Republic of India
Uttarakhand Pey Jal Nigam (UKPJN)
Uttarakhand Jal Sansthan (UJS)

Data Collection Survey for the Urban Water Supply and Sewerage System in Uttarakhand

Final Report

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Japan International Cooperation Agency (JICA)

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【Abbreviations】

Abbreviations	official name
ADB	Asian Development Bank
AMR	Auto Meter Reading
B.F.G	Boulder Filled Gallery
BCP	Business Continuity Planning
CEDAW	Convention on the Elimination of Discrimination against Women
CETP	Common Effluent Treatment Plant
CGWB	Central Ground Water Board
CIFRI	Central Inland Fisheries Research Institute
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CWAPs	City Water Action Plans
CWBPs	City Water Balance Plans
CWC	Central Water Commission
CWR	Clear Water Reservoir
DBO	Design Build Operation
DCIP	Ductile Cast Iron Pipe
DMA	District Metered Area
DMs	District Magistrate
DO	Dissolved Oxygen
DWS	Department of Water Supply
DWSM	District Water and Sanitation Mission
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortization
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
FIRR	Financial Internal Rate of Return
FLFPR	Female Labor Force Participation Rate
FRI	Forest Research Institute

Abbreviations	official name
GEMS	GLOBAL ENVIRONMENT MONITORING SYSTEM
GI Pipe	Galvanized Iron Pipe
GoI	Government of India
GoU	Government of Uttarakhand
GoUK	Government of Uttarakhand
GP	Gram Panchayat
GPRS	General Packet Radio Service
GSDP	Gross State Domestic Product
GSVA	Gross State Value Added
I.S.Code	Indian Standard Code
ICT	Information and Communications Technology
IEE	Initial Environmental Examination
INR	Indian Rupee
IP	Internet Protocol
IPC	Indian Penal Code
IPS	Intermediate Pumping Station
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
JSSS	JICA STANDARD SAFETY SPECIFICATION
JST	JICA Survey Team
KfW	Kreditanstalt für Wiederaufbau
LFPR	Labor Force Participation Rate
LPCD	Liters Per Capita per Day
MBBR	Moving Bed Biofilm Reactor
MDWS	Ministry of Drinking Water and Sanitation
MIS	Management Information System
MLD	Million Liters per Day
MLY	Million Liters per Year
MM	Man Month

Abbreviations	official name
MoHUA	Ministry of Housing and Urban Affairs
MoHUPA	Ministry of Housing and Urban Poverty Alleviation
MoJS	Ministry of Jal Shakti
MoUD	Ministry of Urban Development
MPS	Multi Pumping Scheme
MS Pipe	Mild Steel
MSW	Municipal Solid Waste
NDMA	National Disaster Management Authority
NGT	National Green Tribunal
NRSC	National Remote Sensing Centre
NRW	Non revenue water
NSSO	National Sample Survey Office
NWMP	National Water Quality Monitoring Programme
OCEMS	Online Continuous Emissions/Effluents Monitoring Systems
ODF	Open Defeation Free
OHT	Over Head Tank
PCB	Pollution Control Board
PCCs	Pollution Control Committees
PETP	Polyethylene Terephthalate Polymer
PIU	Project Implementation Unit
PLC	Programmable Logic Controller
PMC	Project Monitoring Committee
PMU	Project Management Unit
PPP	Public Private Partnership
PQ	Prequalification
PSU	Public Sector Undertaking
PTCUL	Power Transmission Corporation of Uttarakhand Limited
PWD	Public Works Department
RAP	Resettlement Action Plan

Abbreviations	official name
RBF	River Bank Filtration
RCP	Representative Concentration Pathways
RTU	Remote Terminal Unit
SBR	Sequencing Batch Reactor
SC	Scheduled Castes
SDMs	Sub-Divisional Magistrate
SGBV	Sexual and Gender-Based Violence
SLL	Special and Local Laws
SPCBs	State Pollution Control Boards
SPV	Special Purpose Vehicle
SSP	Shared Socioeconomic Pathways
ST	Scheduled Tribes
STP	Sewage Treatment Plant
SW	Service Water
SWAP	Sector Wide Approach to Planning
SWM	Solid Waste Management
SWSM	State Water and Sanitation Mission
UERC	Uttarakhand Electricity Regulatory Commission
UFW	Unaccounted For Water
UIRUDP	Uttarakhand Integrated and Resilient Urban Development Project
UJS	Uttarakhand Jal Sansthan
UJVNL	Uttarakhand Jal Vidyut Nigam Limited
UKPCB	Uttarakhand Pollution Control Board
UKPJN	Uttarakhand Pey Jal Nigam
ULB	Urban Local Body
UPCL	Uttarakhand Power Corporation Limited
UPS	Uninterruptible Power Supply
UREDA	Uttarakhand Renewable Energy Development Agency
UT	Union Territory

Abbreviations	official name
UUSDA	Uttarakhand Urban Sector Development Agency
UUWSP	Uttarakhand Urban Water Supply Project
VAT	Value Added Tax
VPN	Virtual Private Network
WB	World Bank
WII	Wildlife Institute of India
WRIS	Water Resources Information System
WTP	Water Treatment Plant



Source : Info GIS MAP
https://www.igismap.com/download-india-administrative-boundary-shapefiles-states-districts-sub-districts-pincodes-constituencies/

Target Area Map

Chapter 1 Introduction

1.1 Outline of Survey

(1) Project name

Data Collection Survey for the Urban Water Supply and Sewerage System in Uttarakhand

(2) Survey period

From 10th April 2023 to 29th February 2024

(3) Survey schedule



1.2 Project Background

The Uttarakhand state (hereinafter referred to as UK state) has 79% of its population residing in the plain areas, including the state capital Dehradun. Due to the increase in population and water demand, there is an urgent need to enhance the water supply capacity. In addition, the sewage generated within the state exceeds the treatment capacity of the existing sewage treatment plants, resulting in the discharge of untreated sewage into public water bodies and causing water quality degradation. Furthermore, 86% of the state's area is covered by mountainous regions, which not only contributes to the delayed development of water and sanitation infrastructure but also suffers from challenges such as poor accessibility, lack of employment opportunities, and outmigration of labor force.

The UK state government formulated the "Uttarakhand Vision 2030" (hereinafter referred to as UK Vision 2030) in 2018, aiming to achieve the Sustainable Development Goals (SDGs) by 2030. The vision sets goals for the water and sanitation sector, primarily focusing on (1) access to safe water, (2) improvement of sanitation conditions, and (3) conservation of water resources. Efforts are currently underway to promote the implementation of water and sanitation projects in various regions.

1.3 Requests from the State Government

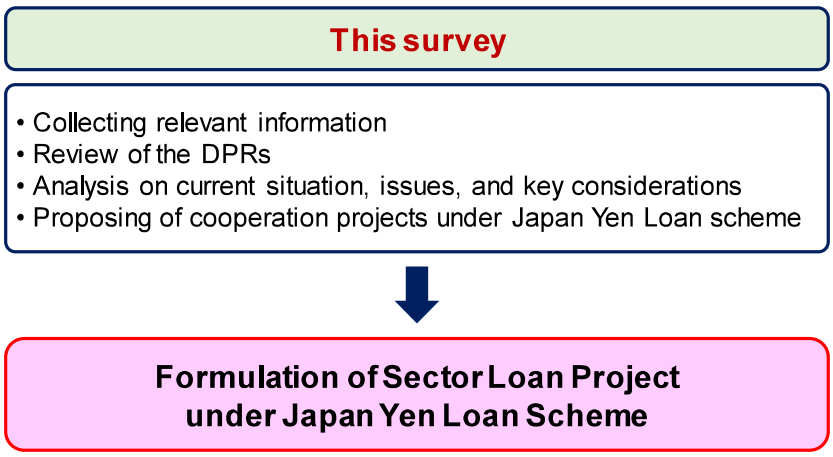
Based on the background, the UK state government has planned the Uttarakhand Urban Water Supply Project (UUWSP) for 38 towns within the state that require urgent development of water supply infrastructure. A Detailed Project Report (DPR) has already been prepared for each project.

However, the funding required for the project exceeds the financial resources of the state government alone. Therefore, a request for support has been made to the Japan International Cooperation Agency (JICA) in this regard. The request seeks assistance to bridge the funding gap for the project.

1.4 Objective of this Survey

This survey aims to collect, organize, and analyze the necessary information related to the water supply and sewerage sector in order to form new projects for sector loans. Its purpose is to propose a cooperative project by selecting priority projects from the DPR prepared for the 38 towns targeted by the UUWSP.

This survey does not assume the implementation of any subsequent preparatory survey. Therefore, the focus will be on examining the validity and feasibility of the project content outlined in the DPR and consolidating the considerations of key factors for the loan evaluation, particularly project cost, implementation schedule, implementation structure, and so on.



Source: Prepared by JST

Figure 1-1 Objective of this survey

1.5 Project Target Area

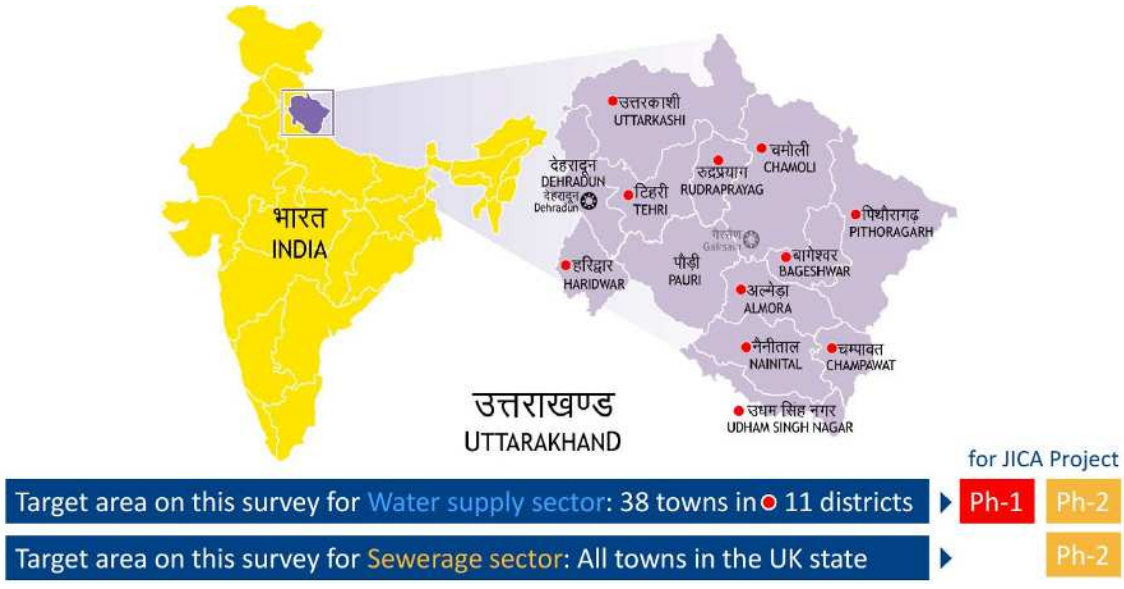
(1) Water supply sector

The formation of water supply projects will focus on the 38 towns covered by the existing DPRs (see Figure 1-2 and Figure 1-3). These towns are scattered across 11 out of the 13 districts in the state. Taking into consideration the specific characteristics and accessibility of each region, the projects will be categorized into Phase-1 and Phase-2, based on the priority of implementation. This approach aims to facilitate a phased implementation of the projects.

(2) Sewerage sector

Regarding the sewerage projects, since there have been no specific requests from the UK state government at the start of the project, the focus will be on gathering information about the sewage infrastructure situation throughout the entire UK state. Based on the collected information and the identified needs for sewerage system development, efforts will be made to explore the formation of new projects.

As the priority and immediate demand from the government are primarily related to water supply projects in the identified 38 towns, the sewerage system development projects will be categorized under Phase-2, considering their relative importance in the overall project implementation.



Source: Prepared by JST based on the data from UKPJN

Figure 1-2 Project target area in this survey



Source: Prepared by JST based on the Info GIS MAP[1]

Figure 1-3 Project target area of the UUWSP

References for Chapter 1

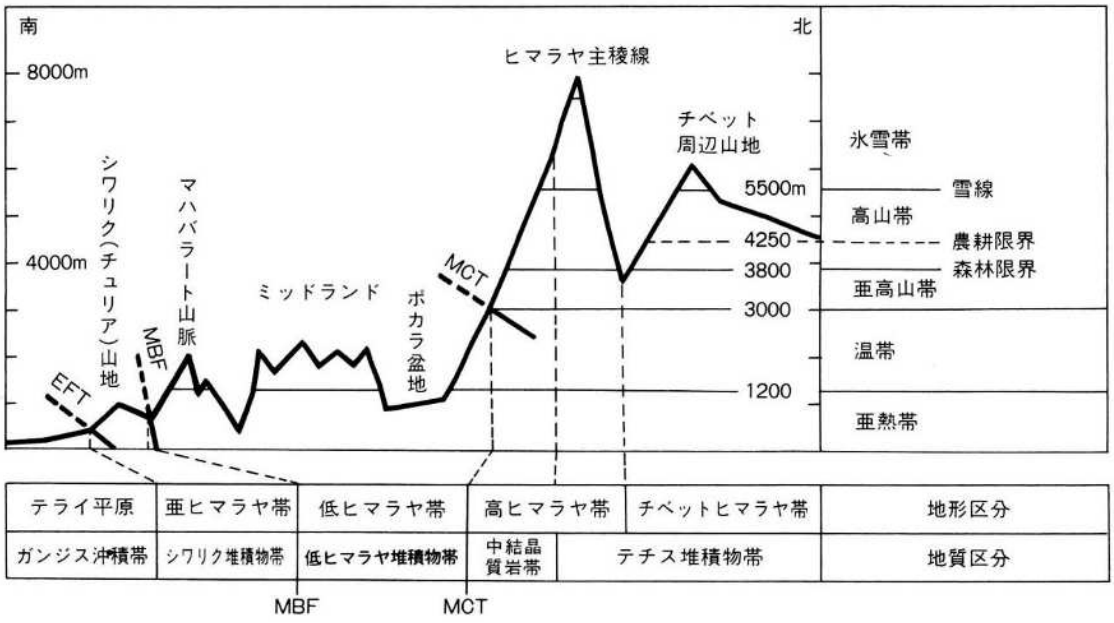
[1] Info GIS MAP, https://www.igismap.com/download-india-administrative-boundary-shapefiles-states-districts-sub-districts-pincodes-constituencies/

Chapter 2 Natural and Social Conditions

2.1 Geographical Characteristics

UK state is a biodiverse hilly state located in the foothills of the Himalayas, with 86% of the state belonging to hilly and mountainous terrain. Elevations range from below 1,000 m to over 3,500 m, with steep and complex terrain and distinct differences in agro-climatic zones. Large-scale commercial agriculture and cereal production take place in the warmer plains.

The terrain varies from the fertile Terai plain in the south to the snow-covered hills in the north, and consists of five latitudinal zones - Terai-Babar, Siwalik, Lesser Himalayas, Higher Himalayas, Trans Himalayas - with no clear boundaries[1].



Source: *Kizaki*, 1988[2]

Figure 2-1 North-south topographic cross section of the Himalayas

Table 2-1 The UK state latitude bands

latitude zone	Feature
Terai-Babar Zone (Terai plain)	It is a narrow strip of land surrounded by fertile land and drained by the Yamna River, Ganga River, Ram Ganga River, Sharda River
Siwalik (Sub-Himalaya)	Hilly areas at altitudes of 700-1,200 m.
Lesser Himalayas (Lower Himalayan Belt)	Huge mountainous area composed of various rock types.
Higher Himalayas (High Himalayan Belt)	Very high snow-covered mountains (5,000 m - 7,000 m+ altitude) are prominent.
Trans Himalayas (Tibetan Himalayan belt)	Arid Zone Susceptible to Rain Shadow Effects.

Source: Prepared by JST from *JICA report* (2014)

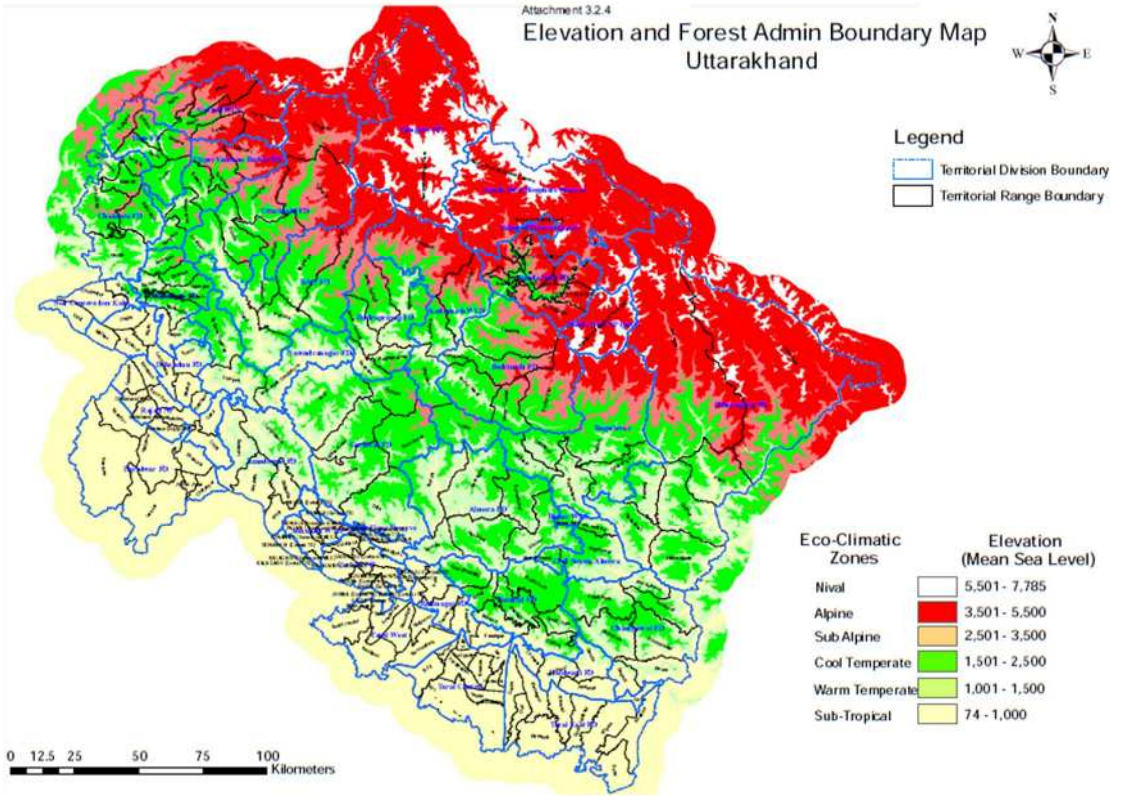
2.2 Climate

2.2.1 Climate Zone Classification

Due to differences in altitude over thousands of metres, the UK state has different climatic conditions in some areas. Various factors such as altitude, slope, proximity to glaciers and forests influence the local climate, making the climatic patterns very complex, to the extent that climatic conditions vary from valley to valley and even slope to slope on the same mountain. Summers are relatively hot and winters cold, with temperatures dropping below 0°C. The minimum temperature in the oblast is -3.0°C and the maximum is 43.2°C[3].

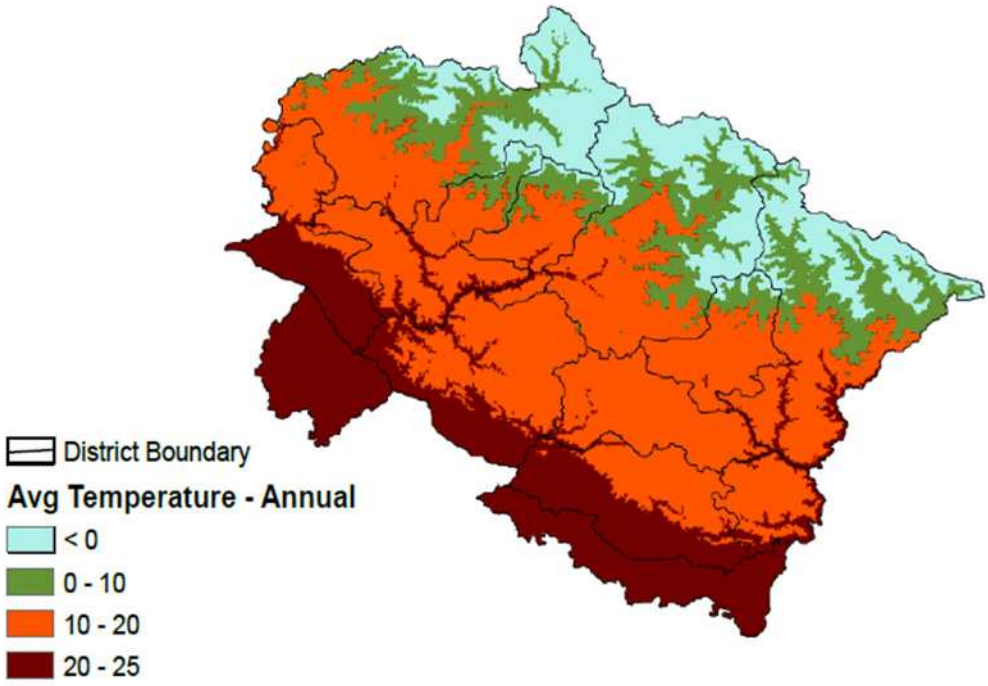
The plains region stretching across the southern part of the oblast (Terai-Babar Zone) is very hot and humid. Average winter temperatures in the region are around 20°C (68°F), with temperatures exceeding 40°C (104°F) in summer. Average temperatures generally decrease with altitude; other climatic zones in the UK state include the subtropical zone below 1,000 m, the temperate zone between 1,000 and 1,500 m, the cool zone between 1,500 and 2,500 m, the subalpine zone between 2,500 and 3,500 m, the alpine zone between 3,500 and 5,500 m, the cool zone, and the snowy mountain zone above 5,500 m[1].

Figure 2-2 shows the elevation map and Figure 2-3 shows the temperature distribution map, which shows that the temperature varies significantly according to the difference in elevation.



Source: *JICA report* (2014)

Figure 2-2 Elevation map of the UK state



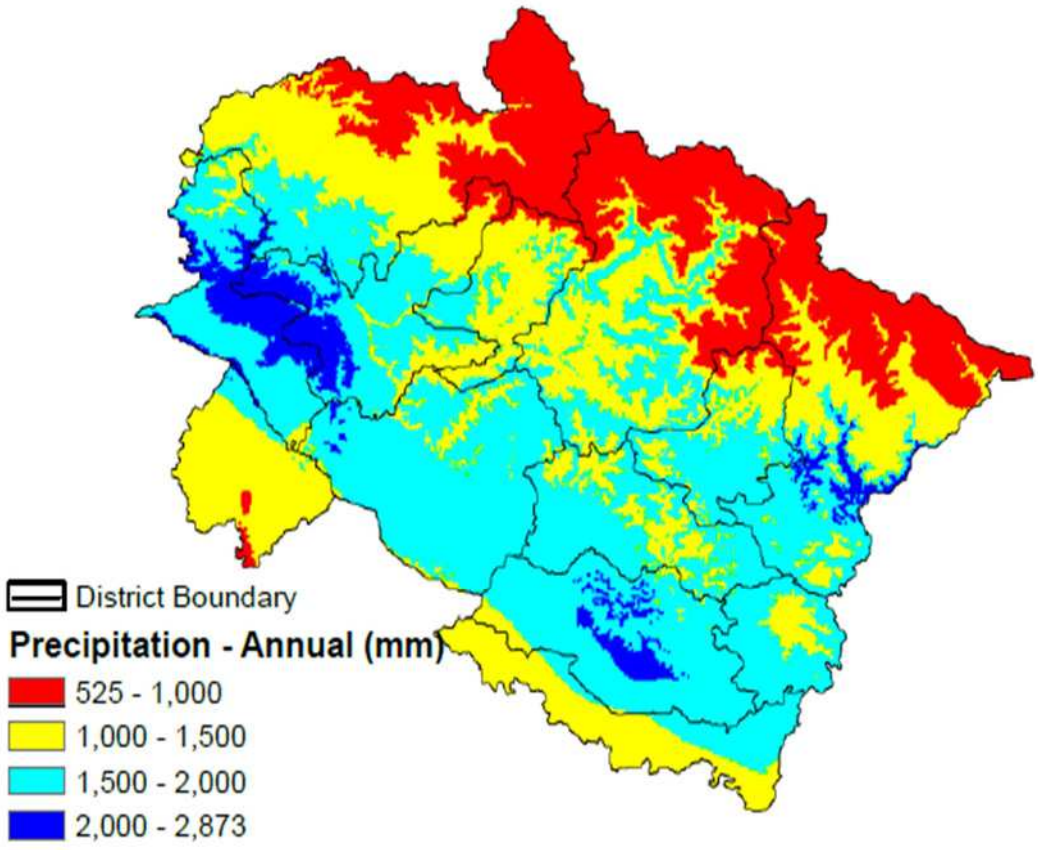
Source: *Government of Uttarakhand*, 2014

Figure 2-3 Temperature distribution map of the UK states

2.2.2 Precipitation

The spatial distribution of precipitation depends on the geographical location and the gradient and azimuth of the location. Precipitation is generally higher in low mountainous areas such as Nainital and Dehradun and gradually decreases with altitude[3]. The monsoon begins around the last week of June and lasts until the end of September. Annual rainfall varies widely from east to west and north to south. The average annual rainfall in Terai-Babar Zone belt is about 1,500 mm, while Lesser Himalayas has an annual rainfall of about 900 mm.

Nainital is one of the wettest regions, with annual rainfall reaching 2,500 mm; from January to March, the highest peaks in the UK state receive heavy to medium snowfall, affecting the climate of the whole state[1].



