as visible in Figure 3.36. Ganeshpur area is getting affected due to flooding during monsoon with rain water, Garbage, sewerage etc. and people are living in unhygienic conditions.

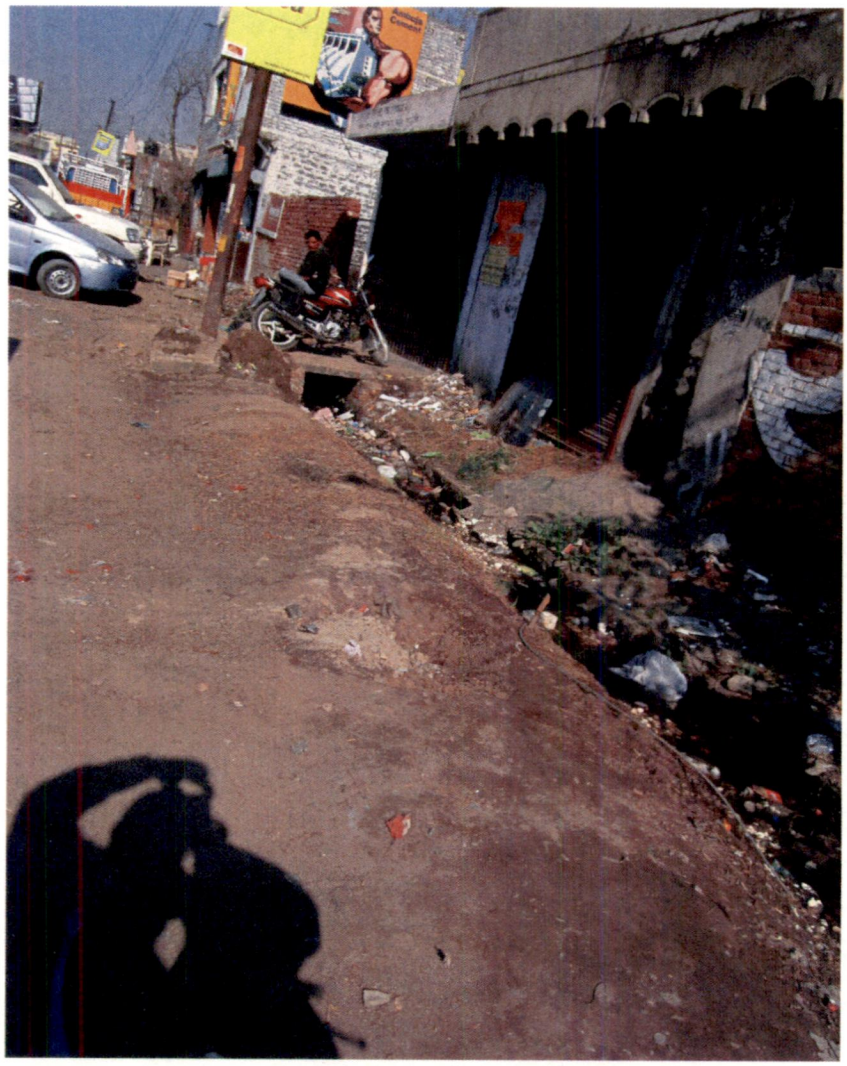


Figure 3.36: Nallah are flowing full with sewage.

3.3.5 SOLID WASTE

In addition to the above mentioned sectors, the solid waste management in the city is also creating unhygienic and unhealthy conditions. Solid Waste Management (SWM) practices have broadly the following components and a clear understanding of each of these components is necessary for a really effective Solid Waste Management system:

3.3.5.1 Generation of Solid Waste:

At present waste generation in the city is around 45 MT/daily presently. And there is daily door to door garbage collection system. and this service coverage number 8000 household covered by door to door collection.

Also there is no available of sufficient waste bins at city level which results into dumping of the waste into nearby open sites. The waste collected from such open areas or existing bins is then carried by lorries and dumped into collection points such as (Saliyar) as visible in Figure: 3.37.

Figure 3.37: Showing problems of garbage disposal in the city Roorkee.

The waste generated from the city includes household waste, commercial waste, clinical waste and industrial waste.

3.3.5.2 Source of Solid Waste Management:

From the below Table 3.22 it can be observed that the domestic waste is the major source of waste generation in the city. The average waste generated from the city is 385 grams per capita per day, which is higher than the standard/norms prescribed in the Manual on Municipal Solid Waste Management; National Environmental Engineering Research Institute (NEERI 1995) (210 grams per capita per day for city with population in between 1 lacs and 5 lacs).

Table 3.22:- Total waste generation in Roorkee city.[9]

S.No.	Type of solid waste	Estimated quantities in (MT/MONTH)
1	Waste generation by households	1100
2	Waste generation by street sweeping	40
3	Waste generation by Hotels, Restaurants	20
4	Waste generation by Markets. (Bazaar and vegetable markets)	90
5	Waste generation by commercial establishments (eg. Institution)	90
6	Waste generation by other (debris, horticulture)	20
	Total Waste Generated (MT/M)	**1360**
	Total Waste Generated (MT/D)	**45**

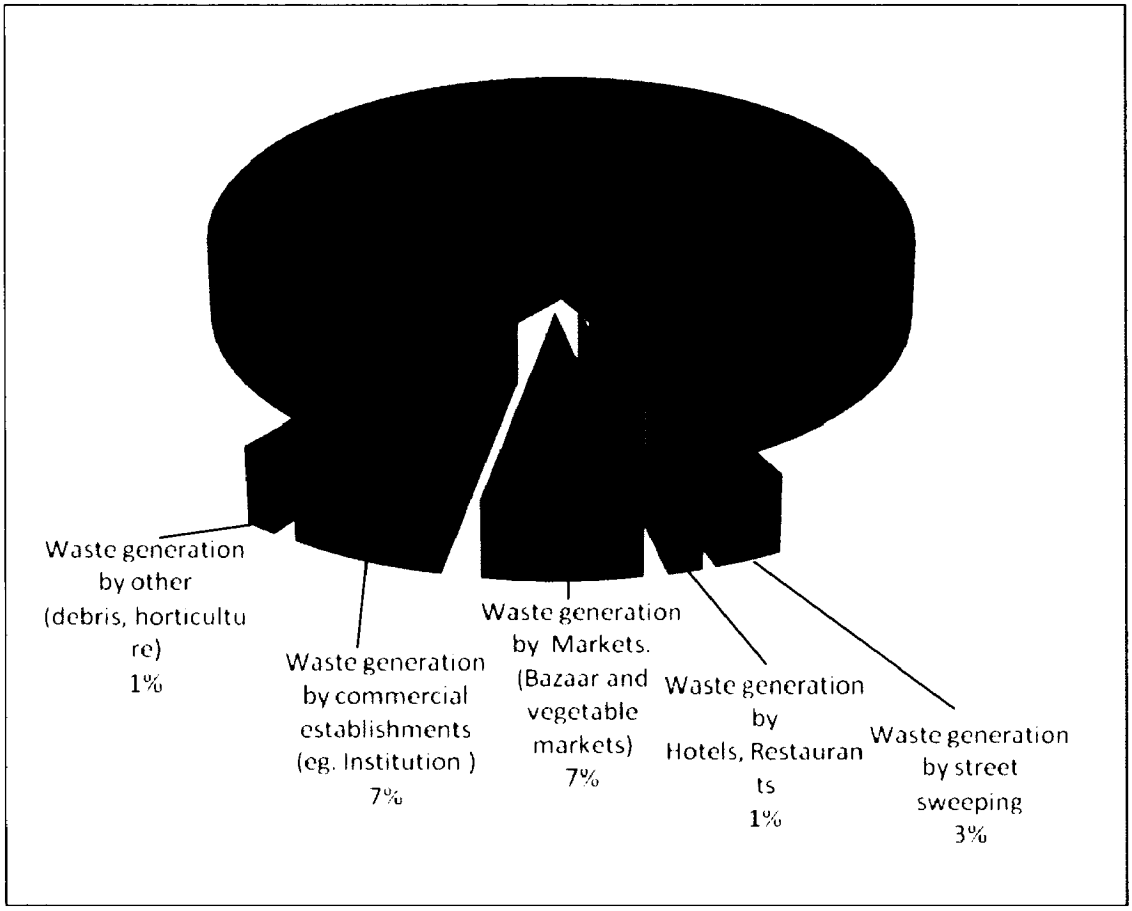


Figure 3.38: Showing % and type of waste generated in the city Roorkee.

1). **Households waste**: The domestic waste is the major source of waste generation in the city. The weighted average house hold waste generation comes to 385 gms/person/day. The residential /household accounts for about 1100 MT/month of total waste generation in the city.

The major portion of residents belonging to the residential establishments dump their household waste outside their homes and in some cases in dustbin (if available), or on the streets (open dumps) or in the drains running in front of the house. The operators collect waste from the various lanes and drains dump it in the vacant plots or in the open dumps.

2). **Waste from commercial establishments:** The commercial areas identified in Roorkee city are situated throughout the city . These areas are mixed zones comprising of commercial (shops and markets) and residential areas as well as hotels and restaurants. The waste from shops starts accumulating in the nearby open dumps in the morning hours (7:00 – 11:00 AM), when they are cleaned.

At this rate the total waste contributed by commercial establishment to MSW is about 90 MT/ month approximately.

3). **Hotels/ Restaurants:** The waste from these establishments mostly includes left-over food, and disposable crockery. Workers of these establishments dump the wastes at nearby container/ open dump from where the same is transported to designated dumpsite by municipal of Roorkee. The total waste generated in metric tons per day (MT/month) from hotels, restaurants, guest houses, marriage halls is 20 MT/month.

4). **Street sweeping:** Street sweeping starts between 6:00 to 7.00 AM and continues up to 12:00 PM. The sweepers are provided with jharoo (brooms), pans, favda, hand-carts, panji (bamboo stick used to clean nalas [drains]), gayti (pointed favda to clean roads), and buckets to clean nalas. They collect the waste on road sides, which are then transported to the nearby open dumps/ dustbins by rickshaw trolley or to out skirt of the city directly by tractor trolley. The street sweeping constitutes about 3% percent of the MSW generated in Roorkee. The total waste estimated from street sweeping is 40 MT/ month.

3.3.5.3 Composition of Solid Waste:

The waste produced from households, shops and commercial establishments are composed of food and other discarded waste materials such as paper, plastic, glass, metal, rags, packaging materials. The waste is found to be rich in organic matter and contains about 56.17 per cent organic content which is reasonably high as compared to other cities of India.

3.3.5.4 Temporary Storage of Waste:

At present there are about 12 of major collection waste storage depots in the city. And 15 large bins size 4.5 m^3 and 40 small bins size 1 m^3. And The following Table 3.23 shows location of different solid waste collection bins in city . The distribution of temporary waste storage point is non-uniform in the city as shown in Figure 3.39.

Table 3.23:- Location of Solid Waste Collection Bin in Roorkee .[27]

TYPE OF BIN	S.NO	LOCATION	NUMBER
DALAO (large concrete bins)	1	IRI	19
	2	IRI Government workshop	3
	3	P.W.D	1
	4	C.B.R.I	21
	5	Khanjarpur	1
	6	Near post office Roorkee	1
	7	Jamun Road	1
	8	Near neelam takies	1
	9	Near Manek Chand Advocate House	1
Total			49
DALAO (Small Concrete Bins)	10	Adarsh Nagar	1
	11	Near Hydle Office	1
	12	Near Roorkee Takies	1
	13	Chattar Road	2
	14	Shamshan Road	1
	15	Purana Hospital	1
	16	Avas Vika (Near Water tank)	1
	17	Sanjay Colony	1
	18	Around Govt. inter College	3

TYPE OF BIN	S.NO	LOCATION	NUMBER
	19	Sanik Colony	2
	20	Ganeshpur Pul	1
	21	Near Dayal Bagh Colony	1
Total			16
DUST BINS	22	Sabji Mandi	2
	23	Lmli Road	1
	24	Rapjutana /Purani Tehsil	1
	25	Ragunath Wala Bagh	1
	26	Ram Nagar	2
	27	Shekhpuri	1
	28	Near Dav college	1
	29	Other place	46
Total			55

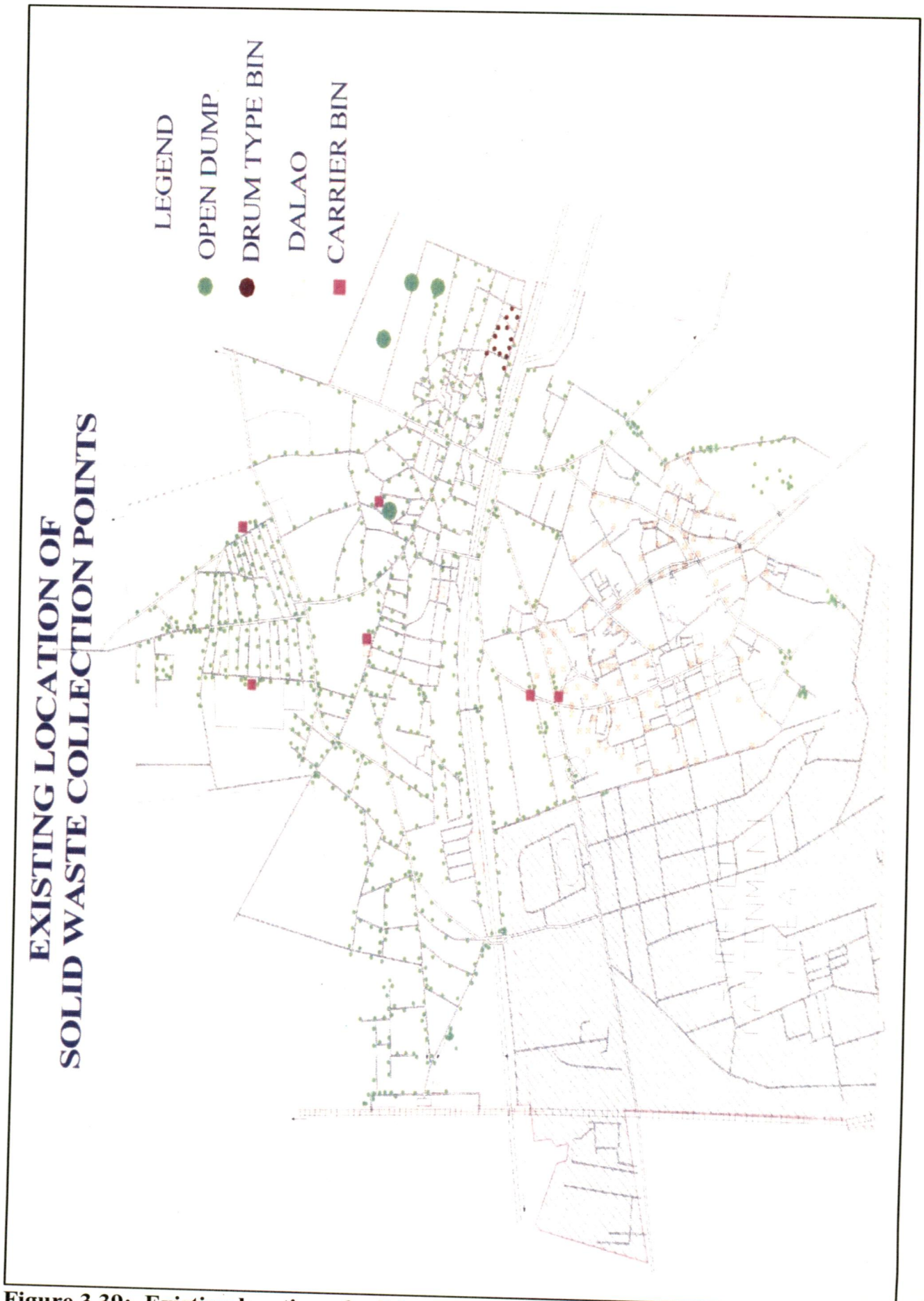


Figure 3.39: Existing location of solid waste collection point in the City Roorkee[27]

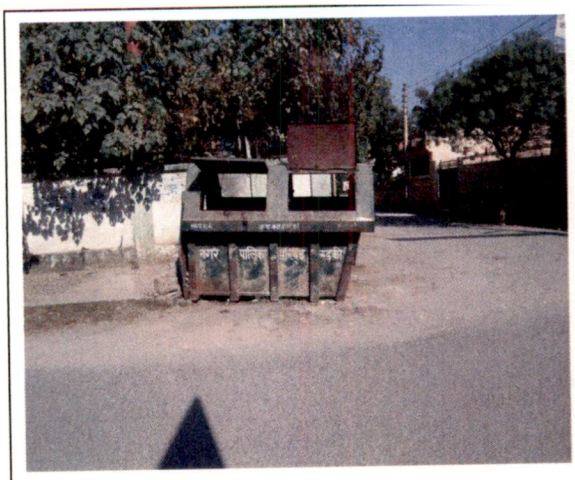


Figure 3.40: Large Bins Size 4.5 m^3

Figure 3.41: Small Bins Size 1 m^3

Figure 3.42: Concrete Bins

3.3.5.5 Transport and Employees:

Details of the number equipment /vehicles deployed for transporting of solid waste. It are provided in the following Table 3.24 And see Figure 3.43.

Table 3.24:- Available Infrastructure in Roorkee .[9]

S.N	Equipment/ Vehicle	Number	Collection Capacity	Trips Per day	Total Collection Capacity per month
1	JCB	1	NL	NL	NL
2	FRONTAL LOADER	1	NL	NL	NL
3	DUMPER PLACERS	2	1 MT	2	60 MT/M
4	Mini lorries	2	1 MT	2	120MT/M
5	TRACTOR TRAILERS	5	0.6 MT	6	540 MT/M
6	tipper trucks	1	1 MT	2	60 MT/M
7	BIN CARRIERS	2	1 MT	8	480
Total quantity of waste collected and transported to disposal (Metric Tons per month)					1250

3.3.5.6 Segregation

Currently there is no segregation facility. but they plan to two bins-large & small capacity , at selected locations like (vegetable market). for organic waste and inorganic. Transportation vehicle were to be modified a partition would be made to separately transport and unload biodegradable wet and dry wastes.

3.3.5.7 Treatment and Disposal of Waste:

The main objective of treatment and disposal is to clear waste from the disposal site in an environmentally friendly manner with little/no serious implication on the health and hygiene of the micro and macro environment. It is the responsibility of the local body to ensure safe disposal of the wastes generated within its jurisdiction. There is no processing of waste being done at the city level. The entire waste, which is collected, is taken for dumping to the disposal site. At present there sanitary landfill site in Saliyar village Figure 3.44. Where the receive landfill site 1140 MT/Month.

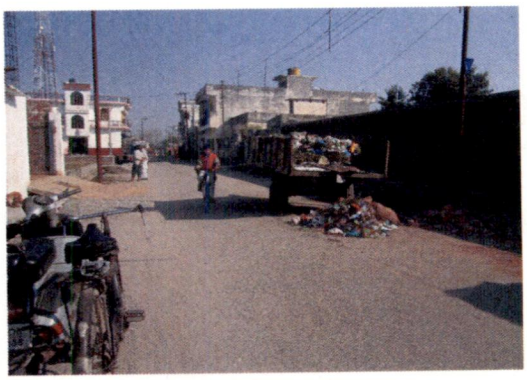


Figure 3.43: Equipment /Vehicles deployed for transporting of solid waste

Figure 3.44: Landfill Site in Saliyar Village

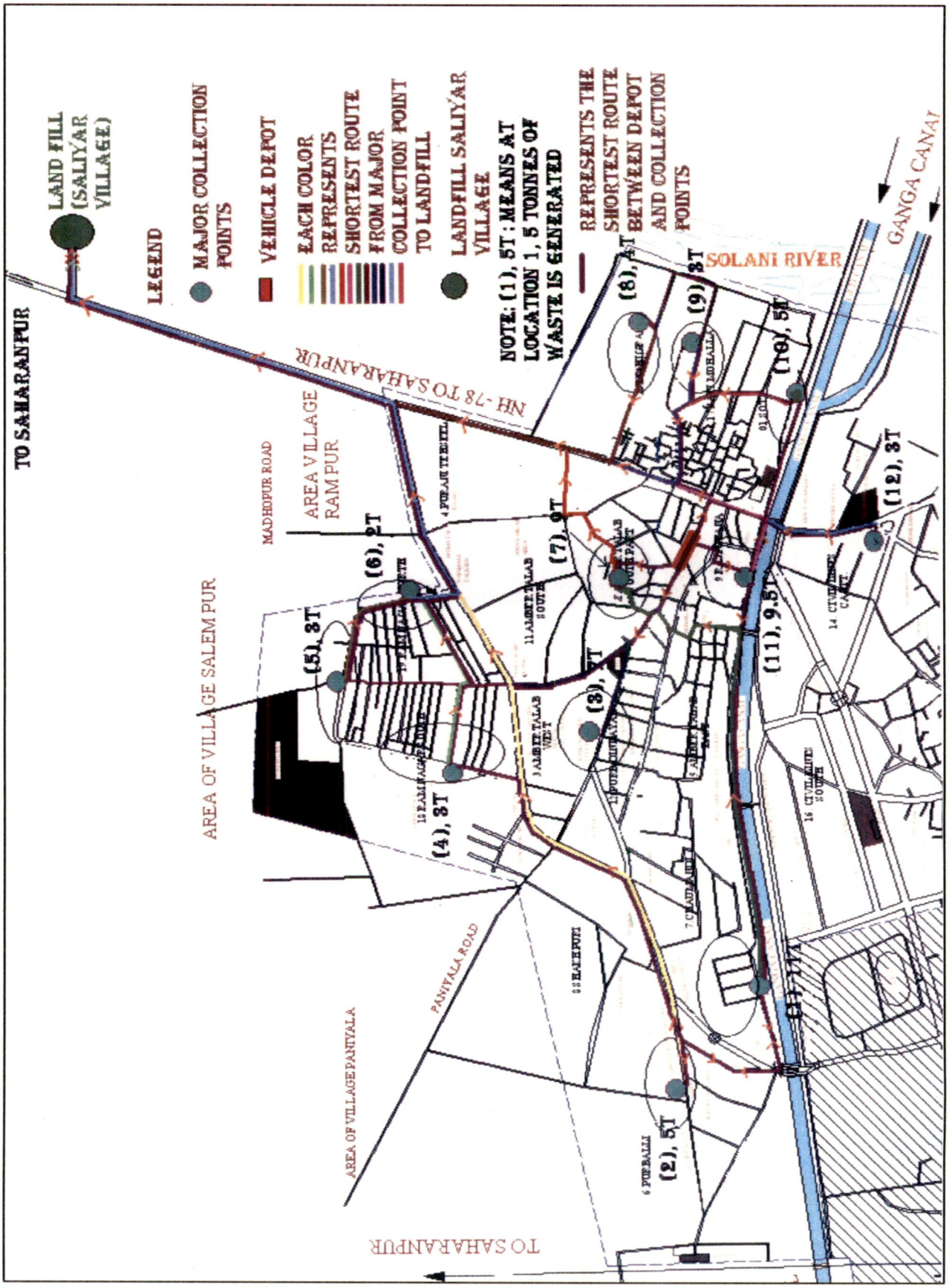


Figure 3.45: Solid waste movement route and location of land fill in the city Roorkee.[27]

There is a gap of more than 16 % of solid waste. Due to some of the ward and hospital dispose of their solid waste after loading in vehicles at locations on the bank of the Solani river and not disposed of the solid waste in landfill. (municipal office)

So in order to mitigate this gap must be control on this is location and Impose financial penalties on the offenders and force them to disposal solid waste in landfill.

Difference between wastes generated and collected at daily and received to landfill site. is derived on the basis of the information received from municipal office of Roorkee city. Table 3.25.

Though substantial amount of paper, rags, glass find ways to the refuse near its source, they are reclaimed by rag pickers, before reaching the disposal point.

Table 3.25:- Difference between wastes generated and collected and received in Roorkee .

Waste generated per day (MT)	Waste collected per day (MT)	Waste Received at landfill site per day (MT)	Gap in the system(MT)
45	41	38	7

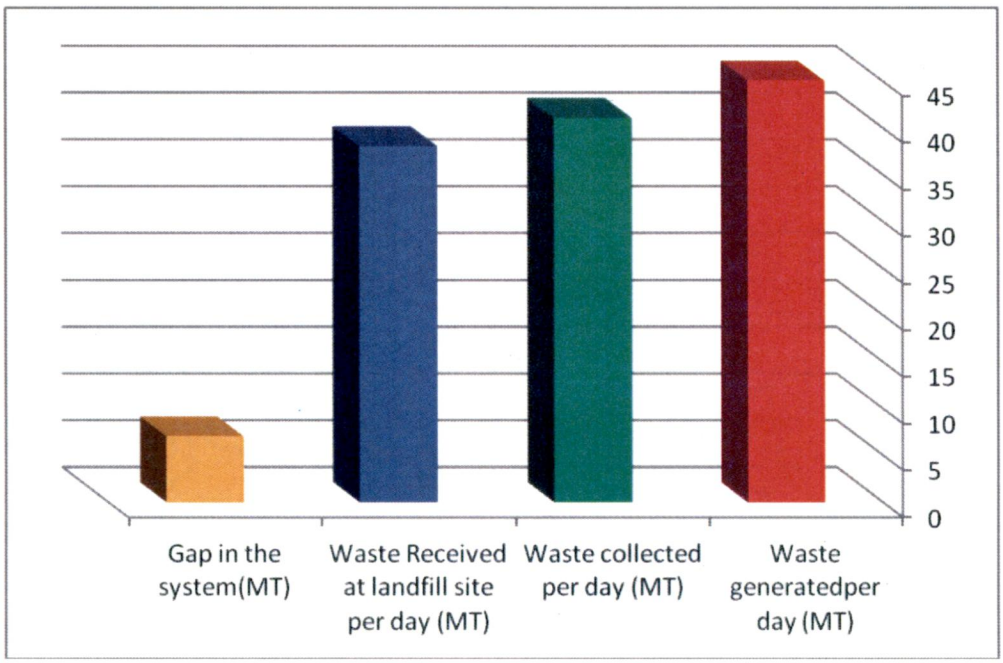


Figure 3.46:- System analysis of solid waste collection system.