Source: *Government of Uttarakhand*, 2014

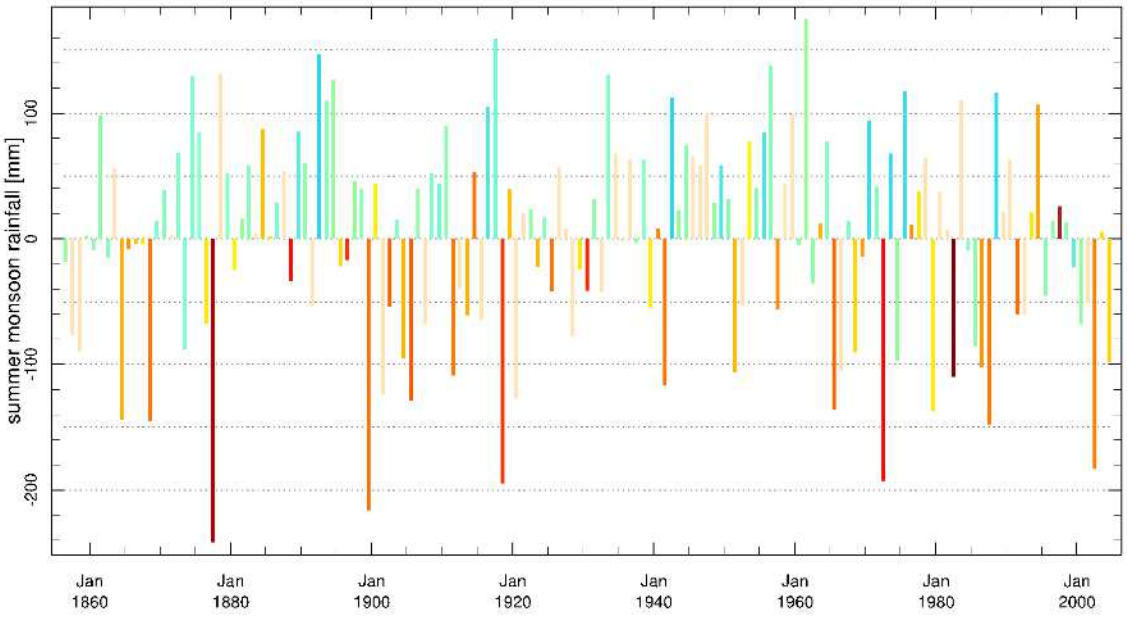
Figure 2-4 The UK state precipitation distribution map

2.3 Climate Change Impacts

2.3.1 Existing climate change trends

In India, it has been reported that the annual average temperature increased by 0.62°C between 1901 and 2020, as an impact of climate change[4].

Regarding rainfall during the monsoon season, while there have been fluctuations in each year, it has generally remained stable in the long term, as shown in Figure 2-5. However, in recent years, a decreasing trend has been observed. Particularly in Bihar, Meghalaya, Nagaland, West Bengal, and Uttar Pradesh, there is a notable decline in monsoon rainfall, while Arunachal Pradesh and Himachal Pradesh report significant decreases in annual precipitation.

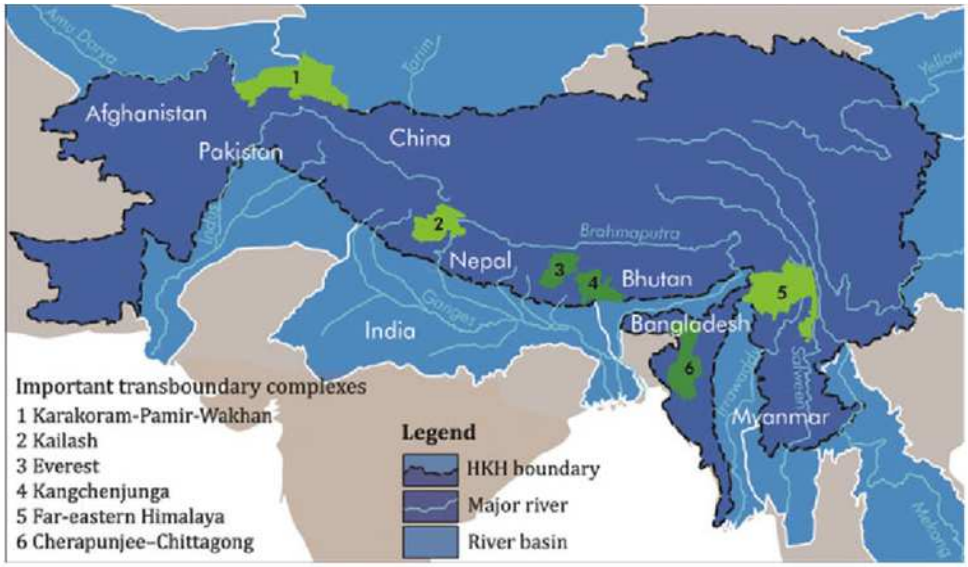


Source: IRI Data Library, 2018

Figure 2-5 Rainy season rainfall change and temperature change in India

2.3.2 Existing Damage Due to Climate Change

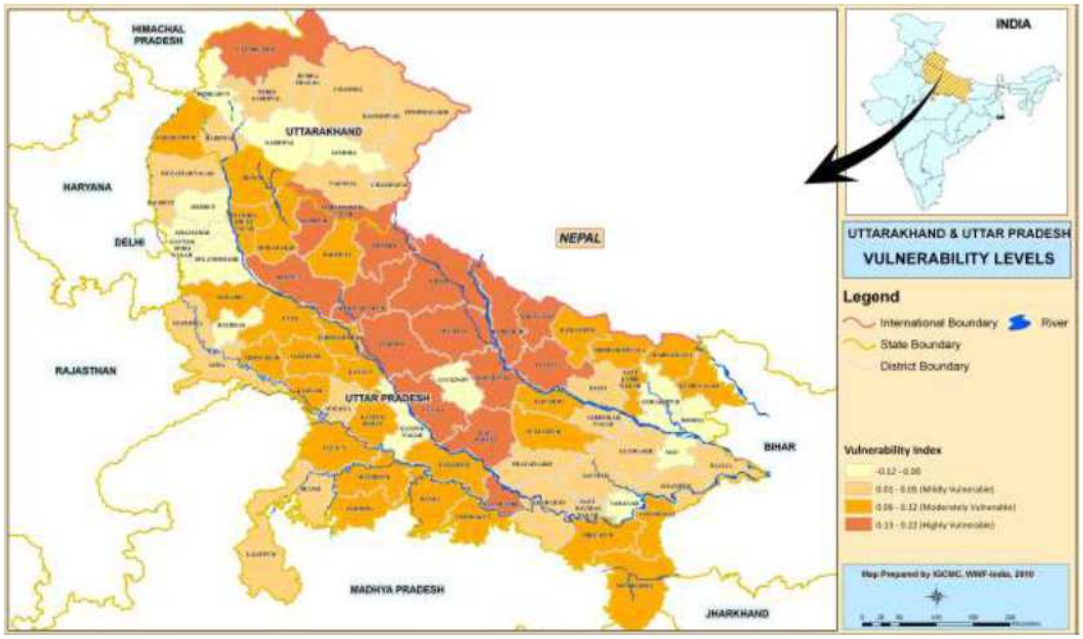
The Hindu Kush Himalayan (HKH: Hindu Kush Himalaya) region, of which the UK state is a part, is one of the most vulnerable to the effects of global climate change. The rate of warming in the HKH region is significantly higher than the global average, and the literature shows that warming is occurring at a much faster rate in highland areas than in lowland areas[5]. This rapid warming has led to massive glacier retreat, and[6] significant negative impacts on livelihoods have been identified, including reduced agricultural productivity, reduced opportunities for farm labour, reduced income from farming and dairy products, conversion to off-farm labour, and population outflow through migration[1].



Source: *M.S.R. Murthy et al.*, May 2016[7]

Figure 2-6 Hindu Kush Himalayan region

Figure 2-7 illustrates the vulnerability to climate change in the UK state and Uttar Pradesh (UP) state, as calculated from indices of exposure, sensitivity, and adaptive capacity to climate change impacts. While high vulnerability is indicated in many cases in UP state, except for Uttarakashi district in the mountainous region, the overall vulnerability is relatively low in the UK state, implying comparatively lower risks from climate change impacts[8].



Source: WWF-India, 2011

Figure 2-7 Vulnerability of UK and UP to climate change

2.3.3 Possible Future Impacts

(1) Climate change projections in India

The Ministry of Earth Sciences in country X has published climate change predictions, as shown in Table 2-2. The average temperature rise is projected to be 3.27°C under the RCP4.5 scenario and 5.33°C under the RCP8.5 scenario for the period from 2070 to 2099. Additionally, there is an overall increasing trend in precipitation across the country.

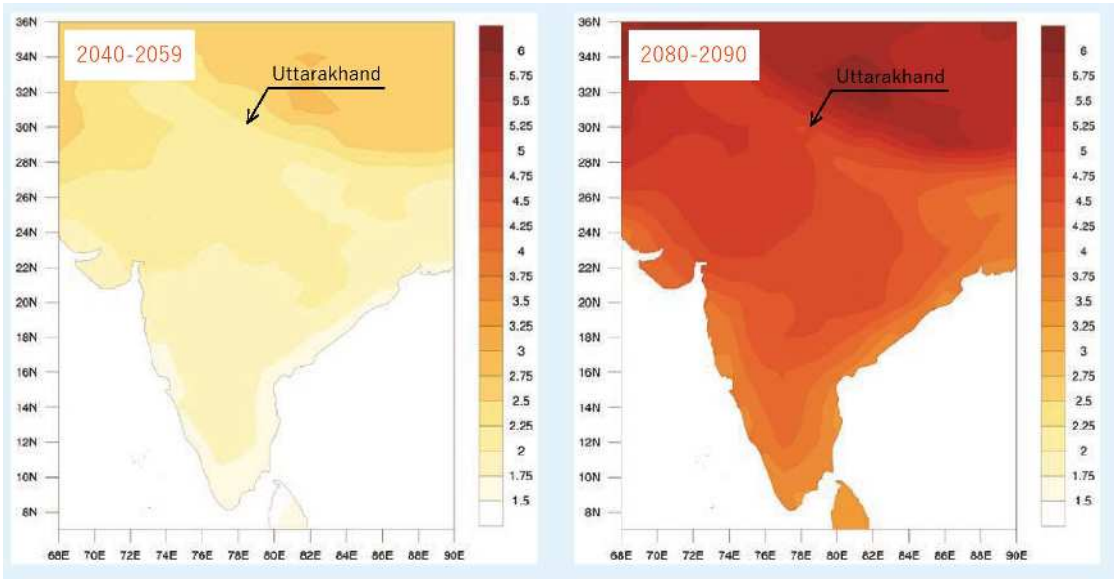
Table 2-2 Climate change projections (average temperature and precipitation) for the global average and India

	Global Mean Estimates					Indian Region Estimates				
	Historical	RCP4.5		RCP8.5		Historical	RCP4.5		RCP8.5	
	1951–2014	2040–2069	2070–2099	2040–2069	2070–2099	1951–2014	2040–2069	2070–2099	2040–2069	2070–2099
Average Temperature (°C)	0.54 (0.28–0.68)	2.16 (1.43–2.75)	2.62 (1.80–3.16)	2.75 (1.94–3.48)	4.31 (3.08–5.25)	0.72 (0.47–1.28)	2.67 (1.72–3.70)	3.27 (2.25–4.27)	3.37 (2.32–4.68)	5.33 (3.70–6.11)
Precipitation (mm)	0.01 (–0.02–0.40)	0.09 (0.05–0.16)	0.13 (0.09–0.18)	0.12 (0.07–0.20)	0.20 (0.11–0.30)	-0.06 (–0.36–0.28)	0.10 (–0.32–0.33)	0.23 (–0.13–0.49)	0.22 (–0.09–0.43)	0.28 (–0.31–0.68)

Source: Climate Risk Country Profile INIDA, 2021

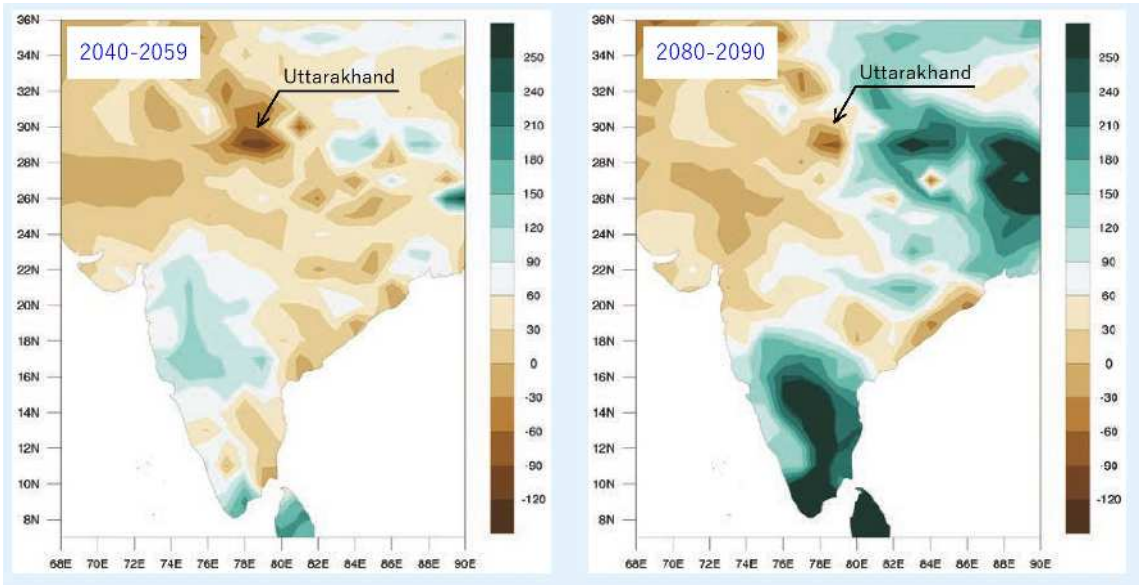
The climate change distribution maps for various regions in India are presented below. There is a general trend of rising average temperatures across India, with particularly significant temperature increases observed in the northern regions, including those where the UK state is located. Precipitation shows a long-term increasing trend in southern and northeastern parts of India, while a decreasing trend is indicated near the UK state.

Furthermore, there is a forecast for the intensification of rainfall patterns, whereby the frequency of light rainfall events is projected to decrease slightly, while the frequency of heavy rainfall events is expected to increase. It is predicted that the daily average precipitation during the monsoon season will increase by 0.74±0.36 mm/day.



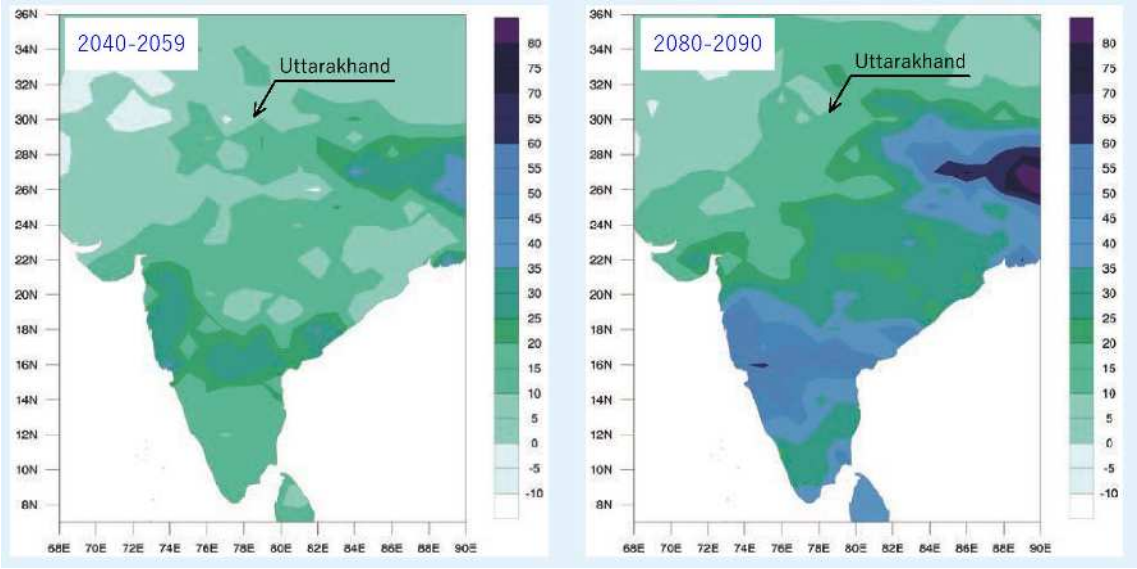
Source: Climate Risk Country Profile INIDA, 2021

Figure 2-8 Map of the projected increase in average temperatures in India (Based on the reference period of 1986-2005)



Source: Climate Risk Country Profile INIDA, 2021

Figure 2-9 Map of the projected changes in precipitation in India (Based on the reference period of 1986-2005).



Source: Climate Risk Country Profile INIDA, 2021

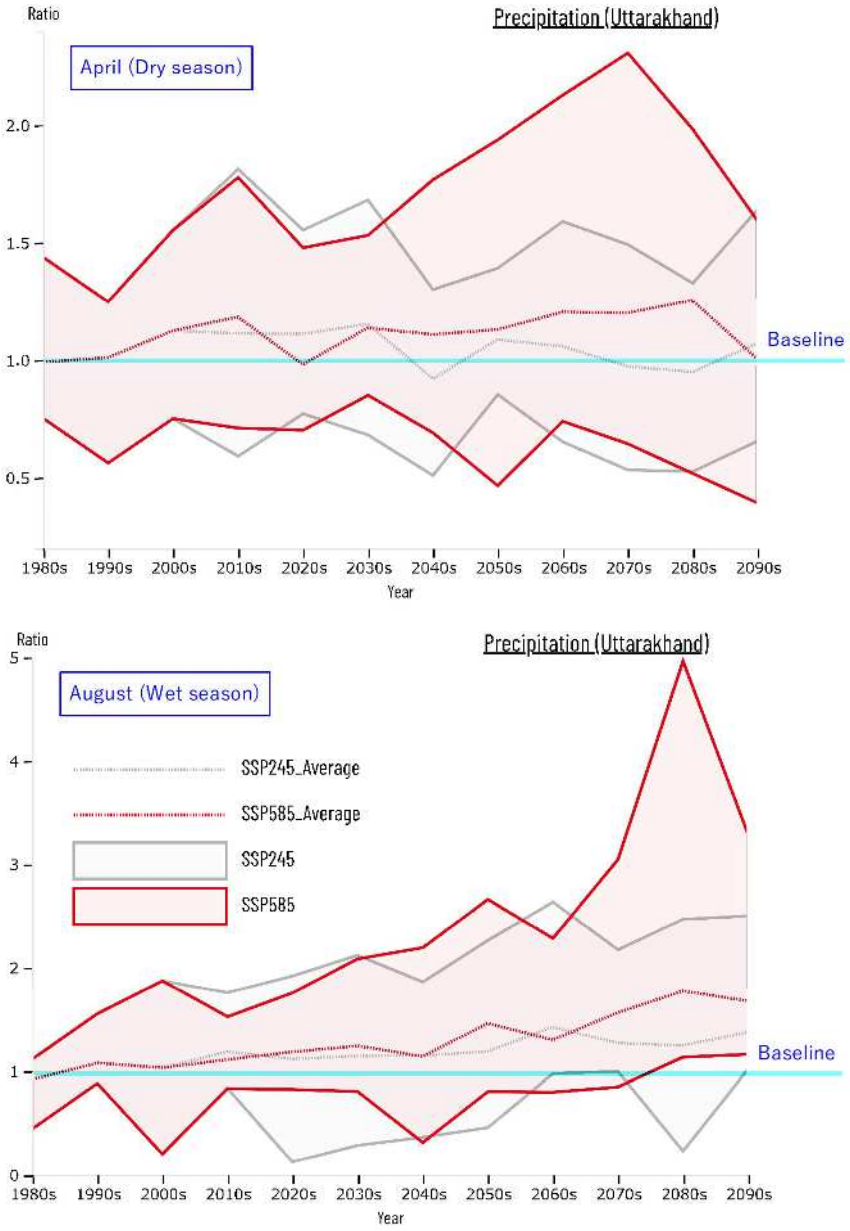
Figure 2-10 Map of the projected changes in rainfall intensity in India (Based on the reference period of 1986-2005).

(2) Climate change impacts in the UK states

According to the latest modelling projections[9], significant warming is projected to occur across the HKH region by the end of the 21st century. The annual temperature range is projected to increase by 1.7°C to 2.2°C compared to the 1970s. However, winter temperatures from October to December could be 2.6°C lower in the 2030s than in the 1970s[3].

Figure 2-11 displays future precipitation variability in the UK state based on the SSP245 and SSP585 scenarios, derived from the Climo Cast database. The data represent the projected changes in precipitation (relative to the 1980s). In the monsoon season depicted in the lower panel, both scenarios show a clear increase in future precipitation. During the dry season shown in the upper panel, there is generally a trend of precipitation increase, with values mostly above 1.0. However, the amplitude of precipitation change rates is wide, indicating high uncertainty.

In consideration of the results from Figure 2-9 and Figure 2-10, along with the findings presented, it can be inferred that the climate change impacts in the UK state entail an increased frequency of drought occurrences during the dry season and an increased frequency of flood occurrences during heavy rainfall events in the monsoon season.



Source: JST based on Climo Cast

Figure 2-11 Projected variations in monsoon and dry season precipitation in the UK state (under SSP245 and SSP585 scenarios)

2.3.4 Government Policies and Measures on Climate Change

Within India, the National Disaster Management Authority (NDMA) has been established and is responsible for developing policies, plans and guidelines for disaster management and for responding quickly and effectively to disasters, with the following responsibilities[1]. It also manages climate change-related disasters.

- Enactment of disaster management policies
- Approval of national plans
- Approval of plans prepared by GoI ministries in accordance with the national plan
- Establishment of guidelines for following state plans prepared by state authorities in the formulation of national plans
- Establishment of guidelines for different GoI ministries to follow in order to integrate disaster precautionary measures and mitigation of their impacts in development plans and projects
- Co-ordination of enforcement and implementation of disaster management policies and plans
- Recommendations for funding for mitigation
- Provision of assistance to other countries affected by major disasters, as determined by the central government
- Implementation of measures necessary for preparedness and capacity building to cope with threatened disaster situations and disasters
- Establishment of broad policies and guidelines on the functioning of the National Disaster Management Institute

2.4 Natural Disaster Risk

2.4.1 Occurrence of Natural Disasters

In India, various types of natural disasters occur, with floods being the most frequent at an average of 8.2 occurrences per year, followed by storms at 2.8 occurrences. In terms of impact, human casualties, particularly from earthquakes and floods, exceed 1,000 annually, while flood-related economic losses overwhelmingly dominate[10]. From Table 2-3, it can be inferred that the UK state is prone to earthquakes, avalanches, landslides, and floods due to its topographical, geological, and meteorological conditions.

Table 2-3 Disasters in India (1995-2014)

Type of Disaster	Frequency (times/year)	Average Number of Deaths (Persons/year)	Average Economic Damage (Thousand US$/year)
Drought	0.2	1	102,056
Earthquake	0.4	1,079	189,100
Tsunami	0.1	819	51,140
Abnormal Weather	1.5	484	20,000
Flood	8.2	1,532	1,979,169
Sediment Disaster	1.3	101	2,725
Storm	2.8	852	681,656
Wildfire	0.1	0	0

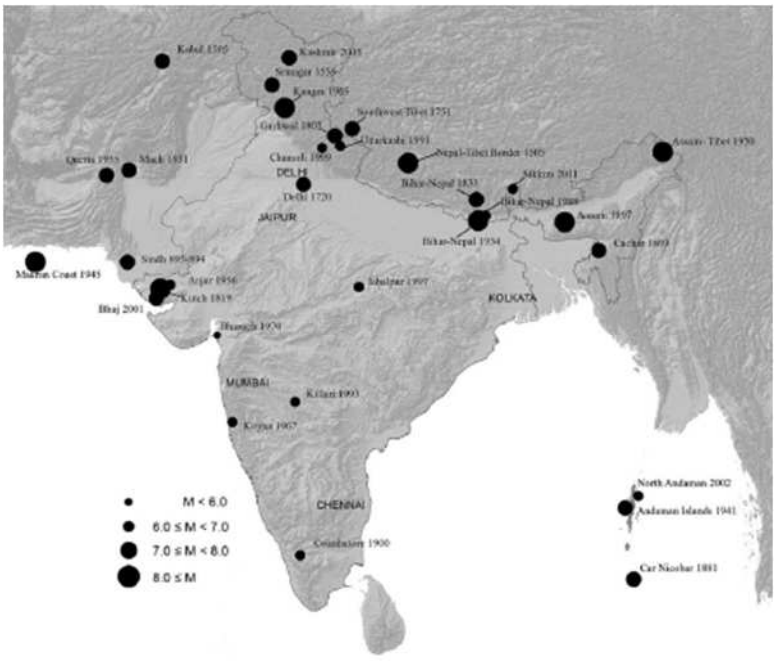
Source: *JICA report* (2015)

2.4.2 Earthquake Disaster

The Himalayan region, including the UK state, is one of the world's most seismically active zones, experiencing numerous earthquakes with magnitudes exceeding 7[11]. In India, seismic zones are classified as follows.

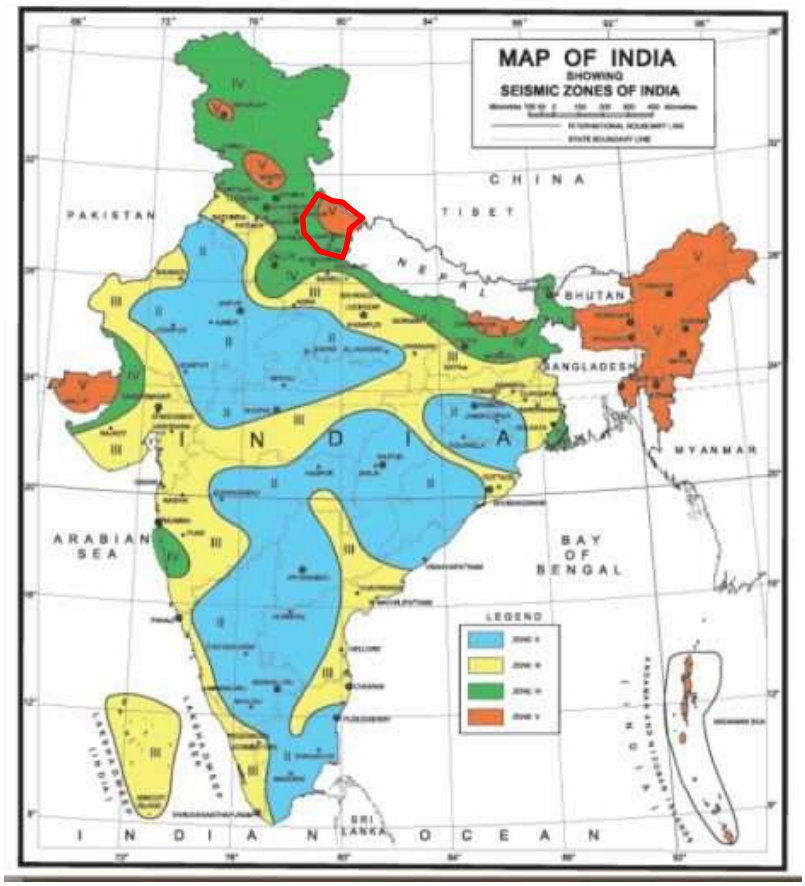
Seismic Zone II: Low-risk zone
Seismic Zone III: Moderate-risk zone
Seismic Zone IV: High-risk zone
Seismic Zone V: Very high-risk zone

The seismic zone map of India is shown in Figure 2-13[12]. In the UK state, the north-eastern part of the state is in Zone V, which is the most hazardous zone. The other area of the state is in Zone IV (Figure 2-14). Within the UK state, major earthquakes of magnitude 9.0 occurred at Badrinath and Garhwal in the 1800s, and a magnitude 8.0 earthquake occurred at Dehradun in 1937. More recently, a magnitude 6.6 earthquake centred in Chamoli occurred in 1999, but no earthquakes larger than that have occurred since then. Furthermore, the distribution of recent earthquakes is as depicted in Figure 2-12, with a concentration in mountainous areas.