3.3.5.8 Recyclables

Currently no plan for recycling. no recycling or composting facility is presently available. It comprises paper, textiles, plastics, Leather and rubber, glass and metal. there are rag pickers community removes most of these recyclables.

However the waste from Leather and rubber trimming is not reused and finally dumped in the secondary collection point or find its place in nalas resulting in chocking of drains.

3.3.5.9 Institutional Arrangements.

The solid waste management is the responsibility of the sanitation Department of Roorkee whereas Engineering Department assists in the procurement of the vehicles, equipment and developing the landfill site, etc. The Chief sanitation Officer is responsible for waste management. The sanitation Department has total employee strength of 164 out of which 123 are the sanitary workers shown in the following Table 3.26.[9]

Table 3.26:- Employees sanitation department in Roorkee

S. No.	Designation	Number
1	Chief sanitation Office	1
2	Sanitary Inspector	1
3	Sanitary Supervisor	10
4	Workers	123
5	Drivers	7
6	Staffs helper drivers	15
	Total	**164**

3.3.5.10 Annual Expenditure

Table 3.27:- Annual expenditure for sanitation department in Roorkee[9]

S.No	Designation	Cost in (Rs. Lakhs)
1	Staff Sanitation	359.00
2	Transportation (operation and maintenance	37.25
3	Supervisory inspector	12.14
	Total	**408.39**

3.3.5.11 Characteristic of solid waste

physicochemical characteristics of MSW at Roorkee varies from season to season. During summer the refuse generation biodegradable in Roorkee city is increased due to consumption of fruits like mangoes, melons, green coconuts etc.

An analysis of physical characteristic of solid waste was done as a part of study carried out. The results were as follows in Table 3.28.

Table 3.28: Physical composition of solid waste

S.No	TYPES OF WASTE	% BY WEIGHT
1	Food Waste	56.17
2	Paper	2.97
3	Plastics	0.58
4	Metal	0.43
5	Glass	0.32
6	Textile	0.25
7	Stones, Bricks, Ash etc.	39.28
	Total	**100**
*	Moisture Content	20.11

*Chemical characteristic.

3.3.5.12 Key Issues:

The waste is handled multiple times leading to potential health hazards for the workers as all types of wastes. are disposal solid waste in the same storage points. The sanitary workers are not given any protective clothing. Multiple handling of the waste is taking place in all the areas of the city. And present waste generation in the city is around 45MT per day.

The dumping of solid waste in roadside and elsewhere, are unhygienic . And also disposal of waste into drains leads to choking of drains (Nallah) . All the solid waste is disposed in the landfill site waste without segregation, no processing and no recycling facilities.

3.3.6 Bio-Medical Waste

3.3.6.1 General

The waste generating by the health care units are termed as bio-medical waste. The hospital waste has always been considered potentially hazardous. The disposal of untreated bio-medical wastes poses an environmental and public health risk. It also presents an occupational health hazards to the health care personnel who handle these wastes at the point of generation, and those involved with their management i.e. segregation, storage, transport, treatment and disposal. The indiscriminate disposal of untreated wastes are the causes to spread the infectious diseases. Apart from these, a good amount of bio-medical wastes such as disposable syringes, saline bottles, I.V. fluid bottles etc. etc. are picked up by the rag pickers and are recycled back into the market without any disinfections. It is imperative, therefore, to adopt appropriate system for the safe collection, storage, transport, treatment and disposal of the hospital wastes. Realizing the seriousness of the problems associated with the poor management of the bio-medical wastes, the Govt. of India had notified the Bio-Medical Waste (Management & Handling) Rules in the years 1998 in order to regulate the environmental menace due to mismanagement of the hospital waste.

3.3.6.2 Generation

Waste generation and composition from health care units depends upon a number of factors such as waste management methods, type of health care units, occupancy of healthcare unit, specialization of the healthcare unit, ratio of reusable items in use, availability of infrastructure and resources etc.

Biomedical Waste Management rules insist that all bio medical hazards waste should be properly treated and dispose. About 2000 kg of bio medical wastes are produced in the health care facilities of Roorkee.

Table 3.29: Health care mode of treatment and disposal in Roorkee [14]

S.NO	Name of Health care	No of Bed	Mode of treatment &disposal
1	Abhilasha Eya Hospital & Nursing Home, Railway Road, Roorkee	11	Self
2	Brahma Hospital, Dehradun Road, Roorkee	18	Self
3	Chiranjiv Hospital, Near Ganeshpure Bridge, Dehradun Road Roorkee	11	Self
4	Bhargav Nursing Home, Station Road, Roorkee	12	CWTF
5	Sanjivan Hospital, Ganeshpur, Station Road, Roorkee	4	CWTF
6	Yashlok Hospital, Oop. Govt Hospital, Dehradun Road, Roorkee	12	CWTF
7	Lakshmi Nursing Home, Near Gang Nahar Thana, Railway Road Roorkee	9	CWTF
8	Anand Nursing Home, Oop. Govt inter College, Chawmandi, Roorkee	6	CWTF
10	Nanhe Munno Ka Hospital, Near Bsm Tiraha, Railway Road Roorkee	30	CWTF
11	Dr. SN Bansal Child Hospital, 634 Sainik Colony, Roorkee	8	CWTF
12	Pratap Clinic & Nursing Home, 641/1 Sainik Colony, Roorkee	5	CWTF
13	Dev Nursing Home, Near BSM College, Dehradun Road,	18	CWTF

S.NO	Name of Health care	No of Bed	Mode of treatment &disposal
13	Arpit Hospital,Oop. Sub jail, Dehradun Road, Roorkee	12	Self
14	Kastoori Nursing Home, 169 Nehru Nager, Roorkee	16	CWTF
15	Paras Nursing Home, Railway Road, Roorkee	7	CWTF
16	Vinay Nursing Home, 109 BT Ganj, Rookee	15	Self
17	Bhagawati Hospital, 325 Chawmandi, Roorkee	20	CWTF
18	Mahavir Children Hospital, Chandrapuri, Roorkee	10	CWTF
19	Pal Clinic & Nursing Home, 1Saket Durga Chowk, Roorkee	5	CWTF
20	Atul Tyagi Nursing Home, DAV College Road, Roorkee	12	CWTF.
21	Roorkee Dental Care, Chandrapuri, Railway Road, Roorkee	2	CWTF
22	Roorkee Nursing Home, 80Chandrapuri, Roorkee	9	CWTF
23	Koshik Pathology, Near BSM Tiraha, Roorkee	-	CWTF
24	Dr. JP Nayyar Nursing Home, Chawmandi, Roorkee	8	CWTF
25	Anant Nursing Home, Chawmandi, Roorkee	8	CWTF
26	Bhatnagar Nursing Home, Ganeshpur, Roorkee	23	CWTF
27	Mahipal Clinic & Nursing Home, 562-Chawmandi,	10	CWTF

S.NO	Name of Health care	No of Bed	Mode of treatment &disposal
	Roorkee		
28	Sant Joseph Hospital, 371 Civil Line, Roorkee	30	CWTF
29	Dr. SK Gupta, SARTHAK Clinic, 33 Civil Line ,Roorkee	7	Self
30	Vardhman Hospital, 29 Civil Line,Roorkee	7	CWTF
31	City Dental Clinic, Chandrapuri Road, Roorkee	1	Self
32	Singh Pathology, 104 BT Ganj, Roorkee	-	CWTF
33	Gothi Hospital, Hardwar Road Roorkee	6	CWTF
34	Saharan Nursing Home Near BSM Tiraha, Dehradun Road ,Roorkee	11	CWTF
35	Dr. Hemendera Singh Clinc, Dehradun Road, Roorkee	2	CWTF
36	Mother & Child Hospital, Ramanager, Dehradun Road, Roorkee	13	CWTF
37	Dr. Ishwar Kumar Arora Clinic, 708 Santi Niketan, Ramnager Chowk, Roorkee	1	CWTF
38	Dental Clinic & Ortho Dentic Center, 12 Civil Line, Oop. Police station Roorkee	1	Self
39	Saini Nursing Home, Sukhdev nagar, Near sub jail, Dehradun Road, Roorkee	11	Self
40	Vardan Dental Clinic, Dehradun	-	Self

S.NO	Name of Health care	No of Bed	Mode of treatment &disposal
	Road, Roorkee		
41	Navin Mulit Specilty Hospital, Oop. Nehru Stadium,Roorkee	11	Self
42	Dr. SL Gupta Clinic, Pahari Bajar, Roorkee	-	CWTF
43	Dr. Satya Kumar Goyal Clinic, 391 Rajputana Street, Roorkee	-	CWTF
44	JNSM Govt. Combined Hospital, Ramnagar, Dehradun Road, Roorkee	106	CWTF
45	TB Hospital, Roorkee	-	Self
46	ESI Dispensary,Roorkee	-	Self
47	Dr. Shalini Aggarwal Nursing Home, Rajputana Street, Roorkee	-	Self
48	Harshvardhan Nursing Home, Dehradun Road, Roorkee	-	Self
49	Infectious Disease Hospital, Roorkee	-	Self
50	Hemant Hospital, Dehradun Road, Roorkee	-	CWTF
51	Maya Hospital, Dehradun Road, Kishanpur, Roorkee	-	Self
52	JP Hospital, Dehradun Road, Bhagwnpur, Roorkee	-	Self
53	Krishna Hospital, Bhagwanpur, Roorkee	-	Self
54	RK Mission Hospital Kankhal	-	Self
55	IIT University Hospital, Roorkee	30	Self
	Total	**538**	

3.3.6.3 Treatment and Disposal

At present Non Government Organization (NOG) is collecting and transporting waste common biomedical waste treatment facility which is located in Dehradun. Separate mechanism is not in place to handle biomedical waste and they are being disposed by the individual health care institutions.

3.3.7 SOLANI RIVER

3.3.7.1 General.

Solani River is getting polluted due to untreated sewage disposal Issued by the cities, which lies on the banks of the river without treatment. As well as some persons and wards and hospital the disposal of solid waste on the banks of the river as shown in Figure (3.47 and 3.48). Water quality in the Solani River shows high pollution content in most of the areas. Especially during the dry season. Where took the number of samples from the Solani river to test water quality and the form shows the sampling sites as the following tables show the results of the tests.

Figure 3.47: Disposal of untreated sewage in the Solani Rivers

Figure 3.48: Disposal solid waste on the banks of Solani Rivers

3.3.7.2 Components of Water Quality

As water is the best solvent available on earth, thus it is made up of several components. They are (1) Chemical Components -Water dissolves several gases and other materials, which influence its chemical properties. (2) Physical properties -Thermal stability, viscosity, vapour pressure and other processes constitute the physical properties of water. (3) Hydrological properties -Water has several hydrological properties like velocity, flow regime; bed characteristics etc. (4) Biological properties - All forms of natural water contains some life forms inhabiting it. (5) Pollutants - Pollutants are the most important components of a water body, because their presence may lead to several adverse effects to the either the water body or the users of the water.

3.3.7.3 Sampling Location

For the examination of different physic-chemical and biological parameters. samples were collected from three different places from Solani river. Sampling locations for different place are shown in the Figure 3.49 the number of sample (3).

Samples have been taken for physic-chemical and biological Examination in 500 ml Plastic bottles. The sampling bottles were transported to ecology Lab, in Department of (AHEC), Indian Institute of Technology Roorkee, Roorkee. The examination of different physic-chemical and biological.

All samples were tested the physic-chemical and biological Characteristics (COD, BOD, DO, TSS, Fecal coli form density, Phosphates, Nitrates and pH).

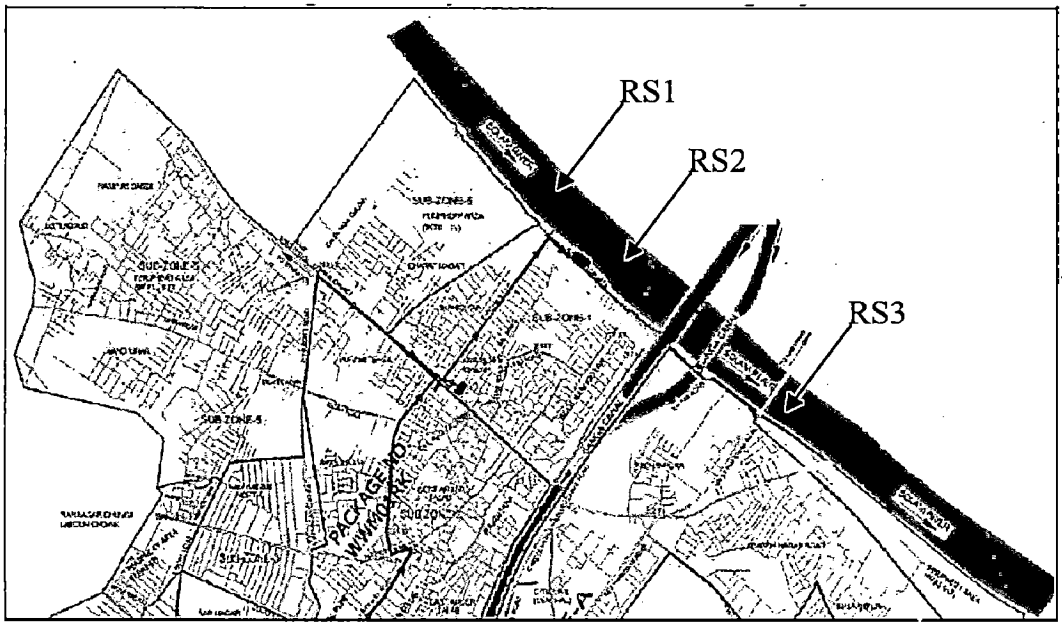


Figure3.49 : Location of sampling stations.

3.3.7.4 Water Quality Parameters

Observed values of various water quality parameters of Solani River are given in Table 3.30 as shows below.

Table 3.30:- Sample of water from Solani river.

No	Parameters	Units	Location		
			RS1	RS2	RS3
1	Biochemical Oxygen Demand (BOD)	Mg/l	17.6	98	130
2	Chemical Oxygen Demand (COD)	Mg/l	125	174	243
3	PH		7.6	7.1	7.1
4	Total solid (TS)	Mg/l	400	700	400
5	Suspended solids (TSS)	Mg/l	300	400	300
6	Dissolved Oxygen (DO)	Mg/l	8.54	1.62	1.60
7	Nitrate	Mg/l	0.60	4.50	4.30
8	Total phosphorus	Mg/l	2.40	14.80	10.36
9	Fecal coliform density	MPN Per100ml	460	2400	2400

3.3.7.5 The Water Use Of The River Solani

The grab samples from solani river (RS1-RS2-RS3) in Roorkee based on The CPCB has identified five such "designated best use" as given in Table 3.31 The river water is used for irrigation and industrial.

Table 3.31:- Classification of water body based on "designated best use"

Sr. No.	Designated Best Use	Quality Class	Primary quality criteria
1	Drinking water source without conventional treatment but with disinfections	A	PH 6.5–8.5; DO≥6.0; BOD< 2; MPN< 50
2	Organized outdoor bathing	B	PH 6.5–8.5; DO≥ 5.0:BOD≤3.0; MPN<500
3	Drinking water source with conventional treatment followed by disinfections	C	PH 6.5-8.5; DO≥6.0; BOD≤5.0; MPN<5000
4	Propagation of wildlife and fisheries	D	PH 6.5–8.5; DO≥6.0; $NH_4^+ \leq 1.2$
5	Irrigation, Industrial cooling and controlled water disposal	E	PH 6.5–8.5; cond 2250μ: Na absorption ratio max 20

3.3.8 Effluent Industrial

Industrial area outside the boundaries the Roorkee city. But the discharge of effluent for industrial area through the sewer network of the city.

3.3.9 Crematoria

The number of cremations two in Roorkee city but in future this number is likely to go up with the increase in population likewise there can be a future demand of a scientific solution of the problem.

3.3.10 Dairies

There is no big dairies in the town although there are cattle in few houses and the amount of excreta generated from this number of cattle is not very huge in quantity and is being used as bio manure in the house plantation therefore dairies are not a big problem in the city.

3.3.11 Dhobi Ghat

Roorkee Does not have a river flowing through the water throughout the year, but there Ganga canal passing through the city. there is no dhobi ghat working in the city.

3.3.12 Motor Garages

Based on discuss with officials in the municipal of Roorkee. There are not big motor garages in the town. As the city is not industrial in nature therefore the load of vehicular washing and consumption of water for washing is not very big in the city.

3.3.13 Cattle Wallowing

Based on discuss with officials in the municipal of Roorkee. There are number one cattle wallowing in the city.

3.3.14 Carcass Disposal

Based on discuss with officials in the municipal of Roorkee. There are not carcass disposal in the city.

CHAPTER- 4

COMMENTS ON ELEMENTS OF CITY SANITATION PLAN.

4.1 GENERAL

Based on the analysis of the existing situation for all the elements of city sanitation plan in the third chapter refer to the following observations:-

4.2 Comment On Water Supply

From the data have obtained from municipal office of Roorkee and UJS there are difference in total discharge of tube wells. This difference is equal to 0.90 MLD see Table 3.13. Also this difference causes in the incidence of errors in calculate the amount of water demand in the city. And from calculation for future water demand in city (2016-2021-2026-2041) see Table (3.16 and 3.17) and Figure (3.9 and 3.10) Roorkee have some zones they have Deficit as flowing:-

1). CIVIL LINES ZONE -I

In this zone has a shortfall in water demand after 30 years (-0.90 MLD) also the water demand in zone sufficient. and surplus in zone (0.07 MLD) after 15 years.

2). RAM NAGAR ZONE II

In this zone has a surplus in water demand after 30 years (+2.89 MLD) also the water demand in zone sufficient.

3). AVAS VIKAS ZONE III

In this zone has a surplus in water demand after 30 years (+1.02 MLD) also the water demand in zone sufficient.

4). MAQTOOLPURI ZONE IV

In this zone has a surplus in water demand after 30 years (+0.11 MLD) also the water demand in zone sufficient.

5). SOT MOHLLA ZONE V

In this zone has big deficit for all future years (2016, 2021, 2026, 2041) (3.65, 3.93, 4.22, 5.06) MLD.

6). GANESHPUR ZONE VI

In this zone has big deficit for all future years (2016, 2021, 2026, 2041) (1.46, 1.67, 1.89, 2.52) MLD.

Also there is no over head tank (OHT) in some zone (Sot Mohalla zone V and Ganeshpur zone VI) and some zone there is deficit in storage capacity (CIVIL LINES ZONE -I and MAQTOOLPURI ZONE IV) (142, 1620) KL. Also some zone it has storage capacity of water is sufficient for example (RAM NAGAR ZONE II and AVAS VIKAS ZONE III).

However . Through the above can supply water to zones that has deficit of water from other zones until the next 10 years and work on the drilling of more wells. even make balance in the water supply between zones in city based on the population in each zones. so not to cause problems in the calculation of the sewage system of the city also explain later.

4.3 Comment On Sewerage Network

Through Review to the amount of water available and calculations of the water demand for each zone. There is a gap between the actual amount of wastewater generated and wastewater calculated for some zones. For example the zones number {1, 5, 6} in this zones there are deficit in the amount of available water supply Whereas wastewater generated which calculated based on 82% of the value of water demand for the expected population. So this causing the blockage in sewer pipes due to of deposition within the pipes for not access to design velocity required for design sewerage network.

while the some zones it has surplus water supply available. this causing of overflow for wastewater. And errors in the calculation of the actual capacity for STP and SPS.

4.4 Comment On Solid Waste.

There are a large number of garbage bins from different kinds of concrete, metal and different size in the city, but notice the way to get rid of garbage not properly on the edge of the road and in the unused space between the living population due to following reasons:-

1). Garbage bins in zones non uniformly distributed. Based on the population in each zone.

2). Some families send their children for disposal garbage but the children can not disposal of the garbage the right way by putting in the garbage bin but left the garbage beside the garbage bin.

4.5 Comment On Bio-Medical Waste

The absence of a clear vision of how the collection and disposal and treatment of medical waste in the city.

CHAPTER- 5

PROPOSED INTERVENTIONS.

5.1 PROPOSAL FOR IMPROVEMENT OF WATER SUPPLY.

5.1.1 General

A proposal for improvement in water supply to improve the supply level, reorganization of existing zones of water supply has been prepared by Roorkee municipal in 2011 and is summarized as below.

Data has been used by collecting through field visits and discussing with responsible personal at the department of water supply network in municipal office Roorkee city.[9] and also referencing the report "Master plan for water supply system of Roorkee town (Februrary 2011)" of the Uttarakhand peyjal sansathan for development and construction Nigam (ADB supported schemes) Dehradun.[10]

1). **Zone 1 :-**

While analyzing the water supply system of this zone it is found that water pressure is not adequate, and as a result people are either getting their house service connection disconnected or using on line pumps to increase pressure. It is proposed that zone 1 comprise ward no 7, 8, 10,12 and 14 for water supply. See Figure 3.9

The existing OHT at Gandhi Vatika and existing tube well at Gandhi Vatika and civil lines as well as a new tube-well at Nagar Palika and the existing tube-well at Adarsh Nagar combined with the proposed tube-well at Solani Puram and proposed OHT at Solani Puram the will cater to the Zone 1.

As per the data available regarding discharge from all tube-well of zone 1 including two new tube-well there is a deficit of 0.90 MLD water zone 1. and therefore only one tube-well of 1800 LPM is proposed for Zone and can be used as standby in case of break down of other tube-well.

2). **Zone 2:-**

The zone boundary is realigned along the major roads for ease of operation, maintenance and identification. Reorganized Zone will comprise ward No 13, 15

and 18. The water production from the 4 tube-well of Ram Nagar is sufficient in this zone and so is the existing storage capacity of the OHT at Ram Nagar.

3). Zone 3:-

Zone 3 consists of ward no 11 (Avas Vikas) which has water supply system with one tube-well and one OHT. Zone 3 water production is sufficient as there is only one tube well. Therefore besides separating the supply of zone 5 it is.

4). Zone 4:-

This zone has three tube-well and one OHT at present. However, the zone boundary is reorganized along Dehardun highway on south side for ease of identification , operation and maintenance. The present discharge of three tube-wells is sufficient. The storage requirement in zone 4 for design stage is a deficit of 1620 KL. Also the existing OHT is in poor condition and therefore. It is proposed to construct a new OHT for storage requirement of design stage.

5). Zone 5:-

This zone also consists of periphery area towards west of the town. As reported by municipal office Roorkee, water is supplied to this periphery area also. Considering the periphery area water demand there is a big deficit of 5.06 in this zone. One tube-well at sabji mandi is in operation in zone 5, which also given a reduced discharage of 600 LPM. To increase the water production, U.J.S has proposed a tube-well at Sati Mohalla. As water production is still not sufficient therefore two new tube-well are required to be developed for this zone, it is also proposed that tube-well at Sabazi Mandi be redeveloped as this will not only meet the water demand but also give standby in case of break down of any tube-well.

As immediate remedial measure the supply in zone 5 can be enhanced by using the excess water from zone 1. There is no OHT in the zone and hence one OHT at Satimohlla is proposed for storage requirement of design stage.

6). Zone 6:-

In this zone also one tube-wells is in operation the zone also has high growth potential. There is a deficit of 2.52 MLD water and therefore 2 more tube-well would be required to meet the demand of intermediate stage out of these one tube well is proposed by UJS and one more needs to be planned. There is no OHT in the

zone and hence one OHT at Ganeshpur is proposed for storage requirement of design stage. The zone 1, 2 and 6 comprises of some area that is not under the authority of municipal council but UJS is supplying water to these area at present. Aspirate water supply scheme for these area is not planned as the extent of area is small and the existing OHT are sufficient to take care of this extra load.

5.1.2 Proposal For Source Improvement Municipal Area

1). Ground water tube-well as source.

To meet the water demand till 2041 following are proposed.

- ❖ New tube-well in zone 1, 5 and 6
- ❖ Rehabilitation of existing tube-well in zone 1, 2, 3, 5, 4 (total 8).

For the above it is suggested that a comprehensive hydro-geological study shall be conducted. This study would include identification of new tube-well location, check that optimum yield of present tube-well is reduced and suggest remedial measures for rehabilitation for improvement of yield.

5.1.3 Proposal For Source Improvement Peri-Urban Area

On similar lines to Roorkee municipal area. The hydro-geological study proposed for Roorkee town shall have peri-urban area in its scope and suitable water source shall be identified. If surface water source is identified for Roorkee town then water demand for peri-urban area will also be included in same source.

5.1.4 Proposal For Storage Improvement

To overcome the shortcomings of storage capacity identified in chapter 3 the proposals:

1). Renovation of existing over head tank including necessary piping arrangement required for scouring, over flow, dead storage for fire fighting, arrangement for level control, provision of bulk water meters, lightening arresters, etc..

2). Construction of new overhead tank as detailed in Table 5.1.

5.1.5 Proposal For Improvement In Pumping Station

Pumping machineries are required to be replaced as most of these are old & in operation since more than the life period. However it is suggested to take up the work of replacement of pumping machinery after the hydro-geological study as this study would

suggest the actual discharge from the bore-wells, and accordingly the pumping machinery can be optimally designed and installed.