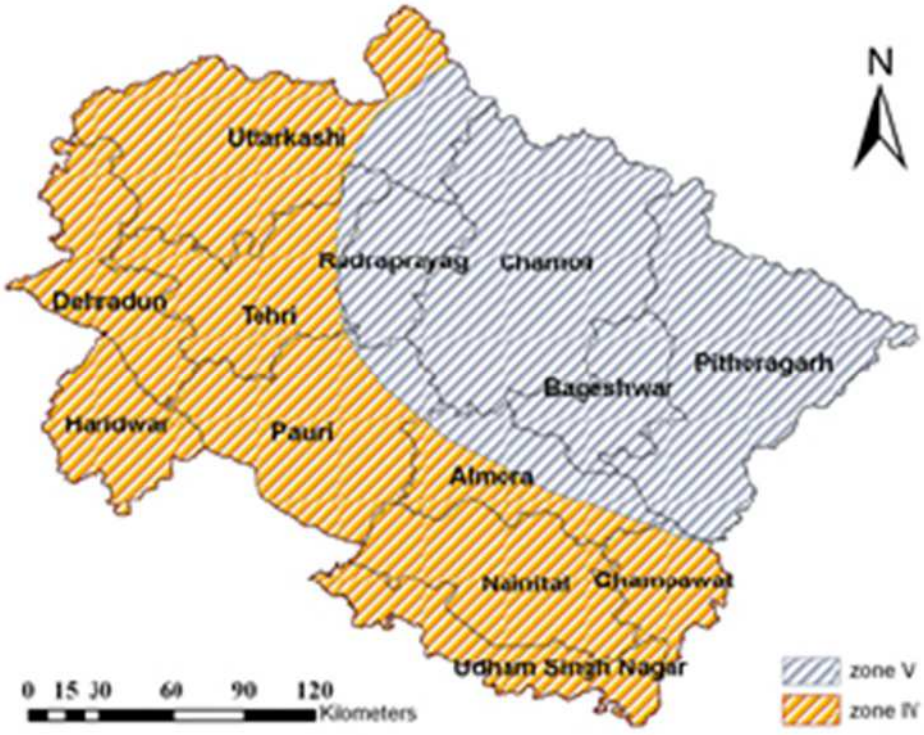
Source: Jain, 2016

Figure 2-12 The distribution of recent large earthquakes around India



Source: Venkataramana & Shreeyasiv, 2018

Figure 2-13 The seismic zone map of India



Source: Bisht et.al., 2017

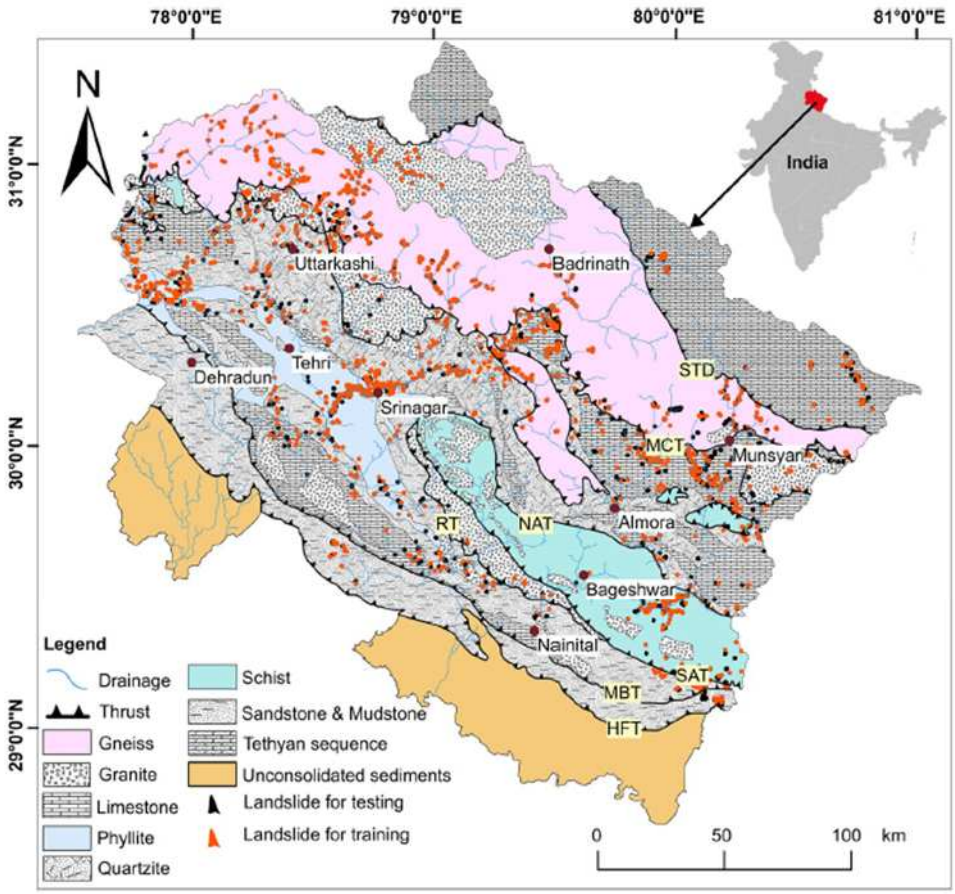
Figure 2-14 The seismic zone map of the UK state

2.4.3 Landslide

(3) Landslide Occurrence Risk in the UK State

Many landslide landforms have been identified in the UK state, and when topographical and geological conditions are considered, about half of the area is assessed to be prone to landslide occurrence (Figure 2-15). According to Gupta et al. (2022)[13], landslides are more likely to occur in areas where limestone, gneiss, quartzite, and phyllite are distributed, and the risk of landslides is high on south-facing 40 to 60 degree slopes located between 2,000 and 4,000 m elevation.

In recent years, there has been a trend towards more frequent landslides, with approximately 220 people killed in the Ganga-Alaknanda valley in 2010 and 68 lives lost in Rudraprayag in 2012[14].



Source: Gupta et.al., 2022

Figure 2-15 Landslide distribution in the UK state

(4) Examples of landslide damage (May 2023)

The following article relates to a landslide in Pithoragarh in May 2023: on the national road (Lipulekh-Tawaghat highway), 45 km north of Dharchula, a landslide caused a huge rock to fall onto the road, which was washed away by a landslide.

This has left at least 300 travellers stranded, and warnings have been issued in other areas, with police advising against unnecessary curfews.



Pithoragarh landslide: SDRF rescues over 200, mostly Adi Kailash pilgrims

Highway Still Blocked, Rescue Ops On

Gaurav Talwar & Prem Punetha | TNN

Pithoragarh/Dehradun: The State Disaster Response Force (SDRF) continued a precarious rescue operation on the Lipulekh-Tawaghat highway in Pithoragarh near the India-China border, where a massive landslide on Tuesday evening had washed away a 100-metre portion of the crucial Lipulekh-Tawaghat road near Lakhanpur and left 300 people, mainly pilgrims of the Adi Kailash yatra, stranded.

SDRF officials said they had safely evacuated 221 people on Friday, "who had been stranded on the road for the last two days due to the landslide".

All of them have been taken to the ITBP camp in Dharchula," said inspector Lalita Negi, spokesperson, SDRF. According to authorities, several pilgrims are still stuck on either side of the road that was hit by the landslide, in Dharchula and Gunji, waiting to be rescued.

Meanwhile, the strategic highway that leads to the international border with China is still blocked. Officials said it may take a couple of more days to restore traffic there.

"The agencies led by the Border Roads Organization (BRO) are working round the clock to open the road. We are trying hard to open it by June 4," said Bhupendra Singh Mahar, district disaster management officer of Pithoragarh.

SDRF officials said they had on Friday safely evacuated 221 people were stranded on the road for two days

Source: *The Times of India, New Delhi / Dehradun* 3 June 2023[15]

Figure 2-16 Landslides in Pithoragrh

2.4.4 Flood

(1) Flood Occurrence Risk in the UK state

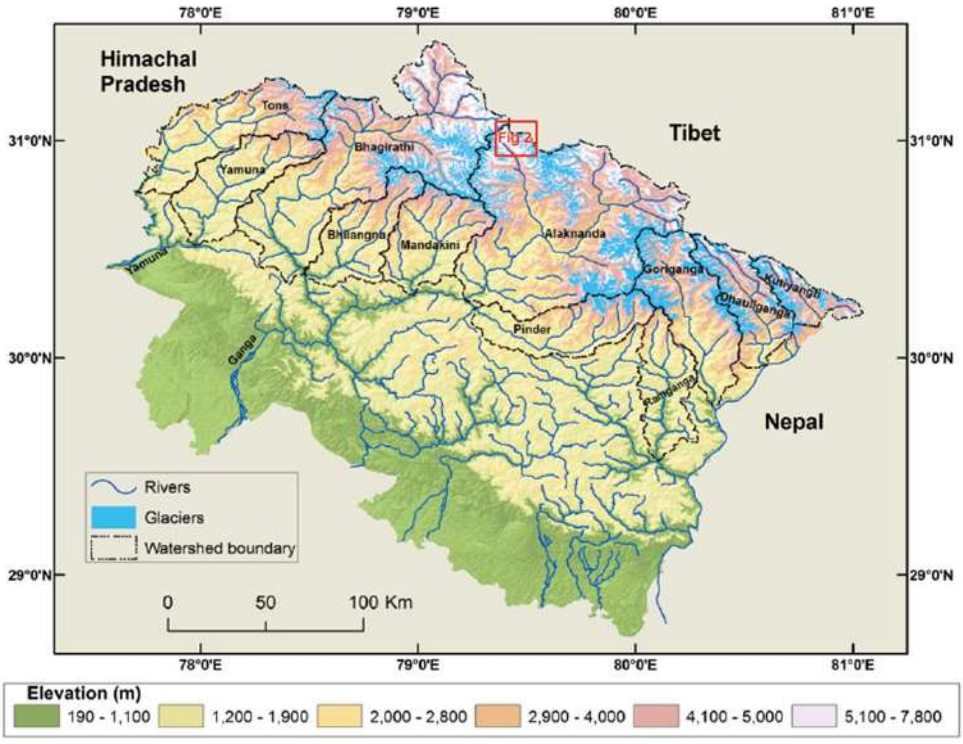
Floods occur annually in the UK state, and the damage can be extensive. Floods are often caused by heavy rainfall, but floods can also be caused by collapsing glaciers. The major flood damage from 2001 to 2021 is shown in Table 2-4[16,17], and the frequency of floods has been increasing since 2012. Looking at flood occurrence by river basin, floods are concentrated in the Alaknanda River basin.

In addition, a total of 1,266 glacial lakes have been identified in the upper reaches of rivers in the UK state at elevations above 2,900 m (Figure 2-17). Due to climate change, the presence of glacial lakes can be a trigger for flooding, and the risk should be increasing every year. The number and area of glacial lakes by river basin are shown in Table 2-5 with the highest risk in the Alaknanda River basin.

Table 2-4 The major flood damage from 2001 to 2021 in the UK state

Sub-basin	Main river	Flood year	District	Flood Location	Number of Damages		
					people	animal	building
Yamuna Upper	Yamuna	2012	Uttarkashi	Pandrasu ridge	35	436	591
		2019		Makudi	21		
Ramganga Confluence	Ganga	2016	Tehri	Kemra		100	120
	Alaknanda	2001	Rudraprayag	Phata	22	64	22
		2013		Kedarnath	10,000		365
		2005	Chamoli	Govindghat	11		
		2012		Ukhimath	66		
		2018		Tharali			55
		2021		Tapovan	200		
		2014	Pauri Gharwal	Purala	16		
Ghaghara	Kali	2016	Pithoragarh	Didihat and Thal	22		
		2017		Dharchula	16		

Source: Prepared by JST based on Prakash et al., 2021 and Kansal and Singh, 2022



Source: Wadia Institute of Himalayan Geology, 2015

Figure 2-17 Distribution of glacial lakes（Light blue） in the UK state

Table 2-5 Number and area of glacial lakes in the UK state

Sub-basin	Main river	Number of glacial lakes	Area of glacial lake (m^2)
Yamuna Upper	Yamuna	65	314,924
Ramganga Confluence	Ganga	347	2,392,198
	Alaknanda	642	3,486,704
Ghaghara	Kali	212	1,401,047

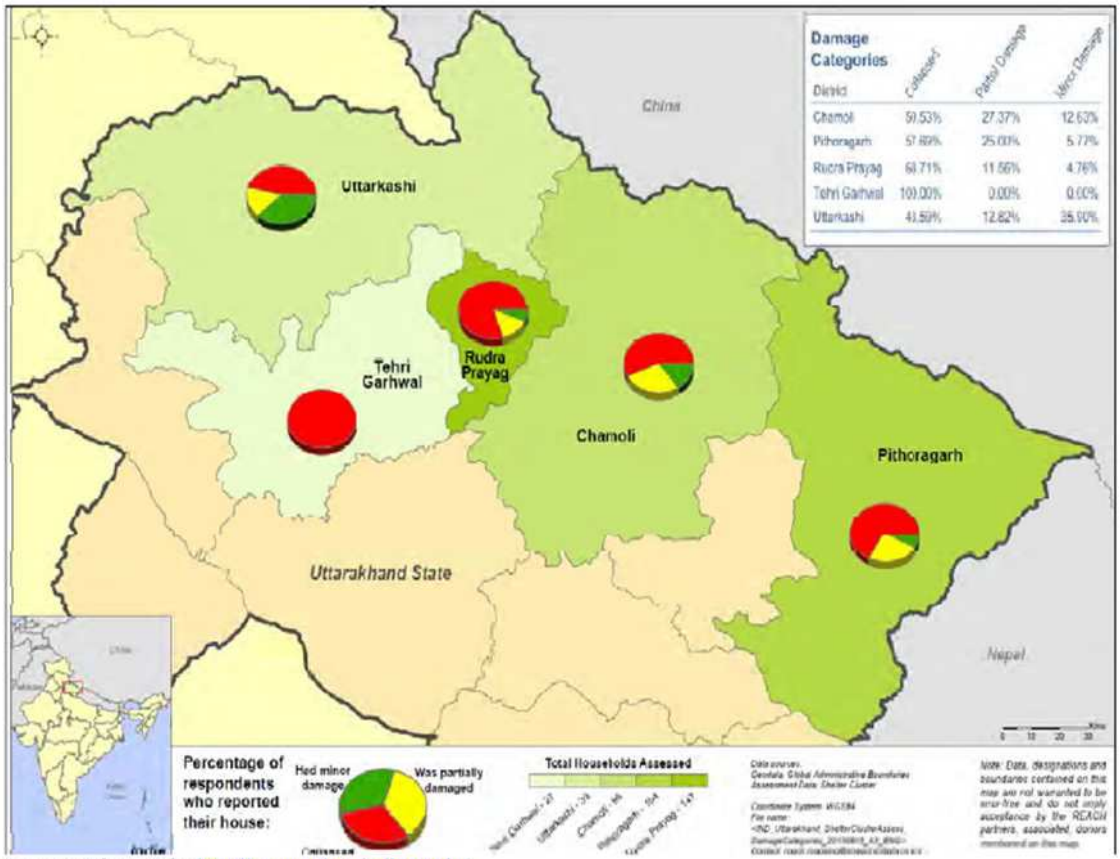
Source: Prepared by JST based on Wadia Institute of Himalayan Geology, 2015

(2) Examples of flood damage (June 2013)

In June 2013, the early monsoon flooded the UK state, with total rainfall over five days exceeding 200 mm in many areas, with Dehradun recording around 750 mm. In particular, Rudraprayag, Uttarkashi, Chamoli, Pauri and Tehri were heavily affected by flooding and landslides due to heavy rainfall in the region since 14 June 2013. Crowdbursts (torrential rains) and landslides have occurred across the state, bringing the death toll rising to more than 5,000.

Further cloudbursts were reported in Pauri Garwal on 24 June, while in the UK state, continuous rainfall since 14 June has increased water levels and flows in the Alakananda and Bhagirathi rivers, causing cloudbursts, sudden flooding and landslides, resulting in loss of life, property damage and road blockages. Rainfall ranged from 50 mm to 500 mm by 16 June.

Figure 2-18 shows the damage caused by shelter flooding. It shows that the worst affected area was Tehri Garhwal, the first study area, where 100% of the shelters collapsed. The next worst affected area was Rudraprayag, the current study area, where 68.71% of shelters collapsed; almost half of the shelters in Chamoli, Pithoragarh and Uttarkashi[1].



Source: Sphere India http://www.sphereindia.org.in/

Source: *JICA report* (2014)

Figure 2-18 Damage to shelters

2.5 Demographics

2.5.1 Ethnic Composition

The total population of the UK state is about 10 million, with an average household size of 4.9 persons. The most populous district is Dehradun, followed by Haridwar and Udham Singh Nagar (US Nagar), all of which are located in the plains. On the other hand, the least populous districts are Rudraprayag and Champawat[1].

(1) SCs (Scheduled Casts)

Scheduled Castes (SCs: designated castes, communities outside the caste quota) account for 18.8% of the total population; Haridwar has the highest proportion of SC population (21.7%), followed by US Nagar (12.6%) and Dehradun (12.1%). Much of the SC population is traditionally engaged in agriculture, making farming implements and handicrafts and working as agricultural labourers. Their settlements are frequently found in certain areas of the district[1]. According to 2011 data, the most common SC in the UK state is Silpukal, accounting for about half of the total. There are also more SCs in rural areas than in urban areas, approximately five times more[18].

(2) STs (Scheduled Tribes)

Scheduled Tribes (STs: designated tribes and minorities) account for 2.9% of the population. US Nagar and Dehradun have the highest proportion of STs. The majority of the ST population in US Nagar is of the Tharu and Buxa communities, whose main occupation is agriculture. Dehradun has the second highest tribal population ratio (ST as a percentage of total population) in the state and is predominantly Jhonsari. Pithoragarh has 6.7% ST population (Raj and Bhotia tribal groups). Chamoli has 4.2% ST population (Bhotia tribal group)[1].

2.5.2 State Population Trends

(1) The UK state population trends

The population of the UK state oblast was 10,086,000 in 2018, of whom 70.37% lived in rural areas and 30.50% in urban areas. The oblast has 13 districts, 49 subdivisions, 95 development blocks and 16,793 census villages, of which 15,745 villages (including forest settlements) are inhabited.

The population of the UK state, like that of the India as a whole, has been increasing year by year. According to census data, between 2001 and 2011, the population of the UK state grew by 18.8%. The population growth rate of the UK state over this same period is higher than the average growth rate of India (17.7%). However, the population growth rate declined between 2001 and 2011 compared to the previous decade (1991-2001). The preceding growth

rate was 20.41%. Table 2-6 shows the population and population density of the UK state over the last 100 years.

Table 2-6 The UK state population trends (100 years)

Table 13.1: Population in Uttarakhand				
	Population (in lakhs)		Population Density (per square KM)	
Census Year	Uttarakhand	India	Uttarakhand	India
1901	20	2384	37	77
1911	22	2521	40	82
1921	21	2513	39	81
1931	22	2790	42	90
1941	25	3187	47	103
1951	29	3611	53	117
1961	37	4392	69	142
1971	46	5482	86	177
1981	57	6833	90	216
1991	71	8463	133	274
2001	85	10287	159	325
2011	101	12105	189	382
Source: Statistical Diary of Uttarakhand 2014-15				

※Lakhs: 10 million

Source: *Indian Institute of Management Kashipur*, 2016-2017

(2) The UK state population growth rate

Table 2-7 shows the decadal population growth rates in the various districts of the UK state. The table shows that the population transition within the UK state is characterised by the migration from the mountainous regions to the plains, which has led to a significant decline in population growth rates in the mountainous regions of the region and, in some areas, negative population growth rates.

For example, between 1991 and 2011, the overall population growth rate in the UK state province decreased from 23.13% to 18.81%. In the case of Chamoli district, the population growth rate declined from 22.63% in 1991 to 5.74% in 2011. Other Tehri and Garwal districts faced a similar situation, with the population growth rate declining from 16.53% in 1991 to 2.35% in 2011. The situation is even worse in Garwal and Almora districts. In these districts, the population growth rate has decreased over the past 20 years: in Garwal, the population growth rate in 1991 was 8.57%, but in 2011 it was -1.41%. In Almora, the population growth rate in 1991 was 8.94%, while in 2011 it was -1.64%.

On the other hand, some regions within the UK state can be said to have benefited from this situation, such as Dehradun province, where the population growth rate decreased from 34.66% in 1991 to 25% in 2001, but increased again 10 years later to 32.33% in 2011. Haridwar also saw an increase in population growth from 26.31% in 1991 to 30.63% in 2011.

Table 2-7 Population trends by province（1/2）

State/Union Territory/District	Census Year	Persons	Variation since the preceding census		Males	Females
			Absolute	Percentage		
UTTARAKHAND	1991	70,50,634	+13,24,662	+23.13	36,40,895	34,09,739
	2001	84,89,349	+14,38,715	+20.41	43,25,924	41,63,425
	2011	1,00,86,292	+15,96,943	+18.81	51,37,773	49,48,519
Uttarkashi	1991	2,39,709	+48,761	+25.54	1,24,978	1,14,731
	2001	2,95,013	+55,304	+23.07	1,52,016	1,42,997
	2011	3,30,086	+35,073	+11.89	1,68,597	1,61,489
Chamoli	1991	3,25,247	+60,031	+22.63	1,64,129	1,61,118
	2001	3,70,359	+45,112	+13.87	1,83,745	1,86,614
	2011	3,91,605	+21,246	+5.74	1,93,991	1,97,614

Figure 2-7 Vulnerability of UK and UP to climate change（2/2）

Rudraprayag	1991	2,00,515	+30,772	+18.13	95,745	1,04,770
	2001	2,27,439	+26,924	+13.43	1,07,535	1,19,904
	2011	2,42,285	+14,846	+6.53	1,14,589	1,27,696
Tehri Garhwal	1991	5,20,256	+73,784	+16.53	2,54,188	2,66,068
	2001	6,04,747	+84,491	+16.24	2,95,168	3,09,579
	2011	6,18,931	+14,184	+2.35	2,97,986	3,20,945
Dehradun	1991	10,25,679	+2,64,011	+34.66	5,56,432	4,69,247
	2001	12,82,143	+2,56,464	+25.0	6,79,583	6,02,560
	2011	16,96,694	+4,14,551	+32.33	8,92,199	8,04,495
Garhwal	1991	6,70,859	+52,967	+8.57	3,26,038	3,44,821
	2001	6,97,078	+26,219	+3.91	3,31,061	3,66,017
	2011	6,87,271	-9,807	-1.41	3,26,829	3,60,442
Pithoragarh	1991	4,16,647	+51,506	+14.11	2,09,177	2,07,470
	2001	4,62,289	+45,642	+10.95	2,27,615	2,34,674
	2011	4,83,439	+21,150	+4.58	2,39,306	2,44,133
Bageshwar	1991	2,26,164	+29,172	+14.81	1,09,979	1,16,185
	2001	2,47,163	+20,999	+9.28	1,17,374	1,29,789
	2011	2,59,898	+12,735	+5.15	1,24,326	1,35,572
Almora	1991	6,10,453	+50,072	+8.94	2,90,921	3,19,532
	2001	6,32,866	+22,413	+3.67	2,94,984	3,37,882
	2011	6,22,506	-10,360	-1.64	2,91,081	3,31,425
Champawat	1991	1,90,929	+39,857	+26.38	98,173	92,756
	2001	2,24,542	+33,613	+17.60	1,11,084	1,13,458
	2011	2,59,648	+35,106	+15.63	1,31,125	1,28,523
Nainital	1991	5,74,832	+1,33,396	+30.22	3,05,494	2,69,338
	2001	7,62,909	+1,88,077	+32.72	4,00,254	3,62,655
	2011	9,54,605	+1,91,696	+25.13	4,93,666	4,60,939
Udham Singh Nagar	1991	9,24,856	+2,56,105	+38.30	4,96,587	4,28,269
	2001	12,35,614	+3,10,758	+33.60	6,49,484	5,86,130
	2011	16,48,902	+4,13,288	+33.45	8,58,783	7,90,119
Hardwar	1991	11,24,488	+2,34,228	+26.31	6,09,054	5,15,434
	2001	14,47,187	+3,22,699	+28.70	7,76,021	6,71,166
	2011	18,90,422	+4,43,235	+30.63	10,05,295	8,85,127

Source: *Indian Institute of Management Kashipur*, 2016-2017

(3) Migration to the plains in the UK state

Migration from the mountains to the plains in the UK state has been a serious policy debate in recent years. Between 2000 and 2011, the population growth rate in the mountains was 0.70%, considerably lower than the 2.8% rate in the plains (2011 Census)[1]. Of the 16,793 villages for which the 2011 census was conducted, 1,053 had no inhabitants and a further 405 villages had a population of less than 10 people, clearly indicating a population exodus from the mountainous areas[19].

The imbalance in economic growth between regions in the oblast has hindered development progress in remote areas of the oblast. As a result, people in the mountainous regions have started to migrate from their regions of origin as economic opportunities increase in the plains regions[20]. Census data[18] also shows that the population engaged in afforestation, livestock, forestry, fishing, and hunting declined between 2001 and 2011, which may be another reason for the decline in the mountain population. The UK state is a border state of extreme strategic importance for defence installations, and such displacement could raise not only humanitarian and socio-economic issues, but also national security concerns for the Indian state[20].