Table 5.1: Proposed OHT and their capacity

S.No	Distribution zone	Present	Capacity in KL			
			by U.J.S [10]		Author's study	
			Required	Proposed	Required	Proposed
1	*Zone 1A	1700 + 450	2160	500	2292	500
2	*1B	NIL	1080	1100	NIL	NIL
3	2	2500	1670	NIL	1051	NIL
4	*3A	NIL	610	700	NIL	NIL
5	*3B	750	430	NIL	253	NIL
6	4	450	950	1000	2070	1700
7	5	NIL	970	1100	1999	2100
8	6	NIL	1550	1600	1507	1600

(*) has not been divided zone 1 and 3, as used by U.J.S. because dont get the maps that define the limits of separation, as well as the census and have not get the maps of water supply system. The difference between calculations and calculation of the Office U.J.S due to the following

- difference in the amount of discharge from wells, according to the table (3.13)
- designed on the basis of 2041|(30) years while UJS has based its proposal for the 2043 (40)years.

5.1.6 Proposal For Distribution System Improvement

1). Feed main from tube-well to over head tanks municipal area.

Under this proposal replacement of some of the existing feeder mains with new as per the design requirement is suggested due to following reasons.

i). It is reported there are direct connection from these feeder mains increasing water loss and reducing pressure.

ii). Distribution system of some of the areas is fed directly by these feeder mains.

iii). Pipe lines are old

The details of the proposed feeder mains are as follows in Table 5.2.

Table 5.2: Rising main details. [10]

S.No	Alignment		Diameter (mm)	Length (m)
	From	To		
1	Gandhi Vatika-1	Gandhi Vatika (OHT) new	150	50
2	Gandhi Vatika-2	Gandhi Vatika (OHT) new	200	60
3	Civil Lines	Gandhi Vatika (OHT) new	200	550
4	Adarsh Nagar	Adarsh Nagar (OHT) proposed	200	50
5	Ram Nagar-1	Ram Nagar (OHT)	200	236
6	Ram Nagar-2	Ram Nagar (OHT)	150	7
7	Ram Nagar-3	Ram Nagar (OHT)	200	48
8	Ram Nagar-4	Ram Nagar (OHT)	200	276
9	Chanderpuri	Magtoolpuri (OHT)	150	340
10	Magtoolpuri	Magtoolpuri (OHT)	150	10
11	Passiyan	Magtoolpuri (OHT)	200	7
12	Sabzi Mandi	Indra park (OHT) proposed	150	700
13	Ganeshpur-1	Ganeshpur (OHT) proposed	200	920
14	Padav	Padav (OHT) proposed	200	20
15	Awas Vikas-1	Awas Vikas (OHT)	150	15
16	Awas Vikas-2	Awas Vikas (OHT)	200	371

5.1.7 Proposal For Treatment Facility.

The water quality analysis of tube-well in the town reveals that, the quality of water is acceptable, however, due to contamination of coli form is proposed for on line chlorination for disinfect of water.[10]

5.1.8 Proposal For Operation And Maintenance .

Suggested operation and maintenance setup for UJS for Roorkee water supply scheme is given in Table 5.3.

Table 5.3: O&M setup for UJS. [10]

Position	Required No	Responsibilities
Assistant Engineer	1	Overall super vision and control of programme
Junior engineer	3	Supervision of field work
Chemist / Bacterial gist	1	Analysis of water sample
Valve operations, fitters, plumbers	8	Routing field work
Instrument mechanic	1	Repair of instruments
Filed technician	4	Sounding and pipe alignment
Draught stman	1	Drawing and updating of plans and network
Record keeper/ Clerk / Typist	2	Office work
Unskilled labour	6	Assisting filter and plumbers

5.1.9 Miscellaneous Work.

1). Procurement of DG (Diesel Generator) set:-

It was observed during the site visit that power cut during the summer month in Roorkee town is very frequent. This in turn affects the functioning of pumps and hence the water supply system overall. To minimize the affect due to power cut it is proposed to install on DG set in each zone so that at least one pump will be under operation even during power cuts.

2). Construction of office building for staff structure for water supply department

In view of expending the staff structure of responsible for operation and maintenance a separate office building would be required. The total built up area requirement would be around 2000 sq. ft.

3). Small laboratory :

It is suggested to construct a small laboratory with in the proposed office building of Jal Sansthan. This would facilities regular water quality monitoring.

4). Pump operators rooms :

It is suggested at least one room with toilet facility for pump operator shall be constructed in each zone. The approximate built up area required for this would be about 150 sq ft.

5). Automation of pumping units and auto level control for over head tank:

For ease of operation and maintenance, it is suggested that auto level controller shall be installed in over head tank which will be connected to pumps. The arrangement shall be such that the pump stops functioning as soon as the water level in the over head tanks reaches to is maximum level and starts operating when the water level in over head tank reaches to its minimum/ per-defined water level.

5.2 PROPOSAL FOR IMPROVEMENT OF SEWERAGE NETWORK

5.2.1. General

The conventional gravity flow system is the most widely used around the world. It has proved to be the most reliable and requires quite limited maintenance and repair when it is properly designed and good material is used.

Roorkee town has a gently sloping topography with slope from south to north towards river Solani. However the Ganga canal slope to wards the southwest. Based on topography and Ganga canal. The Roorkee town has been divided in to two part. East part and western part of Ganga.

The use of a large number pumping stations is not desirable because first they one costly and second they required alert monitoring . often incensing repair and regular maintenance which become a costly operation on the other hand deep excavation and pipe are also costly and difficult to implement due to the site conditions where high water table is expected depth of sub soil water in this area varies from 6.0 meter to 10.0 meter ,with average depth of 8.00m.

Data has been used by collecting through field visits and discussing with responsible personal at the department of water supply network in municipal office Roorkee city.[9] and Uttarakhand peyjal sansathan for development and construction Nigam (ADB supported schemes) Dehradun.[10]

5.2.2. Proposed Sewerage Zones

The Roorkee town is divided in two main drainage districts .eastern part of Ganga canal named as zoneA excluding it CBRI. and cantonments and western part of Ganga canal named as zone B. zone B is further divided in to seven sub zone namely sub zone 1.2.3.4.5.6.7 and based on topography and land use pattern. as show in Figure 5.1

A Eastern part [zone A].

Eastern part of Ganga Canal is surrounded by Solani River on north. Ganga Canal on west. IIT&CBRI on east. This area comprises of civil lines Solani puram Adarsh Nagar. Malakhpur, adjoining periphery area (peri) khanjarpur area (peri-VII) ete...

Eastern part of Ganga Canal including adjoining periphery area of municipal wards is considered as one sewerage zone named as zoneA. Approximate area of this sub Zone is 360.33 hectare.

(Zone A.) Sewage flow from eastern part will be drain by gravity from wards to proposed SPS in eastern part of town at the khanjarpur village sewage flow this proposed [SPS] in khanjarur village will be pumped to a proposed STP in sub zone(1) of zone (B) at the southern bank of Solani river near cremation ground proposed pumping main starting from proposed SPS Khanjarpure will be laid west ward a long the road in malakhpure area up to adarshnagar then it will be laid along the right bank of Solani river and passing through below the bridge of haridwar road NH.58 over Solani river and below the ducts of Ganga canal over Solani river and after crossing duct of Ganga canal it will again laid a long the road up to proposed STP . Figure 5.3.

B western part [zone B]

Western part of Ganga canal surrounded by Solani river on north Ganga. On east railway line on south and Rajendra nagar & subhash nagar area on west. This are comprises of Mahigran ,Chau Mandi Ram nagar. Ganesh pur sheikhpuri , Amber Talab Maqtoolpuri ,et.. western part (zone B) of western part of Ganga canal area is further divided in to seven sewerage sub zone four for municipal area, namely sub zone 1, Sub zone 2, sub zone3, sub zone 4.and three for periphery area (peri urban area) of adjoining municipal wards namely sub zone 5, sub zone 6 and sub zone 7 . see Figure 5.1 and Figure 5.2.

Sub zone 1 :-

Sub zone 1 is area north of NH 73 east of Mandi parished, south of Solani River and west of Ganga Canal and consisting mainly of north west portion of the town. Approximate area of this sub zone is 76.75 hectare. Refer drawing (map 5.2) for sub zone boundary delineation, proposed SPS-STP location. Sewage flow generated from sub zone 1 will be drained by gravity to wards proposed STP along southern bank of Solani River at soot mohalla near cremation ground as show Figure 5.3.

Sub zone 2 :-

Sub zone 2 is the central portion of the western part Consisting mainly of Amber talab , Saket colony, Valmiki colony. Chaumandi, Sewage flow from this zone will be drained by gravity towards existing mahigran SPS. Approximate are of this sub zone is 172.97 hectare. show Figure 5.2.

Sub zone 3:-

Sub zone 3 is the western area of zone B and mainly consistent of the Ram Nagar area ward no 15 and partly 18 and adjoining periphery area (peri II). Sewage from this sub zone will be drained by gravity towards existing mahigran SPS. Approximate area of This zone is 52.05 hectare. See Figure 5.2.

Sub zone 4 :-

Sub zone 4 is the southwest portion of the western Part of the town mainly consisting of Ganeshpune area (word 4) , Shekhapurri(word No3),Ramnager south (word No15 parotly), Malviya chowk , Nehru Nager , Azad Nager,Gandhi Nagar, Preet Vihar, Shivam Vihar, Geetanjali Vihar and adjoining periphery area .Approximate area of this sub zone is 178.36 hectare. See Figure 5.2.

Sub zone 5:-

Sub zone 5 is the adjoining periphery area (peri III) of municipal ward no 18 (Ramanagar) and ward no 19 (Purani teshil) it is surrounded by dehradun road on north and east Ramanager area and industrial area on south and agricultural land on west it is mainly consisting of Rampur village sunahara village, Naibssti, Nand vilar, mangal vihar, Shyam Nagar, Ambedkar Nagar, etc..approximate area of this sub zone 169.51 ha. See Figure 5.2.

Sewage flow from this sub zone will be done by gravity towards existing Mahigran SPS. See Figure 5.3.

Sub zone 6:-

Sub zone 6 is adjoining periphery (area peri-IV) of municipal word no 16 (Mahigrah) and it is surrounded by Solani river on north dehradun road & market area on south Mahigran & Soot Mahalla on east and agricultural land on west.

It is mainly consisting of Rampur village,Bharat Nagar, Sabji Mandi et.. approximate area sub zone 65.97ha. see Figure 5.2.

Sewage from this zone will be drained by gravity towards proposed STP along the right bank of Solani river up to proposed STP near cremation ground at Soot Mohalla waste water. See Figure 5.3.

Sub zone 7:-

Sub zone 7 is adjoining periphery area (peri-V) of ward no-4 (Ganeshpure),ward no 3 (Shekhpuri) and ward no 15 (Ramnager south) it is surrounded by Rajendra Najar area on north Ganeshpur on west and agricultural and on south west. It consisting of shubhash Nagar, Rajendra Nagar, Krishna Nagar. Figure 5.2.

Shastri Nagar, Vinit Nagar ..etc. approximate area 82.00 ha.

Sewerage flow generated from this sub zone will be collected at the lowest point of this area and separate STP will be proposed for this area because this is a medium urbanization and population growth area in last few years.

5.2.3. Sewage Treatment STP and S.P.S

1). Sewage pumping station

i). Ganeshpur SPS

Sewage flow generated from sub zone 4 would be collected by gravity to proposed SPS of 25 MLD capacity at Ganeshpur talab and will be pumped to a proposed ridge manhole in sub zone 2 from the proposed SPS in Ganesshpur area. As show in Figure 5.3

ii). Mahigran SPS

Sewage flow generated from zone B (sub zone 2, sub zone 3, sub zone 4, of municipal area and sub zone 5, of periphery area of municipal boundary) will be collected at existing Mahigran SPS in sub zone 1 and will be pumped to proposed nearest ridge manhole in Mahigran area (Sub zone 1)and pumped sewage from mahigran into mediate pumping station will be drained through sub zone 1 by

gravity to proposed STP along the southern bank of Solani river at soot Mohalla as shown in Figure 5.3.

Capacity of the existing pumping station at Mahigran would be increased to accommodate the 73 MLD sewage flow sub zone 2,3,4,5

iii). Khanjarpur SPS

Sewage flow generated from zone A (including periphery area) would be collected by gravity to proposed intermediate sewage pumping station of 36 MLD capacity at Khanjarpur village. Sewage flow from proposed SPS at kharnpur village will be pumped to a proposed STP at Soat Mohalla. as shown in Figure 5.3

2). Sewage Treatment Plant STP

The total sewage flow generated from all above three SPS will be pumped to a proposed STP of 39 MLD for year 2041 (34 MLD for year 2028 by UJS) MLD capacity and proposed the method of treatment extended aeration (by UJS). The identified land for proposed STP 53 MLD (by UJS for year 2043) capacity along the southern bank of Solani river at soot Mohalla near cremation ground is under the possession of Roorkee revenue department as per the discussion, Roorkee revenue department would make available the required land for STP construction .

Sewage flow generated from sub zone 1 and 6 would be collected by gravity directly to terminal pumping station of proposed STP.

Sewage at STP will be treated and effluent will be discharge in to Solani river or may be used for irrigation purpose . as shown in Figure 5.3

3). Contract package

Area covered under this package zone 2,3,4,5 in zone B including periphery area as shown in drawing

Table 5.4: Salient features of proposed contract package area.[10]

1	Total coverage area of city in this package	5.76 km^2
2	Total length of sewer network (approximate)	118 km
3	Proposed min diameter of sewer pipe	200 mm
4	Proposed Max diameter of sewer pipe	1000 mm
5	Pipe material	RCC-NP3 and NP4
6	Number of manholes (approximate)	4998
7	Manhole material	Brick, RCC
8	Approximate cost estimates (including 2 SPS)	Rs 6837 lacs

Table 5.5: Area covered under zone A and sub zone1 and zone A.[10]

1	Total coverage area of city in this package	3.68 km^2
2	Total length of sewer network (approximate)	80 km
3	Proposed min diameter of sewer pipe	200 mm
4	Proposed Max diameter of sewer pipe	600 mm
5	Pipe material	RCC-NP3 and NP4
6	Number of manholes (approximate)	3000
7	Manhole material	Brick, RCC
8	Approximate cost estimates (including 2 SPS)	Rs 4000 lacs

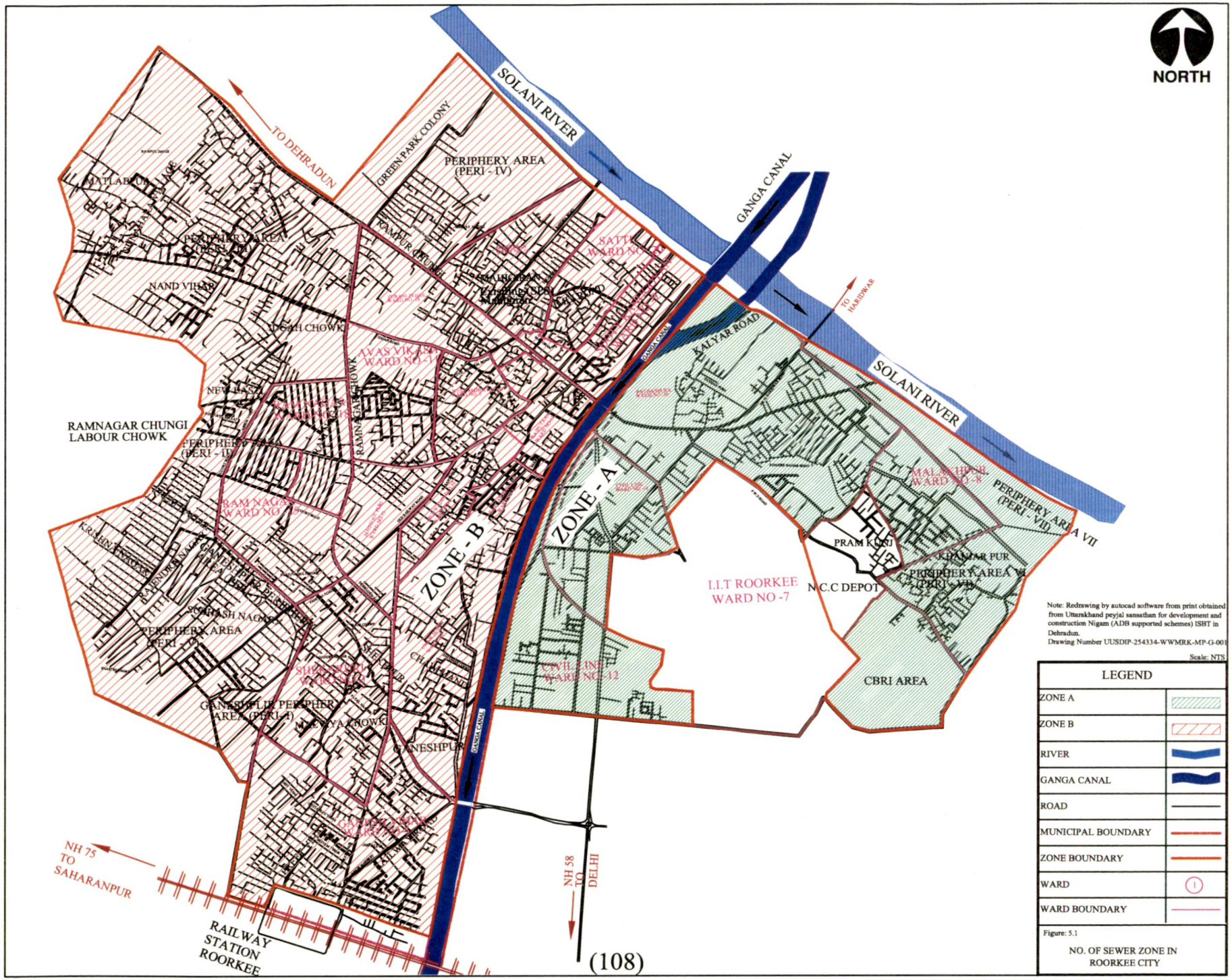
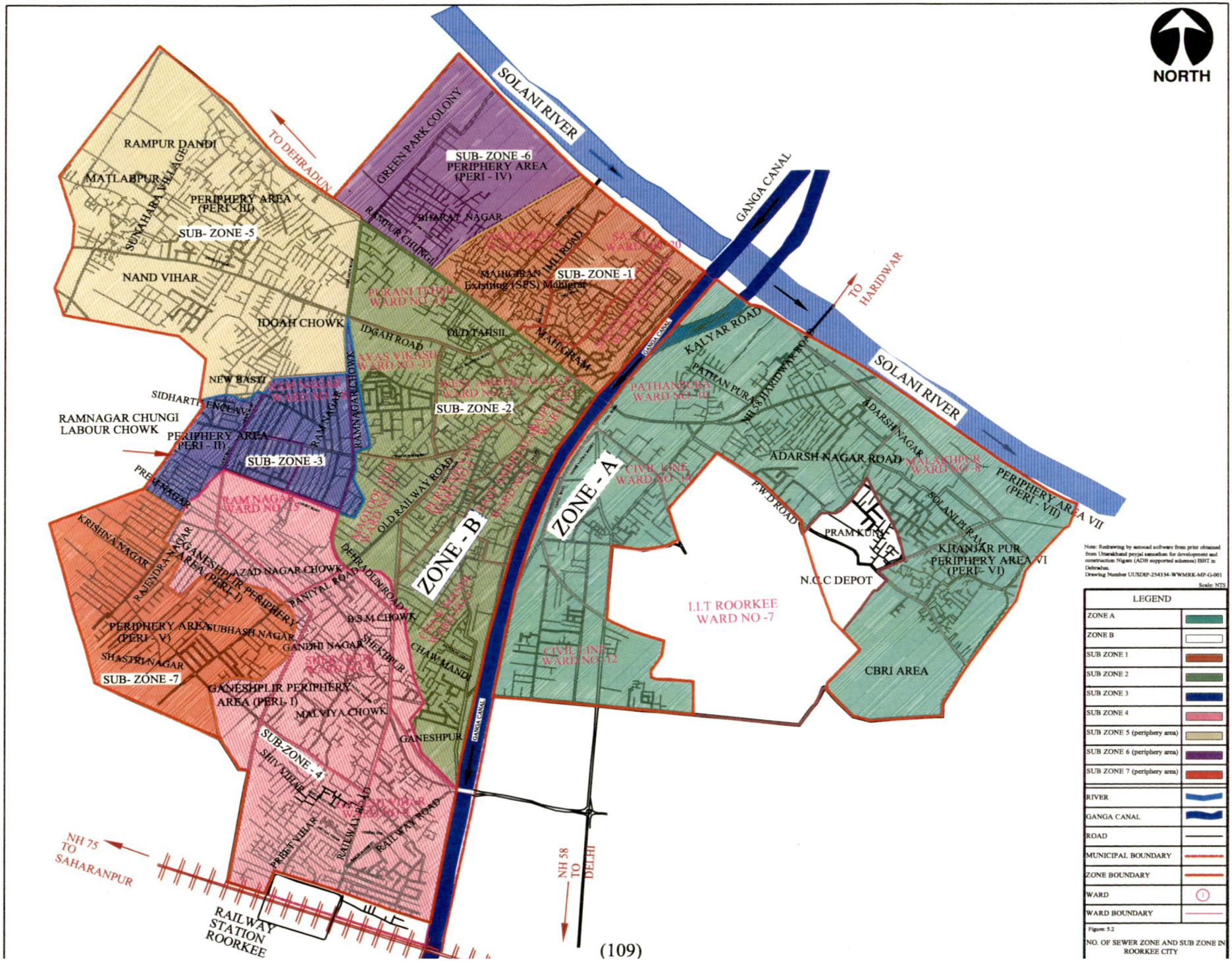


Figure: 5.1

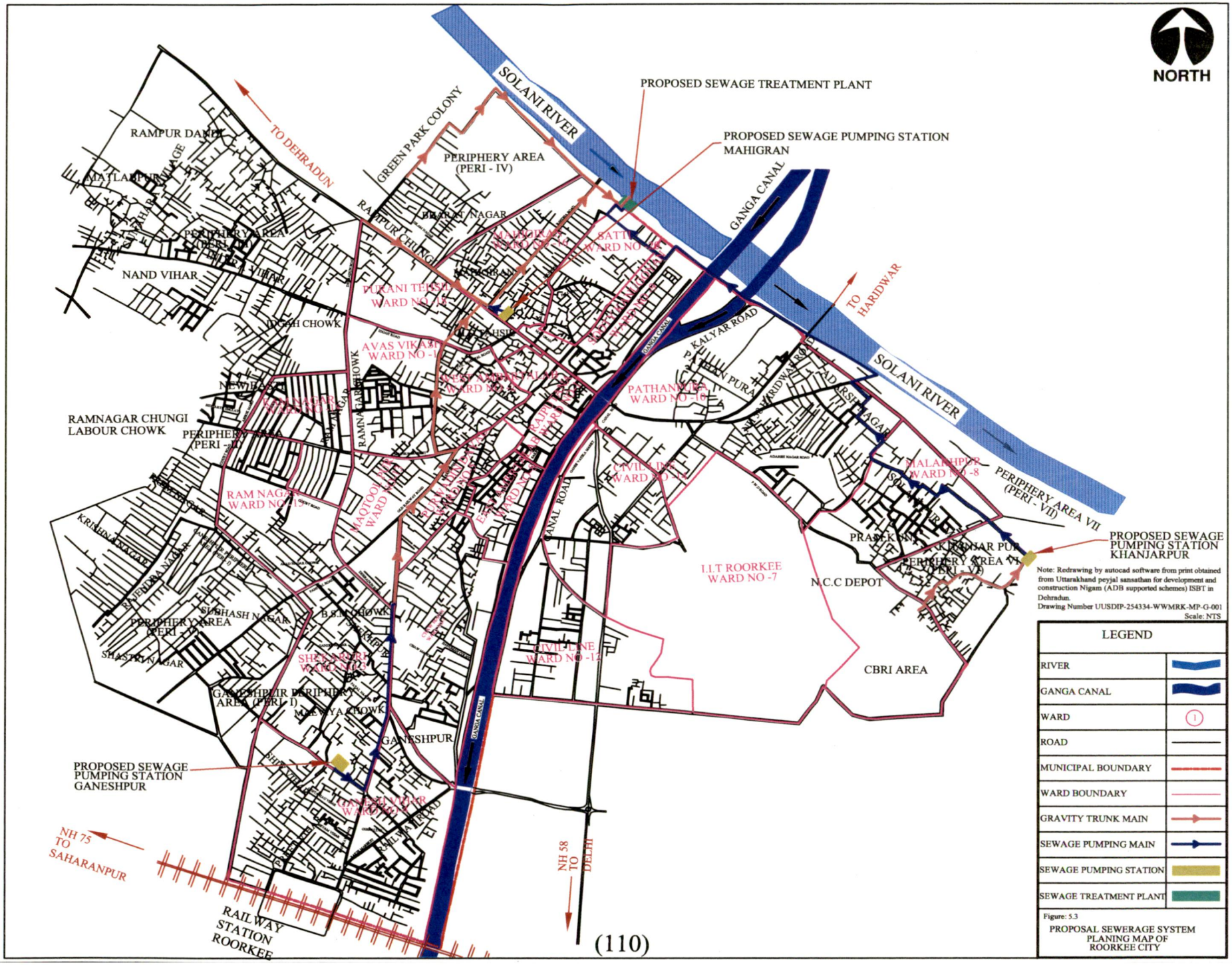
NO. OF SEWER ZONE IN ROORKEE CITY



Note: Redrawing by autocad software from print obtained from Uttarakhand peyjal sansathan for development and construction Nigam (ADB supported schemes) ISHT in Dehradun.
Drawing Number UUSDIP-254334-WWMRK-MP-G-001
Scale: NTS

LEGEND	
ZONE A	
ZONE B	
SUB ZONE 1	
SUB ZONE 2	
SUB ZONE 3	
SUB ZONE 4	
SUB ZONE 5 (periphery area)	
SUB ZONE 6 (periphery area)	
SUB ZONE 7 (periphery area)	
RIVER	
GANGA CANAL	
ROAD	
MUNICIPAL BOUNDARY	
ZONE BOUNDARY	
WARD	1
WARD BOUNDARY	

Figure: 5.2
NO. OF SEWER ZONE AND SUB ZONE IN ROORKEE CITY



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Drawing Number UUSDIP-254334-WWMRK-MP-G-001
Scale: NTS

Figure: 5.3
PROPOSAL SEWERAGE SYSTEM PLANING MAP OF ROORKEE CITY

5.3 PROPOSAL FOR IMPROVEMENT OF SOLID WASTE

5.3.1. Calculation Of Amount Of Solid Waste Dumped And Required Number Of Bin For Each Ward (short-term plan and medium-term plan).

1). The solid waste generation per person per day in Roorkee town 385g/c/d

2). Assumed density of municipal solid waste (300 to 560) kg/m^3(Bhide et al.) **[5]** taken average density =430 kg/m^3

3). Degree of cleaning =(as per actual)

Table 5.6: Amount of solid waste of Bins 2016.

Ward No.	Ward Name	2016		
		Population	Solid Waste Generation (Metric Tonne)	Required volum of bins in m^3
1	Chaw Mandi	8408	3.24	7.53
2	West Ambar Talab (Northern Area)	7345	2.83	6.58
3	Shekhpuri	9596	3.69	8.59
4	Eastern Walli	10959	4.22	9.81
5	Easernt Deen Dyal	3703	1.43	3.32
6	Eastern Amber Talab	5214	2.01	4.67
7	I.I.T Roorkee	9868	3.80	8.84
8	C.B.R.I	3790	1.46	3.39
9	Sot	4182	1.61	3.74
10	Civil Line (Northern Area)	10871	4.19	9.73
11	West Ambar Talab (Western Area)	3456	1.33	3.09
12	Civil Line (Southern Area)	3792	1.46	3.40
13	West Ambar Talab (Middle Area)	5402	2.08	4.84
14	Civil Line (Middle Area)	2957	1.14	2.65
15	Ram Nagar (Southern Area)	5025	1.93	4.50
16	Mahigran	11275	4.34	10.10
17	Rajputana West	3569	1.37	3.20

Ward No.	Ward Name	2016		
		Population	Solid Waste Generation (Metric Tonne)	Required volum of bins in m^3
18	Ram Nagar (Northern Area)	3914	1.51	3.50
19	Old Tehsil	6202	2.39	5.55
20	Satti Mohalla	5608	2.16	5.02
TOTAL		**125134**	**48.18**	**112.04**

Table 5.7 :-Amount of solid waste for each ward of Bins 2026.

Ward No.	Ward Name	2026		
		Population	Solid Waste Generation (Metric Tonne)	Required volum of bins in m^3
1	Chaw Mandi	9527	3.67	8.53
2	West Ambar Talab (Northern Area)	8322	3.20	7.45
3	Shekhpuri	10873	4.19	9.73
4	Eastern Walli	12418	4.78	11.12
5	Easernt Deen Dyal	4195	1.62	3.76
6	Eastern Amber Talab	5908	2.27	5.29
7	I.I.T Roorkee	11181	4.30	10.01
8	C.B.R.I	4295	1.65	3.85
9	Sot	4738	1.82	4.24
10	Civil Line (Northern Area)	12317	4.74	11.03
11	West Ambar Talab (Western Area)	3916	1.51	3.51
12	Civil Line (Southern Area)	4297	1.65	3.85
13	West Ambar Talab (Middle Area)	6120	2.36	5.48
14	Civil Line (Middle Area)	3350	1.29	3.00
15	Ram Nagar (Southern Area)	5693	2.19	5.10
16	Mahigran	12776	4.92	11.44
17	Rajputana West	4043	1.56	3.62

Ward No.	Ward Name	2026		
		Population	Solid Waste Generation (Metric Tonne)	Required volum of bins in m^3
18	Ram Nagar (Northern Area)	4435	1.71	3.97
19	Old Tehsil	7027	2.71	6.29
20	Satti Mohalla	6355	2.45	5.69
TOTAL		**141784**	**54.59**	**126.95**

Table 5.8 :-Amount of solid waste for each ward of Bins 2041.

Ward No.	Ward Name	2041		
		Population	Solid Waste Generation (Metric Tonne)	Required volum of bins in m^3
1	Chaw Mandi	11205	4.31	10.03
2	West Ambar Talab (Northern Area)	9787	3.77	8.76
3	Shekhpuri	12788	4.92	11.45
4	Eastern Walli	14606	5.62	13.08
5	Easernt Deen Dyal	4934	1.90	4.42
6	Eastern Amber Talab	6948	2.68	6.22
7	I.I.T Roorkee	13151	5.06	11.77
8	C.B.R.I	5051	1.94	4.52
9	Sot	5572	2.15	4.99
10	Civil Line (Northern Area)	14488	5.58	12.97
11	West Ambar Talab (Western Area)	4605	1.77	4.12
12	Civil Line (Southern Area)	5053	1.95	4.52
13	West Ambar Talab (Middle Area)	7197	2.77	6.44
14	Civil Line (Middle Area)	3940	1.52	3.53
15	Ram Nagar (Southern Area)	6696	2.58	6.00
16	Mahigran	15027	5.79	13.45
17	Rajputana West	4754	1.83	4.26

Ward No.	Ward Name	2041		
		Population	Solid Waste Generation (Metric Tonne)	Required volum of bins in m^3
18	Ram Nagar (Northern Area)	5216	2.01	4.67
19	Old Tehsil	8265	3.18	7.40
20	Satti Mohalla	7475	2.88	6.69
TOTAL		**166759**	**64.20**	**149.31**

Table 5.9: The actual volume bins in Roorkee twon.

S.No	Type of Bin	Number	Volume (m^3)	Total volume (m^3)
1	DALAO (Large Concrete Bins)	49	2	98
2	DALAO (Small Concrete Bins)	16	1	16
3	DUST BINS (Iron) Small size	40	1	40
4	DUST BINS (Iron) Big size	15	4.5	67.5
Total volume				221.5

5.3.2. Landfill Site.

Landfills must be generally design to dispose of inert waste which cannot be used any further. Sanitary landfills must be design on the principle of waste containment and are characterized by the presence of a liner and leachate collection system to prevent ground water contamination. The landfills are scientifically design for waste disposal wherein inerts are stored. To prevent the groundwater contamination, the surface is lined and leachate collection system is provided. The figure below shows Figure 5.4 the schematic representation of different components of landfills.

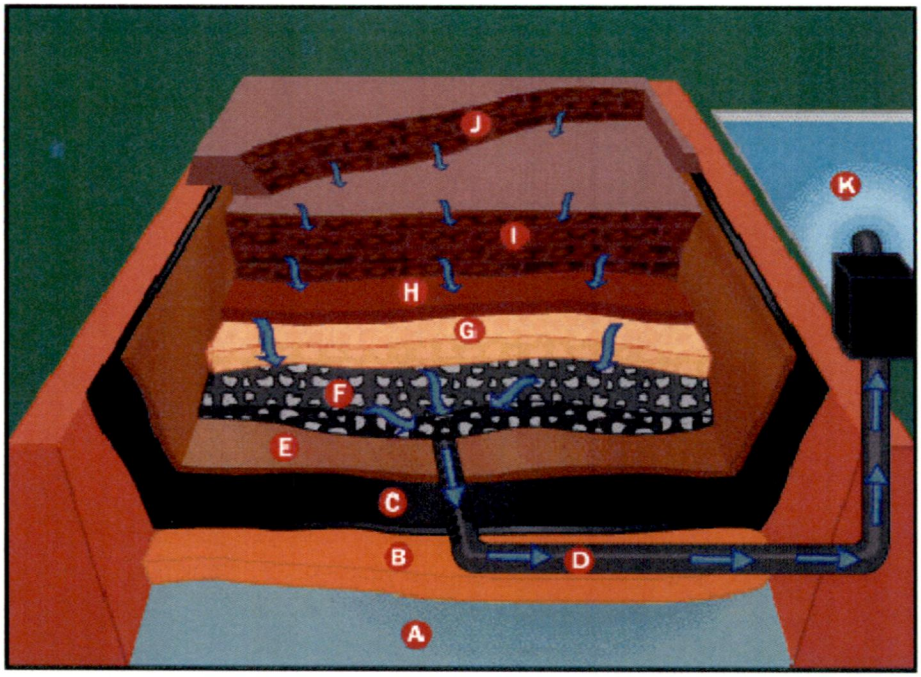


Figure 5.4: Schematic representation of land fill site.

Where :-

A	**Ground water.**	**G**	**Drainage Layer.**
B	**Compacted Clay.**	**H**	**Soil Layer**
C	**Plastic Liner.**	**I**	**Old Cells**
D	**Leachate Collection Pipe**	**J**	**New Cells**
E	**Geotextile Mat**	**K**	**Leachate Pond**
D	**Gravel**		

5.3.3. Suggested Options For SWM

Considering the issues and concerns related to solid waste disposal in Roorkee, the need is to develop an sustainable, low cost, environment friendly system that works with public-private-community participation. The system is not only decentralized but also reduces the overall disposable burden and contributes to improve environment as well as local economy. following options are suggested for the city of Roorkee.

i). Establish solid waste management centre for Processing of municipal waste

ii). Seeking chances for development of sanitary landfill site for inert and non-recyclable wastes.

1). **Long Term Option:** The option suggests door to door collection of solid waste by hand driven or peddles driven carts. It is suggested to segregate the dry and wet garbage generated from each house in two separate plastic bins. It will be taken to transfer station or then taken to the landfill site for treatment. The separately collected biodegradable waste will be to the community level composting site. The number of sites may vary depending upon the size of the cluster or ward and amount of collected waste. Dry garbage (or nonperishable or non biodegradable waste) will be collected separately and taken to transfer station.

2). **Short Term Option:** The option is similar to the existing practice of using community bins. There won't be household level door to door waste collection. The waste dumped in these bins will be directly taken to the landfill site and will be segregated before treatment.

3). Segregation of Biodegradable and non Biodegradable waste at the source of generation is households/ shop/ markets plan Separate containers at the collection site for both . 25 more bins are to be purchase.

5.3.4. Plan for Solid Waste Management for Roorkee

Proposed plan for solid waste management includes:

i). Mass awareness campaign through IEC [Information, Education and Communication].

ii). Collection of domestic/trade /institutional and slaughterhouse waste from source.

iii). Primary segregation at source.

iv). Establishment of solid waste management centre, which includes Municipal waste processing units for transformation of biodegradable and organic waste into organic manure.

v). Second level segregation of waste at solid waste management centre.

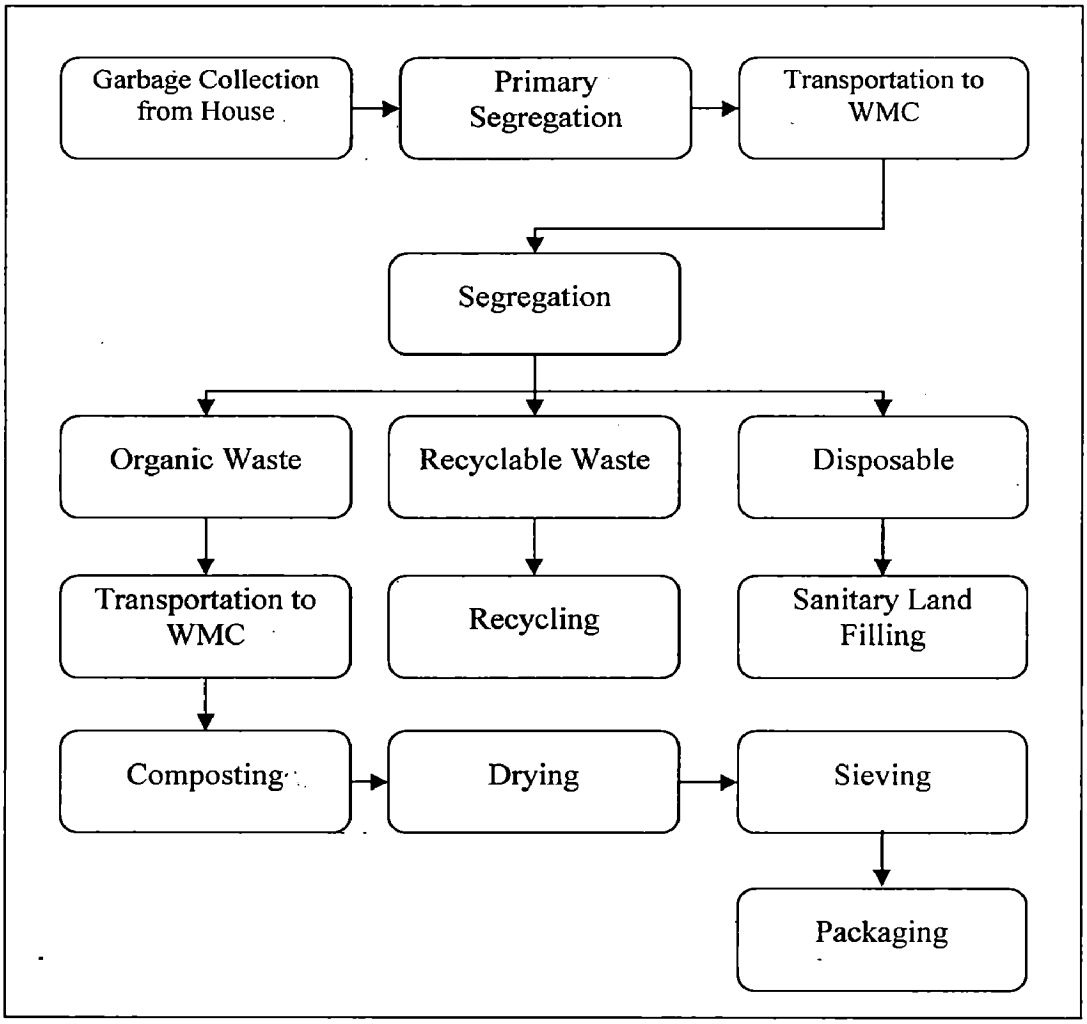
vi). Development of sanitary landfill site as per sanitary land filling norms

vii). Installation of water quality monitoring hand pump at sanitary landfill site

viii). Construction of waste collection centres at identified locations.

ix). Training and capacity building of concerned staff.

x). Regular review and monitoring.



*75-80% Reduction of garbage to be disposed off in land filling.

Figure 5.5:- Chart for municipal waste management.[9]

5.4 PROPOSAL FOR IMPROVEMENT OF BIO MEDICAL WASTE

5.4.1. General .

Means a waste that may contain human pathogens of sufficient virulence and in sufficient concentrations that exposure to it by a susceptible host could result in disease. And "Biomedical waste activity" means the generation, handling, storage, transport, treatment, or disposal of biomedical waste.

The hospitals, nursing homes, clinic, dispensary, animal house, pathological lab etc., are therefore required to set in place the biological waste treatment facilities. It is however not incumbent that every institution has to have its own waste treatment facility. The rules also envisage that common facility or any other facilities can be used for waste treatment. However it is incumbent on the occupier to ensure that the waste is treated within a period of 48 hours (The Gazette of India 1998).

5.4.2. Recommendations For Roorkee Hospital Waste

Handling, segregation, mutilation, disinfection, storage, transportation and final disposal are vital steps for safe and scientific management of biomedical waste in any establishment. The key to minimization and effective management of biomedical waste is identification of the waste and segregation (separation). The most appropriate way of identifying the categories of biomedical waste is by sorting the waste into color coded plastic bags or containers. Biomedical waste should be segregated into containers bags at the point of generation in accordance with Schedule II of Biomedical Waste (management and handling) Rules 2001. General waste like garbage, garden refuse etc. should join the stream of domestic refuse. Sharps should be collected in puncture proof containers. Bags and containers for infectious waste should be marked with Biohazard symbol. Highly infectious waste should be sterilized by. autoclaving. Cytotoxic wastes are to be collected in leak proof containers clearly labeled as cytotoxic waste. Needles and syringes should be destroyed with the help of needle destroyer and syringe cutters provided at the point of generation. Infusion sets, bottles and gloves should be cut with curved scissors.

Disinfection of sharps, soiled linen, plastic and rubber goods is to be achieved at point of generation by usage of sodium hypochlorite with minimum contact of 1 hour. Fresh solution should be made in each shift. On site collection requires staff to close the waste bags when they are three quarters full either by tying the neck or by sealing the bag. Kerb side storage area needs to be impermeable and hard standing with good drainage. It should provide an easy access to waste collection vehicle. Biomedical waste should be transported within the hospital by means of wheeled trolleys, containers or carts that are not used for any other purpose. The trolleys should be cleaned daily. Off site transportation vehicle should be marked with the name and address of carrier. Biohazard symbol should be painted. Suitable system for securing the load during transport should be ensured. Such a vehicle should be easily cleanable with rounded comers. All disposable plastic should be subjected to shredding before disposing off to vendor. Final treatment of biomedical waste can be done by technologies like incineration, autoclave, hydroclave or microwave.

Biomedical Waste Management rules insist that all infectious hazards waste should be properly treated and disposed off. About 2000 kg of infectious wastes are produced in the health care facilities of Roorkee. A properly planned project for the

management and disposal of these hazards wastes should be implemented and carried out at the earliest.

Presently individual waste management facilities in hospitals are not advised due to economic reasons. It is strongly recommended that a common waste treatment facility is established in the city which can cater to every health care facility. The financial requirements for such a facility include the following:-

1). **The initial investments.**

With systems being installed in most of the HCUs, financial provision is necessary for capital and recurring expenditure. A long-term plan for resource recovery should also be included, and provision of funds for sufficient manpower, disinfectants, devices and equipment needs to be made. The total cost of the land, equipments and vehicles will be Rs 1.50 crore. see the Table 6.4

2). **The cost of packing and transportation from hospitals to the facility.**

This will include containers, bags, trolleys etc to be provided inside the hospital, specially designed vehicles for carrying the waste bags to the facility, fuel and other costs, cost of labour etc.

3). **Treatment and disposal cost.**

Maintenance of the equipments, vehicles and the facility. Continuous maintenance of equipments such as Incinerators and Autoclaves is a must. A Break down of any equipment can be costly.

4). **Maintenance of the facility and equipments**

Continuous research is being carried out in the field of waste management and treatment. Methods with lesser pollution to the environment at lesser cost will be available in the near future. Funds are to be earmarked for modernizing the facility with the purchase of newer equipments such as Irradiation Equipments. It is recommended that the funds for the initial investments and the maintenance and operation of the Common Facility may be obtained.

5). **Updating and modernizing the facility.**

The infectious wastes produced in a health care facility amounts to about, 30% of the total wastes (Patil and Shekdar 2001). All the other wastes can be considered as harmless domestic wastes. The treatment of infectious wastes being very costly, segregation wastes at sources is necessary. Proper training of every one in the hospital is a must and such training should he apart of this programme. Help and assistance may be obtained from suitable agencies such as Indian Medical Association for this purpose.

5.4.3. Common Bio-Medical Waste Treatment Facility

The recommendations made could facilitate further improving the state of the waste collection in Roorkee, presently about 2000kg of infectious wastes have to be treated daily. The wastes to be incinerated as per the Biomedical Waste

Table 5.10: Machinery requirement for common bio-medical waste treatment facility. [27]

S.No	Description	Capacity	Quantity
1	Incinerator(1 +1 standby)	250kg/per hr capacity	1
2	Auto Clave	150kg/hr	1
3	Shredder for plastics		1
4	Effluent Treatment Plant		1
5	30 m high chimney		1
6	Vehicles for transportation		2 small
7	Other equipments such as Transformer, Water Pump, Air Compressor		

Management and Disposal Rules (2000). The machinery requirements will be as as shown in above Table 5.6 (Machinery Requirement for Common Biomedical Waste Treatment Facility).

Common Biomedical treatment Facilities are setup for the treatment and disposal of Biomedical Wastes generated in a number of health care facilities. They are likely to be more economical than individual waste treatment facilities. Resources can be utilized

optimally in case of common Facilities. Implementation of Common Waste Treatment Facility. The land for setting up CWTF has to be selected after detailed studies.
the main considerations are:

1). **Minimum Area:-**

The buildings required for the Plant, Effluent Treatment, Vehicle parking, Offices etc could be managed in about 0.5 acres. But it is mandatory that such treatment facilities should have a landfill site and naught green cover. Again this plot of land should be as far away from habitation (This is definitely not because of any pollution from such facilities). Again it is better to have such facilities away from water bodies.

The Hospitals and Nursing Home are solely responsible for segregation packaging. Storage and labelling of wastes should be done as per the relevant schedules of Biomedical Waste (Managements & Handling) Rules. The vehicles transporting the wastes to the facility shall be designed exactly as per the standards of Bureau of Indian Standards. They should also be labelled with symbols meant for hazardous wastes. The common Treatment facilities should comply with all the emission and effluent standards of the pollution control Board. More over prior to installation of any CWTF the operation of such facilities should obtain the authorization from the prescribed authorities. Private Health care facilities participating in the Common Facilities shall bear the expenses for treatment and transportation. The criteria for fixing the amount to be charged shall be worked out depending on the wastes produced.

2). **Treatment of Infectious Biomedical Solid Waste**

The final disposal of infectious bio-medical waste can be carried out by incineration. Destromat Pyrolytic Incinerator Model PY-300 equipped with a 30-m high chimney with a load capacity of 1000 kg and 150 kg/h incineration rates, operates using an oil-blast technique. The minimum operating temperature maintained in the incinerator is 800°C over an 12 h incinerating cycle (from 8 AM to 8 PM), having a break period of 12 h for cooling and emptying the accumulated ash, before a fresh load of bio-medical waste can be inserted. During incineration, the door of the incinerator has to be periodically opened and the waste material should be turned upside down for complete incineration of the

waste matter. The last load of biomedical waste that is charged in the incinerator in a particular day has to be fed at least 2 h prior to start of the cooling cycle so that no part of the bio-medical waste is left unburned. The ash generated in the incinerator is to be removed from the incinerator every day and stored outside the incinerator room. Periodically, after accumulation of a sufficient quantity of ash, the material has to be transported to be dumped in pits, away from the populated area or in a landfill.

Even though there are Rules stipulating the method of safe disposal of Biomedical Waste (BMW), hospital waste generated by the Hospitals is still largely being dumped in the open, waiting to be collected along with general waste. Hence if not managed properly it can prove disastrous to the public health. Similarly if the incinerators are not efficiently (the biomedical waste rules states that the combustion efficiency must be at least 99% with zero emission standards of dioxins, furans, heavy metal vapours, harmful particles) run then the deadly residues and toxic emissions such as cancer-causing dioxins and furans besides chemicals which cause neonatal abnormalities, reproductive and skin disorders, endocrine disruption and suppression of the immune system.

5.5 EFFLUENT INDUSTRIAL

The industries area should be have their own water sources and waste water collection and treatment plants. for each factory based on product which need to different technical treatment, which may be generating small quantities of waste water, will discharge to a municipal sewer. Good control and monitoring by the State Pollution Control Board is necessary to ensure that the waste water being discharged to the municipal drains in safe as per the standards

5.6 TOILET

The need exists to cover the certain areas with community toilets 10 and community urinals 5 in the specifically in some location and right bank of Solani river as show in Figure 5.6

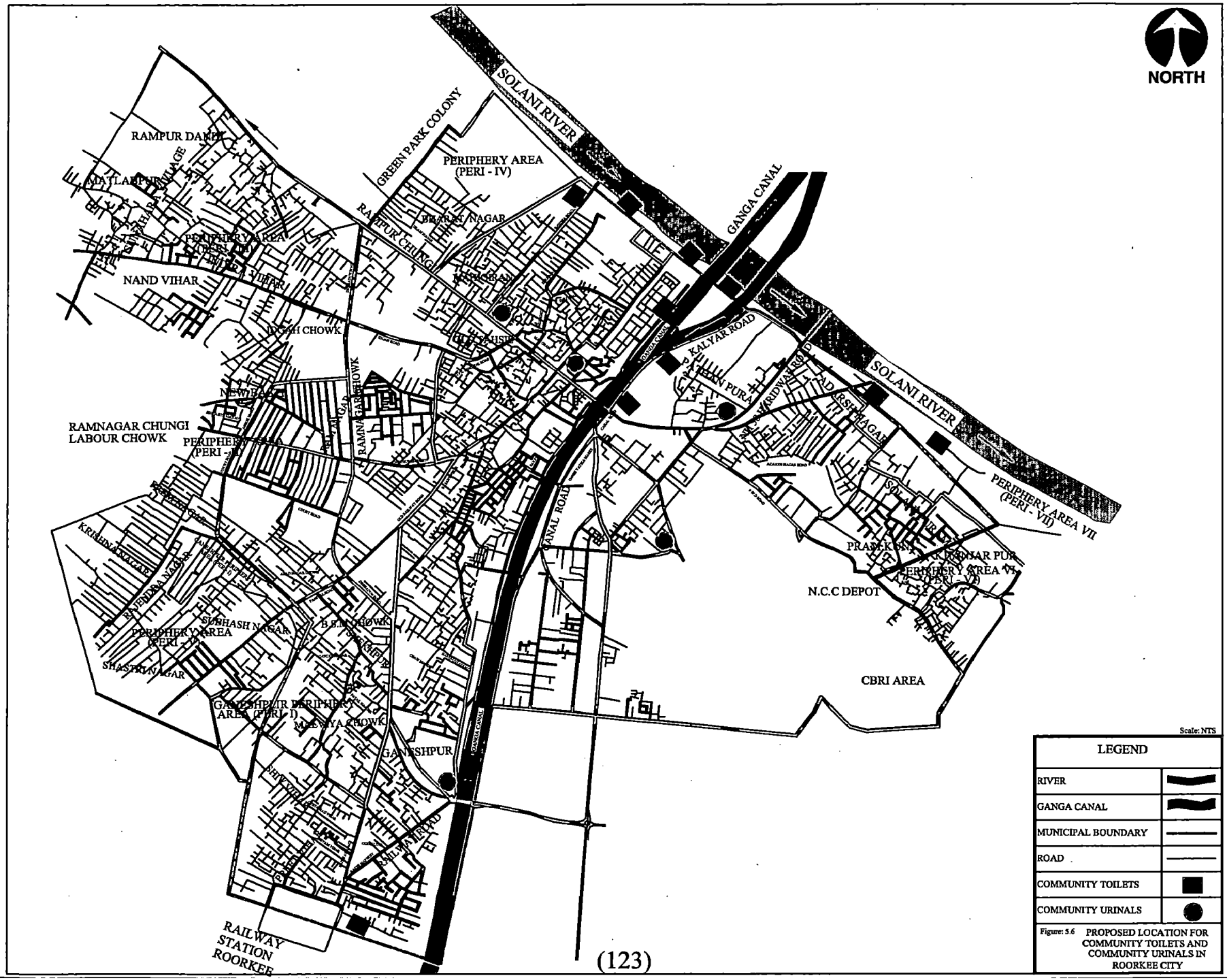


Figure: 5.6 PROPOSED LOCATION FOR COMMUNITY TOILETS AND COMMUNITY URINALS IN ROORKEE CITY

CHAPTER- 6

INSTITUTIONAL DEVELOPMENT.