(4) Disparities between rural and urban areas

The disparity between rural and urban areas is striking, with more than a third of households in rural hilly areas having at least one migrant, compared to 11% of households in urban areas[19]. According to a recent study by the Giri Institute of Development Studies (GIDS: Giri Institute of Development Studies), improved literacy and education levels among the population of the UK state are another cause of migration from the mountainous regions. Many migrants seek stable, well-paid jobs rather than looking for seasonal work elsewhere.

Lack of employment opportunities in mountainous areas is one of the main factors contributing to this problem. Agricultural activities in mountainous areas face serious water supply problems, forcing young people in these areas to migrate to support their families. This exacerbates the problem, as the lack of labour to work on the farms leads to farmland abandonment and the start of another migration cycle. Low productivity and lack of technical know-how for crop choice diversification also contribute to this phenomenon[20].

2.5.3 Changes in the Population of Each District

Table 2-7 shows the population performance by province in the UK state, and shows that overall, the population has increased, while in Garhwal and Almora the population has decreased between 2001 and 2011. There is also no significant difference in the sex ratio[20].

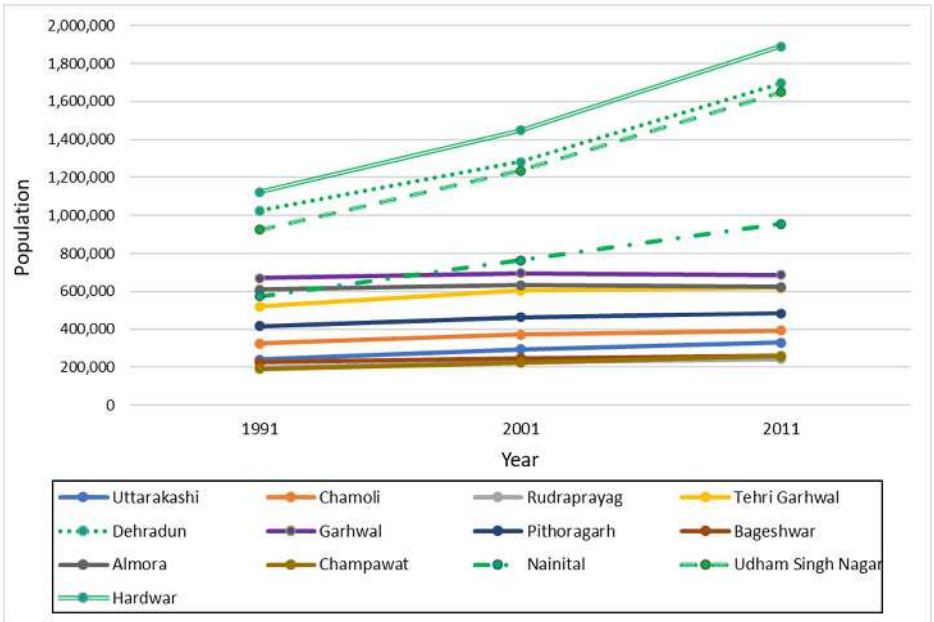
Population trends in Table 2-7 are shown in Figure 2-20, with plains areas (Dehradun, Hardwar, Naintal and Udham Singh Nagar) in green and mountainous areas in a non-green colour. Figure 2-20 shows that the population of the plains has increased more than that of

the mountains. Table 2-7 and Figure 2-20 together show that the population of the UK state as a whole has increased, but not so much in the mountains, indicating a significant population outflow from the mountains to the plains.



Source: Prepared by JST

Figure 2-19 County divisions within the UK state



Source: Prepared by JST from *Indian Institute of Management Kashipur*, 2016-2017

Figure 2-20 Population trends in each district

2.6 Socio-Economic and Industrial Profiles

2.6.1 Main Industrial Forms

In the UK state, agriculture is the primary industry; however, the share of the primary sector in the Gross Domestic Product (GDP: Gross Domestic Product) has decreased from 14% in 2011-12 to 10% in 2021-22. In recent years, the tertiary and service sectors have begun to replace the primary and secondary sectors in terms of employment generation. Particularly, the primary sector has lagged the secondary and tertiary sectors, and the expansion of the secondary and tertiary sectors has promoted urbanization, leading to a significant migration of labour from rural to urban areas. However, agriculture remains a crucial sector for the UK state, with a significant number of individuals employed in this field. According to a survey conducted in 2019, it is estimated that 67.4% of households depend on agriculture for their livelihoods[21].

Two cropping seasons are practised in the UK state: rabi (mid-November to April) and kharif (July to November). Mixed cropping has traditionally been practised to minimise crop failure and to allow different varieties of cereals to be grown, but these traditions are gradually being replaced by monocultures.

Agriculture in hilly areas is a major source of livelihoods, but productivity is known to be low due to lack of access to agricultural inputs and irrigation. Irrigated land amounts to 336,136 ha, or 53% of the arable land area, excluding land divided into small plots in hilly areas where mechanisation is not possible. Land ownership in the hilly areas is very small (0.68 ha), making mechanisation of agriculture impossible.

This situation has rendered agriculture non-industrial and encouraged men to migrate for employment. When men left the village, women took on substantial responsibility for the household, taking on household chores and agricultural activities, which increased their workload. Some women have abandoned farming and the amount of abandoned land is increasing. This corresponds to 127,793 hectares, or 33% of the cultivated area. This is further degrading the local ecosystem[20].

In addition, although various industries were stagnant or declining in the Corona Disaster, they are recovering as of 2020-21 (Table 2-8) [21].

Table 2-8 Status of recovery from the Corona disaster in various industrial sectors

Sector	2021-22AE over 2020-21 PE	2021-22AE over 2019-20 RE	Status
Agriculture, Forestry and Fishing	5·66%	3·73%	Resilient
Mining and Quarrying	5.39%	-14.62%	Still Suffering
Manufacturing	2 40%	0 40%	Recovering
Electricity, Gas, Water Supply & Other Utility Services	2.98%	-1.39%	Still Suffering
Construction	11.61%	1.38%	Recovering
Trade, Repair, Hotels and Restaurants	8.63%	-6.28%	Still Suffering
Financial Services	4 00%	10 59%	Resilient
Real Estate, Ownership of Dwellings & Professional Services	10.50%	7.04%	Resilient

Source: Author's calculations using data from the Department of Economics and Statistics, Government of Uttarakhand.

Source: *Indian Institute of Management Kashipur*, 2021-2022

2.6.2 The UK state Tourism Industry Overview

The UK state is known as the 'Dwelling Place of Gods (Dev Bhoomi)' due to its natural gifts such as snow-capped mountains, rivers, forests and glaciers, and famous religious tourist attractions such as the 'Char Dham'. The state is considering developing a tourism circuit based on spiritual and religious themes and has become a venue for eco-tourism under the Swadesh Darshan scheme of the Ministry of Tourism, Government of India.

Other themes include trekking and hiking tours to see the famous Himalayan mountains, treks along the Ganges and villages that maintain a traditional lifestyle, which are often of interest to tourists.

The UK state is a domestic tourist destination, attracting 29 million visitors in 2015, more than neighbouring Himachal Pradesh ('HP'), but accounting for only 2% of the total number of tourists in the India as a whole (Table **2-9**). As regards foreign visitors, the development of the tourism sector in the UK state lags far behind that of other states[20].

Table 2-9 Number of tourist arrivals and ranking of states as tourist destinations

	Tourist Arrivals in 2015 (million)		Rank in 2015	
	Domestic	Foreign	Domestic	Foreign
Uttarakhand	29	0.1	12	20
Uttarakhand share (%) in all-India	2.0	0.4		
Himachal Pradesh	17	0.4	17	12
Himachal Pradesh share (%) in all-India	1.2	1.7		
All-India	1432	23		

※ 2015

Source: *Uttarakhand Vision 2030*

A comprehensive interpretation of Table 2-10 and Table2-11 also shows that GSDP growth is concentrated mainly in tourism (trade, hotels and restaurants), while the value added is much higher in real estate and other professional services. To make further progress in the UK state growth, there is a need to focus on increasing the amount of value added in the tourism sector.

A closer look at Table2-11 shows that tourism showed good growth rates between 2007-08 and 2009-10 and has continued to grow well since.

Table 2-10 The UK state value added by industry (GSVA)

Sectors	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
IV. Service Sector					
(i). Trade, Repair, Hotels and Restaurants	**1192897**	**1408869**	**1614577**	**1743106**	**1991602**
(a). Trade and Repair Services	1013998	1218822	1426694	1534073	1768221
(b). Hotels and Restaurants	178899	190047	187883	209033	223381
(ii). Transport, Storage, Communication and Services Related to Broadcasting	**703706**	**825647**	**951652**	**1066693**	**1224232**
(a). Railways	14140	16514	17214	21295	24470
(b). Road Transport	218487	259840	287156	307147	339240
(c). Water Transport	-	-	-	-	-
(d). Air Transport	652	1229	2158	3889	7053
(e). Services Incidental to Transport	-	-	-	-76	-
(f). Storage	579	678	735	660	699
(g). Communication and Services Related to Broadcasting	469848	547386	644389	733778	852770
(iii). Financial Services	293318	320421	357514	385030	421624
(iv). Real Estate, Ownership of Dwelling and Professional Services	588825	671182	739177	831307	935310
(v). Public Administration	412001	323723	483887	579409	711920
(vi). Other Services	498856	668947	827478	982430	1255262
Total Services	**3689603**	**4218789**	**4974285**	**5587975**	**6539950**
VIII. Gross State Domestic Product (GSDP)	**11552349**	**13183522**	**14981660**	**16198529**	**18409131**
IX. Population (In Million)	101650	103020	104410	105820	107240
X. Per Capita GSDP (In Rs.)	113648	127971	143489	153076	171663

※ Years: 2011～2016, unit: INR

Source: *Indian Institute of Management Kashipur,* 2016-2017

Table2-11 The UK state Gross State Domestic Product (GSDP) factor cost Base by Industry of Origin

Sector	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
IV. Service Sector											
Transport, Storage and communication	**162784**	**188045**	**228158**	**270962**	**304211**	**352599**	**392150**	**431735**	**465592**	**501560**	**549170**
(i) Railways	7005	6450	6956	11810	10620	12062	10774	11967	12328	12498	12958
(ii) Transport by Other Means (Including Storage)	113466	131516	153478	181441	207802	242417	272291	309363	341528	375120	420236
(iii) Storage	1714	1731	1975	2072	2197	2326	2257	2554	2765	2990	3358
(iv) Communication	40599	48348	65749	75639	83592	95794	106828	107851	108971	110952	112618
Trade, Hotel and Restaurants	419564	520974	600787	782549	950243	1259244	1405787	1609852	1710103	1852517	1988540
Banking and Insurance	93663	113455	137394	162803	190769	218345	266258	286736	313203	339702	369751
Real Estate, Ownership of Dwellings and Business Services	159893	167621	176023	184626	193998	198979	206299	215059	224212	233854	244561
Public administration	133372	145124	156246	210783	284137	321954	306637	282630	249206	262970	293041
Other services	257667	273806	289614	300726	327593	331790	342151	346393	395550	423717	452994
Total Services	**1226943**	**1409025**	**1588222**	**1912449**	**2250951**	**2682911**	**2919282**	**3172405**	**3357866**	**3614320**	**3898057**
State Domestic Product	**2478567**	**2834035**	**3218960**	**3802186**	**4283246**	**5059803**	**5566681**	**6087959**	**6541424**	**7092553**	**7755209**

※ Years: 2004～2015, unit: INR

Source: *Indian Institute of Management Kashipur*, 2016-2017

2.6.3 Size of Tourism Businesses and Tourism Population in Each Region

Table 2-12 shows the number of foreign visitors to the main tourist destinations in the UK state between 2008 and 2010, by region. These are the main tourist destinations in the state. There is a slight increase in 2010 compared to the previous year. However, it can be seen that despite the UK state's potential, the number of tourists to these destinations is very low. In light of this, while tourism in the state lags behind in terms of value added, it plays an important role in the gross state domestic product (GSDP) of the services sector. Within the district, Haridwar, Kotdwar, Dehradun and Tehri are the top four districts in terms of the number of travellers. Mussoorie, Rishikesh, Pauri, Srinagar, Kedarnath, Badrinath, Auli, Valley of Flower, Ranikhet, Kathgodam, Pithoragarh etc. show insufficient demand from foreign tourists.

Table 2-13 also shows that Haridwar leads the largest number of domestic tourists, followed by Joshimath, Dehradun, Mussoorie and Rishikesh in that order[20].

Table 2-12 Number of foreign visitors in the UK state by region (2008-2010)

Tourists Place	2008	2009	2010
Dehradun	18483	17051	20699
Rishikesh	5052	4550	5548
Mussoorie	5545	5869	5926
Pauri	53	32	160
Srinagar	306	339	1098
Kotdwar (Incl. Swargashram, Chillaetc)	18252	23532	26095
District Rudraprayag (Excl, Kedarnath)	1429	1581	380
Kedarnath	1066	1003	268
Gopeshwar (N. Prayag, K. Prayag, Thralietc)	108	36	32
Joshimath (Incl. Ghangria and GovindGhat)	1411	2219	2076
Badrinath	211	141	276
Auli	561	375	376
Hemkund Sahib	123	15	262
Valley of Flower	511	356	301
District Tehri	14748	15329	16103
Uttarkashi (Incl. HarsilGagnanietc)	1817	2418	2967
Gangotri	285	484	306
Yamunotri	190	241	182
District Haridwar	17854	20067	29555
Nainital	7070	5722	7123
Kathgodam	466	488	691
Corbett National Park	9001	8617	7696
District Udham Singh Nagar	1212	1254	1509
Almora	4821	4530	5031
Ranikhet	448	573	398
KausaniBageshwar	525	237	299
District Pithoragarh	653	926	774
District Champawat	222	258	328
Uttarakhand	**111918**	**118243**	**136459**

Source: *Indian Institute of Management Kashipur*, 2016-2017

Table 2-13 Number of domestic travellers in the UK state by region (2008-2010)

Tourists Place	2008	2009	2010
Dehradun	1422578	1123715	1401942
Rishikesh	551495	581869	1093164
Mussoorie	1086411	1096698	1098870
Pauri	85447	90960	97516
Srinagar	202486	247974	219103
Kotdwar (Incl. Swargashram, Chillaetc)	310324	310402	321438
District Rudraprayag (Excl, Kedarnath)	592368	416775	404527
Kedarnath	468982	402633	400243
Gopeshwar (N. Prayag, K. Prayag, Thralietc)	389978	401838	381722
Joshimath (Incl. Ghangria and GovindGhat)	1279659	1350280	1609216
Badrinath	1075372	798063	921250
Auli	24902	40732	40290
Hemkund Sahib	400410	332451	308888
Valley of Flower	11551	1419	4155
District Tehri	1067869	871827	898505
Uttarkashi (Incl. HarsilGagnanietc)	656851	680764	593290
Gangotri	326081	379673	310255
Yamunotri	327421	322001	309452
-District Haridwar	11356250	12049450	18837125
Nainital	615469	749556	786705
Kathgodam	69480	112698	150423
Corbett National Park	186933	191866	181000
District Udham Singh Nagar	86890	95579	100457
Almora	93615	97492	95947
Ranikhet	80105	88506	83211
KausaniBageshwar	77184	78987	70523
District Pithoragarh	164225	183484	189474
District Champawat	53834	56522	63443
Uttarakhand	**23064170**	**23154214**	**30972134**

Source: *Indian Institute of Management Kashipur,* 2016-2017

The impact of the COVID-19 pandemic on the tourism industry has been significant. The revenue loss for the state of Uttarakhand, due to the lockdown regulations, is estimated to be around 7,000 to 8,000 billion rupees. In terms of employment, approximately 2.5 million people employed in the hotel industry had lost their jobs by the end of June 2020. Moreover, in 2020, the number of tourists decreased by 90% to 95% compared to 2019. Looking at Table 2-14, it is evident that the number of tourists to Uttarakhand's most popular religious tourism destination, Char Dham, decreased by 90% from 2019 to 2020.

However, from August 2020, the state government began a phased unlocking, and by March 2021, there was a noticeable return of tourists, with a normal influx of tourists observed at most tourist destinations[22].

Table 2-14 Number of tourists to Char Dham

S. N.	Dhaams	Domestic Tourists in 2019	Foreign Tourists in 2019	Domestic Tourists in 2020	Foreign Tourists in
1.	Kedarnath	9,98,956	1065	1,35,287	62
2.	Badrinath	12,44,100	893	1,55,009	46
3.	Gangotri	5,29,880	454	23,736	38
4.	Yamunotri	4,65,111	423	7,717	11
5.	Hemkund Sahib	2,39,910	223	8,290	00
	Total	**34,77,957**	**3,058**	**3,30,039**	**157**

Source: Uttarakhand Tourism Department

Source: Indian Institute of Management Kashipur, 2020-2021

2.7 Security Situation

As can be seen from the comparative statistics on offences falling under the Indian Penal Code (IPC) shown in Table 2-15, the UK state is a relatively low crime state compared to other states. The table includes national averages, the UK state statistics and, as a comparison, statistics for HP, another mountain state[23].

In most areas of serious crime, the UK state has better statistical indicators compared to the national average and is better than HP State on many indicators. However, in relation to crimes against public order and economic crimes, the UK state is roughly comparable to the national average.

In addition, the UK state have local laws (SLL). This category of SLL includes the Arms Act, Liquor Act, Gaming Act, Narcotics and Psychotropic Drugs Act and Civil Rights Protection Act. In terms of SLL incidents per 100,000 population, the UK state has a very high crime rate of 840.5, compared to the national average of 347.6 and HP of 45.5.

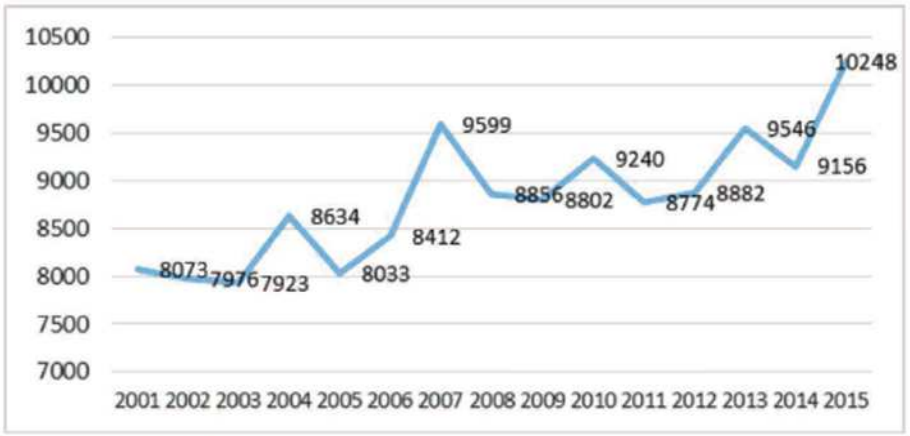
As shown in Figure 2-21, Figure 2-22 and Table 2-15, while the incidence of basic violence and crime is relatively low in the state and the security situation is not bad, the number of crimes has shown a slight upward trend in recent years. Among the major categories of crimes against women, the number of dowry killings (dowry killings) has shown a downward trend, while the number of rapes and indecent acts/assaults on women has risen since 2012[23].

Table 2-15 Crime rate of IPC crimes in 2015 (per 100,000)

Type of Crime	All India	Uttarakhand	Himachal Pradesh
All IPC crimes	234.2	97.2	198.5
Crime against women^	53.9	28.2	37.4
Crime against children^^	21.1	16.5	22.1
Crime against Scheduled Castes	22.3	4.9	5.5
Crime against Scheduled Tribes	10.5	2.1	1.5
Crime against body*	68.1	25.3	57.0
Crime against public order**	11.9	10.1	8.0
Economic crimes$	11.9	10.1	8.0

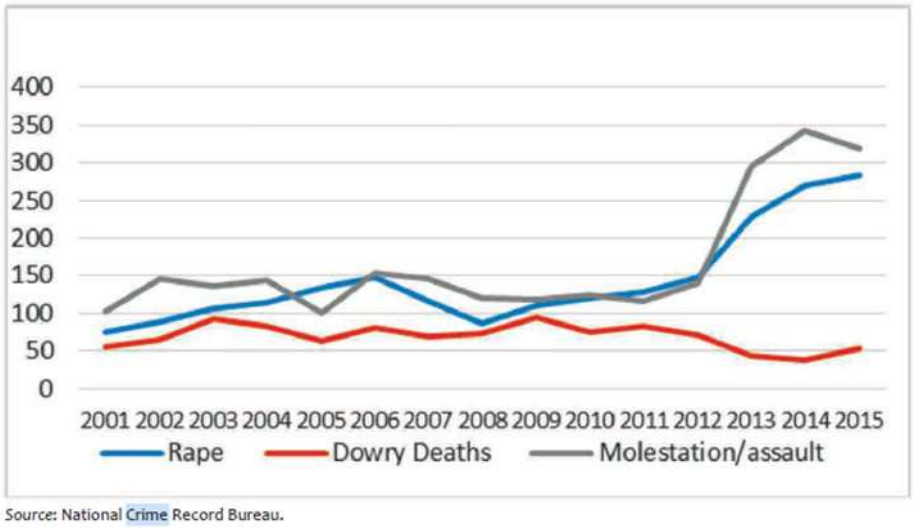
Source: National Crime Record Bureau.
Notes:
^Rape, Assault on women with intent to outrage her modesty, Insult to the modesty of women, Cruelty by husband or relatives
^^ Foeticide, Infanticide, Procuration of minors, Murder, Exposure and abandonment, Offences under the POCSO Act, the Prohibition of Child Marriage Act, etc.
*Murder, attempt to commit murder, culpable homicide not amounting to murder, attempt to commit culpable homicide, kidnapping and abduction, grievous hurt, causing death by negligence, causing injury due to rash driving/road rage, dowry death and human trafficking.
** Riots, Arson, Unlawful assembly and Offences promoting enmity between different groups;
$ Criminal breach of trust, Cheating, Forgery and Counterfeiting;

Source: *Uttarakhand Vision 2030*



Source: *Uttarakhand Vision 2030*

Figure 2-21 Number of IPC crimes across the UK state



Source: *Uttarakhand Vision 2030*

Figure 2-22 Major crimes against women in the UK state (2015)

2.8 Status of Infrastructure and Social Services

2.8.1 Water and Sewerage Facilities

In October 2016, approximately 582,000 households were connected to water pipelines in the oblast, of which about 280,000 were rural households. Of the 39,209 settlements in rural areas, 54% (21,345 settlements) have access to water according to standards.

There are 17,864 settlements with less than 40 LPCD, of which 6,204 settlements are more than 75% to less than 100% connected; 5,586 settlements are more than 50% to less than 75% connected; and the remaining settlements are only less than 50% connected.

Only 21 ULBs (23% of the total) out of a total of 91 ULBs receive water supply services of 135 LPCD, which is set as the water supply standard for urban areas. In addition, 37 ULBs are between 70 and 135 LPCD and 33 ULBs do not even meet 70 LPCD.

2.8.2 Electricity Situation

Currently, electricity coverage in the UK state is almost 100% in the urban areas and 96.5% in the rural areas. Although the implementation of the Ministry of Electricity's RGGVY （Rajiv Gandhi Grameen Vidyutikaran Yojana） scheme has been completed, there are still 3.5% (100,407) rural households in the rural areas of the state that are not electrified.

In accordance with the provisions of the Electricity Act 2003, the following three separate and separate utilities operate in the UK state.

（1） Power Generation Companies - Uttarakhand Jal Vidyut Nigam Limited (UJVNL)
（2） Power Transmission Company - Power Transmission Corporation of Uttarakhand Limited (PTCUL)
（3） Power Distribution Company - Uttarakhand Power Corporation Limited (UPCL)

The UK state electricity sector is regulated by the UK state Electricity Regulatory Commission (UERC), while the UK state Renewable Energy Development Agency (UREDA) is the body responsible for promoting and implementing various renewable energy programmes in the state.

The UK state has many rivers and canals, and there is enormous potential for hydropower energy in the state. This potential is enhanced not only by the availability of river surface water from glacial snowmelt and rainwater, but also by the steep topographical gradients created by the mountainous terrain of the UK state. There is potential for small hydropower projects to play an important role in improving the energy situation across the country, especially in remote and inaccessible areas.

Small hydropower is therefore particularly suited to mountain states such as the UK state, where, for example, Badrinath in Chamoli, in the remotest part of the state, is supplied with electricity using this technology as an auxiliary source.

2.8.3 Internet Communication Status

Table 2-16 and Table 2-17 show indicators of internet use in the oblast. The total number of internet subscriptions in the oblast exceeded 24 million in 2014, a significant increase compared to 10 000 in 2002[20].

Table 2-16 Number of internet and broadband subscriptions

Table 10.25 Number of Internet (Narrowband + Broadband) and Broadband Subscribers in Uttarakhand (As on March, 2014)		
State	Total Number of Internet(Narrowband + Broadband)Subscribers	Total Number of Broadband Subscribers
Uttarakhand	24327142	3652710
India	251590542	60874434

※ March 2014, The UK state

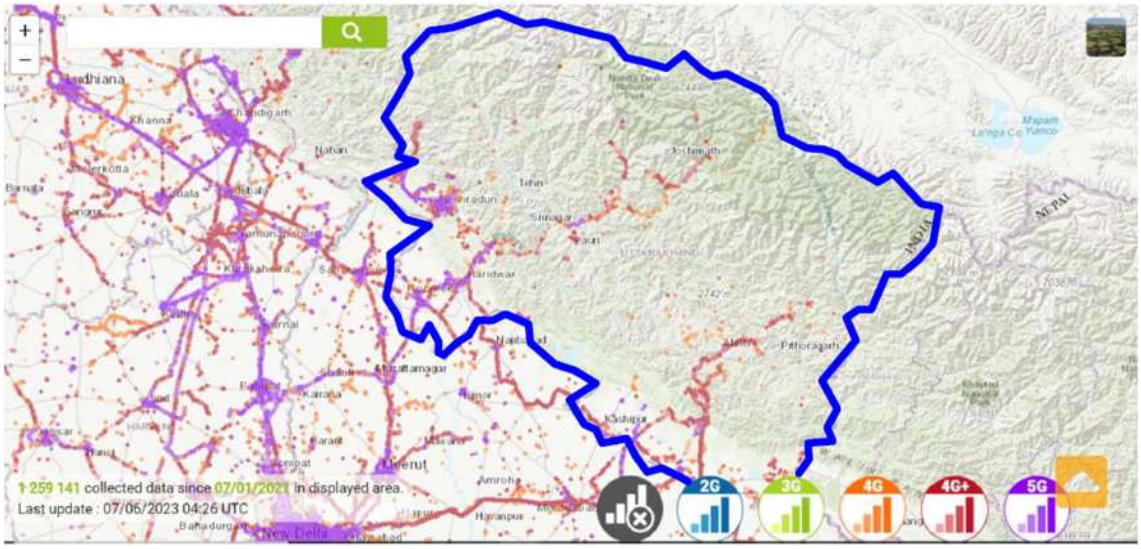
Source: *Economics Area, Indian Institute of Management Kashipur*, 2016-2017

Table 2-17 Number of internet subscriptions in the UK state (2002 and 2003)

Table 10.26 Number of Internet Subscribers in Uttarakhand (2002 and 2003)		
States/UTs	As on 31st March	
	2002	2003
Uttaranchal	10902	19801
India	3239675	3500278

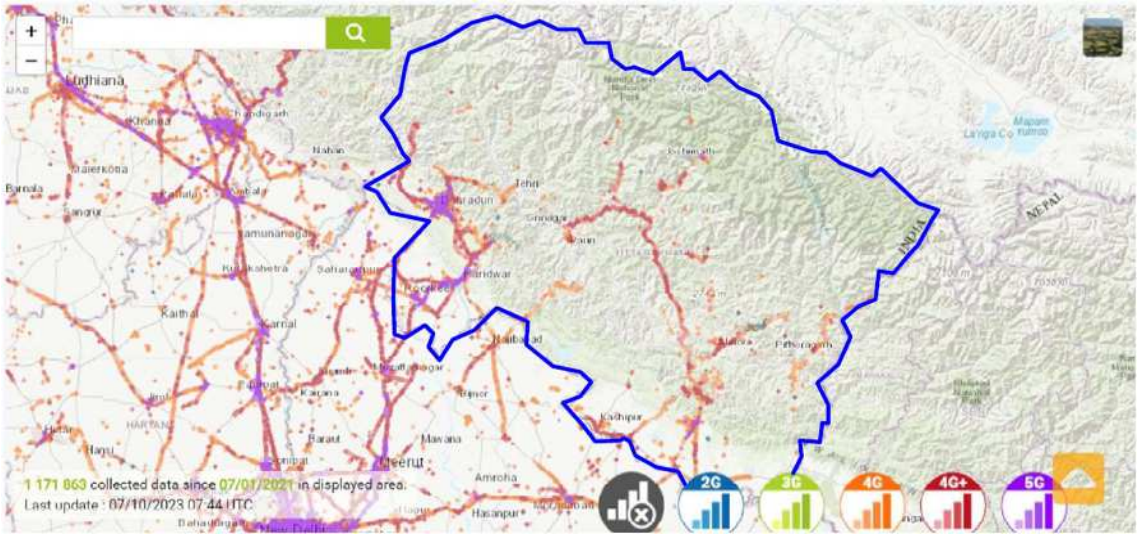
Source: *Economics Area, Indian Institute of Management Kashipur*, 2016-2017

The diagram below shows the connectivity areas of mobile carriers Jio and Airtel in the UK state. Although each carrier's coverage varies slightly, it can be said that the internet is usable even in mountainous areas.



Source: Prepared by JST from *3G / 4G / 5G coverage map*, India[24]

Figure 2-23 Jio penetration chart in the UK state



Source: Prepared by JST from *3G / 4G / 5G coverage map*, India

Figure 2-24 Airtel penetration chart in the UK state

2.8.4 Transport Networks

(1) Road transport network

As a large part of the state's area is covered by mountainous regions, it is essential to develop transport networks from urban areas to various parts of the state. To meet this traffic demand, the Government of India and the State Governments have been working hard to improve paved roads, including National Highways and State Highways, as shown in Table 2-18. This has resulted in the road pavement coverage in the UK state reaching 67% in 2016, with paved roads leading to various regions in the mountainous regions being secured.

However, unpaved roads can be found when heading into mountainous village areas, and such roads require extreme caution for vehicular traffic, as they are narrow and cliffy, but are not guardrailed.

In addition, with road improvements and growth in tourism, the total number of vehicles in the UK state doubled between 2008 and 2015 to approximately 1.9 million (as of 2015), and with this increase in traffic, the endemic congestion in Dehradun, Rishikesh and elsewhere is a new challenge. The traffic congestion in Dehradun, Rishikesh, etc. is a new challenge.

(2) Rail transport network

In railways, narrow-gauge lines have not yet been converted to broad-gauge lines and double-tracking of lines has not yet progressed, resulting in delays and cancellations of trains, making this an area where development progress lags behind that of road transport networks[20].

(3) Airport transportation network

Currently, the UK state has Dehradun and Pantnagar airports, with the former being the main airport. Pantnagar Airport can be unusable during the winter months due to weather disruptions[20]. However, Figure 2-25 shows that although there were fewer arrivals and departures in 2021, the year of the Corona disaster, there were almost daily arrivals and departures in 2022 and 2023, making them available.

Table 2-18 Road and rail extensions within the UK state

Table 9.1 Length of road and train tracks in Uttarakhand					
					(in KM)
	2009-10	2011-12	2012-13	2013-14	2014-15
1. Under PWD					
National Highway	1375.76	1375.76	1375.76	1375.76	1422.26
State Highway	1575.50	3788.20	3788.20	3782.24	3736.64
Main District Roads	567.88	3289.74	3289.74	3289.74	3296.73
Other District Roads	6827.14	2945.04	2945.04	2985.27	3020.67
Village Roads	12375.68	14543.89	15436.89	16177.16	18187.11
Light Vehicle Roads	1100.65	858.22	858.23	790.38	750.44
Total	23822.61	26800.85	27693.86	28400.55	30413.85
2. Under Local Authorities					
District Panchayat Vehicle Roads	745.56	862.45	862.45	807.6	852.4
Municipality/ Town Panchayat/ Municipal Corporation/ Other Vehicle Roads	1928.48	1974.3	2040.23	2356.13	2312.84
Total	2674.04	2836.75	2902.68	3163.73	3165.24
3. Under Other Departments					
Irrigation	741	741	741	741	741
Sugarcane	803	885	899.61	850.12	864.04
Forest	3256	3257	3313	3270	3270
BRTF	1273.81	1281.32	1281.32	1281.32	1281.32
Others	1344.24	1685.00	1906.31	2060.21	950.94
Total	7418.05	7849.32	8141.24	8202.65	7107.3
Total Length of Roads (1+2+3)	33914.70	37486.92	38737.78	39766.93	40686.39
Length of Train Tracks					
Broad Gauge	283.76	283.76	283.76	283.76	283.76
Narrow Gauge	61.15	61.15	61.15	61.15	61.15
Total	344.91	344.91	344.91	344.91	344.91
Source: Statistical Diary of Uttarakhand 2009-10, 2011-12, 2012-13, 2013-14, 2014-15					

Source: *Uttarakhand State Economic Survey* 2016-2017



※ 2021～2023

Source: *FlightAware*[25]

Figure 2-25 Annual number of arrivals and departures at Pantnagar Airport

(4) Traffic situation in the regions

The region with relatively good transportation infrastructure is only Haridwar, while other areas have many mountainous roads, making it time-consuming to travel by car from the airports. Especially in Chamba and New Tehri, which are situated in hilly terrain at high altitudes, the mountain roads can be challenging due to their steep and rugged nature.

Additionally, there is often only one access road to these towns, and if caught in traffic, one can be stuck for extended periods.

2.9 Current Situation Regarding Gender Gap

2.9.1 Gender Gap Issues

(1) Literacy rate

According to the Census 2011 results, the literacy rate of the population aged 7 years and above in the UK state is 78.8%. Within the state, Dehradun district has the highest (84.2%) and Udham Singh Nagar district the lowest (73.1%).

As far as male literacy is concerned, Rudraprayag district has the highest literacy rate (93.9%) and Haridwar has the lowest (81.0%). In contrast, when it comes to female literacy, Dehradun has the highest literacy rate (78.5%) and Uttarkashi has the lowest (62.4%)[20]. The employment rate in the oblast is 65.9% for men and 34.1% for women in 2013-2014 data.

Literacy rates in the UK are higher than in the Indian country as a whole, but there is no significant difference with regard to gender differences.

Table 2-19 Statistics on literacy rates across India and in the UK state

Indicator	Year	Total	Male	Female
Literacy rate (%), Uttarakhand	2011	78.80	87.40	70.00
Literacy rate (%), India	2011	74.04	82.14	65.46
Literacy rate (%) for SCs, Uttarakhand	2011	74.41	84.34	64.05
Sex ratio (females/000 males) Uttara-khand	2011	963		
Sex ratio (females/'000 males), India	2011	940		
Child sex ratio, Uttarakhand	2011	890		
Child sex ratio, India	2011	919		

Source: Directorate of Economics and Statistics, Government of Uttarakhand and Census 2011.

Source: *Uttarakhand Vision 2030, Department of Planning*, Government of Uttarakhand

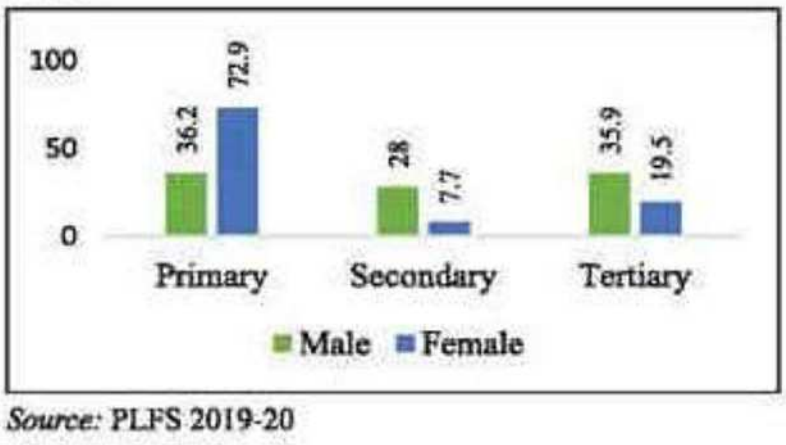
(2) Labour participation rate

There is a tendency for men in the UK state to migrate to other states in search of better employment opportunities. As many men leave their homes, women are often left to shoulder various outdoor chores such as agricultural work and fodder collection, in addition to typical household duties.

As shown in Figure 2-26, female workers are primarily engaged in the primary sector, although it can be inferred that approximately half of the female workforce is employed in the primary sector, where male workers are predominantly employed.

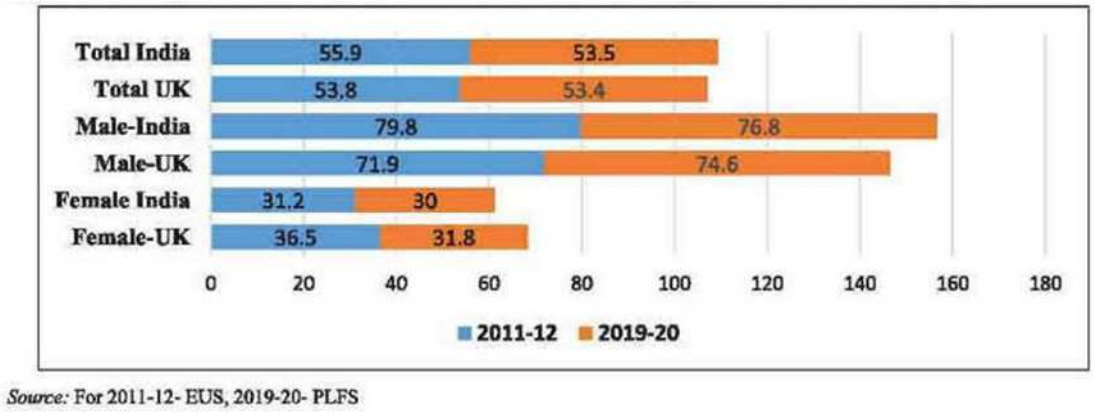
Furthermore, as indicated by Figure 2-27, there is a significant disparity in labor force participation rates between men and women, with women having notably lower rates. This

suggests that women are primarily required to allocate their time to domestic work within the household[21].



Source: Indian Institute of Management Kashipur, 2021-2022

Figure 2-26 Gender-specific employment rates in various industry sectors in the UK

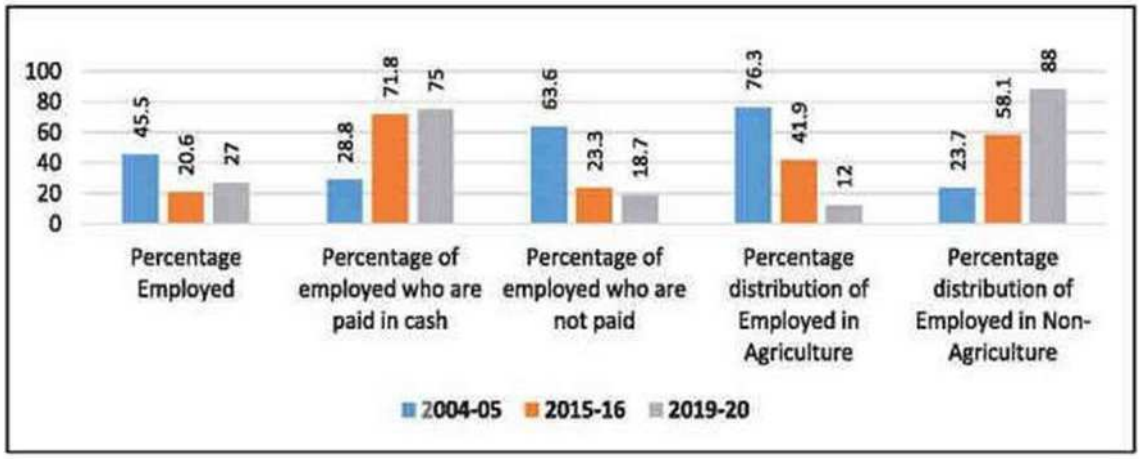


Source: Indian Institute of Management Kashipur, 2021-2022

Figure 2-27 The labour force participation rate by gender（LFPR）

(3) Employment rate

The employment rate, as seen in Table 2-20, exhibits a significant gender disparity, with women comprising approximately half of the workforce. Even for those who are employed, approximately 65% of women earn a monthly income of less than 15,000 rupees. However, the percentage of employed women receiving cash payment as remuneration increased from 28.8% in 2004-05 to 75% in 2019-20. As a result, the proportion of women in employment without remuneration decreased substantially from 63.6% in 2004-05 to 18.7% in 2019-20 (refer to Figure 2-28) [21].



Source: Indian Institute of Management Kashipur, 2021-2022

Figure 2-28 Income and employment status distribution by type for female workers aged 15 to 49.

Table 2-20 The UK state employment rates

	Total	Male	Female
Workers (% of total)		65.9	34.1

Source: *Uttarakhand vision 2030, Department of Planning*, Government of Uttarakhand

(4) Enrolment rate

Regarding the enrolment rate, as per Table 2-21, the ratio of female students to male students in primary and middle schools is high, with values of 0.89 and 0.92, respectively.

Table 2-21 School attendance (ratio of girls to boys)

	2016-17 Baseline	2017-18 to 2019-20	2017-18 to 2023-24
Gender Parity Index (primary school)	0.89	0.92	0.95
Gender Parity Index (secondary school)	0.92	0.93	0.97
Gender Parity Index (higher school)	0.94	1.04	1.24

Source: Prepared by JST from *Uttarakhand vision 2030*

Currently, the Government and the Ministry of Micro, Small and Medium Enterprises have launched various initiatives to support women's skill development and capacity building. These initiatives include the Pradhan Mantri Mudra Yojana, Mahila Udyam Nidhi Scheme, and SAMART (Special Assistance for Minority Advancement and Rehabilitation for Women) among others（Figure 2-23）. Since 23 January 2019, a total of 138,000 projects have been initiated under the Prime Minister's Employment Generation Program (PMEGP) scheme.

However, the Female Labour Force Participation Rate (FLFPR) in the state of Uttarakhand has been sharply declining since the early 2000s (refer to Table 2-22). This can be attributed to factors such as the rise in educational levels (refer to Figure 2-29), an increase in household income, and a decrease in agricultural employment. With improved education and the ability to pursue higher-paying occupations, women have seen an increase in household income, reducing the necessity for them to participate in the workforce.

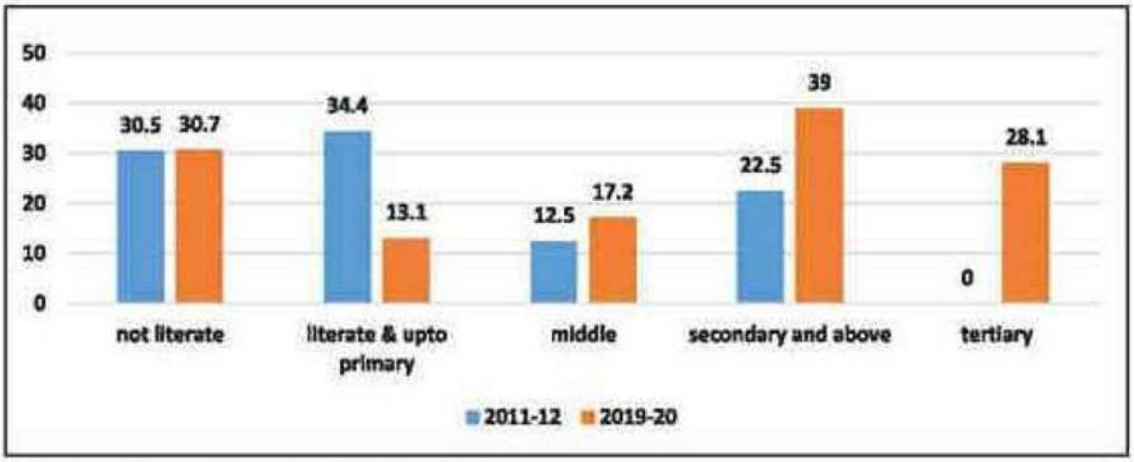
When comparing urban and rural areas, it is evident that the labor force participation rate is lower in urban areas than in rural areas. This reflects the higher household incomes in urban areas, resulting in lower necessity for women to work. Additionally, the decline in agriculture has led to a decrease in the number of women engaged in agricultural work[21].

Table 2-22 Trends in women's labour force participation rates

Area	State	2004-05	2011-12	2019-20
Urban	Uttarakhand	19.8	15.0	17.5
	HP	36.0	30.1	40.6
	India	24.4	20.5	23.2
Rural	Uttarakhand	65.7	43.8	37.3
	HP	71.3	67.2	68.2
	India	49.4	35.8	33.0

Source: National Sample Survey Reports various rounds (EUS & PLFS)

Source: *Indian Institute of Management Kashipur*, 2021-2022



"*Source:* EUS 2011-12 and PLFS 2019-20

Source: *Indian Institute of Management Kashipur*, 2021-2022

Figure 2-29 Percentage distribution of women aged 15 and above in the state of Uttarakhand by their general education level

Table 2-23 Central initiatives to promote women's entrepreneurship

Policies and Schemes	Description
Mudra Yojana Scheme	This is a government programme for women who wish to start a small business, such as a beauty parlour, a tuition centre, or a tailoring business. Three plans have been implemented under this scheme: Shishu plan (loans up to Rs 50,000 [US$ 655.38] for new businesses), Kishor plan (loans between Rs 50,000 [US$ 655.38] and Rs 5 lakh [US$ 6,553.81] for well-established businesses), and Tarun plan (loans of Rs 5–10 lakh [US$ 6,553.81–13,107] for business expansion).
Trade-Related Entrepreneurship Assistance and Development (TREAD) Scheme	PMEGP created TREAD, a programme that strives to empower women by giving credit to projects, offering particular training and counselling, and disseminating information for their businesses. The government would finance up to 30% of the overall project cost, as determined by financing institutions. The remaining 70% would be financed by these institutions.
Mahila Udyam Nidhi Scheme	This initiative intends to assist women in starting new enterprises as well as improving and modernising the existing ones. The loans must be returned within 10 years, which includes a five-year moratorium period; interest rates would be adjusted as per the market rates.
SAMARTH	This drive aims to help women become independent through self-employment. In FY 2022–23, the Ministry of MSME will focus on providing skill development and market development assistance to women, with over 7,500 women applicants from rural and sub-urban regions being trained. Around 20% of seats in free skill development programmes offered under the Ministry's skill development plans will be reserved for women. Under the Ministry's marketing assistance programmes, 20% of MSME Business Delegations sent to local and foreign exhibits would be devoted to women-owned MSMEs.
Annapurna Scheme	This plan is designed specifically for women's hidden cooks, as the name implies. A loan of up to Rs. 50,000 (US$ 655.38) would be provided to establish a catering business and buy cooking equipment including utensils and water filters. To procure the funding, collateral in the form of assets as well as a guarantor is required. Also, the loan must be returned within three years. The women can obtain a one-month grace period before the repayment process starts.
Stree Shakti Package for Women + Entrepreneurs	To secure a loan under this programme, women must first register under their State's Entrepreneurship Development Program (EDP). They also need to possess a controlling stake (more than 50%) in a small firm. On loans above Rs 2 lakh (US$ 2,621.52), a 0.05% concession on interest is offered.

Source- Annual MSME report 2019-2020,2021-22, IBEF MSME report March 2022

Source: *Indian Institute of Management Kashipur*, 2021-2022

2.9.2 Existing Policies and Institutions

On the issue of eliminating discrimination against women and girls, the Constitution of India provides the legal basis for the advancement of women's rights. The principle of gender equality is also enshrined in the Constitution and states have the power to adopt positive discrimination measures against women. Among the fundamental rights are those guaranteeing equality before the law and equal protection of the law, prohibiting discrimination against citizens on the basis of religion, race, caste, sex and place of birth, and guaranteeing equal opportunities to all citizens in employment matters.

In addition, within the framework of democratic politics, legislation, development policies and programmes focus on the advancement of women. The Indian state has also ratified international conventions and human rights instruments (notably CEDAW: A treaty that is based on the fundamental principle of eliminating all forms of discrimination against women and girls) related to ensuring equal rights for women, and initiatives include.

（i） National Commission for Women

In January 1992, the Government established the National Commission for Women. This is a legally constituted body with the specific task of studying and monitoring all issues relating to women and proposing amendments to existing legislation where necessary, including measures necessary to strengthen and protect women's rights.

（ii） Women's reservation system in ULB

The 73rd Constitutional Amendment Act passed by Parliament in 1992 guarantees that 1/3 of all constituency seats are reserved for women in ULBs (whether in rural or urban areas).

（iii） National Behaviour Meter for Girls (1991-2000)

The aim of this action plan is to ensure the survival, protection and development of the girl child, with the ultimate goal of bettering her future.

（iv） National policies for strengthening women's rights (2001)

This national policy, developed in 2001, provides a framework for strengthening women's social, economic and political power.

The UK state Women's Commission Act 2005 was passed by the UK State Legislative Assembly in November 2005, establishing the UK State Women's Commission. The functions of the Commission include:

- Examine issues relating to the protection of women under the Constitution and other legislation.
- Raise instances of non-compliance with the above safeguards with the appropriate authorities.
- Investigate relevant issues such as women's disenfranchisement and non-implementation of laws enacted to protect women in order to achieve equality and development goals.
- Participate in and provide advice on the planning process for women's socio-economic development.
- Collect information on crimes against women.

2.9.3 Actual Conditions of Water Pumping Labour

Around 35% of rural settlements are not covered by a safe water supply or tap water, and water has to be transported from a distance. All these factors increase the burden of women's

household chores, especially in rugged mountainous areas characterised by undulating roads and steep gradients. This burden involves not only adult women, but also women in their under-teens, which has a negative impact on their education and health.

Figure 2-30 illustrates the actual situation of a woman in Jambunpada, a hilly settlement with a population of 200 people, who works as a water fetcher. Every morning at 4 am, she leaves her house and goes to several water fetching stations to fetch water for 10 hours under the blazing sun at 40°C (104°F).

For bathing and for washing clothes, they have to go downhill for about 3 km. She is also unable to accommodate her family in her house because the amount of water she needs to fetch increases with the number of people in the house. Although this woman now has access to tap water, many people do not have water points close to their homes and still waste long hours fetching water and are forced to live in inconvenience.



A DAY In The Life Of

Sunita Khutade, who spends 10 hrs a day to get four pots of water

Aditya.Waikul@timesgroup.com

If Sunita Khutade is not up at 4am every day, her whole day collapses around her. After a quick freshen-up before the first light of dawn, she rushes about collecting the two kalshis (pots), stuffs her feet into slippers, and walks briskly to a water source just outside her hamlet.

She descends to the small pit with water that can only be scooped with a flat dish, but an old woman who slept overnight at the spot has beaten her to it and the water that trickled from an aquifer into the pool is gone. Sunita must wait for it to fill up again which can take an hour.

But she is patient, even resigned. An hour later, she fills half a pot and heads home as other latecomers arrive to fill their pots. She parks it at home and heads out again to water holes in the nearby forest.

Sunita's story is that of every woman in Jambunpada, a hamlet of 200 people in the hills around 80km from Nashik.

She spends at least 10 hours every day looking for water, which includes walking for four hours across sources and waiting for six hours for the trickle to fill her pots. "My entire day for the last 11 years has revolved around water. We race against each other to these pits, run around, climb the hill through shortcuts, sleep there to book a place — it's exhausting," Sunita says as she lights the fire to make tea for her husband. Her two daughters are asleep but will join their mother's water hunt when they wake up.

Later in the day, Sunita braves 40-degree Celsius temperature to go to Jambunacha zeera, a nearly dry stream. It is a 45-minute walk downhill. Here, she fills up two buckets of murky water which she will filter and use for cooking lunch. "We prefer the nearest water source despite the long wait because other places are far away and going alone in the forest is risky at dawn and late in the night," she explains.

Back home after a long walk with her daughters, Sumita gets busy in the kitchen. "I cook food with whatever water I get in the morning. We mix the water from the washed utensils with cow dung to coat the flooring and for plants."

Her parents in Kathwadpada, which is 8 km away, have a big well and she never had to struggle for water till she got married and came to Jambunpada. "I will make sure there is enough water where my daughters get married," says Sunita as she winnows the rice.

Bathing and washing clothes are a luxury in Jambupada. For that, Sunita has to walk three km downhill to a nearly dry river under a blazing late afternoon sun.

Back from the river, Sunita quickly dries her clothes, grabs her two kalashis and dashes towards another pit in the forest called Ambhecha zeera. It takes her 45 minutes to reach the spot and an hour to fill up and she wants to be there first.