6.1 GENERAL

Institutions are the arrangements, which exist In society to undertake particular activities. And colloquially this covers individual organizations, such as Ministries or their arms. It also however, encompasses linkages between organizations and the framework of law, policy, convention and culture within which they operate. This wider context within which any individual institution or organization operates is called its external environment.

Institutional Development is the process and content of change in institutions. But unfortunately, there is no standard terminology for this in development circles. In Some of the differences between the terms are drawn 'institution' and 'capacity' and between "development" and "building". These usually reflect whether the focus is an individual organization, the environment or functional capacity such as policymaking or accountancy and whether the focus was on existing or new organizations. Where the focus is on internal development of an individual organization, the term institutional strengthening may be used to emphasize the narrower scope intended.

The terms 'process' and 'content' cover "how" change is achieved and "what" is to be achieved, respectively. 'How' is the area of change management of organizational development. It concerns the processes through which the need for change is identified and accepted (ownership), programs of change are designed and agreed (commitment) and implementation is organized. 'What' relates to the changes, which are to be made, such as redefinition of objectives, reorganization or new human resource policies.

It is increasingly understood that institutional arrangements for CSP shall be critical to its success. The City Sanitation Plan for Roorkee aims at a local body with the capacity to undertake envisaged functions related to improved urban sanitation services for all the key role of Roorkee municipality as the principal stakeholder in CSP is recognized. In order to fulfil its role the ULB shall have to work in close coordination with other stakeholder groups in CSP implementation.

This Section therefore focuses on institutional strengthening of the ULB as principal stakeholder; roles and responsibilities of other stakeholder institutions CSP and stakeholder co-ordination mechanisms. Recommendations are given in the light of the

applicable policy, legal frameworks and guidelines in place that are relevant in the context of CSP implementation arrangements. The following Table 6.1 shows the responsibility of the government and some public agencies to implement schemes 'city sanitation plan' within the area study. And Table 6.2 shows pollution that needs to be curbed through regulation and development.

Table 6.1: Schemes within the area of responsibility of government or public agencies[1]

Name of Scheme	Implementing	Agency Likely Funding
Interception and diversion of waste water	PHED or any other agency implementing such projects in the State	NRCD
Sewage treatment	Do	NRCD
Community toilet complexes	ULB	NRCD
Crematoria	ULB	NRCD
Municipal solid waste directly polluting riverwater	ULB	NRCD
Other municipal solid waste management	ULB	MOUD
Dairies	ULB	MOUD and MNRE (energy generation)
Other non-point sources e.g., washing vehicles, dhobi ghats etc	ULB	MOUD
River front development	Irrigation/water resources	NRCD

Table 6.2: Pollution that needs to be curbed through regulation and development[1]

Type of pollution	Regulating Agency	Development Work
Industrial effluent	SPCB	Common effluent treatment plants
Industrial solid waste	SPCB	Encourage them to create disposal facility
Bio-medical waste	SPCB	Promote establishment of facility to dispose of bio-medical waste
Open defecation	ULB	Establish community toilet complexes
Dairy waste	ULB	Promote establishment of dairies at proper locations with facility to generate energy and compost
Washing vehicles, dhobi ghats etc	ULB	Create alternative facilities

6.2 APPROACH

Institutional Development (ID) is particularly suited to a process approach. It usually long- term commitment with the flexibility to respond to changing opportunities problems. Extensive participation by what may be heterogeneous local stakeholders is of importance. Institutional appraisal should continue throughout the project cycle, from growing experience of the organization.

Institutional development is difficult, complex and time consuming, with no easy solutions. Success factors include local ownership and commitment, and incentives for change and flexibility in responding to the opportunities change. Enhance ownership and commitments are the main functions. This requires time and a participatory approach and involvement of the opposition, as well as supporters of the change. It should be sought at an early success and also should encouraged the organization to identify a vision for the change and a clear action plan. Champions of change should be identified, over reliance on them should be avoided.

Change of agents within organizations will be needed and may need development. Financiers and aid agencies including donors can bring in wider experience, is a catalyst for dialogue and can encourage accountability. And institutional work is quintessentially interdisciplinary. Content, process expertise and continuity are important factors in any institutional development process.

6.3 INSTITUTIONAL DEVELOPMENT STRATEGY

Institutional Development Strategy for City Sanitation Plan implementation in Roorkee city has been prepared in close collaboration with the officials of Roorkee Municipal Corporation.

6.4 OBJECTIVES OF THE INSTITUTIONAL SET UP

The objective of the institutional study is to propose an Institutional Development Strategy (IDS). The end result would be a cost effective and efficient institutional set up. This should be legally, administratively and financially capable of performing functions necessary in respect of implementing the city sanitation plan.

This may be done by:

1). Defining objectives of the institutional set up.

2). Identification of administrative, legal (regulatory provisions) and financial functions which need to be assigned and performed by institution(s) to ensure effective management for elements the city sanitation plan.

3). Identifying the objectives and functions assigned to the existing institutions.

4). Identifying gaps between all these.

This objective includes the need to:

1). Implement the project in an efficient manner.

2). Promote a more rational and efficient approach to improve the health status of the city.

3). Improve the institutional capabilities through a comprehensive revision of the focus, organization and sourcing and outsourcing of necessary skill sets and services.

4). Ensure sustainability of operations.

5). Encourage enterprise and employability.

6). Create a project preparation and design cell as a capacity building measure. It will have the capacity to prepare projects, undertake design and provide other engineering services.

6.5 METHODOLOGY

First of all objectives of the Institutional Development Strategy have been defined Constraints and limitations have been identified thereafter. The existing set of institutions is studied to find out their effectiveness and efficiency in serving the objectives of IDS. Thereafter, a new set of institutional arrangement is proposed. Effectiveness of the new set up is seen in relation to the needs of various societal sectors it satisfies through various administrative, legal and financial functions that are required to be performed.

6.6 CONSTRAINTS AND LIMITATIONS OF THIS STUDY

The study faced from following constrains and limitations:

1). There was limitation of time in meeting various stakeholders a number of times.

2). There was no effort made in the past as far as addressing the issues of Institutional Development Strategy is concerned.

3). Limited availability of relevant data affected the speed of work and choice of various options for decision making.

6.7 PRESENT INSTITUTIONAL SET UP

6.7.1 Institutional Profile

Roorkee Nagar Palika Parishad (RNPP) is the urban local authority for the city of Roorkee. The municipal body has constantly 'network' with a number of organizations and agencies to cope with civic needs of the city. In other words, Roorkee civic administration has to be constantly prepared broadly, the institutions involved in infrastructure/service provision in the city are:

1). Roorkee Municipal Council.

2). Uttarnchal Jal Sansthan(UJS).

3). Public Works Department.

4). Uttarakhand State Electricity Board.

5). Uttarakhand State Environment Protection and Pollution Control Board.

6). Uttarakhand Transport Corporation.

6.7.2 The Municipal Body

The Municipality (Nagar Palika Parishad) is the main governing body catering to the essential services of the town. It was established on 1st Sep, 1884 in accordance with the provisions of Section 5 of the Municipalities Act 15 of 1873. It is elected by the people. There were 25 Municipal councilors from 1996 to 2002 and currently (in 2003 elections) has 20 Municipal councillors with reduction of number of wards from 25 to 20 (2001). The main functions of Nagar Palika are Improvement and maintenance of internal city roads, Cleaning of roads and streets and Solid Waste Management, Management and improvement of notified slums in the town under various programs, Construction and management of drainage system (which has now come under the jurisdiction of newly constituted, Uttaranchal Jal Sansthan) and Construction of shops and houses on lease land. It also had a building department till 1994, looking after the sanctioning of various plans as per the building bye-laws. The structure is shown at Figures.

6.7.3 The Executive Officer

The Executive Officer functions under the general control and supervision of the Chairman. He looks after the entire executive administration of RNPP including municipal personnel management. The EO has to manage:

1). the affairs of the political wing: advising the Chairman, holding meetings of the board and the committees;

2). the professional, administrative wing: executing board and committee decisions, and overseeing the functioning of different municipal departments including field/site inspections;

3). doing the liaison function insofar as conducting external relations are concerned: keeping in touch with State Government including its field officials and the parastatals (like UPJN, UJS, HAD etc.);

4). public relations and the handling of public grievances.

6.7.4 Committee System

RNPP has as many as ten committees whose domain of activities can be inferred from their names:

1). Social welfare .

2). Finance committee.

3). Health committee.

4). Sub rules committee.

5). City transport committee.

6). Physical development.

7). Public works.

8). Land scape.

9). Tax Assessment.

10). Mother and child welfare.

6.7.5 Functional Departments

Among the major functional departments, engineering department, solid waste management department, taxation department, and accounts department are bearing the brunt of municipal administration. Considering the work load – roads construction and maintenance, removal of unauthorized constructions (which are numerous in the town) etc, Roorkee needs a full-fledged Assistant Engineer. Also status up gradation of the municipal engineer will help in external negotiations with his counterparts in other departments like the Public Works Department, Irrigation and so on.

The other functional department of importance is the solid waste management department which has the onerous duty of keeping the city clean by organizing collection, transportation and disposal of solid waste. The solid waste generated increases dramatically more than 1.1 lakhs of people in town. For this purpose, the town is divided into twenty circles . one sanitary inspector supervising there work.

The department is headed by a health officer. In view of the special nature of Roorkee town, there is a suggestion to have a public health engineer as head of the department which would be in conformity with the Supreme Court's guidelines on solid waste management. The entire solid waste management of Roorkee, subsuming the processes of collection, midpoint storage, transportation, and disposal needs to be properly planned and managed. There is need for generating public awareness about

sound local garbage collection methods to persuade the general public not to throw garbage on to the streets (which is the general habit now).

The taxation management – revenue mobilization – is in the hands of a tax superintendent. RNPP is dependent on state grant to the extent of 80 per cent of its ordinary revenue. Both in terms of valuation and collection, property tax management of the town needs to be thoroughly overhauled. It is suggested that the state government seriously think of setting up a commission/committee on rationalization of property taxation to provide a more rational, citizen-friendly and revenue-yielding basis for the levy of this tax.

The lighting department is currently being looked after by a lighting superintendent on ad hoc basis who has no technical experience in this field. Planning of lighting, procurement of fixtures and bulbs, man management, repairs and maintenance need a properly qualified person to head the department.

Municipal administration of Roorkee needs to be radically restructured both from the political and professional perspective. The city has to have a strong political executive – either a collegial body or a strong chairman supported by a senior professional executive. Similarly, as mentioned earlier, Roorkee municipality needs dynamic modern-day professional management based on information technology and computer application in different segments of city administration.

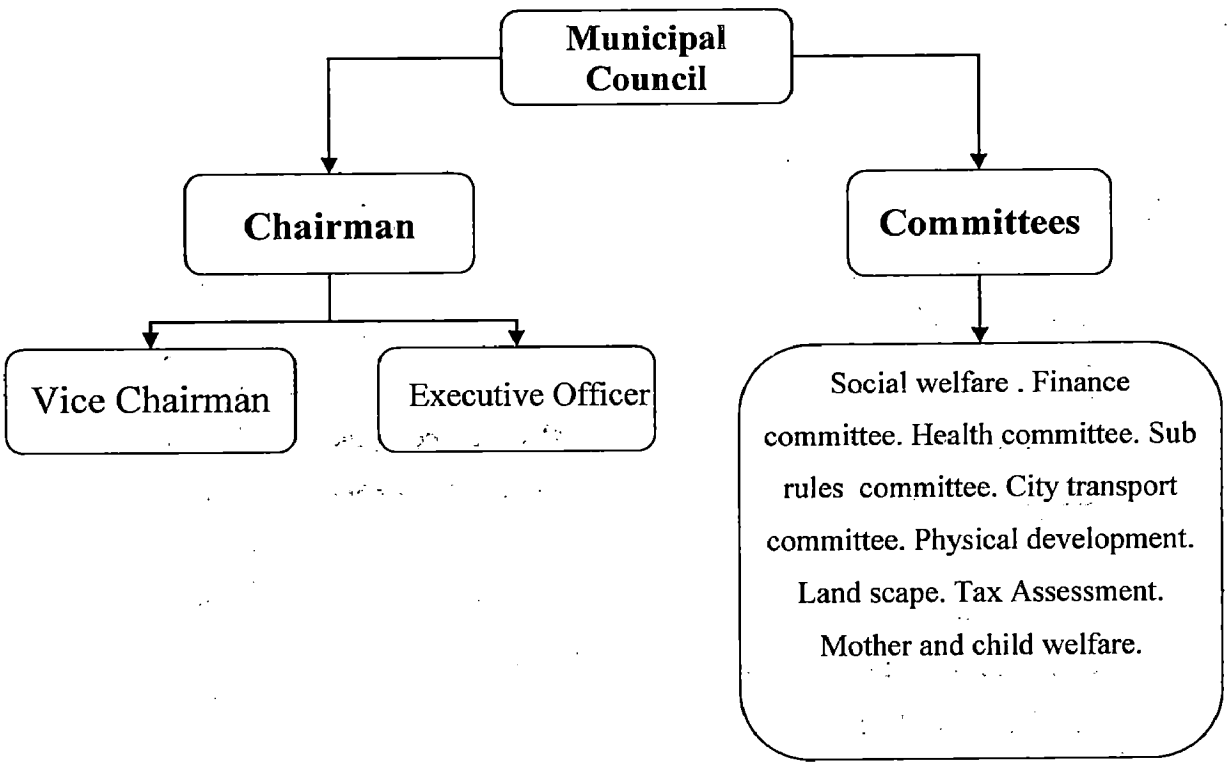


Figure 6.1: Existing Roorkee municipal council.[9]

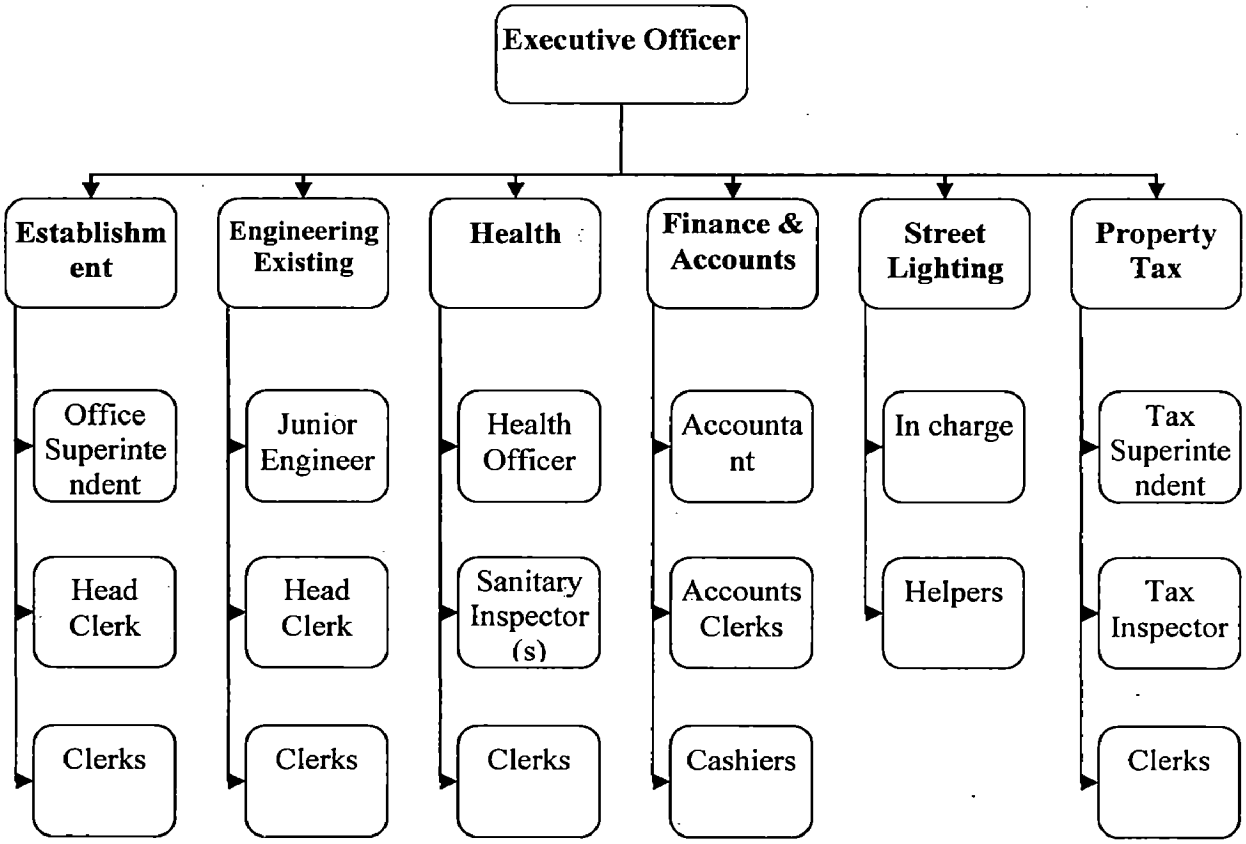


Figure 6.2: Existing organizational structure of RNPP[9]

As per the present policy of the State Government, there are five kinds of officers and staff in the municipality:

1) State appointees.
2) Officers belonging to Unified/Integrated cadres.
3) Locally recruited staff.
4) Staff recruited on contractual basis, and
5) Staff recruited on purely ad hoc basis.

6.7.6 Municipal Functions

The functions of RNPP are listed in Uttar Pradesh Municipalities Act, 1916. It provides for mandatory functions as well as discretionary functions of RNPP. The major functions of RNPP are: city cleanliness, solid waste management, maintenance of gardens/dividers/circles, street light, bio-medical waste, slaughter house, flood control, encroachment removal, stray cattle management, community toilets, community halls, storm water and wastewater drainage, parking lots, development works, advertisement,

sale of land, house tax, and licensing. Responsibility for water supply which is also provided for under the act is transferred to the responsibility of UJS.

6.8 ROLE OF PRIVATE SECTOR IN URBAN INFRASTRUCTURE PROVISION

Private sector participation in infrastructure provision in Roorkee city is yet to emerge. But there are a number of potential areas where the PPP model can be applicable on the lines of similar efforts successfully made in many cities in India. Selective references, in this context are:

1). Solid waste management, especially transportation, disposal and composting
2). Maintenance of parks and gardens
3). Infrastructure creation such as off-street parking, roads and bus stands
4). Street lighting etc.

6.9 SUGGESTIONS AND RECOMMENDATIONS

The integrated development of city sanitation plan for Roorkee. its could lead to economic development of the city leading the rise in per capita income and better standard of living of people of this city. But there is weak infrastructure, no space to house zonal offices, staff and equipment, and not enough or poor quality equipments, illiteracy, lack of coordination amongst institutions, lack of interest of stakeholders, lack of organizational capacity and lack of willingness to pay due to distrust on government machinery or lack of paying power of the users of the services, there is a silver lining that Roorkee is a relatively small town with no legacy issues and most of the stakeholders have an open mindset.

And we are feel that the executive branch at the level of the city sympathetic and focused on the cause of environment protection and sanitation plan for city. Thus, the time is ripe for planning at a scale that the long term objectives of the state planning are served. Further, the institutions have long and generally perpetual life; it will be appropriate to take a long-term view.

There is an opportunity to showcase the city and upgrade the civic facilities. Further, with urbanization emerging as a mega trend, funding does not remain a major constraint. It is an opportunity to partner with NGOs and implement well thought for city sanitation plan for city.

6.10 POLICY ISSUES

The legislative powers of Urban Local Bodies provide details on building requirements and the mandated provision of tube well one over head tank of water supply and (SPS and STP) and toilets and bath facilities in public places. The building plan approval process requires an Urban Development Authority to approve the building plan and the Municipal Authority to provide a Completion Certificate. The existing rules presuppose the existence of a municipal database and requisite monitoring, provides Urban Local Bodies with powers to ensure safe sanitation provisions in each building or land parcel within the city and also has some penal provisions for noncompliance. also Policy issues cover identification of methods of collection and appropriate disposal, policies governing informal sector like slum dwellers, policies towards NGOs and issues relating to legalization of unauthorized dwellings and licensing of workers in marginalized activities such as rag picking. also it should have roads and internal road facilities for efficient access and it should be large enough to last for long-term operation. The ULB is empowered to raise revenue through taxes on property, water supply, tax on private latrines, tax on drainage provision and access on all buildings to pay for public facilities and city cleaning arrangements.

6.11 IMPLEMENTATION STRATEGIES

6.11.1 At Government Level

It is now accepted that the urban areas constitute the engines of growth in the States and sound infrastructure in its cities is a necessary condition of growth. The infrastructure in urban areas in the State has not received the attention that is required and there is urgent need to pay attention to improve it.

Government of India has taken initiative which will enable the States to receive funds for improving the urban infrastructure related to city sanitation plan. Also the Government of India (Ministry of Urban Development) has launched a programme of urban renewal known as "Jawaharlal Nehru National Urban Renewal Mission (JNNURM)". Its objective is to provide project based grant-in-aid, and enable the States to leverage larger amount of funds to support development of infrastructure including, among other things, water supply, sewerage and sanitation, solid waste management and conservation of water bodies. For accessing funds the State Government and the

Municipal bodies have to take the prescribed measures and after doing so, make an application to the Ministry of Urban Development. The application must be accompanied with:-

1). City Development Plan providing perspective and vision of development of the city.
2). Detailed Project Report of specific proposals.
3). Timeline For Urban Reform Agenda.

6.11.2 Strategic Plan

Planned urban development in Uttarakhand, in the context of current initiatives, demands a fresh look at the Secretariat-level set-up of the Urban Development Department. This is addressed as part of the ongoing work for the Uttarakhand Urban Development Project, but preliminary broad-brush analysis suggests that the future shape of UDD could develop as presented here graphically in Figure 6.3, although this structure will be further refined based on further analysis of the current situation. Imaginative policy guidelines and time-bound monitoring and evaluation of large programmes, as well as guiding and assisting the municipal bodies (in their new role as vibrant local self-government) would require a refined organisation structure for the Urban Development Department in the coming years.

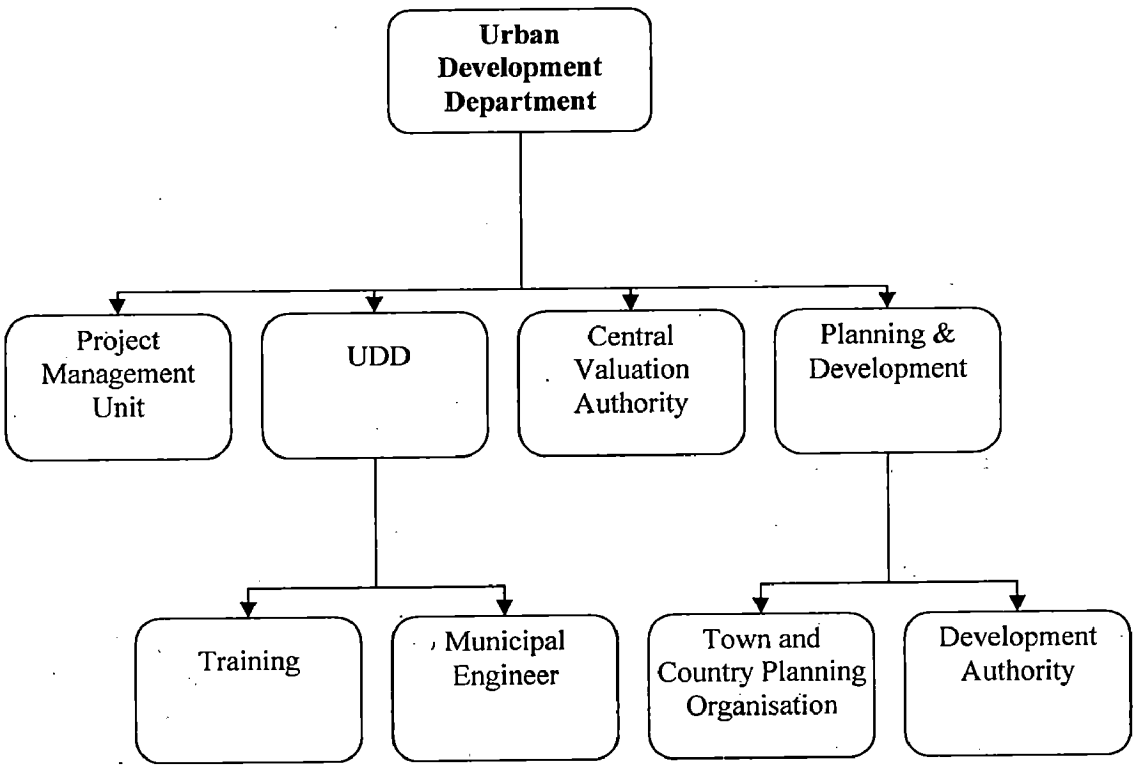


Figure 6.3: The structure of institutional arrangement proposed.[9]

6.12 Proposal Upgraded Roles Municipal Body

Roorkee. As discussed above, it has unique problems of governance that demand a unique institutional response. The problems and issues are similar to those being faced by any city anywhere else in the country. Hence, it may be seriously considered as to whether the city could be invested with the status of a Municipal Corporation. This deserves consideration as, in near future, the functions such as planning and building regulations, water supply and sewerage etc.