DAILY STRUGGLE: Sunita and her sister tackle risky terrain while carrying filled pots. (Below left) Scooping up water from a shallow pool that takes hours to fill

"Last month, my brother and his daughter were visiting. I had to tell him not to stay overnight. Two extra people mean an additional four pots. I don't mind fetching it but there is no water," Sunita says, as she completes the climb and reaches Ambecha zeera.

As the other women arrive, they crack jokes at Sunita's quick hike, and the group bursts into laughter. Everyone waits for their turn in the fading sunlight surrounded by thick forests along the slope of a stream that is a trickle. Leopards, hyenas and wild boars also visit this pool.

During their long wait, the conversation is never about water. "We don't talk about what we can never have," a woman from the group says.

At 8.30pm, when everyone has filled up at least one pot, the women walk towards the village balancing a kalashi on their heads in the light of LED torches. They look like a search party on a dusty trail.

Back home, Sunita is glad she has two pots of clean water to cook dinner and for her family to drink.

While putting her daughters Saraswati and Deepali to sleep she repeats her promise of going to her parents' house for a few days to get away from the search for water.

Jambunpada falls silent by 10pm except for the distant chatter of a group of youths watching reels standing on a rock. It's the only place where there is mobile network.

As Sunita calls it a day, her mind is already working on planning the next one just a few hours away. She tells herself to wake up at 3am so that she can be the first at the pit and start her day with a pot of clean water.

Source: *The Times of India, New Delhi / Dehradun* June 7, 2023[26]

Figure 2-30 The reality of water pumping labour

2.10 Access to Sanitation Facilities

In recent years, the UK state has been the first state to declare itself Open Defecation Free (ODF). According to the latest information from the NSSO（The National Sample Survey Office, which is responsible for conducting sample surveys across various fields throughout India） in 2015, the UK state ranks 8th out of 26 states in terms of the percentage of households equipped with and using more sanitary latrines. Since the 2011 census and particularly since the launch of the Swachh Bharat Abhiyan (Government of India's campaign against solid waste) in 2014, the sanitation status of rural areas in the UK state has improved significantly.

In the rural areas of the UK state, pit latrines (simple drop-in latrines) were constructed as part of the Swachh Bharat Mission (SBM: Swachh Bharat Mission), but these are not connected to the sewerage system. Even in urban areas, only 26 out of 91 ULBs, or 28.6% of the total, have partial sewerage connections, while 65 cities have no sewerage connections at all. The situation could worsen in the future, as the urban population is growing rapidly due to massive migration to cities and the rapid growth of slums.

Table 2-24 State ranking among 26 states according to the NSSO survey on sanitation

Rank	State	% Households with Sanitary Toilets	% People Using Household/Community Toilets out of Households Having Toilets	% Households Having Access to Sanitary Toilets and Using Them
8	Uttarakhand	80.5	99.6	80.2

※ 2015

Source: Uttarakhand Vision 2030

Furthermore, most of the Urban Local Bodies (ULBs) within the state are not in compliance with the 2016 MSW Rules (Municipal Solid Waste Management Rules). Although household collection of solid waste is claimed to be conducted in all districts, waste segregation is not implemented in any of them. Solid waste is partially collected and disposed of without separation. Moreover, in the state of Uttarakhand, only a meager 37% of the collected solid waste was treated during the fiscal year 2018-19.

One of the reasons for the lack of progress in solid waste management can be attributed to the financial constraints faced by Urban Local Bodies (ULBs). Most ULBs allocate over 90% of their total expenditure towards the salaries of ULB staff. For instance, Haridwar Nagar Nigam spent 92%, 74%, and 59% of its total expenditure on salaries in the fiscal years 2014-15, 2015-16, and 2016-17, respectively. Similarly, Dehradun Nagar Nigam also allocated over 90% of its total expenditure to salaries during the same period. With only a minimal amount dedicated to infrastructure, it is believed that the intended Solid Waste Management (SWM) objectives were not adequately achieved.

As a result, the majority of solid waste has been left unattended on the outskirts of urban areas, where it has remained for decades, turning into open dumping sites[22].

Table 2-25 The situation regarding the generation, collection, treatment, and landfilling of solid waste

States	2015-16	2016-17	2017-18	2018-19
Solid Waste Generation (TPD)				
Uttarakhand	917	1180	1099	1527.458
Himachal Pradesh	276	342.35	276	389
Jharkhand	3570	NA	3570	2205
Chhattisgarh	2245.25	6000	2000	1650
Solid Waste Collection (TPD)				
Uttarakhand	917	1180	1099	1437.4
Himachal Pradesh	207	NA	207	340
Jharkhand	3570		3570	2043.4
Chhattisgarh	2036.97	4200	1680	1386
Solid Waste Treated (TPD)				
Uttarakhand	0	NA	NA	913.4
Himachal Pradesh	125	NA	125	150
Jharkhand	65	NA	65	836.69
Chhattisgarh	828.18	20	1411.2	1271
Solid Waste Landfilled (TPD)				
Uttarakhand	0	NA	NA	524
Himachal Pradesh	150	NA	150	190
Jharkhand	3505	NA	0	0
Chhattisgarh	1294.97	4180	268.8	115

Source: Author's own compilation based on CPCB Annual Reports; TPD is Tonnes per Day

Source: *Indian Institute of Management Kashipur*, 2021-2022

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Chapter 3 Overview of the Water Supply and Sewerage Sector

3.1 Policies Pertaining to the Water and Sewerage Sector

3.1.1 Overview

No.	Policy	Enactment Year	Field	Contents	Description
1	The U.P. Water Supply and Sewerage Act, 1975	1975	Water supply and sewerage	Law on water and sewerage	3.1.2
2	Environment Protection Act 1986	1986	Provisions including sewage	Provisions for environmental pollutants	3.1.3
3	73rd and 74th Constitutional Amendment Acts 1992	1992	Water supply and sewerage	Basic framework for devolution of powers and authority to ULBs (water supply and sanitation) at different levels	3.1.4
4	National Water Policy	2002	Water supply and sewerage	National level policy on water	3.1.5
5	National Urban Sanitation Policy	2008	Sewerage	Policies defining integrated city-wide sanitation planning	3.1.6
6	UK vision 2030	2018	Various policies, including water and sewerage	Targets for water, sewerage and water resources in the UK state	3.1.7
7	The Uttarakhand State Water Policy, 2019	2019	Water supply and sewerage	Policies on water resources in the UK state	3.1.8
8	UK State Improving Drinking Water for Peri-Urban Area 2019	2019	Water supply	Drinking water improvement policies in the UK state	3.1.9
9	Draft Regulation of Common Effluent Treatment Plants Rules, 2022	2022	Sewerage	Provisions on CETP （Common Effluent Treatment Plant）	3.1.10

3.1.2 The U.P. Water Supply and Sewerage Act, 1975

'The U.P. Water Supply and Sewerage Act' is the UK state water and sewerage legislation enacted in 1975. Some of its main contents are extracted and presented below.

(1) Water supply

・Water supply by Jal Sansthan

（A）Jal Sansthan must provide water supplies for the following purposes if an application is made by the owner or occupier of a building.

（a） Buildings located within 30 metres of an existing distribution pipe

（b） The applicant to connect the building to the nearest existing distribution pipe exceeding 30 metres

（B） Even if the person receiving the water supply bears the cost of the extension under clause (b) of subsection (A), the ownership of the water supply shall vest in Jal Sansthan.

（C） Jal Sansthan may also provide water supplies for purposes other than residence if an application is made to do so, etc. (Hereinafter omitted).

・Right to provide water meters

（A）Jal Sansthan can install water meters in the service pipes of buildings connected to Jal Sansthan's water supply facilities.

（B）The user shall pay for the installation and use of the meter.

（C）The installation, transfer of connections, use, maintenance, testing, installation costs, charges for use and provision of warranties where required are regulated by applicable regulations.

・Plumbers

（A） No person other than a plumber authorised by Jal Sansthan (hereinafter referred to as 'authorised plumber') may carry out work on water connections, except work of an insignificant nature, and shall not allow such work to be carried out by anyone other than an authorised plumber.

（B） If the work is carried out in breach of subsection (A), the work may be dismantled at the discretion of Jal Sansthan.

・Authority to disconnect water supply

Jal Sansthan may disconnect the water supply in the following cases:

（A） Taxes, fees, rent, water costs or other costs or charges are not paid within 15 days of the due date after the invoice under this Act has been sent.

（B） If, after receiving written notification from Jal Sansthan, the user continues to use or permit the use of water in breach of this Act or any rule, regulation or rule thereunder.

（C）User damages or causes damage to the water meter, connecting pipe or ferrule, etc.

・Prohibited acts

（A） Deliberately obstructing any person acting under the authority of Nigam or Jal Sansthan in setting up a line of work to be performed by him, or pulling out or removing any post, post or prop fixed in the ground for setting up such line of work, or injuring or destroying any work done for that purpose.

（B） Intentionally or negligently damaging, operating, opening, closing, blocking or interfering with any lock, valve, pipe, meter or other facility or device belonging to Nigam or Jal Sansthan.

（C） Illegally obstructing the flow of water in any waterworks or watercourse belonging to Nigam or Jal Sansthan, or diverting, discharging, diverting or withdrawing water, etc.

(2) Sewerage

・Authority to request sewer connection from owner

If a property is not equipped with an adequate means of sewage disposal and the sewer is located 50 metres from any part of the property, Jal Sansthan may, by written notice, require the owner of the relevant property to connect to the sewer as required by the regulations.

・Prohibition of connection to sewers

No person shall make any connection or communication with the Jal Sansthan sewers without Jal Sansthan's permission.

・Installation of shafts and other equipment for ventilation of sewage reservoirs

The Jal Sansthan may install shafts and pipes within the grounds of any building, or outside the building or in trees, for the purpose of ventilation of sewers or sewage reservoirs, whether belonging to the Jal Sansthan or not, if it deems necessary.

・Authority to inspect and test sewers and other items thought to be faulty

（A） If Jal Sansthan has reason to reasonably believe that a private sewer or sewage reservoir is hazardous to health or causing a nuisance, or that a private sewer communicates directly or indirectly with Jal Sansthan's sewer and is so defective that it passes groundwater, gravel or other material, if it appears to be defective, Jal Sansthan may apply a test other than a hydraulic test to investigate its condition and may excavate the ground if necessary.

（B）

（a） If, as a result of the investigation, the sewers and sewage reservoirs are found to be in a suitable condition, Jal Sansthan shall, as soon as possible, restore the ground excavated by itself and pay compensation for any damage caused thereby.

（b） On the other hand, if an investigated sewer or sewage reservoir is found to be defective, the Jal Sansthan may immediately stop its functioning or disconnect it

from the Jal Sansthan's sewerage system and direct the owner or occupier to take the remedial measures indicated and require them to be implemented within a specified period. In this case, Jal Sansthan may recover the costs incurred from the owner or occupier.

(C) If there is a dispute as to the appropriateness of the amount determined, Jal Sansthan refers the dispute to the Nigam and the Nigam's decision is final.

・Rights of entry, investigation, etc.

(A) An officer of the Nigam or Jal Sansthan, authorised by it, may enter any premises with an assistant or workers, may enter any premises:

(a) To inspect, investigate, measure, evaluate or conduct research

(b) To level out

(c) To dig underground, etc.

(B) When an officer authorised under the Nigam or Jal Sansthan enters any premises in accordance with the provisions of the preceding paragraph, he shall, at the time of such entry, make an offer of payment or municipal payment for any damage caused by the said act. And if there is a dispute as to the reasonableness of the compensation, the dispute should be referred to the Chairman of the Nigam in the case of a Nigam or to the Chairman of the Jal Sansthan in the case of a Jal Sansthan.

(C) In exercising the authority under section (A), any person who has the right to enter a facility may also enter adjacent facilities in a similar manner for the purposes of the work permitted under this Act, work permitted under this Act, or for the purpose of, depositing soil, abrasives, or other materials there, or for accessing such works, or for using it for other purposes related to the execution of such works[1].

3.1.3 Environment Protection Act 1986

The Environment Protection Act 1986 sets out standards for the discharge and emission of environmental pollutants. Some excerpts relating to sewage systems are presented below.

・Persons handling hazardous substances must comply with procedural safeguards. No person shall handle or cause to be handled hazardous substances unless they follow the established procedures and comply with the prescribed safety measures.

・Provision of information to authorities and institutions in certain cases

(1) Where a discharge of an environmental pollutant in excess of specified standards occurs or is foreseen to occur as a result of an accident, unexpected act or incident, the person responsible for the discharge and for the place where it occurs or is foreseen to occur is obliged to prevent or reduce the environmental pollution caused by the discharge. They must then immediately do the following:

(a) Notifying the fact of its occurrence or anticipated occurrence.

(b) Providing all necessary assistance when requested by the designated authority or agency.

(2) Notwithstanding the notification of facts or forecasts in subsection (1), the authority or agency referred to in subsection (1) shall, as soon as possible, implement the remedial measures necessary to prevent or reduce environmental pollution.

(3) Costs incurred by an authority or agency in connection with a remedy referred to in subsection (2) (with interest at a reasonable rate to be fixed by the Government by order) may be recovered as local tax revenue or arrears of public debt from the person concerned from the date the costs are claimed until they are paid.

・Admission and inspection powers

Subject to the provisions of this section, any person so authorised by the Central Government shall be entitled, at reasonable times and with such assistance as may be necessary, to enter any place for any of the following purposes:

(a) Carrying out any of its functions entrusted to it by the Central Government.

(b) Determining whether and how any notice, order, direction or authorisation made under this Act or any regulation made thereunder or provided under this Act has been complied with.

(c) Examining and testing equipment, industrial plant, records, registers, documents or other material objects, or where there is a contravention of regulations made under this Act, where such contravention is about to be committed, where it may be evidence of an offence punishable under this Act or under it, or where environmental pollution search of such premises where the seizure of such equipment, industrial plant, records, registers, documents or other material objects is necessary in order to prevent or abate[2].

3.1.4 73rd and 74th Constitutional Amendment Acts 1992

The 73rd and 74th Constitutional Amendment Acts of 1992 mandate states to establish a three-tier system of village, intermediate and district level panchayats and urban municipalities respectively. States are expected to delegate appropriate powers, responsibilities and finances to these institutions to enable them to prepare and implement plans for economic development and social justice. These laws provide the basic framework for decentralising power and authority to ULBs at different levels. However, the responsibility for giving practical shape to this lies with the states.

The amendments to Articles 73 and 74 of the Constitution of India constitute a new chapter in the process of democratic decentralisation in the country. These amendments place the responsibility for taking decisions on grassroots-level activities that directly affect people's lives on the elected people themselves. Local self-government in the Republic of India, similar to the two higher levels of government - the Central Government and the State

Government, is explicitly mentioned in the Indian Constitution. The local Urban Local Bodies (ULBs) constitute the third tier of government, and currently, the rural ULBs, known as the Panchayati Raj system, operate under Article 73, while the urban ULBs, which are the municipalities, operate under Article 74. Since the passage of Article 73 in 1992, legislation has been passed in most states of the India to conform to the provisions of Article 73[3].

3.1.5 National Water Policy

The National Water Policy sets out the principles for the management of water resources in the country of India, first formulated in 1987, revised in 2002, with the latest version approved in December 2012. The 2012 version of the document incorporates new issues with regard to the national water policy, such as addressing climate change and water pricing.

The key aspects of the latest 2012 edition are set out below.

- The need for legislation on water at the federal level is emphasised. The Constitution of India confers management powers over water on the states, which means that there is currently insufficient legislation at the federal level.
- The minimum quantity required for sanitation is recognised as a demand that should be prioritised and secured. For the portion exceeding this, water is to be seen as a commodity with economic value and the value of water is to be maximised and efficient use and conservation of water is to be promoted.
- Emphasise the need for adaptation to climate change.
- The importance of efficient use of water is noted. It also includes information on the water footprint and the development of water audits.
- Require the establishment of new water agencies and appropriate water pricing to incentivise water recycling and reuse.
- Shift the role of the government as a 'service provider' to a regulatory manager and facilitator of services, and transfer water-related services to communities and the private sector adopting appropriate public-private partnership (PPP) models.
- Facilitate technological research and development to solve problems in the water sector.

The 2012 version is effectively intended to promote privatisation, by viewing water as a commodity with economic value and by shifting the role of government from service provider to facilitator[4].

3.1.6 National Urban Sanitation Policy

The National Urban Sanitation Policy is aimed at making all cities and towns in the India fully sanitised, healthy and liveable and providing good sanitation and environment for all citizens, with special emphasis on hygienic and affordable sanitation facilities for the urban

poor and women. The policy is aimed at providing good sanitation and environment for all citizens. Specific objectives are set out below:

（A） Awareness-raising and behaviour change

- Raise awareness of the link between sanitation and public and environmental health in communities and institutions.
- Promotion of mechanisms to promote behaviour change towards the adoption of healthy hygiene practices.

（B） Open Defecation Free (ODF) cities

Ensure that all urban residents have access to safe and hygienic sanitation facilities and that no one defecates in the open. To achieve this goal, the following activities will be implemented.

- Promoting household access to safe sanitation facilities (including appropriate disposal facilities).
- Facilitation of co-planned and managed latrines for household groups with space, ownership and financial constraints, where necessary.
- Ensure adequate supply and 100% maintenance of sanitation facilities in all urban areas, eliminating open defecation and environmental hazards.

（C） Integrated city-wide sanitation

（a） Institutional review and mainstreaming of hygiene management.

- Mainstream sanitation-related measures across all sectors and sector areas as a cross-cutting issue, particularly in all urban management initiatives.
- Strengthen national, state, urban and regional institutions (public, private and local) to prioritise sanitation provision, planning, implementation and operational management.
- Extend access to adequate sanitation facilities to poor communities and underserved settlements.

（b） Hygienic and safe waste management

Human faecal and liquid waste from sanitation facilities, including all toilets, must be disposed of safely. To achieve this goal, the following activities will be implemented:

- Facilitate the proper functioning of network-based sewerage systems and ensure that households are connected as far as possible.
- Wherever possible, promote the reuse of treated sewerage in non-potable uses.
- Facilitate proper treatment and disposal of sludge from on-site facilities such as septic tanks and pit latrines.
- Ensure that all human faeces are collected safely and disposed of so that they do not pose a hazard to public health or the environment after disposal.

（c） Proper operation and maintenance of all sanitary facilities

Promote proper use, regular maintenance and upkeep of household, communal and public sanitation facilities. Strengthening local ULBs to ensure sustainable sanitation service provision[5].

3.1.7 UK Vision 2030

(1) Overview of UK Vision 2030 for water and sewerage

UK Vision 2030 aims to provide improved drinking water and water pipelines to all households in rural and urban areas by 2030. Under SDGs（Sustainable Development Goals）Target 6.1 'Access to water and sanitation for all and sustainable management', the current 40 LPCD water supply is targeted to gradually fully cover 17,864 inadequate rural settlements by 2030.

First, an additional 6,074 settlements will be covered by 2019-20, followed by a total of 11,660 settlements (including an additional 5,586 settlements) by mid-term 2023-24. Then, by 2030, the remaining 6,204 rural settlements will be provided with 40 LPCD of water supply, covering all 17,864 settlements.

Similarly, the gap faced by 70 Urban Local Bodies (ULBs) vis-à-vis urban households will be gradually closed. First, an additional 18 ULBs will receive 135 LPCD water supplies by 2019-20, followed by coverage of an additional 23 ULBs by 2023-24 in the medium term. The remaining 27 ULBs will be covered by 2030 as a long-term target.

(2) Solid waste management

At present, solid waste management in the UK state is at a rudimentary stage, with only 0.5% of municipal solid waste processed as of September 2015. In 431 wards, 100% of solid waste is collected and transported door-to-door. The total hazardous waste generated in the UK state in 2012 was 55,627 tonnes, while in Himachal Pradesh it was 34,033 tonnes in 2013 (excluding used oil and contaminated containers).

Large quantities of medical waste of 2,257 kg per day are also generated in the UK state. The Uttarakhand Jal Nigam Corporation (UJVNL) has constructed STPs at places like Haridwar, Srinagar, Tapovan and Dehradun, which release emissions as per design. Parameters are monitored by a committee comprising Jal Sansthan, Jal Nigam and members of the Pollution Control Board.

Preparations are being made for 2030 to segregate municipal solid waste according to whether it is biodegradable or not, and to properly separate and dispose of hazardous waste and wet and dry medical waste. The initiative for 100% door-to-door collection and transport of waste will also be extended to all wards over the next 15 years. A new initiative, Protocol Septage Management, has also been introduced, whereby each ULB and each Gram Panchayat (village council) will manage its waste in a hygienic manner. A waste management unit will be set up

for collection and sanitary disposal of waste. District Magistrates (DMs) and Deputy District Magistrates (SDMs) will be responsible for overall programme management[6].

3.1.8 The Uttarakhand State Water Policy, 2019

This policy is in respect of water resources in the UK state and its purpose is to recognise the current situation and propose a framework for the planning, development and management of the State's water resources based on the State's consumptive, ecological and developmental perceptions.

As for the current status of drinking water in the UK state, the total rainfall in the UK state is 79,957 million m3 and the total water requirement is approximately 3% of this. However, annual precipitation is very uneven both spatially and temporally, being approximately 100 rainy days per year. In addition, the country has approximately 2.27 billion cubic metres (BCM: Billion Cubic Meters) of usable groundwater per year. However, only 2.10 BCM of this is actually used annually. Some of the key details of the policy are extracted below:

- All water resources are treated by the state as community common resources under the principle of public trust, with the state as the primary trustee.
- Planning, development and management of water resources must be managed from a common, integrated perspective that has an environmentally sound basis and takes account of local, regional, state and national circumstances, while keeping human, social, economic and ecological needs in view.
- The entire water resources of the State shall be mapped and registered as revenue records in the Government's Water Resources Register and shall fall under the category of available resources as far as possible. The State shall be divided into various water zones to ensure proper planning and development of water resources through inventorying of springs and rivers, regular monitoring of flow and water quality for hydrological quantification purposes, status of these resources, seasonal behaviour/scarcity, availability/suitability for various uses and long-term trends.
- Safe water for drinking and sanitation/sewerage purification shall be considered as a pre-emptive need, followed by priority allocation to other basic livelihood needs (including animals) to achieve food security, support sustainable agriculture and maintain a minimum environment and ecosystem. Minimum river flows shall be left undeveloped to meet ecological needs through a scientifically regulated system.
- The use of water resources for hydropower generation and commercial and industrial use must be done in a sustainable manner, giving due consideration to the development and improvement of groundwater and the prevention of over-exploitation.
- The development and management of water resources, both surface and groundwater as a common resource, for hydrological units as a whole, such as drainage basins, or for sub-

basins and spring complexes, should be planned on a multi-sectoral basis, incorporating not only quantity and quality aspects, but also environmental and sustainability considerations[7].

3.1.9 UK State Improving Drinking Water for Peri-Urban Area 2019

This policy is the 2019 policy for drinking water around urban areas in the UK state. The policy is broader than the policies for water supply being considered at the state level. Peri-urban areas in this context are defined as areas with a minimum density of 200 people/ 1 km^2, within 10 km of an ULB and not a statutory city as of 1 April 2016.

The lack of a formal drinking water policy in peri-urban areas has not resulted in technical and financial sustainability, increased energy efficiency, reduced energy use, lower operating costs and climate resilient water supply infrastructure. It is therefore essential to develop a separate drinking water policy for peri-urban areas in the UK state.

The main contents of the Policy are set out below:

- Targets and guidance on improving water supply services throughout the peri-urban area
- Recognition of the challenges specific to peri-urban areas and specific strategies to address these challenges
- Specific policies and strategies on quality and level of service, tariffs, subsidies, customer connections, billing and collection, O&M（Operation and Maintenance）guidelines and cost recovery programmes, and overall financial sustainability of water services in peri-urban areas
- Specific policies on institutional arrangements and the role of different institutions and the private sector in the provision of water services in peri-urban areas
- The UK state government signs performance agreements with water utilities to ensure timely completion of improved water supply schemes in peri-urban areas.
- The UK State Government shall encourage users to make maximum house connections, and these connections may be metered so that the amount of water used can be measured and a volumetric charge similar to the urban tariff system can be collected from the user.
- The UK state government must receive feedback from consumers on whether the services provided by the utility companies are satisfactory.
- Private sector participation is also encouraged wherever possible in the planning, development and management of drinking water supply schemes[8].

3.1.10 Draft Regulation of Common Effluent Treatment Plants Rules, 2022

Draft Regulation of Common Effluent Treatment Plants Rules 2022 were issued by the Ministry of Environment, Forests and Climate Change (MoEFCC) on 4 January 2023. The main contents are as follows:

Roles and responsibilities:

(i) The UK state Government/SPCBs/PCCs - The UK State Government or its agencies shall ensure that adequate upstream and downstream conveyance linkages/waterways are in place to adequately convey effluents.

(ii) CETP Governing Body - A special purpose vehicle (SPV) or association (registered under the Societies Registration Act 1860) or trust (registered under the appropriate legislation) is established to professionally manage the CETP and is responsible for the overall operation and maintenance of the CETP.

(iii) Member industrial establishments of CETPs - Member industrial establishments must discharge trade effluents that meet the discharge standards for their PETPs（Polyethylene Terephthalate） as specified in the permits issued by the SPCBs/PCCs[9].

3.2 Superior and Related Plans in the Water and Sewerage Sector

3.2.1 Overview

No.	Policy	Enactment Year	Field	Contents	Description
1	Water Resources Information System (WRIS)	2009	Information systems, including water and sewerage systems	Plans for information systems to monitor and manage water resources	3.2.2
2	National Water Mission	2011	Plans including water supply	Plans for the conservation of water resources	3.2.3
3	Namami Gange	2014	Plans including sewerage systems	Plan to reduce, protect and rehabilitate pollution from the Ganges River	3.2.4
4	Swachh Bharat Mission Grameen	2014	Plans including sewerage systems	Plans aimed at improving sanitary conditions with regard to sewage and waste	3.2.5
5	Swachh Bharat Mission-Urban 2.0	2014	Sewerage	Plans for managing municipal solid waste	3.2.6
6	Jal Jeevan Mission	2019	Water supply	Plans for the development of water supply systems in rural areas	3.2.7
7	AMRUT (Atal Mission for Rejuvenation and Urban Transformation) 2.0	2021	Water supply and sewerage	Planning for the installation of adequate water and sewerage systems	3.2.8
8	UK State Roadmap 2025	2023	Plans including water and sewerage	The UK state roadmap to 2025	3.2.9

3.2.2 Water Resources Information System (WRIS)

India-WRIS（Water Resources Information System） WebGIS is a project aimed at providing a 'single window' solution for data and information, and was implemented in 2009 by the Central Water Commission (CWC), the Ministry of Jal Shakti (MoJS), the NRSC (National Remote Sensing Centre National Remote Sensing Centre), ISRO (Indian Space Research Organisation) and DoS (Department of Space). It has tools for searching, accessing, visualising, understanding and analysing Indian national water resources and associated natural resource data within a national GIS framework. This enables the use of data for assessment, monitoring, planning, development and ultimately Integrated Water Resources Management (IWRM). In addition, the area covered is the entire India and includes whole the UK state.