The devolution of functions may not happen overnight, but a process of 'municipalisation' of the above functions has to start in a phased manner. This will necessitate rebuilding the RNPP's administrative-managerial set-up with appropriate departmentalization and organizational redesign. All these are conventional municipal functions but internal managerial strength of RNPP would then have to be augmented in a planned manner. In other words planned capacity building of RNPP must precede any scheme of 'municipalisation' as might happen in future to conform to the constitutional.

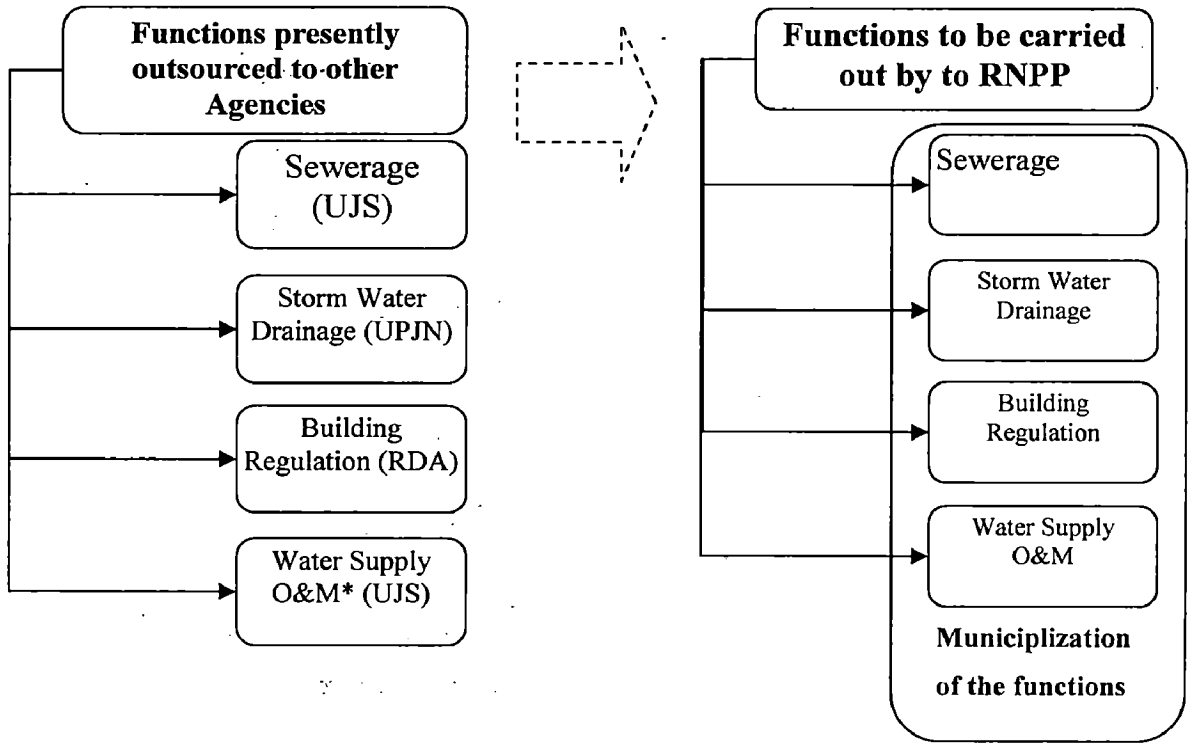


Figure 6.4: Transfer of functions to RNPP[9]

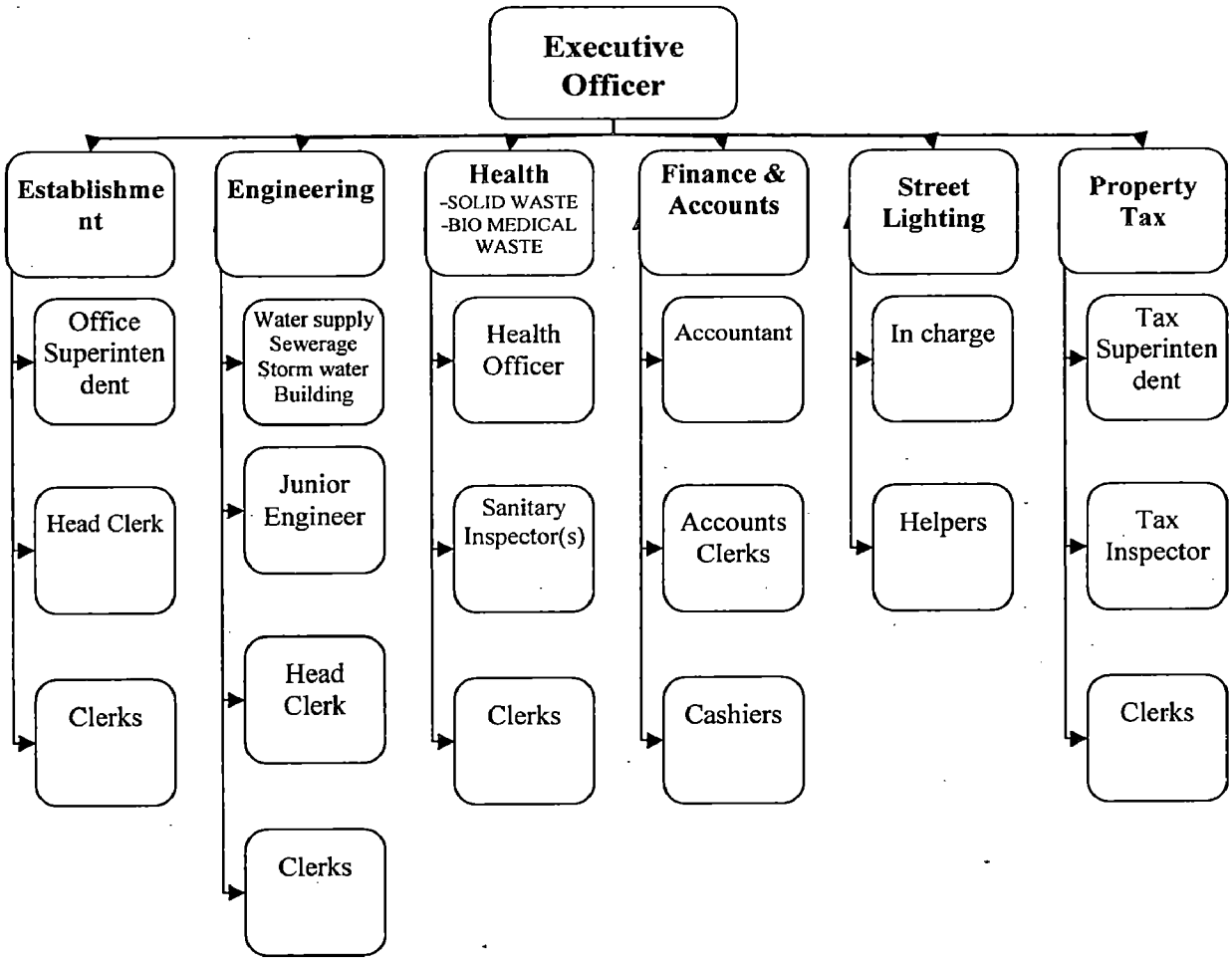


Figure 6.5: Proposal organizational structure of RNPP

6.13 IMPLEMENTATION SCHEDULE

6.13.1 General

Based on the availability of manpower, machinery, requisite resources – technical and financial, the proposed interventions are prioritized. over immediate phase, short-term, mid-term, and long-term. The aforementioned paradigm additionally leads the definition of the timeline and the corresponding phases and goals for the various components of the city sanitation plan.

Manifestly, high-priority interventions, less capital intensive technical interventions are addressed in the immediate and short-term phase, while capital intensive and O&M exacting technical interventions shall be spread over a longer timeline and addressed in the long –term phase.

The system shall be designed under the broad framework as per the guidelines for a design period of 30 years, however, the planning shall entail the implementation of the design in phases to meet the ultimate goals of the CSP.

The phased approach aims to navigate through the challenges posed by the limitations in investments, institutional capacities, and community engagement in a proficient manner. It is envisaged to develop a phased manner sanitation development plan for Roorkee city as depicted below in Figure 6.6.

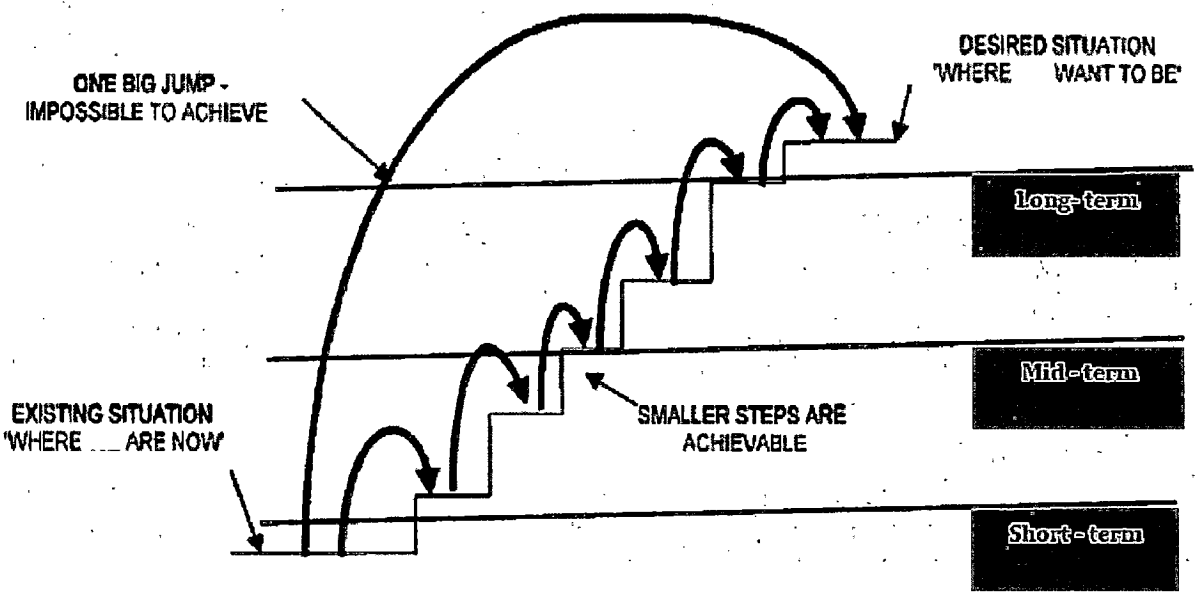


Figure 6.6 : Phased manner sanitation development plan

6.13.2 Sewerage

The Table 6.4 presents the phase-wise implementation action plan for the City of Roorkee

Table 6.3: Implementation strategy plan for sewerage system

COMPONENTS	APPROACH	INTERVENTIONS	RESPONSIBLE AGENCIES
Collection, Treatment, and Disposal of Household Waste-water	All the waste water shall be collected, treated and disposed as per the norms specified in CPHEEEO Manual for sewage and Sewerage Treatment	Centralized Waste Water Treatment System , sewage pumping station and sewer network	Roorkee municipal, UJS and NGO's

Table 6.4: Phase- wise implementation plan for sewerage system

PHASE	YEAR	GOALS
Immediate	2011-2013	i). Connections to the Households; ii). Finalization of Collection System; iii). Initiation of Conveyance System; iv). Septage Clearance v). Finalize centralized waste water treatment systems as a permanent solution vi). Rehabilitation of missing links and worn out network in existing sewerage system vii). Provision of sewerage network and sewerage pumping station in ward 3&4. and should stop disposal sewage in this ponds
Short-Term	2014-2016	i). Conveyance System ii). Treatment and Disposal iii). Septage Treatment & Disposal iv). Establish O&M and M&E systems
Mid-Term	2017-2026	i). Phasing out of Septic Tanks by institution of centralized waste water treatment systems ii). Augmentation of the system iii). Replacements of components Treatment iv). Provision of new components for STP v). Regular O&M and M&E of entire sewerage system
Long-Term	2026-2041	i). Augmentation of the system by provision of sewerage network in newly extended areas ii). Augmentation of STP capacity iii). Replacements of components iv). O&M and M&E Regular O&M and M&E of entire sewerage system

6.13.3 Toilets

Intervention phasing ward wise

Places where open defecation is practiced have to be dealt immediately, followed by areas where public facility is difficult to access and finally areas where the population has access but inadequate toilet seats.

Table 6.5: Implementation strategy plan – access to toilets

COMPONENTS	APPROACH	INTERVENTIONS	RESPONSIBLE AGENCIES
Community Toilets	Commercial, market places, religious places shall be provided with public toilets at the rate of 1 seat per 100 users, connected to sewerage, and centralised waste water treatment system	Construct new toilets with full-fledged supporting infrastructure; Rehabilitate/upgrade existing toilets with water services and sewer network connections	Roorkee municipal, PPP, Market Associations

Table 6.6: Phase- wise implementation plan for toilets

PHASE	YEAR	GOALS
Immediate	2011-2013	i). Review condition of existing facilities against design considerations through a detailed ward level survey ii). Rehabilitate all facilities which do not comply to the design considerations (repairs and up-gradation of public toilets) iii). Design & Construction of the new facilities (toilet seats as well as urinals) mainly focusing on in areas with no toilet (right bank of Solani River,

PHASE	YEAR	GOALS
		beside railway and public markets) iv). Institutional is O&M and M&E procedures v). Conduct awareness generation campaign on health and hygiene aspects of public sanitation vi). Provision of mobile toilets at open defecation spots for immediate remediation until permanent infrastructure can be provided, and at places under temporary sanitation stress during festivals and other events vii). Promotion of individual household toilets through subsidies/incentives
Short-Term	2014-2016	i). 100% Coverage and Infrastructure Development ii). Design of System to handle the human excreta
Mid-Term	2017-2026	i). Finalization of phasing out of Septic Tanks ii). Augmentation of the system iii). Repairs & Maintenance
Long-Term	2026-2041	i). Augmentation of the system ii). Repairs & Maintenance

6.13.4 Solid Waste

Table 6.7: Implementation strategy plan – solid waste

COMPONENTS	APPROACH	INTERVENTIONS	RESPONSIBLE AGENCIES
Primary Collection and Secondary Storage	Mixed strategy for primary collection of waste from domestic, commercial, industrial and institutional sources comprising motorized primary collection, manual collection through handcarts and individual disposal at community waste depots to collect waste	i). Improve door-to-door collection services ii). Encourage use of community waste depots iii). Strengthen collection from nondomestic sources iv). Timely replacement of equipment and containers v). Improved service delivery vi). Strengthen street sweeping and drain cleaning	Roorkee municipal, supported by community / commercial / institutional / industrial establishments / NGO
Secondary Collection, and transport	Strengthen collection and transport, treatment and disposal of waste with highest priority to safeguard public health	Primary collection can be transported either directly to disposal site or transferred into containers installed at strategic locations depending on location of landfill site	Roorkee municipal,

Treatment and disposal of solid waste	Strengthen treatment and disposal of waste with highest priority to safeguard public health	i). Multi-dimensional strategy comprising centralized composting, home composting, and recycling center ii). Sanitary landfill till treatment operations are commissioned	Roorkee municipal,

Table 6.8: Phase- wise implementation plan for solid waste

PHASE	YEAR	GOALS
Short-Term	2011-2016	i). Rehabilitate all facilities of solid waste (concrete bins and steel bins). and distribution over whole city equal based on population of each wards ii). Initiate primary segregation , storage and door to door collection system (for all population) iii). Procurement of gears/equipments for street sweeping, waste transportation as per the SWM DPR iv). Construct and operationalize the transfer station v). Construct and operationalize of waste processing unit vi). Municipal Roorkee should mobilise funds and implement landfill facility at Saliyar village. vii). Promote decentralised solid waste management practices. viii). Municipal Roorkee should take necessary measures for 100% collection of user charges. ix). Municipal Roorkee should strengthen the existing M&E system. x). Enforcement of application of Polluter pays

PHASE	YEAR	GOALS
		Principle/penalty for littering as per MSW Rules 2000. xi). Initiate measures to enhance the safety and dignity of sanitary workers.
Mid-Term	2017-2026	i). Augmentation of SWM system to meet the demands of growing population ii). Regular O&M involving in entire system of SWM iii). Replacements of components as per the maintenance plan iv). Regular M&E of entire SWM system
Long-Term	2027-2041	i). Augmentation of the MSW system to meet the demands of growing population. ii). Finalization of the Annual Phases of the SWM facility. iii). Replacements of components as per the maintenance plan.

6.13.5 Storm water

Table 6.9: Phase- wise implementation plan for storm water

PHASE	YEAR	GOALS
Immediate	2011-2013	i). Installation of grating points for collection of solid waste entering into storm water drains ii). Conduct feasibility study for treatment measures iii). Cleaning of drainage system – removal of silt and solid waste iv). Database management – detailed mapping of natural and built storm water drains

PHASE	YEAR	GOALS
Short-Term	2014-2016	i). Source control strategies - Construction of rain water harvesting structures ii). Removal of unauthorised structures and encroachments on natural drains iii). Construction of road side drains as per the drainage designs iv). O&M and M&E systems v). Technical and O&M Manual
Mid-Term	2017-2026	i). Ensure 100% coverage by storm water drainage system ii). Augmentation of storm water drainage system
Long-Term	2027-2041	Augmentation of storm water drainage system

6.13.6 Bio-Medical Waste

Table 6.10: Phase- wise implementation plan for bio medical

PHASE	YEAR	GOALS
Immediate	2011-2013	i). Transportation of BMW from Hospital and dispensaries where treatment facilities are not available will be done by Centralized treatment facility Operator. ii). Procurement of Segregation Bags, containers and other materials used in management of Biomedical Waste. iii). Establishment of Centralized Bio-Medical Waste Treatment Facilities with the help of Private Entrepreneurs at Roorkee. iv). Inspection of Hospitals and dispensaries under Roorkee Govt. for BMW. v). Organization of workshop / seminars on Bio-Medical Waste Management

PHASE	YEAR	GOALS
Short-Term	2014-2016	i). Replacements of components as per the maintenance plan. ii). Regular O&M involving in entire system of bio medical waste.
Mid-Term	2017-2026	i). Augmentation of BIO medical system to meet the demands of growing population ii). Replacements of components as per the maintenance plan. iii). Regular O&M involving in entire system of bio medical waste.
Long-Term	2027-2041	i). Augmentation of BIO medical system to meet the demands of growing population ii). Replacements of components as per the maintenance plan. iii). Regular O&M involving in entire system of bio medical waste.

Figure 6.7 : Chart for implementation schedule of CSP

S.No	COMPONENTS	YEAR					Exclusive agency	Monitoring Agency
		1	2	3	4	5		
1	Design and Prepare of plan							Municipal Roorkee
2	Drinking water						UJS	Municipal Roorkee
3	Sewerage network						UJS	Municipal Roorkee
4	Solid waste						Municipal Roorkee	Health department
5	Bio-medical waste						HUCs	Health department
6	Toilet						Health department	Municipal Roorkee
7	Storm water						Municipal Roorkee	Municipal Roorkee
8	Crematoria						Municipal Roorkee	Municipal Roorkee
9	Dhobi ghats						Municipal Roorkee	Municipal Roorkee
10	Cattle wallowing						Municipal Roorkee	Municipal Roorkee
11	Motor garages						Municipal Roorkee	Municipal Roorkee
12	Dairies						Municipal Roorkee	Municipal Roorkee

6.14 FRAMEWORK FOR IMPEMENTATION AND MANAGEMENT OF CSP

IUSP Guidelines provide the institutional structure for implementation of the City Sanitation Plan. The Guidelines clearly define the structure/composition of City Level Sanitation Committees to support and facilitate CSP implementation and City level Urban Sanitation Cell for preparation and implementation of the CSP . Hence, the discussion in this section focuses on institutional arrangements for O&M, for which overall responsibility rests with the ULB, as per National Urban Sanitation Policy.

6.15 INSTITUTIONAL STRENGTHENING AND CAPACITY BUILDING

The City Sanitation Plan presents an opportunity for Roorkee municipality to address issues related to improved financial management and address human resource development needs through staff training and capacity building for effective urban management.

6.15.1 Towards an Appropriate Institutional Framework

The Institutional Strategy focuses on arriving at an appropriate institutional/management framework that is likely to foster effective and efficient use of existing human resources. The proposals are expected to help achieve a capable and motivated workforce in the ULB; responsible and accountable elected representatives; stronger financial management; improved capacity of Roorkee municipality staff as 'urban managers' to oversee implementation and management of projects beyond CSP.

CSP interventions are envisaged as "Phased interventions" to guarantee sustained services. In order to ensure that the ULB has the ability to manage CSP implementation and ensure effective management of assets created under the project, the following institutional / management options were considered:

Option 1: ULB handling the O&M

Under this option, Roorkee municipality would be responsible for undertaking O&M of all assets created under CSP. Additional staff requirement for implementation and O&M of CSP interventions (for wastewater and solid waste management) and resource requirements in this scenario was undertaken.

Option 2: Outsourcing of CSP

In this Option, outsourcing of operation and maintenance to the private sector is envisaged. The role of Roorkee municipality would be to monitor implementation and O&M of CSP.

Other Initiatives

In addition to addressing staff requirements for management of CSP implementation, the following initiatives would go a long way in ensuring project sustainability:

1). Outsourcing of billing and recovery or, providing financial incentives to municipal staff to achieve recovery and other financial targets.

2). Involvement of the ULB in Sanitation Promotion and resolution of tenure issues in urban poor settlements (supported by NGOs), would help foster demand and ensure sustainability.

6.16 PARTNERSHIPS FOR CSP IMPLEMENTATION

While the ULB is the stakeholder with the primary responsibility for CSP (as defined in the National Urban Sanitation Policy), the role of other stakeholders in CSP implementation cannot be undermined and will in fact, be critical to its success.

Identification of stakeholder agencies / entities was undertaken at city level, with a view to mapping their envisaged role as partners in CSP implementation and arriving at suitable co-ordination mechanisms.

6.17 TRAINING AND CAPACIY BUILDING OF ULB STAFF

The review of existing staffing and skill levels of staff provided by the ULB reveals the need for capacity building in the following areas. Training for CSP would be targeted towards members of the City level Urban Sanitation Cell and the City level Sanitation Committee, staff in relevant wings of the ULB (wastewater, drainage, solid waste management and water) and staff in the general administration/accounts/finance section of the ULB. A detailed training calendar specific to ULB staff (with specific training needs of each staff member identified based on roles and responsibilities to be assigned related to CSP implementation and operation/maintenance) would need to be prepared at DPR stage.

6.17.1 Training Cell

6.17.1.1 Training needs

Training needs of skilled manpower are met through short term training programmes of duration of a few days, weeks and months. But training can be imparted only if the trainee has the necessary educational attainment. Regarding the projects that are under execution, after it has been commissioned, it is necessary that staff with proper training and experience is in place for O&M of assets. The responsibility of operation and maintenance of STPs and main pumping stations should rest with the contractor who supplied the plant, for 5 years after commissioning of the project. It should be ensured that the contractors/suppliers of equipments deploy properly trained and experienced staff for this work. Even if contractors and suppliers are bound by the contract to operate and maintain the equipment they supplied or erected, they should be required to

1). Impart training to the identified personnel of the agency that owns the project and has the responsibility for its proper functioning.

2). Provide operating manuals of the equipment installed.

6.17.1.2 Training of officials

Orientation and Sensitisation Programs for Councillors as well as for officials/technical staff to increase their technical capacities for effective discharge of the sanitation functions and creating awareness about the sanitation issues, working with various partners in service delivery, technical knowledge and monitoring. Orientation programs will focus on the following areas of discussion:

1). Best management Practices for the various sanitation components;

2). Project Finance

3). Risk Mitigation;

4). Stakeholder Identification and Assessment;

5). Community Engagement; - Participatory Means

The strategy shall define the organization of exposure visits to main problem in the city which may reflect the successful of the above parameters or organization of educational programs like workshops / seminars / lecture series which will disseminate the required information.

6.17.1.3 Training of staff / community

There is greater need for orienting the support staff and community with a focus on the following subject matters

1). Best management Practices for the various sanitation components;

2). Occupational Safety and Health Training

3). Benefits of the best system ‹economy, public health and environment

The strategy shall define the organization of exposure visits to main problem in the city which may reflect the successful of the above parameters or organization of educational programs like workshops / seminars / lecture series which will disseminate the required information.