The India WRIS Web-GIS is categorised into five main groups of 12 main information systems and 36 sub-information systems (including 95 layers) based on requirements and data availability.

- Watershed Atlas
- Administrative Layers
- Water resources projects
- Thematic layers
- Environmental data

Key layers developed under the WRIS include watersheds, water systems, rivers, water bodies, urban and rural population ranges, dams, weirs, canals and command boundaries. These layers contain 5-100 years of data, depending on the theme. All unclassified data from CWC HO（Hydro-meteorological） stations and CGWB groundwater data can be downloaded from the portal free of charge. The information system has sub-information systems dedicated to various components of surface water, groundwater, hydro-meteorological observations, water quality, snow cover, inter-basin transfer links, land resources, socio-economic parameters, infrastructure and other administrative layers[10].

3.2.3 National Water Mission

The main goal of the National Water Mission is to 'conserve water, minimise wastage and ensure fairer distribution within and outside the state through integrated water resources development and management'. The five main objectives of the mission are:

（1） Comprehensive water database in the public domain and assessment of climate change impacts on water resources
（2） To promote citizen and state action to conserve, increase and preserve water

（3） To focus on vulnerable areas, including over-utilised areas
（4） To improve water use efficiency by 20%
（5） To promote integrated water resources management at basin level[11]

3.2.4 Namami Gange

The Namami Gange Programme is an integrated conservation mission to be implemented with a total budget of R200 billion as a 'flagship programme' approved by the federal government in June 2014. The programme aims to achieve effective pollution reduction, protection and rehabilitation of the national river, the Ganges. The main pillars of the programme are: improvement of sewage treatment infrastructure, riverfront development, river surface cleaning, biodiversity, afforestation, public awareness, monitoring of industrial effluents and ganga grammes. The following are the main results achieved by the programme:

(1) Creation of sewage treatment capacity

In the states of UK, Uttar Pradesh, Bihar, Jharkhand, West Bengal, Delhi, Himachal Pradesh, Haryana and Rajasthan, 48 sewage management projects are under implementation and 99 sewage projects have been completed. 27 sewage projects are out to tender and 8 new sewage projects have been initiated in these states. Work is underway to create 5658.37 (MLD) of sewage treatment capacity.

(2) Riverfront development

71 ghats/crematorium projects have been initiated for the construction, modernisation and renovation of 270 ghats (riverbanks)/crematoriums and kund (ponds)/ponds.

(3) River surface cleaning

River surface cleaning is underway to collect and dispose of suspended solid waste from ghats and river surfaces and has been introduced into service at 11 locations.

(4) Biodiversity conservation

One of the long-term visions of Ganges River restoration is to restore sustainable populations of endemic and endangered biodiversity in the Ganges, which occupy their full historical range and play a role in maintaining the integrity of the Ganges River ecosystem. In response, the Wildlife Institute of India (WII) Dehradun, Central Inland Fisheries Research Institute (CIFRI) Kolkata and the Uttar Pradesh State Forestry Department have given a project involving many stakeholders, including conservation and aquatic biodiversity restoration, to develop a science-based aquatic species recovery plan for the Ganges.

(5) Afforestation

The Forest Research Institute (FRI), Dehradun, has prepared a detailed project report (DPR) for deforestation in an area of 1,34,106 ha in the Ganges coastal states of the UK state, Uttar

Pradesh, Bihar, Jharkhand and West Bengal. The estimated cost of the project is Rs 2293.73 crore. FRI's DPR proposes to work under four main headings: natural landscape, agricultural landscape, urban landscape and conservation interventions.

(6) Public awareness

A series of events, workshops, seminars, conferences and a number of information, education and communication (IEC) activities were organised to strengthen public awareness and community participation in the programme. Various awareness-raising activities were organised, including marches, campaigns, exhibitions, shram daan (donation of labour), clean-up activities, competitions, tree-planting activities and the development and distribution of resource materials. Publicity was widely promoted through mass media, including TV/radio, print media adverts, feature stories and advertorials. The Ganges theme song was also widely publicised and played on digital media, increasing the visibility of the programme; NMCG（National Mission for Clean Ganga） had a presence on social media platforms such as Facebook, Twitter and YouTube.

(7) Monitoring of industrial effluents

As of April 2019, the number of grossly polluting industries (GPIs) was 1072. Regulation and policing is carried out through regular and unannounced inspections of GPIs to verify compliance with environmental standards; GPIs are also inspected for compliance with annual standards for pollution standards and process modifications through third-party technical laboratories as required.

(8) Ganga Gram

The Ministry of Drinking Water and Sanitation (MDWS) has identified 1674 gram panchayats on the banks of the Ganges in five states, including UK, Uttar Pradesh, Bihar, Jharkhand and West Bengal. Rs 578 million was allocated to the Ministry of Drinking Water and Sanitation (MDWS) for construction of toilets in 1674 gram panchayats in five states on the Ganges river basin.

The project aims to utilise the best available knowledge and resources worldwide in the regeneration of the Ganges River and many countries with expertise in Ganges River regeneration have always shown interest. Countries such as Australia, the UK, Germany, Finland and Israel have expressed their willingness to work with the Indian State in Ganges River Regeneration. MoUs（Memorandum of Understanding）have been signed with various central ministries (Ministry of Human Resource Development, Ministry of Rural Development, Ministry of Railways, Ministry of Shipping, Ministry of Tourism, Ministry of Ayush, Ministry of Petroleum, Ministry of Youth and Sports, Ministry of Drinking Water and Sanitation and Ministry of Agriculture) to synergise government plans[12]. The programme for each district is presented below.

Table 3-1 Programme for each district

Programme	Manager District	District/Town	Progress Status (%)
I&D Part- I Jagjeetpur, Haridwar	Haridwar	Haridwar Jagjeetpur	100
I&D Part- II Sarai, Haridwar	Haridwar	Sarai	100
Construction of 68 MLD STP for Zone-A,B,C,D&E at Jagjeetpur, Haridwar in Uttarakhand State including 15 years of O&M	Haridwar	Jagjeetpur	100
Construction of 14 MLD STP for Zone-F at Sarai, Haridwar in Uttarakhand State including 15 of years O&M	Haridwar	Sarai	100
Upgradation of 27 MLD STP in Haridwar at Jagjeetpur	Haridwar	Jagjeetpur	100
Upgradation of 18 MLD STP, Sarai	Haridwar	Sarai	100
Haridwar Arihant Vihar Sewerage Scheme	Haridwar	Arihant Vihar	100
Rudraprayag I&D with STP	Haridwar	Rudraprayag	100
Srilkot I&D with STP	Haridwar	Srilkot	100
Repair & Restoration (Protection works) in existing STPs/Sewerage network and its appurtenant works damaged during natural calamity (Cloud Burst & Glacial Breakdown) 2021 in Uttarakhand at Devprayag, Karanprayag & Chamoli-Gopeshwar under Nanami Gange Programme	Haridwar	Devprayag, Karanprayag, Chamoli	100
Detailed Project Report of pollution abatement works in Haridwar under KFW financing	Haridwar		
Supply, laying & jointing of sewer line and its appurtenant in Soniya Basti area Jwalapur for abatement of pollution in Haridwar	Haridwar	Jwalapur	
Kirtinagar I&D with STP	Srinagar	Kirtinagar	100
Srinagar I&D with STP	Srinagar	Srinagar	100
Upgradation of existing 3.50 MLD STP in Srinagar Garhwal	Srinagar	Srinagar	100
I&D and STP for Gaurikund and Tilwada, District Rudrapyag (DBOT mode) under NGP	Srinagar	Gaurikund, Tilwada	
Badrinath I&D with STP	Gopeshwar	Badrinath	100
Joshimath I&D with STP	Gopeshwar	Joshimath	100
Chamoli-Gopeshwar	Gopeshwar	Chamoli	100
Nandprayag I&D with STP	Gopeshwar	Nandprayag	100
Karanprayag I&D with STP	Gopeshwar	Karanprayag	100
Upgradation of existing 2.00 MLD STP at	Uttarkashi	Gyansu	100

Programme	Manager District	District/Town	Progress Status (%)
Uttarkashi (Gyansu)			
Upgradation of 3.5 MLD STP, Tapovan, Tehri	Rishikesh	Tapovan	100
Swargashram, Upgradation of 3 MLD STP	Rishikesh	Swargashram	100
I&D with 26 MLD STP, Rishikesh, Dehradun	Rishikesh	Rishikesh	100
I&D with STP, Muni-ki-Reti-Dhalwala, Tehri	Rishikesh	Dhalwala	
Sludge Management Plants a 5 T/Day at Chorpani		Chorpani	100
Co-treatment of septage at existing STPs of Haridwar 150 KLD, (100 KLD Jagjeetpr + 50 KLD), Sarai0 Rishikesh -50 KLD, Srinagar 30 KLD and Devprayag 5.0 KLD under NGP		Jagjeetpr, Sarai Rishikesh Srinagar Devprayag	
Interception & Diversion (I&D) and STP works for Muni Ki Reti Dhalwala (8.0+0.3 MLD STP), Neelkanth Mahadev (1.5 MLD STP), Jonk-Swargashram (3.0 MLD STP) in Uttarakhand under Nanami Gange Programme		Dhalwala, Mahadev	
Ramnanagar Interception & Diversion works with STP for Kosi river under Nanami Gange Programme		Kosi River	100
Inception & Diversion works for Rispana River & Bindal River under Nanami Gange Programme			100
I&D Work of Rispana and STP (15MLD) work at Sapera Basti, Dehradun Under Nanami Gange Programme Bindal River		Sapera Basti	
Interception & Diversion (I&D) and 6 STP works. Polluted River Stretches to Rejuvenate River Bhela, Dhela, Kichha, Kosi, Nandhore, Pilakhar and Kashipur Sewerage (I&D) Scheme (Dhela River) Phase-I of District Udham Singh Nagar, Uttarakhand		River Bhela, Dhela, Kichha, Kosi, Nandhore, Pilakhar, Kashipur	22
Household Connection of Devprayag town		Devprayag	100
Bioremedlation-Srikot and Rudraprayag Drains		Rudraprayag	100
Purchasing of land for construction of 7.50 MLD STP at Dhalwala, 5.0 MLD STP at Chorpani MPS at Dhalwala under State Sector Programme		Dhalwala, Chorpani	100
Land at Bapugram and Sarvharanagar Rishikesh		Bapugram, Sarvharanagar	100

Source: Prepared by JST

3.2.5 Swachh Bharat Mission Grameen

Swachh Bharat Mission Grameen (SBMG: Swachh Bharat Mission Grameen) is a flagship programme of the Government of India, launched on 2 October 2014. The target area is villages across the country of India. It is the largest sanitation campaign in the world, achieving the construction of more than 100 million individual household latrines in five years and increasing sanitation coverage from 39% in 2014 to 100% in 2019. By 2 October 2019, more than 600,000 villages had been declared open defecation free (ODF). The achievement of SDG 6 target 6.2 (sanitation and hygiene) 11 years earlier than the specified deadline was also achieved.

Also, as of 2022, the targeted areas in the UK state are Haridwar, Chamoli, Dehradun, Uttarakashi, Rudraprayag, Bageshwar, Pauri, Champawat, Pithoragarh, Almora, Nainital, Udham Singh Nagar, and Tehri Garhwal. 97.7% of households in the UK state have access to toilets and 94.5% own toilets[13].

After achieving ODF status, SBM-G Phase-2 will start in 2020-21 to maintain ODF status and manage solid and liquid waste to bring visual cleanliness by 2024-25. To make the village ODF plus, the following interventions will be focused on: a. ODF-plus village, which is a village with a high level of cleanliness and a high level of solid waste management.

- The Individual Household Toilets (IHHL: Individual Household Latrine) and Community Sanitary Complexes (CSC: Community Sanitary Complex)
  Construction will provide access to toilets for remaining and emerging households.
- Management of biodegradable waste through composting facilities and biogas plants
- Establishment of plastic waste collection, sorting, and storage facilities; establishment of material recovery centres for plastic waste management
- Greywater management through construction of soak pits, sewerage treatment ponds, DEWATS（Decentralized Wastewater Treatment Systems）, etc.
- Management of feed sludge through joint treatment at existing STP / feed sludge treatment plant (STP / FSTP) and installation of FSTP under the program
- Decentralized operation and maintenance of community sanitation facilities in rural areas by ULB[14]

3.2.6 Swachh Bharat Mission-Urban 2.0

Swachh Bharat Mission-Urban 2.0, launched in 2014 and starting in 2021, aims to make all cities "garbage free", ensure grey and black water management in all cities not covered by AMRUT, make all ULBs ODF+ and areas with less than 10,000 inhabitants ODF ++, the plan aims to achieve safe sanitation conditions in urban areas. This initiative will focus on source separation of solid waste, utilization of 3R principles (reduce, reuse, recycle), scientific

treatment of all types of municipal solid waste, and renovation of heritage dump sites to achieve effective solid waste management. The main features of the project are listed below:

- Ensure access to full sanitation facilities for additional populations migrating from rural to urban areas for employment and better opportunities by increasing construction of public toilets over the next five years.
- Implement complete liquid waste management in cities with a population of less than 1 lakh（100,000 INR）to ensure that all sewerage is safely collected, transported, and treated, and that there is no discharge into water bodies.
- Focus on phasing out single-use plastics by establishing material recovery and waste treatment facilities.
- Systems and processes are in place to ensure that all statutory cities are at least ODF+ (Open Defecation Free Plus) and all cities with a population of less than 1 lakh are ODF++ (Open Defecation Free Plus Plus), that all sewerage is safely treated and optimally reused, and that untreated effluent does not pollute water bodies.
- For solid waste management, all cities are expected to achieve at least 3-star trash-free certification under SBM-U 2.0.
- A particular focus is on the welfare of sanitation and informal waste workers through the provision of personal protective equipment and safety kits, links to government welfare schemes, and capacity building[15].

3.2.7 Jal Jeevan Mission

The Jal Jeevan Mission aims to provide safe and adequate drinking water through individual tap connections to every household in rural areas of India by 2024. The program will also mandate source sustainability measures such as reuse through re-filling and grey water management, water conservation, and rainwater collection.

The Jal Jeevan Mission is based on a community approach to water and includes extensive use of information, education, and communication as key elements of the mission to create a Jan Andolan (people's movement) on water, thereby making water a priority for everyone. UK Province is covered by all the provinces. The mission set forth in this plan is as follows:

- Support each state/Union Territory (UTs) in planning participatory rural water supply strategies to ensure safe drinking water supply through long-term infrastructure development. This includes supply to rural households and public facilities (village council buildings, schools, Anganwadi centres, health centres, wellness centres, etc.)
- For each state/UT, support the development of water supply infrastructure with functioning tap connections (FHTC: Functional Household Tap Connection) for all rural households by 2024 to ensure that adequate quantities of water of defined quality are provided on a regular basis.

- Assist states/UTs in planning for their own drinking water safety.
- Provide assistance to village councils (GPs) and rural communities to plan, implement, manage, own, operate, and maintain water supply systems within their villages.
- Support the development of strong institutions focused on service delivery and financial sustainability of the sector by promoting a public utility approach to each state/UTs.
- Build stakeholder capacity and raise community awareness of the importance of water for improving quality of life.
- Provide and mobilize financial support to states/UTs for mission implementation[16]

3.2.8 AMRUT 2.0

(1) Overview of AMRUT

AMRUT 2.0 is a plan aimed at providing every household with a functional faucet connection. It also aims to provide 100% sewage treatment and sewage management in the 500 cities （With a population of over 100,000） in AMRUT's target area. Providing 20% of water demand with recycled water, reducing the non-revenue water ratio below 20%, and rehabilitating water bodies are major reforms, as are reforms related to property taxes, user fees, ULB credit enhancement, and urban planning.

(2) Positioning of the UK State

In the UK state, the project areas are Dehradun, Haridwar, Roorkee, Kashipur, Rudrapur, Haldwani, and Nainital.

(3) Memorandum of Understanding (MoU)

The Provincial/Federal Direct Authorities and Urban Local Bodies (ULBs) have agreed to a tripartite Memorandum of Understanding (MoU) with the Ministry of Housing and Urban Affairs (MoHUA). This MoU represents the joint intent of the MoHUA, the State/Union Territories, and ULBs to make Urban India "water safe" through broad community involvement in protecting water sources, reclaiming water bodies and wells, recycling/reusing treated used water, and collecting storm water.

(4) City Water Balance Plans (CWBPs)

The CWBP consists of details on water sources, including water bodies, water treatment and distribution infrastructure, water supply by area, non-revenue water (NRW) status, and sewerage network including STPs (ULBs). ULBs will generate baseline data on connections between household taps and sewage and sanitary sewerage systems and investigate gaps in service provision. Based on the assessed gaps, potential projects targeting functional outcomes will be identified. The State and ULBs aim to universalize water supply to all households and sewer and sewerage connections in 500 cities in all ULBs through projects proposed in AMRUT 2.0, ongoing AMRUT projects, State and ULB funds, XV FC （Fifteenth Finance Commission） grants, external funds, PPPs, and other project initiatives The project

will City Water Action Plans (CWAPs).

The CWAP will consist of a list of projects proposed by ULBs in the priority areas of water supply, sewerage, septic tank management, and rehabilitation of water bodies, including green spaces and parks. It will also ensure that projects aimed at meeting 20% of the city's water needs through recycling and reuse of treated used water will be implemented. Projects proposed under AMRUT 2.0, and projects in progress or proposed in sources other than AMRUT 2.0 in the three sectors will be presented.

(5) City Water Action Plans (CWAPs)

The CWAP consists of a list of projects proposed by ULBs in the priority areas of water supply, sewerage, septic tank management, and rehabilitation of water bodies, including green spaces and parks. It will also ensure that projects aimed at meeting 20% of the city's water needs through recycling and reuse of treated used water will be implemented. Projects proposed under AMRUT 2.0, and projects in progress or proposed in sources other than AMRUT 2.0 in the three sectors will be presented.

(6) State Water Action Plans (SWAPs)

The SWAP is prepared by the Provincial Mission Director by aggregating the CWAPs submitted by ULBs. The SWAP contains a full list of city-specific and sector-specific projects proposed to be implemented by the province/city. The cost of projects to be implemented does not include the cost of land acquisition. The SWAP will include for each project the number of households proposed to receive new water and sewer connections and expansion of existing water and sewer connections as a result of the project. Projects to be implemented under the Public Private Partnership (PPP) method will be clearly identified. It will be ensured that projects will only be implemented if land with clear title and no disputes is available.

(7) Urban Aquifer Management Plan

The aquifer management plan will focus on maintaining a favourable groundwater balance in the urban aquifer system. Cities will develop a roadmap for improving stormwater use within the city limits and develop strategies for augmenting groundwater recharge. Cities will map aquifers with technical assistance from the Central Ground Water Board (CGWB)/State Ground Water Board/other agencies to identify recharge and discharge areas and integrate aquifer management into city planning. Cities will prepare annual groundwater balance reports to identify current and future groundwater availability.

(8) Implementation of Projects

Projects in line with the approved SWAP will be planned, tendered, awarded and implemented by ULBs. If ULBs do not have sufficient capacity, a specialized extra-judicial agency will implement the project. For efficient implementation of projects, states/cities/ULBs should

take the approach of having external agencies (PDMCs) provide end-to-end support to ULBs/states/cities on project design, development, implementation, and management. Maintenance and management of the created assets will be the responsibility of the state/UT/ULB. Smart elements will be part of the project.

(9) Monitoring of Projects

Achievement of mission goals will be monitored through an online module. This module is directly a prelude to funding. Therefore, the portal needs to be updated regularly by state, city, and ULB officials for information flow and funding authorization. Items to be updated include physical progress, financial progress, documents required to seek central assistance, photos, videos, and third-party reports. Progress reported on the portal will be randomly validated by feedback from citizens and third parties. Implementing agencies and community stakeholders will also be able to access the portal and upload progress and feedback[17].

3.2.9 UK State Roadmap 2025

With the preparation of UKPJN, the UK state has established a roadmap for (1) human resources and capacity building, (2) drinking water security, and (3) faecal sludge management by the planning year 2025. The details of the roadmap for 2025 are as follows.

Table 3-2 UK State Roadmap 2025[18]

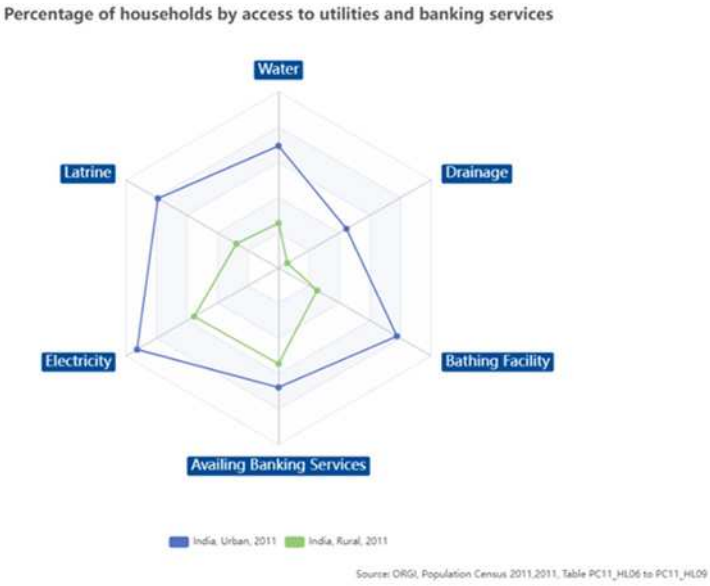
Problems/Issues	Solutions and Initiatives	Activities	Results
Human Resource and Capacity Building Requirements	Human Resource Development	Recruitment, Hiring and Retention	100% employee retention
		Training and Development	Improve employee knowledge, skills, understanding, values, attitudes, motivation, and competence
		Workplace Safety	Nurture and support employees and ensure a positive work environment
	Institutional Development	Office construction and renovation	100% usable office
		Construction/renovation of residential colony	
	Financial Resource Development	Benefits and Compensation	Salary, benefits, and compensation paid on time
		Facilities, buildings, vehicles and other expenditures	Operation on time
Provide sufficient quantities of safe portable drinking water to the state's population	Regular and long-term supply of drinking water in adequate quantity (55 LPCD), of prescribed quality, to improve the standard of living in rural areas, especially to rural women and adolescent girls, to address adverse health and other problems	Plan a participatory rural supply strategy to ensure long-term portable drinking water for each household and public facilities (medical practitioner buildings, schools, Aaganwadi centres, health centres, wellness centres, etc.)	Ease of living for rural communities, especially women. (According to the Imis Portal dated April 1, 2022, there are 1494304 households benefiting from the F.H.T.C.)
	Construct/reinforce/expand the town's water supply system/infrastructure as per the requirements of 102 cities	Planning and construction of drinking water supply schemes in cities	Metered supply of 135 LPCD (per person per day) of safe drinking water
	Provide 100 to 135 LPCD of safe drinking water to villages near cities to make life as easy as in the city	Plan to ensure a safe and portable water supply in urban areas at a rate of 100-135 LPCD per minute	Provides safe portable water to 87,757 households in 22 suburban areas for 16 hours at 12 meters of pressure
Faecal sludge management	Urban population coverage of communal treatment facilities/sewage treatment facilities	Planning and construction of joint treatment facilities for existing STDs (STPs) and construction of FSTPs (faecal sludge treatment plants) in locations where no STPs exist	Installation of sewage treatment facilities in all urban areas of the state

Source: *UKPJN Roadmap 2025*

3.3 Overview of the Water and Sewerage Sector in the Target Countries

3.3.1 Overview of Water and Sewerage Facilities Development

Figure 3-1 shows that access to water in urban areas in India is 69%, access to toilet facilities is 79%, access to drainage facilities is 45%, and access to bathing facilities is 78%. In rural areas, access to water is 26%, access to toilet facilities is 28%, access to drainage facilities is 6%, and access to bathing facilities is 25%. Comparing the figures for urban and rural areas, one can see that the rural figures are extremely small and the disparities are large. In addition, both urban and rural areas have poor access to sewage facilities.



Source: *Census India 2011*

Figure 3-1 Infrastructure penetration in India including water supply and sewage facilities (2011)

3.3.2 Organizational Structure in the Water Supply and Sewerage Sector

(1) Related Organizations in the Water Supply and Sewerage Sector in India

The Table 3-3 shows the related organizations for the water supply and sewerage sector in India. The roles and responsibilities of each organization are defined by the legal framework.

Table 3-3 Related Organizations in the Water Supply and Sewerage Sector

No	Affiliation	Organization	Abbreviation
1	Central Government	Ministry of Drinking Water and Sanitation	MDWS
2		Ministry of Housing and Urban Poverty Alleviation	MoHUPA
3		Ministry of Urban Development	MoUD
4	UK State Government	Department of Drinking Water	DDW （Department of Drinking Water & Sanitation）
5	Local Government	Urban Local Bodies	ULBs

Source: The JST

At the central government level, the “Ministry of Drinking Water and Sanitation” is responsible for the operation, planning, and financing of the water supply and sewerage services in rural areas, while the “Ministry of Housing and Urban Poverty Alleviation” and the “Ministry of Urban Development” are responsible for the water supply and sewerage services in urban areas. However, except for the Delhi Capital Territory and other Union Territories, central ministries are limited to advisory and funding roles for water supply and sewage projects, and policy-making power in this sector is entrusted to the UK state government.