6.17.1.4 System operating procedures

Roorkee Municipal Corporation training cell shall establish suitable training goals for the O&M personnel and in accordance with the same shall develop policies, procedures, protocols and schedules. Periodic review and appropriate revisions of the program shall be undertaken.

6.17.1.5 Training of other partners and stakeholders in CSP

These include local NGOs, CBOs and other partners in CSP implementation and their roles, responsibilities and powers with respective to CSP implementation.

6.17.1.6 Training strategy and calendar

A comprehensive training strategy incorporating training objectives, methods and delivery within the project period, needs to be developed by the ULB and milestones defined, at CSP Detailed Project Report stage. A calendar of training activities also needs to be prepared. All training activities / programs, including awareness generation programs need to be completed in a time-bound manner, from the date of finalization of the training strategy.

6.17.1.7 Citizen report cards

Report Cards with citizen perception surveys can be prepared by independent research organizations/NGOs commissioned by the State. The Report Cards could serve

as the basis for awards and incentives to ULBs that perform better in CSP implementation.

The number of people at various levels required for such projects should be estimated and the personnel should be posted on appropriate jobs.

Training need identification is a continuous process and in the identified subject areas training institutions can be requested to develop training programmes.

Table 6.11: Educational requirement of staff required for pollution abatement projects[1].

Stage of Project	Requirement of Manpower			
	Highly educated Master's Degree	Degree Level	Diploma Level	Certificate Level
Problem Identification	√	√		
Conceptualization	√	√		
Project Planning	√	√		
Project Preparation	√	√	√	
Project Implementation		√	√	√
O&M		√	√	√
Monitoring		√	√	
Evaluation	√	√		

Table 6.12: Number and cost estimate of training staff

S.No	Staff	Number	Cost Per capita (Rs.Lakhs)	Total Cost (Rs.Lakhs)
1	Officer	10	0.10	1.00
2	Sanitary inspector	5	0.10	0.50
3	Supervisors	5	0.07	0.35
4	Labor	15	0.05	0.75
Total				2.6

CHAPTER- 7

ASSESSMENT OF COST FOR THE DIFFERENT COMPONENTS.

7.1 MUNICIPAL FISCAL ASSESSMENT

This section assesses the financial performance of the Municipal Corporation of Roorkee town. It will help in providing an understanding of the existing sources of revenue and expenditure. The objective is to assess the financial capability of the local body to execute the projects proposed.

7.1.1 Review of Municipal Fiscal Situation

Roorkee Municipality maintains the accounts on a cash basis single entry system. The detailed revenue accounts of Roorkee Municipality have been reviewed for the period of five years starting from 2007-2011. For the purpose of review, the municipal accounts have been classified under two major head - revenue items and capital items:

i). **Revenue Account:** All recurring items of income and expenditure are included under this head. These include taxes, charges, salaries, maintenance expenditure, debt servicing etc.

ii). **Capital Account:** Income and expenditure items under this account are primarily non-recurring in nature. Income items include loans, contributions by Government, other agencies and capital grants under various State and Central Government Programs. Expenditure items include expenses booked under developmental works and purchase of capital assets.

7.1.2 Revenue Account

The Revenue Account comprises recurring items of income and expenditure. These are essentially all financial transactions related to the day-to-day operations of the municipality. The details of each of major revenue contributing items are discussed in the following section. Figure 7.3 indicates that Roorkee Municipality has not maintained a good revenue account status during the review period.

7.1.3 Revenue Income

Revenue income for the municipality Roorkee fluctuate from decline to growth during the last five years while the final year revenue income of Roorkee Municipality has grown to a level of INR 901.61 lakhs in the FY 2010-11 from INR 842.68 lakhs in FY 2006-07, thus registering an average annual growth of over 2.32 percent (CAGR) as show in Table 7.1 and show chart Figure 7.1.

Table 7.1: Revenue income of Roorkee municipal (Rs. In Lakhs) (2006/07 and 2010/11)

S.No	Item	Year ((Rs. Lakhs)/year)				
		2006-07	2007-08	2008-09	2009-10	2010-11
1	House tax	48.212	54.992	51.459	64.755	72.089
2	License charge	1.385	1.7278	2.0878	2.6358	2.5659
3	Show tax	0.092	0.0942	0.0584	0.0627	0
4	Rent	21.409	21.033	20.266	19.488	12.744
5	Sewerage	10.807	10.036	12.175	2.8796	12.836
6	Tehbazari	19.339	12.185	13.702	19.785	15.156
7	Slaughter house	0.34	0.1535	0.1323	0.1844	0.1631
8	Copy fee	0.0659	0.2059	0.1231	0.243	0.2268
9	Penalty	1.5343	0.8363	0.7221	0.6064	1.3475
10	Interest	0.5791	0.3069	0.5773	0.0314	0.1962
11	Twelfth finance	21.691	0	0	0	28.26
12	State finance	303.33	339.45	339.45	339.45	450.01
13	Surcharge	1.3774	3.1437	1.6253	1.7973	1.8648
14	Advance	0.9056	0.31	0	0	0
15	Miscellaneous	21.501	17.415	13.628	14.816	21.335
16	2% immovable property	390.11	287.23	280.38	278.83	281.71
17	Bail	0	0	0.518	2.1	1.1021
18	Next loan return	0	0	0.1876	0	0
	Total	**842.68**	**749.12**	**737.09**	**747.66**	**901.61**

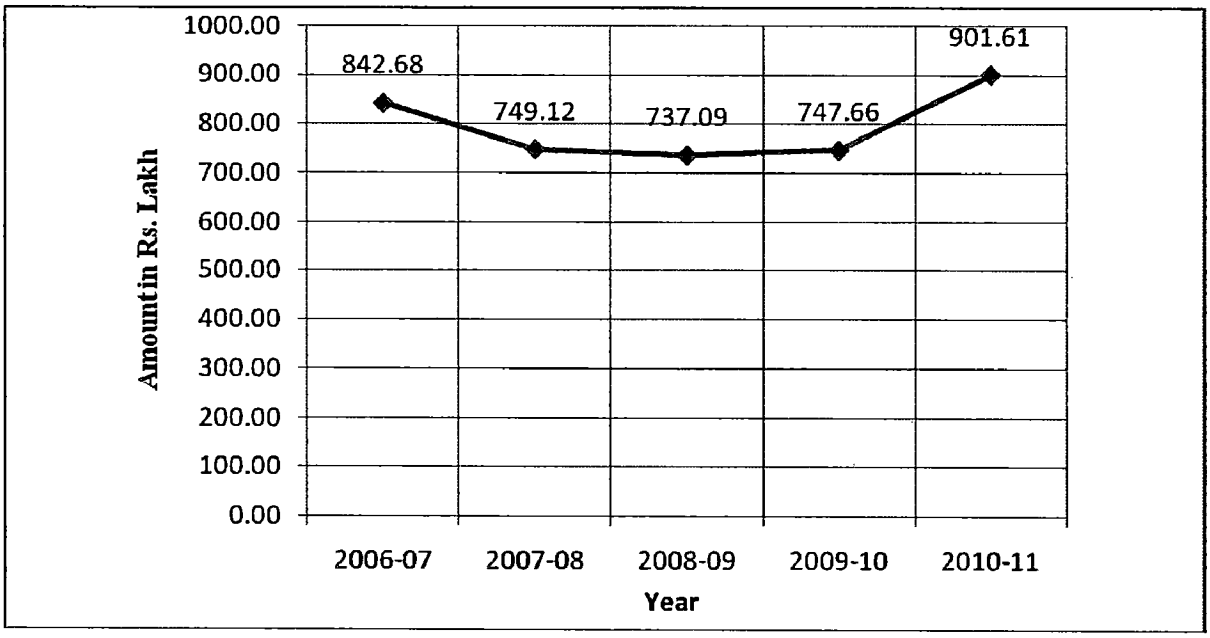


Figure 7.1: Revenue income for municipal Roorkee (2006/07 - 2010/11)

7.1.4 Expenditure

The total expenditure has been subject to fluctuations over the five year period from 2006/07 until 2010/11. It increased by Rs 432.44 Lakhs in 2007/08 over 2006/07, decreased by Rs. 55.19 Lakhs in 2008/09 over 2007/08, increased by Rs 783.18 Lakhs in 2009/10 over 2008/09 and decreased by Rs. 756 Lakhs in 2010/11 over 2009/10. while revenue expenditure increased at an average annual rate of only 34.06 percent during the same period. Table 7.2 provides a summary of the revenue expenditure of Roorkee municipal for the last five years from 2006/07-2010/11 and Figure 7.2.

Table 7.2: Expenditure of Roorkee municipal (Rs. In Lakhs)

(2006/07 and 2010/11)

S.No	Item	Year ((Rs. Lakhs)/year)				
		2006-07	2007-08	2008-09	2009-10	2010-11
1	General administration	28.368	32.244	37.06	32.673	68.118
2	Tax department	22.944	28.864	18.641	34.003	38.343
3	Light arrangement	9.3584	7.1253	5.0003	14.113	13.449
4	Repair of sewer drain	3.5851	5.7089	1.6027	1.5357	0
5	Cleaning of sewer drains	6.2656	6.2738	0	0.3498	0.9858
6	Salary of Sweeper	167.15	169.26	205.35	283.84	358.92
7	Petroleum, Oils, and Lubricants Repair	33.152	26.759	42.936	33.45	37.258

S.No	Item	Year ((Rs. Lakhs)/year)				
		2006-07	2007-08	2008-09	2009-10	2010-11
8	Health office department	8.3574	8.8863	8.9488	12.102	12.145
9	Park	7.8111	7.2958	6.2	5.8341	1.851
10	SI etc.	0.2831	0	0	0	2.1405
11	Public welfare department salary	7.5855	4.1913	4.5183	774.86	11.32
12	Building computer	0	1.2627	0.0119	0	0.506
13	Construction of roads	40.247	31.653	18.877	45.809	99.692
14	Library	0.5775	1.1965	0.2163	0.7717	0.5396
15	Printing expense	4.9881	3.5813	3.3279	1.8621	1.0012
16	Provident fund	58.816	52.122	74.994	51.198	53.345
17	Audit fee	0.1083	1.6874	1.637	0	2.2505
18	Twelfth finance	21.254	33.507	0	0	28.087
19	State finance	16.319	33.323	82.148	23.802	0
20	Miscellaneous	10.594	15.606	20.936	14.816	15.799
21	Permanent advance	1.79	0.22	0	0	0
22	Bail	0.0556	0.435	0.06	0	0.36
23	Litigation expenses	4.9512	2.8147	3.6816	5.1485	3.4782
24	Immovable property	0	412.98	295.68	278.83	109.41
	Total	**454.57**	**887.01**	**831.82**	**1615**	**859**

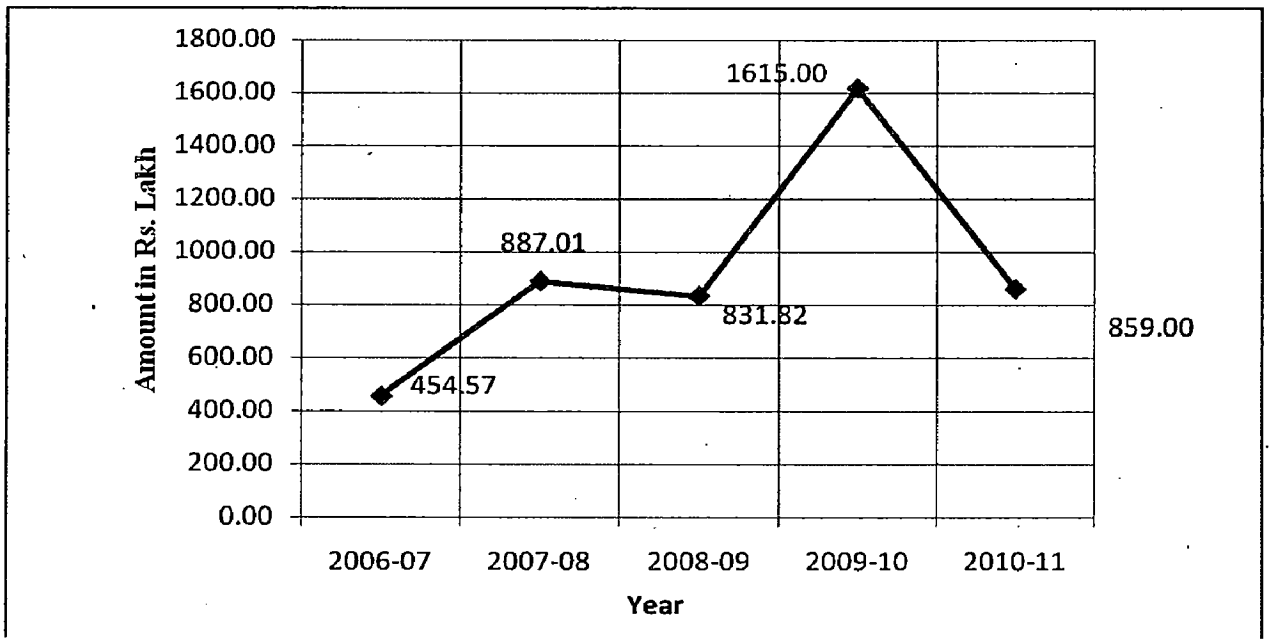


Figure 7.2: Expenditure for municipal Roorkee (2006/07 - 2010/11)

7.1.5 Financial Balance

The Municipal Corporation of Roorkee has not managed in most years to obtain an overall positive surplus 2006/07 and 2010/11 but nevertheless this deficit has continuously and significantly decreased over time, from Rs.(-867.34) Lakhs in 2009/10 to Rs. (+42.61) Lakhs in 2010/11. This could be an indicator that Roorkee's overall annual financial balance is negative. Show Table 7.3 and chart Figure 7.3 and Figure 7.4

Table 7.3: Revenue expenditure status of Roorkee municipal (Rs. In Lakhs) (2006/07 and 2010/11)

Item	Amount in Rs. Lakhs				
	2006-07	2007-08	2008-09	2009-10	2010-11
Revenue income	842.68	749.12	737.09	747.66	901.61
Revenue expenditure	454.57	887.01	831.82	1615.00	859.00
+Surplus /(-Deficit)	388.12	(-137.89)	(-94.73)	(-867.34)	42.61

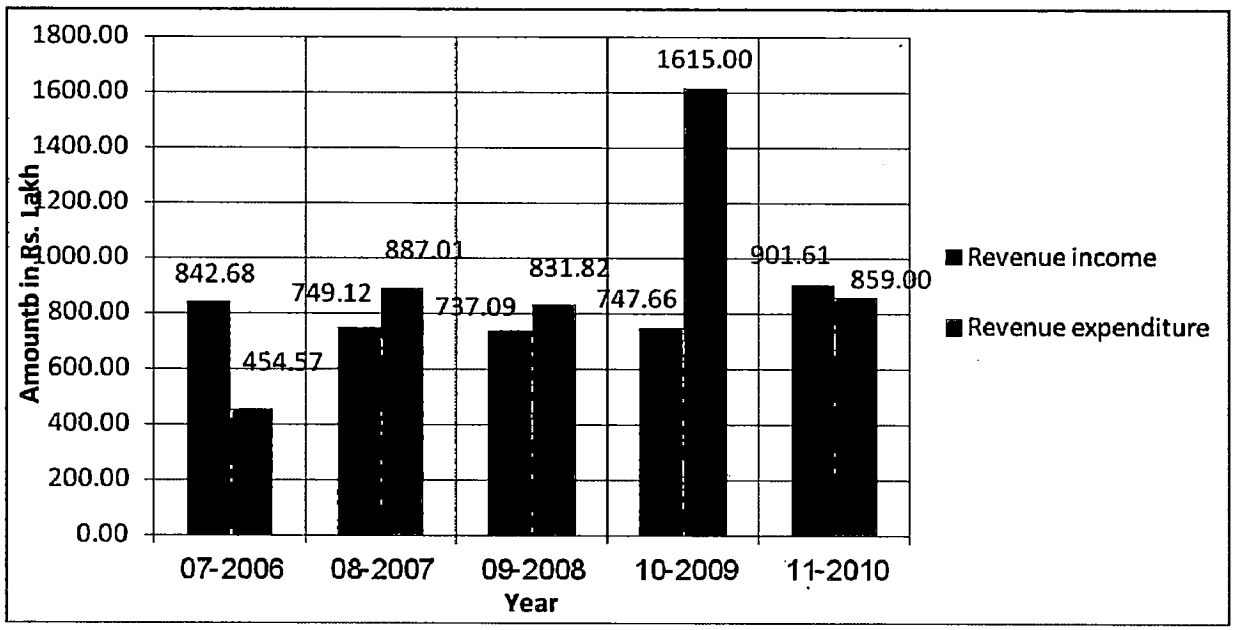


Figure 7.3: Annual financial flow for municipal Roorkee (2006/07 – 2010/11).

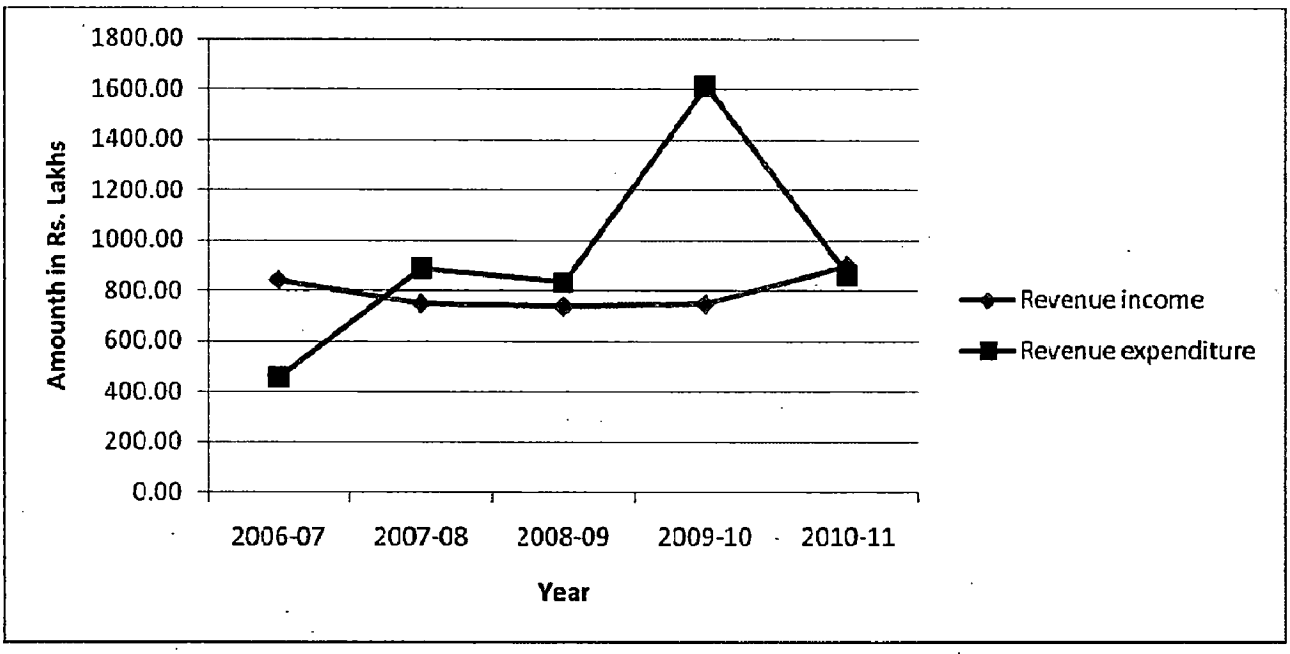


Figure 7.4: Annual financial flow of municipal Roorkee (2006/07 – 2010/11).

7.2 FINANCIAL FOR IMPLEMENTATION

7.2.1 WATER SUPPLY.

Summary of cost of different proposal are showing in Table 7.4 tentative estimated cost of the proposed improvement of water supply system is Rs. Lakh 4597.567.

Table 7.4: Preliminary cost estimate of water supply [10]

S.No	Description	Cost in Rs. Lakhs
Capital cost		
up gradation of distribution system laying of pipe with ancillary work for existing water supply distribution zone with in town.		
1	Laying of pipe line	757.600
2	Provision for valve and ancillary works	18.940
3	Restoration of road	800.000
4	Construction of new area head tanks	333.890
5	Renovation of existing over head tank	50.000
6	Privation of bulk meter	20.000

S.No	Description	Cost in Rs. Lakhs
7	House service connection up to property	500.000
8	Rain water harvesting structure.	10.000
	Total cost	**2739.473**
hydro-geological study		
1	Study of existing tube-wells study and identification of new tube well locations identification of alternate source and suggested remedial.	25.000
	Total cost	**25.000**
Re-placement of pumping machineries providing additional machineries with necessary electrical work, laying of rising mains from tube-well to over head tank, construction and renovation of pump houses, construction of operator rooms in existing water supply distribution zone with the town.		
1	Re placement of pumps	20.000
2	Development of new tube-well including pump house, pumping machinery, and ancillary work	250.000
3	Rehabilitation of existing tube well	28.000
4	Necessary electrical works for pumps house and automation	50.000
5	Laying of rising mains from tube-well over head tank (taking average dia as 350 mm detailed during DPR)	211.365
6	Restoration of road	26.125
7	Construction of new pump house	15.000
8	Renovation of existing pump house	1.250
9	Construction of operator room.	34.000
	Total cost	**699.314**
improvement of water supply in peri-urban area.		
1	Laying of pipe line	274.336
2	Provision for valve and ancillary works.	6.858

S.No	Description	Cost in Rs. Lakhs
3	Restoration of road	225.000
4	Construction of new over head tank	251.015
5	Provision of bulk meter	7.500
6	House service connection up to property	190.000
	Total cost	**1050.180**
construction of office building including laboratory for J.S		
1	Construction of office building laboratory and land scaping..et	10.000
	Total cost	**11.000**
installation of water meter in Roorkee town in the existing water supply distribution zone with in the town and peri-urban area.		
1	Installation water meter of suitable technology Roorkee town	10.000
	Total cost	**11.000**
supply of DG sets & No		
1	Supply of silent DG set 8 No. with complete accessories	56.000
	Total cost	**61.600**
	Total of capital cost water suplly work	**4597.567**
	O&M cost	
1	Establishment cost water supply network O&M cost of water supply network and equipment of pumping station and tube wells a	137.930
	Total O&M cost	**137.930**
	Capital cost	**4597.567**
	5 years O&M cost	**689.65**
	Grand total (capital cost +O&M cost (5 years))	**5287.217**

7.2.2 SEWERAGE

Table 7.5: Summary of capital cost and O&M cost of sewerage network [10]

S.No	Description	Cost in (Rs.Lakhs)
	Capital cost	
1	Total cost of sewerage network	12455.00
2	Cost of mechanical and electrical items pumping station	463.60
3	Cost of civil items of pumping station	699.50
4	Cost of pumping mains	133.75
5	Cost of STP's	2016.50
	Total capital cost	**15768.35**
	O&M cost	
6	Establishment cost of STP, SPS and sewerage network	119.22
7	O&M cost of sewerage network	72.24
8	O&M cot of STP	210.41
9	O&M cost of 3 SPS	40.57
	Total O&M cost	**442.40**
10	**Capital cost**	**15768.35**
11	**5 years O&M cost**	**2212.00**
	Grand total (capital cost +O&M cost (5 years))	**17980.35**

7.2.3 SOLID WASTE.

Table 7.6: Capital cost of solid waste [9]

	Capital	Rate	No/sq meter	Cost in (Rs. Lakhs)
1	Composting unit (Sq meter)	1000	3200	32.00
2	Recyclables segregation unit	1000000	1	10.00
3	Rickshaw trolleys	8000	100	8.00
4	Sieving Machine	100000	2	2.00
5	Office furniture & fixture	100000	1	1.00
6	Technical knowhow	Lump sum		1.00
7	Pre-operative expenses	Lump sum		1.00
			Total capital cost	**55.00**

Table 7.7: Estimate O&M cost for solid waste management Roorkee.[9]

Description	Amount in (Rs.Lakhs) for 5 year				
	I	II	III	IV	V
Training- Staff & Waste Workersl capacity building for staff	0.40	0.00	0.00	0.00	0.00
Segregation bags	2.40	2.77	3.33	3.78	4.31
Workers uniform & accessaries	2.52	2.71	2.89	3.13	3.35
IEC	4.99	0.75	3.00	0.00	0.00
External review & evaluation	2.00	2.00	2.00	4.00	4.00
Trollies repair & maintenance	0.83	3.43	3.74	4.87	6.16
Purchase of new Trollies from 2nd year own words & 75% replacement in 5th Year	0.00	0.30	0.32	0.43	7.98
Becterial culture (in liters)	5.05	5.88	6.85	7.98	9.30
Packaging material	0.21	0.29	0.30	0.32	0.34
Decomposting Tripal	1.13	1.43	1.50	1.57	1.65
Gloves and Mask	0.74	1.00	1.11	1.24	1.38

Description	Amount in (Rs.Lakhs) for 5 year				
	I	II	III	IV	V
Small equipments for composting	0.30	0.30	0.30	0.30	0.30
Operational cost for recycling unit	3.00	4.32	5.18	5.70	6.27
Administrative Cost @ 7% /annum	7.94	8.72	9.92	11.10	12.97
Total O&M Cost	**31.50**	**33.90**	**40.46**	**44.41**	**58.01**
				Capital cost	**55.00**
				Total 5 years O&M cost	**208.28**
				Grand total (capital cost +O&M cost (5 years))	**263.28**

7.2.4 BIO MEDICAL WASTE.

Table 7.8: Cost of Common Biomedical Treatment facility for 1500 beds [27]

S.NO	Description	Cost in (Rs. Lakhs)	Total cost in (Rs. Lakhs)
1	PLANT & MACHINERY	**15.0**	**56.0**
	Incinerator 200kg/hr	**3.0**	
	30 m Chimney	**3.0**	
	Wet scrubber	**12.0**	
	Auto c1aves 2 nos 3.0	**3.0**	
	Shredder 1 nos	**3.0**	
	Blood bag shredder 1 nos	**7.0**	
	ETP plant	**10.0**	
	Other upkeep equipments		
2	**LAND**	**6.0**	**7.0**
	2.3 Acres	**1.0**	
	OTHER LAND RELATED EXPENSES		
3	**VEHICLES**	**18.0**	**29.5**
	A) BIG TRUCKS - 3 NOS @ 6 LAKHS each	**10.0**	
	B) SMALLERVEHICLES- 4 Nos @	**1.0**	

S.NO	Description	Cost in (Rs. Lakhs)	Total cost in (Rs. Lakhs)
	2.5each		
	C) Bikes 2 Nos @ *50000/-* each	**0.50**	
	D) Other vehicles for office purpose		
4	**BUILDING**		**27.5**
	A) Compound wall for 3 Acres	**7.50**	
	B) To house Incinerator, autoclave, Shredders, etc	**10.0**	
	C) Guard room, Unloading Bay, Office Weighing room, Toilet, Cloak, R&D Rest room, dining, and etc	**10.0**	
5	PRE OPWERA TIVE EXPENSES		**5.0**
6	PRILIMINARY EXPENSES		**5.0**
7	TRAINING		**5.0**
8	OTHER CONTINGENCY		**10.0**
	Total capital cost		**145**

O&M cost

S.No	Description	Cost in (Rs.Lakhs)
1	Equipment	2.80
2	Maintenance of vehicles	4.43
3	Maintenance of building	0.55
	Total O&M cost	**7.78**
	Capital cost	**145.00**
	5 years O&M cost	**38.90**
	Grand total (capital cost +O&M cost (5 years))	**183.90**

7.2.5 TOILETS

Table 7.9: Preliminary cost estimate of toilets

	Description	cost per unit	Number of units	Cost in (Rs. Lakhs)
1	Construction of community toilets	1.00	10	10
2	Construction of Community urinals	.5	5	2.5

	Description	cost per unit	Number of units	Cost in (Rs. Lakhs)
			Total capital cost	**12.5**
		O&M cost		
1	Maintenance of toilets	0.1	14	1.4
5	Maintenance of urinals	0.08	15	1.2
			Total O&M cost	**2.6**
			Total capital cost	**12.5**
			5 years O&M cost	**13**
			Grand total (capital cost +O&M cost (5 years))	**25.5**

7.2.6 TOTAL COST

Table 7.10: Total capital cost estimate of all elements CSP

S.No	Description	Cost in (Rs.Lakhs)
1	Water supply	5287.22
2	Sewerage	17980.35
3	Solid waste	263.28
4	Bio-medical waste	183.90
5	Toilets	25.50
6	Crematoria	10
	Dairies	10
	Motor garages and catlle wallowing	5
	Dhobi ghats	5
Total		23770.25

Table 7.11: Total O&M cost estimate of all elements CSP

S.No	Description	Cost in (Rs.Lakhs)/year
1	Water supply	137.93
2	Sewerage	442.40
3	Solid waste	58.01
4	Bio-medical waste	0
5	Toilets	2.60
	Total	**640.94**

CHAPTER- 8

RESOURCE MOBILIZATION

8.1 REVIEW OF THE EXISTING FISCAL AND FINICAL AND FINANCIAL SITUATION

The purpose of this stage is to review the existing financial situation in terms of trends in the revenues and expenditures of the authorities concerned with the development of the city.

The urban services are provided by multiple agencies in Roorkee. They are:-

1). Roorkee Nagar Palika Parishad, (RNPP),

2). Uttarakhand Jal Sansthan (UJS),

3). Public Works Department (PWD),

4). Irrigation Department (ID),

RNPP the responsible organizing resources for creating and maintaining the urban infrastructure in Roorkee. RNPP's revenue receipts (own) mainly comprise Property / House tax, rentals and advertisement. UJS's revenue receipts are mainly water tax and water charges would only be able to meet the maintenance and operation expenses. However for creating the new infrastructure special resources shall be required.

8.2 RESOURCE MOBILIZATION STRATEGY

Conventional sanitation finance in the past in Roorkee relied on grants / subsidies for household and public toilets and solid waste systems. A review of funding available in the past 5 years in Roorkee reveals that sanitation funding has been largely dependent on Central grants (Thirteenth Finance Commission grants); while in the water sector, the ULB has contributed >15% of the expenditure from its own sources.

That even after undertaking reforms as envisaged, Roorkee municipality would still look towards higher levels of Government for 30% - 90% of CSP capital investments. While it is well understood that reforms, privatisation and leveraging of additional resources are required, they can happen only if the State Government provides an enabling framework for the same.

The Resource Mobilization Strategy for CSP draws upon a review of emerging paradigms and strategies for sanitation financing adopted by cities and state governments, keeping in view the prioritized sectors for CSP investment in Roorkee. It also identifies potential sources of finance, which may be possible to tap for the city.

The Resource Mobilization Strategy and Action Plan for Roorkee are based on the following principles:

1). Promote reforms

2). Leverage resources for the sector

3). Pro-poor strategies

Keeping the above principles in mind, the following is identified for

i). Policy and Strategic Interventions at State level, and

ii). Interventions at ULB level.

8.3 POLICY/ STRATEGIC INTERVENTIONS AT STATE LEVEL

1). From 'grants and subsidies' to financing 'sanitation promotion and resource leveraging'. Review of emerging thought and practice indicates the need for a shift in sanitation financing from funding 'grants and subsidies for sanitation facilities' to financing 'sanitation promotion and resource leveraging'.

2). Defining the Reform Agenda. The Reform Agenda for ULBs needs to be defined by the State; this may be modeled on the Urban Infrastructure development for small and medium towns Reform Framework prescribed by Government of India. In addition, by providing a combination of "Awards and Incentives " and "Conditional Grants " for the City Sanitation Plan, the State can help foster reforms at ULB level, which will be the cornerstone of the resource mobilization strategy.

3). Tariff Reform Policies. The state government needs to put in place policies related to tariff setting and revision by ULBs. Frequency of revision and the basis for structuring tariffs must be clearly defined for reference by ULBs.

4). PPP (Public Private Partnership) Framework. The state government may prepare a Public Private Partnership Framework. The ULB shall then have the option of outsourcing service delivery to the private sector, within the defined framework. The PPP framework should also provide clear guidelines

regarding the ULB's role in regulating tariffs and overseeing implementation and O&M.

5). Policy Guidelines for Cross-subsidization. Alternative subsidy mechanisms to ensure coverage of the poor and vulnerable/disadvantaged households, to be considered

i). Cross-subsidies across sectors/income sources e.g. from customers connected to water supply (i.e., cross-subsidies between water and sanitation services) or even cross-subsidies from taxes/income in other Sectors (e.g. property tax or municipal rents);

ii). Cross-subsidization by other consumers e.g. entities such as hotels and commercial establishments, industries and other bulk producers of solid waste and wastewater etc. that benefit from sanitation services can be a source of cross-subsidies for adoption of sanitation at household level.

iii). Cross-subsidisation through additional resource generation from reuse / sale (e.g. composting of solid waste and sale of treated water to farmers, industries and commercial establishments) with the involvement of the private sector.

iv). Design of appropriate cross-subsidy mechanisms and guidelines for ULBs to implement the same would need to be prepared.

8.4 INTERVENTIONS AT ULB LEVEL

1). Comprehensive Resource Mobilization Strategy and Financial Reforms as per a time-bound and agreed framework.

2). Review of tax rates (all taxes and charges) and sustained improvement of collection efficiency in a time-bound

3). Introduction of new taxes and/or surcharges.

4). Leveraging more of household and community resources and facilitating household level access to microfinance to ensure inclusion of all households that are unable to bear user contribution/connection charges envisaged.

5). Devising an appropriate strategy for cross-subsidization (across sectors and across consumer groups) based on guidelines provided by Government

6). Focus on project development for market-based resource mobilization (in the medium term) e.g. for waste collection, transportation, composting and landfill;

7). Devise strategy for generation of additional revenues for the Sector e.g. identification of viable options for reuse/sale of treated waste.

8.5 SOURCES FINANCE FOR IMPLEMENTATION CSP

This section of the report outlines the annual capital expenditure (capex) required, as well as funds required for operations and maintenance of all aspects of the CSP and the sources for funding both.

It is expected that Government of India shall provide the major resources for the development of City Sanitation Plans, under the aegis of the National Urban Sanitation Project, they would evolve a program to financially support implementation of these plans as well. Wherein a city like Roorkee would will be receiving up to 70% of its total approved capital expenditure for implementation of its CSP from the Government of India (GoI) scheme and another 20% from STATE Government. Thus, Roorkee Municipal Corporation would need to finance the balance 10% of the total capital expenditure (capex). Table 8.1

In addition to the capex and the first five year of operation & maintenance (O&M) there expenses (O&M) to be incurred annually for the various elements of the CSP are also quite significant. The following Table 8.2 outlines the annually O&M expenditure required, and the incremental expenditure that would be required to be made by the Roorkee Municipal, in addition to the revenue expenditure that Roorkee Municipal is incurring currently,

TABLE 8.1: Sources of funds for CSP

S.No	Description	Cost in (Rs.Lakhs)
1	Water supply	5287.22
2	Sewerage	17980.35
3	Solid waste	263.28
4	Bio-medical waste	183.90
5	Toilets	25.50
6	Other (crematoria, dhobi ghats, dairies, motor garages, catlle wallowing)	30
Total capital expenditure		**23770.25**
Financing Plan		
Govt of India	**70%**	**16639.20**
STATE Govt	**20%**	**4754.05**
capital expenditure to be Financed by Roorkee Municipal	**10%**	**2377.00**

TABLE 8.2: Expenditure required for annual (O&M) of CSP

S.No	Description	Cost in (Rs.Lakhs)/year
1	Water supply	137.93
2	Sewerage	442.40
3	Solid waste	58.01
4	Bio-medical waste	0
5	Toilets	2.60
Total expenditure required		**640.94**

CHAPTER- 9

PUBLIC PARTICIPATION AND PUBLIC AWARENESS

9.1 GENERAL

This section presents a strategy for information, education, and communication (information, education and communication) / awareness generation on sanitation, hygiene, environmental concerns, and public health in the city of Roorkee. The information, education, and communication /awareness generation strategy is an integral component of the CSP for Roorkee, which is understood to be critical for its success.

As a key first step to awareness generation strategy formulation for Roorkee CSP, different types of consumers in the city were identified; consumers were classified into general households, slum households, commercial units, industries, institutions, and hospitals.

9.2 OBJECTIVE

The strategy will have objectives of

1). establishing linkages of hygiene and sanitation behaviors and health impacts to improve knowledge and among general public for improved healthy living conditions'

2). developing mechanisms for collective action to bring about and sustain behavioral changes aimed at adoption of healthy sanitation practices.

9.3 NEED FOR SPECIFIC STRATEGIES

The need for an IEC strategy for CSP, Roorkee, emerges from the analysis of data on sanitation at household level as well as the existing waste disposal practices of households and industrial, commercial, and institutional establishments, as well as hospitals. Must be especially focus on the expected observations and interventions the in Table 9.1.

Table 9.1: Observations and expected interventions

Observed Behaviors	Expected intervention or Hygiene Behavioral Change
Majority of the families allow their children to use open fields for open defecation	Children should be encouraged to use household level toilets for defecation
Infants excreta is thrown in open fields and drains	Infants excreta is equally harmful as of adults excreta and hence, it should be disposed off safely in toilets or pits where every disposed excreta needs to be covered with soil
Solid Waste is thrown in open fields or drains	Adequate community bins based on preferred locations to be provided, collection efficiency to be improved and awareness among citizens to be raised through campaigns on using the bins for disposal of their solid waste.

9.4 TARGET AUDIENCE

The awareness programme will target the following segments to promote the sanitation plan.

1). Youth (local and those among floating population) - there is likelihood of gaining good participation
2). School children – awareness generation at early stage useful in long term
3). Women – they are involved in maintenance activities at residential level and also work in sanitation services
4). People engaged in informal sector – these are the ones who have least awareness
5). Elected Representatives
6). NGOs, Local Community Groups (SHGs, Youth Mandals, Hotel Associations, School Associations)
7). Civil Societies
8). Spatial segments
9). Residential areas – elite areas, slums, EWG housing areas, etc.
10). Commercial areas, hotels, etc.

11). Public places – markets, bus stands, etc.

12). Other – hospitals, schools, government offices, religious places, Municipal Council Office etc.

9.5 THE PROPOSED AWARENESS STRATEGY

The suggested Awareness (IEC) strategy has four major elements which are discussed below. The Task Force for City Sanitation Plan shall be involved in designing and delivering the awareness strategy in the city.

9.5.1 Engagement of a Media Agency and NGOs

The Corporation will engage an experienced Media Agency to develop print material (pamphlets, brochures, messages, pictures etc) and audio-visual as well other forms of raising awareness such as street plays, folk media etc. NGOs involvement would be useful to develop implementation strategies maximizing participation of citizens in the programme.

9.5.2 Development of IEC Material

The material should be developed based on the targeted behaviors, low cost technology options for toilets, sanitation facilities proposed including tariffs, and the demographic traits of local and floating population. Material developed should be tested among sections of citizens to assess its appropriateness prior to its printing.

9.5.3 Developing Outreach Strategy

Multiple strategies for reaching floating population as well local population have to be developed to ensure continuity and to increase its effective in terms of reach as well costs with participation of other relevant partners and stakeholders.

9.5.4 Inter-sectoral Collaborations

Municipal Council needs to explore inter-sectoral collaborations with other departments such as PWD, Health Department, Education Department and Department for Information and Publicity. Such collaborations could be in a form of sharing of resources (funds, material, staff etc) and integrating some of the awareness strategies in their programmes. For example, education department can take up special programmes for schools using their own resources.

9.5.5 Private Sector Participation

The Corporation can also explore participation of private partners in the awareness programme. The involvement of private partners could be beyond awareness programme also in the form of sponsorship, sharing of costs (fully or partially) for various events organized in the city and IEC material development etc, funding infrastructures/maintenance etc.

9.5.6 Launch of the Awareness Campaign

This activity need not to wait for the above two activities to complete. But initial planning would help participation of other departments and potential private sector players in such launch campaign. Awareness Campaign shall be launched through a formal programme of all stakeholders and representatives. Hoardings of this launch initiative shall be displayed at public places – preferably at bus stands, hospitals, theatres, colleges, near traffic squares, Municipal Council building it, etc. This is to be done only to announce about the initiative – this is not meant for mass awareness about the schemes or IEC contents itself.

9.5.7 Community Mobilization

This is an important and critical activity which will help reach the grassroot sections of the community and will help motivate and trigger initiative at the individual, group or community level. Such community mobilization is recommended for slum areas and among population who is resorting to open defecation. Mobilization could be done through intensive and continuous interactions with the targeted population. Through mobilization, issues such as high cost of toilets, segregation of waste etc. can be effectively handled through comprehensive discussions and demonstrations on low cost toilet models, financing mechanisms available, availability of masons, and technical advice and supervision available from the Municipal Corporation. Community mobilisation activities could be led by concerned Councilors to ensure that there is adequate political support for the awareness campaign.

9.6 TIME FRAME FOR IMPLEMENTATION OF AWARENESS STRATEGY

Awareness Strategy is to be implemented intensively in a campaign mode during the first year involving a range of stakeholders in the city. In order to continue sustained efforts for behavioral change, activities which are effective shall be continued based on the outcomes of the activities of the first year.

9.6.1 Monitoring and Regulation

1). Awareness campaigns and other activities help generate awareness but this would not necessarily result into practices and expected behavioral change. The Awareness has to be backed up with

2). Resources in case of demand for any particular resources by communities (e.g. collection bins in areas where they do not available now),

3). Motivation where change is happening and needs to be further supported with incentives for replicating it across other sections of community,

4). Regulation where change is not happening and change can be brought about by legal actions.

5). In order to decide on the support required to further the behavioral change, it is necessary that the awareness programme is monitored closely. Based on this monitoring, the strategies could be continued or modified.

9.7 COST ESTIMATE

A provision of 2% of the project cost made for generation of public awareness and securing public participation. Various items of cost for which provision should be made are illustrated in the table below:

Table 9.2: Cost Estimate for Public Awareness and Public Participation

S. No.	Item	Basis of Calculation Amount in (Rs. Lakhs)	Total Amount in Rs. Lakhs
A	**Mass Media**		
1 (a)	Television (films and promotional for TV Advertisement) (Professional grade digital recording)	3.50	36.00
(b)	Advertisement of local Cable Network	1.50	14.00

S. No.	Item	Basis of Calculation Amount in (Rs. Lakhs)	Total Amount in Rs. Lakhs
2 (a)	Radio talks (preparation and subject expert charges)	0.1	2.50
(b)	Advertisement in Local F.M.	.05	0.50
3	Print Media publicity in local papers, magazines etc. Advertisement in the tourist guide books etc., Special features and commissioned articles	2.00	25.00
4	Print material for Distribution including publicity on match boxes, stationary, stickers, etc.	2.00	23.00
5	Hoarding at strategic points in the city and on buses, rickshaws etc.	3.50	35.00
6	Website Development with hosting and updation for three years	0.5	5.00
B.	**Events**		
7	Sponsoring / Organising Events like Puja, Local Festivals etc.	5.00	25.00
8	Preparation of Exhibition Material, Posters and Organising these events-rivere festival and run for the river events	2.50	20.00
9	Special Cultural Events, Performances of Folk Media: (Folk theatre, Folk Music, Folk Stories) Street Plays **(performances specially for slum localities)**	1.00	10.00
C.	**Groups and Meetings**		
10	Environmental Awareness at Schools Level (Talks, Essay, painting competitions, debates, other activities 5 per ward per year for 3 years	0.01	1.00
11	Formation of Action Groups, Self help groups and support to social groups/clubs for awareness generation activities	0.05	2.00
12	Other Awareness activities like public meetings, public debates, Meetings with different Unions, felicitation of best workers etc.	0.05	1.00
	Total for Public Awareness and Public Participation Activities		**200.00**

CHAPTER-10

CONCLUSIONS AND RECOMMENDATION

10.1 CONCLUSIONS

From the present study analysis existing situation and proposal for all elements of city sanitation plan. the following conclusions are drawn:

10.1.1 Water Supply

Water supply per capita for city has taken 135 lpcd plus 15% loss. There was difference in the total water supply data collected from Roorkee municipal and UJS equal to 0.9 MLD. there are number of tube well 17 in city and over head tank 5, Some zones not available over head tank (OHT) like zone (Sot Mohalla zone V and Ganeshpur zone VI) and some zone there is deficit in storage capacity (CIVIL LINES ZONE -I and MAQTOOLPURI ZONE IV) (142, 1620) KL. some zone it has storage capacity of water is sufficient for example (RAM NAGAR ZONE II and AVAS VIKAS ZONE III).

10.1.2 Toilet

Preliminary studies indicate few from public toilet and general urinals. Where, available only number 4 public toile and 10 general urinals in the city.

10.1.3 Sewerage

Waste water generation by 80% from water supply plus 2% infiltration. where present waste water generation in city is around 14.87 MLD and there is not sewage treatment plant in the Roorkee city just disposal of effluent to the Solani River without treatment.

Existing situation for sewerage facility in city not good. For example sewerage network very old and sewage pumping station also very old and not work efficiency. and number SPS in city not enough. where found many of nature ponds for collect effluent and around this ponds there are people's homes, which may cause the spread of serious diseases among the population.

10.1.4 Solid Waste

Roorkee city generated solid waste is around 45 MT/daily. Where there is not recyclables and segregation

10.1.5 Storm Water

Presently the storm water drain and sewage drains are together. And Drains are filled with sewage and garbage.

10.1.6 Bio–medical Waste

Present bio-medical waste generation in city is around 2000 kg/daily from HCUs. But absence of a clear vision of how the collection and disposal and treatment of medical waste in the city.

10.1.7 Financial Management

Revenue income for the municipality Roorkee fluctuate from decline to growth during the last five years while the final year revenue income of Roorkee Municipality has grown to a level of INR 901.61 lakhs in the FY 2010-11 from INR 842.68 lakhs in FY 2006-07, thus registering an average annual growth of over 2.32 percent (Compound Annual Growth Rate). Where The total expenditure has been subject to fluctuations over the five year period from 2006/07 until 2010/11. It increased by Rs 432.44 Lakhs in 2007/08 over 2006/07, decreased by Rs. 55.19 Lakhs in 2008/09 over 2007/08, increased by Rs 783.18 Lakhs in 2009/10 over 2008/09 and decreased by Rs. 756 Lakhs in 2010/11 over 2009/10. while expenditure increased at an average annual rate of only 34.06 percent during the same period

10.2 RECOMMENDATION

10.2.1 Water Supply

Recommend export water supply to zones that has deficit of water from other zones until the next 10 years, change water supply network because its very old and dilapidate and ensure efficient maintenance of supply water pipes

10.2.2 Toilet

It is suggested that the big shops and commercial establishment should provide for public toilets in the ratio of 1 seat for 100 users. The actual number of toilet seats may be assessed from their market surveys. This can be enforced by the corporation through the bye laws and the clearance procedure and that the existing community and public toilet complexes should be repaired/ rehabilitated at an immediate phase through a strict monitoring protocol enforced by the municipal corporation also the municipal corporation enforces the existing private operators to collect user charges for the community toilets.

It is suggested that a DPR should be prepared for the identification, both spatially and quantitatively the number of toilets seats public required in the city. The DPR should also consider the following issues:

i. Access and the number of seats required and the provision for toilets in special areas like right bank of solani river and public markets..etc.
ii. Location (mapping of the existing and proposed toilet complexes).
iii. Gender sensitivity.
iv. Financial mechanism.

Once approved it is suggested that the design construction, operations and maintenance of the new public toilets as per the DPR should be tendered and implemented and it is recommended that the RNPP should develop a design specification and operation manual for maintenance of a minimum desirable quality of the amenities created including punitive and incentive mechanisms. A tripartite monitoring system consisting of the users, private party and the ULB for the promised levels of maintenance should be developed on a medium term.

The RNPP should conduct a feasibility study on the technology options for the public toilets. A detailed comparison between the technical options, ease of

maintenance, local know and adaptability and the cost benefit analysis should be used to identify the technology suited for public toilets in the city.

10.2.3 Sewerage

A municipal shall be mandated to ensure existing and future households to be connected to the existing/proposed sewer networks. and stop use septic tank in city, the RNPP should certified plumbers who have the required qualifications for the connection to the branch/trunk. The connection shall be undertaken by these certified plumbers such as to ensure high quality control. This system should also ensure the connection of both grey and black water streams into the network .

Septic tank & Septage management shall be a part of the dedicated unit for Sewerage Sector under the Sanitation Department personnel management system & Sanitation worker's training program shall be implemented to conduct occupational safety and health training campaigns to educate the sanitary workers with respect to the benefits of adopting best operating practices.

10.2.4 Solid Waste

The treatment and segregation the solid waste in landfill site should be commissioned as soon as possible, the RNPP should enforce the safety and occupational health safeguards. This can be done through strict monitoring and punitive measures.

The RNPP should re-study of location of point collection and distribution of Bins. where equal over all city based on population for each ward in city. and should the RNPP taken all the stringent measures to stop the disposal of garbage on the roadside and on the banks of the Solani river.

Setting up centralized & decentralized treatment plants for biodegradable waste, study the route optimization of the Solid Waste transport system by RNPP, Rehabilitation of existing dump sites and setting landfill facility to save environmental and strengthening the solid waste collection and transport system.

10.2.5 Storm waste

It is recommended that re study for loading the Nallah focusing on area, cleanliness and urban design interventions taken up on an immediate term by the RNPP. Cover for storm water drains to stop the garbage inside the drains

10.2.6 Bio-medical Waste

Strict implementation of biomedical waste management rules is the need of the hour and it should be made compulsory for healthcare facilities to get their healthcare personnel trained from accredited training centers. These training sessions should not become merely a one-time activity but should be a continuous process.

Training of sanitary staff should be specially emphasized, ensured that the injuries happening to the healthcare personnel are reported to the person in-charge of biomedical waste management or to the biomedical waste management committee, and they report it in the prescribed format to the pollution control board.

10.2.7 Financial Management

Efforts to increase the revenue generation by regulating the tax regime and efficient assessment and collection of taxes need to be taken up with immediate effect for example increase the water tax. At present, the Roorkee municipal is heavily dependent on the State level grants. The functions like water supply, sewerage and solid waste especially need to be made self sufficient and adopt accounting and budgetary standards also Institute efficient data management system ensuring appropriate financial administration and reporting mechanism.

10.2.8 Effluent Industrial

The industries area should be have their own water sources and waste water collection and treatment plants. for each factory based on product which need to different technical treatment, which may be generating small quantities of waste water, will discharge to a municipal sewer. Good control and monitoring by the State Pollution Control Board is necessary to ensure that the waste water being discharged to the municipal drains in safe as per the standards.

10.2.9 Other

It is recommended focusing and control on pollution due to for crematoria, dairies, dhobi ghat, motor garages, cattle wallowing and carcass disposal

10.2.10 General

1). Establishment of environmental and mobile laboratory

2). Establishment and Implementation of Environmental Management System.

3). Development and Implementation of Environmental Monitoring Plan – Air, Water and Noise

4). Proposal for an Environmental Awareness and Activity Centre

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