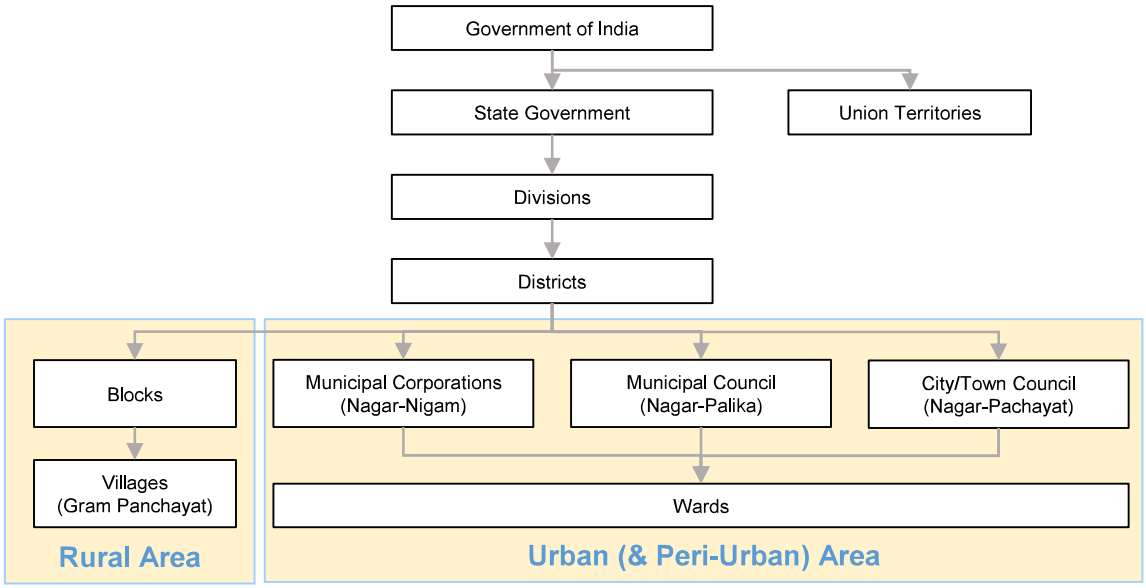
Decentralization has been promoted in the water supply and sewerage sectors in India, but the powers entrusted to the related departments and organizations at the state government level vary from each state or Union Territory. The following are listed four cases of role-sharing in water supply and sewerage projects. In the UK state, case ② is applicable.

① Departments or affiliated organizations of the state government are in charge of planning, funding, construction of facilities, licensing and financial management, while Urban Local Bodies (hereinafter referred to as "ULBs") are in charge of operation and maintenance of the constructed facilities.
② The Infrastructure Development Agency of the state government is in charge of planning, funding, and maintenance of water supply and sewerage facilities, while the departments in the state government are in charge of the operation and maintenance of the constructed facilities.
③ Departments in the state government are responsible for the development of infrastructure and its operation and maintenance.
④ Municipal Corporation, having sufficient financial resources and capacity, shall be in charge of infrastructure development and operation and maintenance.

(2) Local Administration

The structure of local administration in India is shown in Figure 3-2.

In urban areas, ULBs are classified into three categories according to population size in order to provide administrative services. On the other hand, in rural areas, the Village Council (Gram Panchayat) is the smallest unit of local government. Higher administrative bodies above those ULBs, District Administration Offices (District Magistrates), supervise and support local administration in their jurisdictional areas.



Source: Prepared by the JST based on interviews

Figure 3-2 Administrative Structure in India

3.4 Overview of the Water and Sewerage Sector in the UK State

3.4.1 Overview of Water and Sewerage Facilities Development

Figure 3-3 shows that access to water in urban areas in UK state is 76%, access to toilet facilities is 92%, access to sewage facilities is 42%, and access to bathing facilities is 88%. In rural areas, access to water is 51%, access to toilet facilities is 53%, access to sewage facilities is 9%, and access to bathing facilities is 49%. Compared to India as a whole in Figure 3-1, access is good, especially access to toilet facilities, which is over 90% and usable by the majority of people. However, access to sewage facilities is poor in both urban and rural areas, comparable to the figures for the country as a whole.

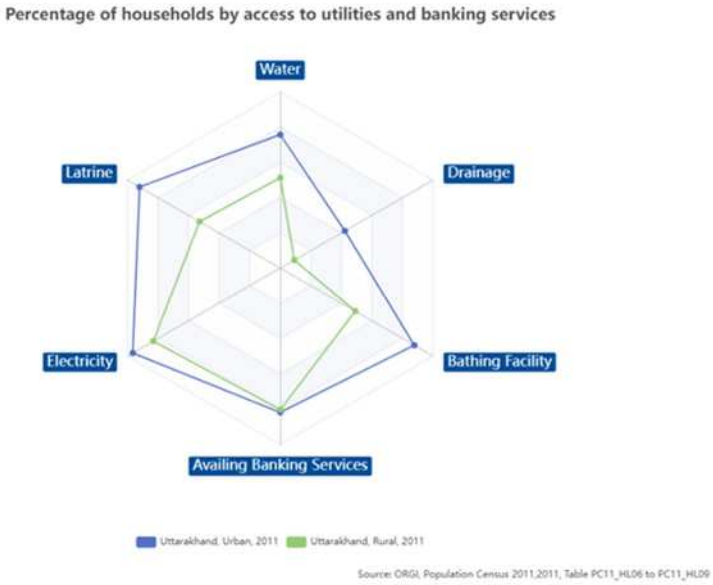


Figure 3-3 Infrastructure penetration in UK states, including water and sewerage facilities (2011)

Source: Census India 2011

【Reference】

The following figure is from a newspaper article about a stalled drinking water project in Mussoorie, a city located about 40 km north of Dehradun. Mussoorie has a 144-million-rupee Yamuna Mussoorie drinking water project that has stalled due to lack of electricity supply. Although construction is complete, the project is expected to supply only about 2 million litres of water per day for several months.

Currently, the town receives only 8 to 10 hours of electricity supply per day, and this is due to frequent breakdowns. The town's water demand is 12.62 MLD during peak hours, but residents are only receiving 2-3 MLD of water supply per day, which is not enough to meet the town's demand. Note that a substation will be installed in the village by September for

this project. Thus, in some cases in the UK state, although water facilities have been built, proper infrastructure systems have not been established due to lack of electricity supply.



No end to Mussoorie water crisis as ₹144 cr project remains incomplete

'Lack Of Power Supply' Reason Behind Delay

Anmol Jain | TNN

Mussoorie: The Queen of Hills continues to grapple with severe water scarcity, particularly during the summer months. Hopes were high among residents that the Yamuna-Mussoorie drinking water project, costing Rs 144 crore, would alleviate the water woes. However, the project remains stalled, ostensibly due to a "lack of power supply".

Sandeep Kashyap, the executive engineer of Peyjal Nigam (the implementing agency), said that while the civil works have been completed, the department can only supply around "2 million litres per day (MLD) of water in the coming months due to power shortages".

Praveen Rai, the superintendent engineer of Peyjal Nigam, expressed concerns over the limited power supply. "We currently receive power supply for only 8 to 10 hours a day, and there are frequent breakdowns. This will prevent us from providing an adequate water supply to Mussoorie," he said. Residents are disappointed as the department had promised a supply of up to 6 MLD of water per day, making the current allocation of 2 to 3 MLD per day woefully insufficient to meet the town's demand.

"After waiting eagerly for three years, they now claim they don't have sufficient power. This shows poor planning and a lack of consideration for our town and its residents," said Nidhi Bahuguna, a resident.

However, Shailendra Singh, superintending engineer of the power department in Tehri district, dismissed claims of power shortages affecting the water project.

Residents are disappointed as the department had promised a supply of up to 6 MLD of water, making the current allocation of 2 to 3 MLD insufficient to meet town's demand

"While there were some breakdowns in May due to bad weather, we are currently providing power supply for 15 to 20 hours per day. Additionally, we're establishing a substation at Khyarsi village for this project, which will be completed by September"

SHAILENDRA SINGH, superintending engineer, Tehri power department

While there were some breakdowns in May due to bad weather, we are currently providing power supply for 15 to 20 hours per day. Additionally, we are establishing a substation at Khyarsi village for this project, which will be completed by September," Singh said.

Currently, the town receives 7.5 MLD of water, while the peak season demand is 12.2 MLD, leaving a shortfall of nearly 5 MLD. Mussoorie's total population, including the floating population, is estimated to be slightly over 93,500, according to government data.

Source: *The Times of India, New Delhi / Dehradun* 30 May 2023[19]

Figure 3-4 Electricity shortages in Mussoorie drinking water project

3.4.2 Related Organizational Structure in the UK State

Water supply and sewage services for urban and rural areas in the UK state are supervised and administered by the Department of Drinking Water (hereinafter referred to as "DDW") in the UK state government, under which UKPJN and UJS function as executing bodies.

The 11 District Administration Offices (District Magistrates) in the UK state allocate subsidies to the Divisional Offices of UKJPN and UJS in accordance with the District Plan, but such ULBs as Municipal Council (Nagar Parika) and Town Board (Nagar Panchayat) are not involved in water supply and sewerage services. Note that there is no Municipal Corporation in the UK state.

On the other hand, for the operation and maintenance of facilities constructed under the "Single Village Scheme" in rural areas, the State Water and Sanitation Mission (hereinafter referred to as "SWSM") and District Water and Sanitation Mission (hereinafter referred to as "DWSM") are formed as supervisory body under the Swajal Project by the World Bank, and the Village Council (Gram Panchayat) is in charge of the operation and maintenance of the facilities.

The following figure shows the correlation between the major organizations involved in the water supply and sewerage services in the UK state.



Source: Prepared by the JST based on interviews

Figure 3-5 Major Organizations related to Water Supply and Sewerage Services in the UK State

(1) Uttarakhand Peyjal Sansadhan Vikas Evam Nirman Nigam

Uttarakhand Peyjal Sansadhan Vikas Evam Nirman Nigam (hereinafter referred to as "UKPJN") revenues from the centage charge on development projects and subsidies, and is accountably and financially separate from the state government as a Public Sector Undertaking (hereinafter referred to as a "PSU"). And it is responsible for the planning, design, supervision, and construction of water supply facilities in urban and rural areas and sewerage facilities in urban areas. In addition, there is a department for design and construction supervision for the buildings undertaken by other government ministries and agencies.

The functions of UKPJN, as described in the "Water Supply and Sewerage Act of 1975", are as follows.

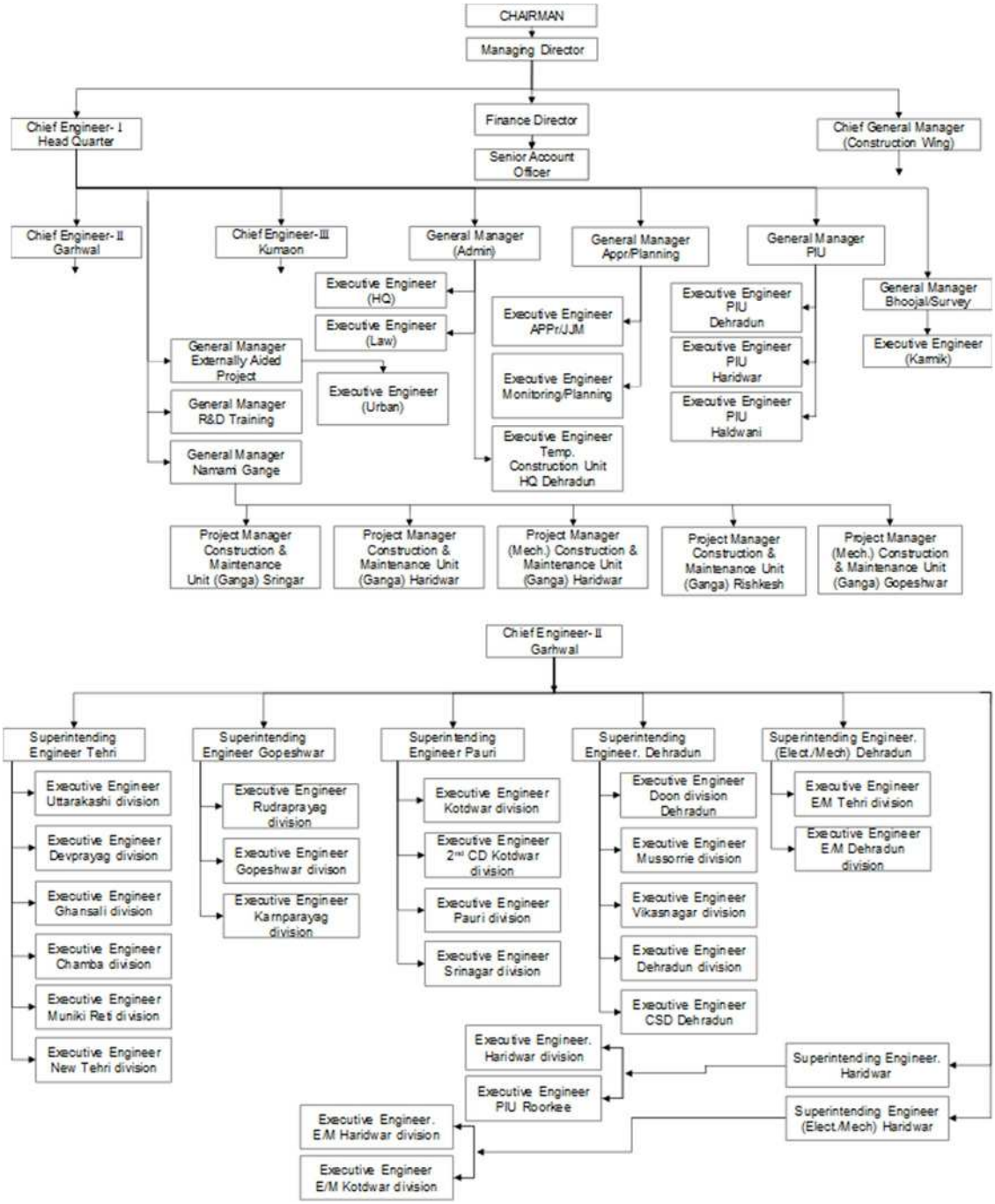
Table 3-4 Functions of UKPJN

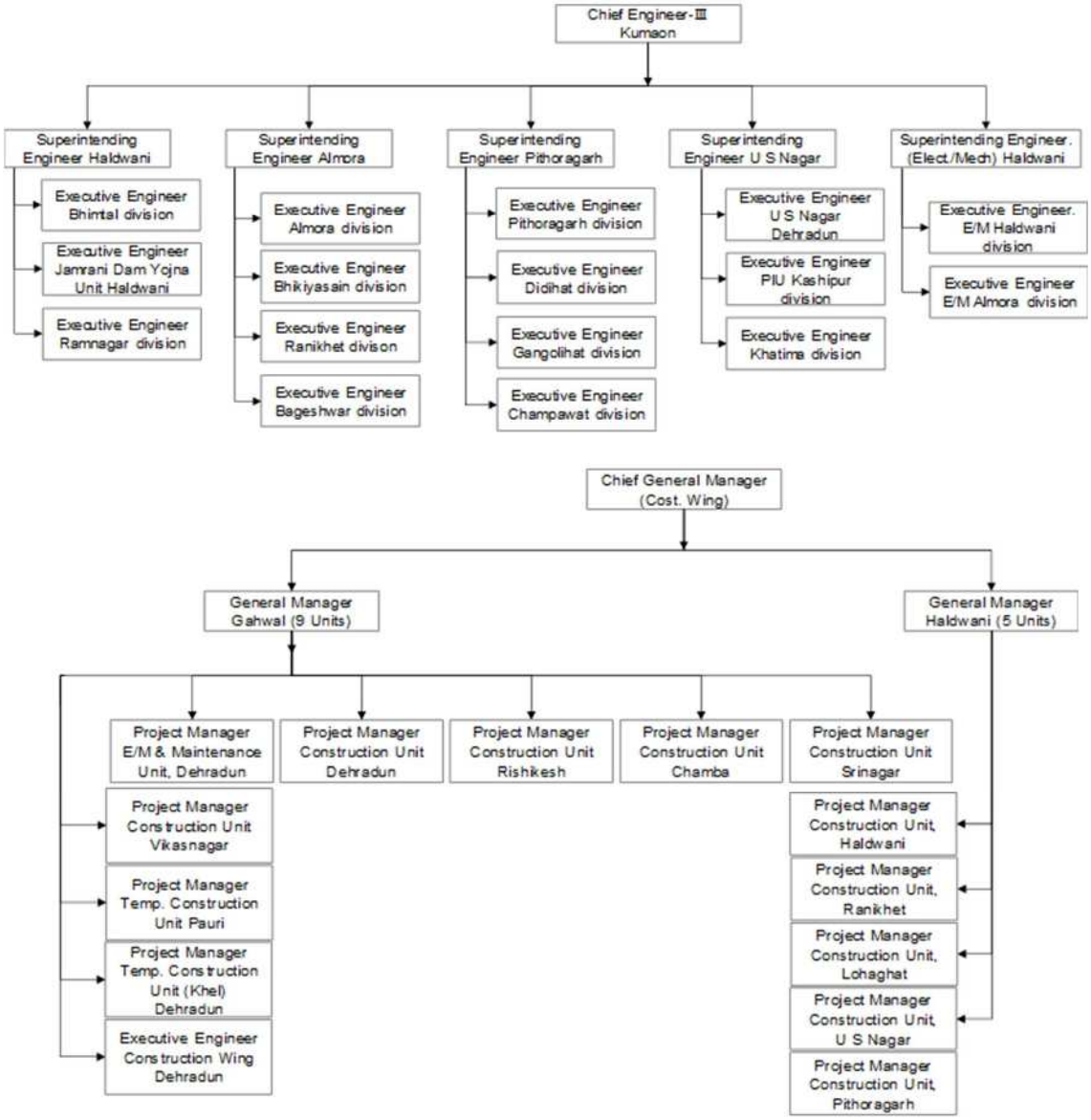
i. To prepare, execute, promote and finance the schemes for the supply of water and for sewerage and sewage disposal.
ii. To render all necessary services in regard to water supply and sewerage to the state government and local bodies, on request to private institutions or individuals.
iii. To prepare State plans for water supply, sewerage and drainage in the direction of the state government.
iv. To review and advise on the tariffs, taxes and charges of water supply.
v. To assess the requirement for materials and arrange for their procurement and utilization.

vi. To establish State standards for water supply and sewerage services.
vii. To review annually the technical, financial, economic and other aspects of water supply and sewerage system.
viii. To establish and maintain a facility to review and appraise the technical, financial, economic and other pertinent aspects of every water supply and sewerage scheme in the State.
ix. To operate, run and maintain any waterworks and sewerage system, if and when directed by the state government, on such terms and conditions and for such periods as may be specified by the state government.
x. To assess the requirements for manpower and training in relation to water supply and sewerage services in the State.
xi. To carry out applied research for efficient discharge of the functions.

Source: Excerpt from Water Supply and Sewerage Act 1975

As of June 2023, UKPJN has a total of 1,395 staff, of which 575 are technical staff, 300 are administrative staff, and 520 are field staff. The following figure shows an organizational chart for UKPJN. The organization is controlled by a Board of Directors chaired by the Secretary of DDW, and is headed by a Managing Director.


CHAIRMAN
Managing Director
Chief Engineer- I Head Quarter
Finance Director
Senior Account Officer
Chief General Manager (Construction Wing)
Chief Engineer- II Garhwal
Chief Engineer- III Kumaon
General Manager (Admin)
General Manager Appr/Planning
General Manager PIU
General Manager Bhoojal/Survey
Executive Engineer (HQ)
Executive Engineer (Law)
Executive Engineer (Urban)
Executive Engineer APPr/JJM
Executive Engineer Monitoring/Planning
Executive Engineer Temp. Construction Unit HQ Dehradun
Executive Engineer PIU Dehradun
Executive Engineer PIU Haridwar
Executive Engineer PIU Haldwani
Executive Engineer (Kamik)
General Manager Externally Aided Project
General Manager R&D Training
General Manager Namami Gange
Project Manager Construction & Maintenance Unit (Ganga) Sringar
Project Manager Construction & Maintenance Unit (Ganga) Haridwar
Project Manager (Mech.) Construction & Maintenance Unit (Ganga) Haridwar
Project Manager Construction & Maintenance Unit (Ganga) Rishkesh
Project Manager (Mech.) Construction & Maintenance Unit (Ganga) Gopeshwar
Chief Engineer- II Garhwal
Superintending Engineer Tehri
Executive Engineer Uttarakashi division
Executive Engineer Devprayag division
Executive Engineer Ghansali division
Executive Engineer Chamba division
Executive Engineer Muniki Reti division
Executive Engineer New Tehri division
Superintending Engineer Gopeshwar
Executive Engineer Rudraprayag division
Executive Engineer Gopeshwar divison
Executive Engineer Karnparayag division
Superintending Engineer Pauri
Executive Engineer Kotdwar division
Executive Engineer 2nd CD Kotdwar division
Executive Engineer Pauri division
Executive Engineer Srinagar division
Superintending Engineer. Dehradun
Executive Engineer Doon division Dehradun
Executive Engineer Mussorrie division
Executive Engineer Vikasnagar division
Executive Engineer Dehradun division
Executive Engineer CSD Dehradun
Superintending Engineer. (Elect./Mech) Dehradun
Executive Engineer E/M Tehri division
Executive Engineer E/M Dehradun division
Executive Engineer. Haridwar division
Executive Engineer PIU Roorkee
Executive Engineer. E/M Haridwar division
Executive Engineer E/M Kotdwar division
Superintending Engineer. Haridwar
Superintending Engineer (Elect./Mech) Haridwar



Source: Prepared by the JST based on UKPJN Organogram

Figure 3-6 Organizational Chart for UKPJN

(2) Uttarakhand Jal Sansthan

The Uttarakhand Jal Sansthan (hereinafter referred to as "UJS") is an autonomous body under the DDW, but has been entrusted with accounting and financial independence whose operating revenue is derived from water and sewerage tariffs. In addition, the role of UJS is to operate and maintain the water supply and sewage facilities handed over by UKPJN. The operation and maintenance is performed either by UJS itself or by subcontracting to private companies.

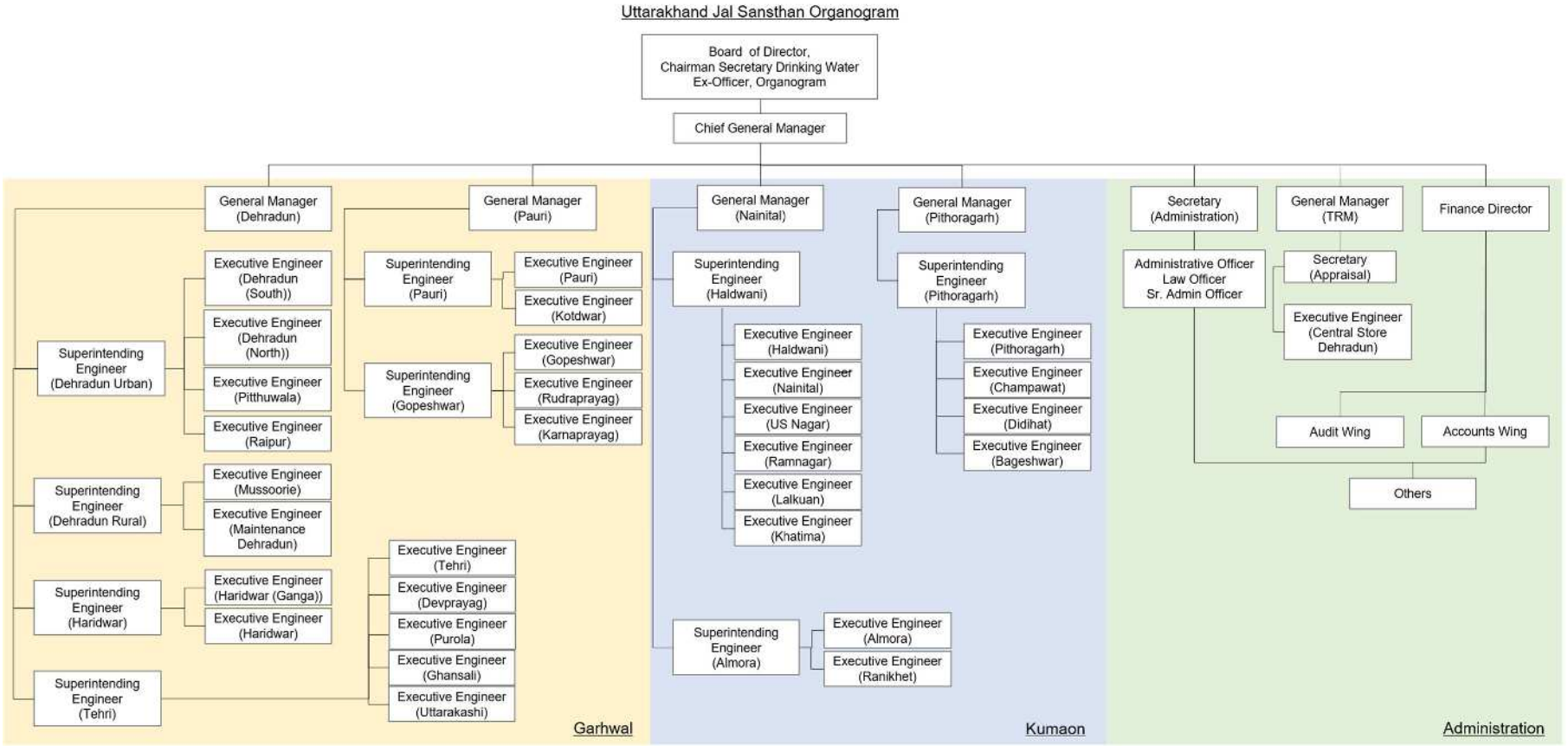
The functions of UJS, as described in the "Water Supply and Sewerage Act of 1975", are as follows.

Table 3-5 Functions of UJS

i. To plan, promote and execute schemes of and operate an efficient system of water supply.
ii. Where feasible, to plan, promote and execute schemes of, and operate, sewerage, sewage treatment and disposal and treatment of trade effluents.
iii. To manage all its affairs so as to provide the people of the area within its jurisdiction with wholesome water and where feasible, efficient sewerage service.
iv. To take such other measures, as may be necessary, to ensure water supply in times of any emergency.

Source: Excerpt from Water Supply and Sewerage Act 1975

As of June 2023, UJS had a total of 2,209 employees, including 8 managerial staff, 287 technical staff, 529 administrative staff, and 1,385 field staff. The following figure shows an organizational chart for UJS. The organization is controlled by a Board of Directors chaired by the Secretary of DDW, and is headed by a Chief General Manager.



Source: Prepared by the JST based on UJS Organogram

Figure 3-7 Organizational Chart for UJS

3.4.3 Monitoring Structure

In the execution phase of the water supply and sewerage projects, the project monitoring structure is established in collaboration with the UK state government, UKPJN headquarters, and UKPJN divisional office level. The monitoring structure shown in Figure 3-8 shall also be considered for JICA loan projects in the execution phase.

The PMU, PMC, and PIU shall complete their roles and be disbanded at the end of the construction supervision period.

1.	Project Management Unit (PMU)	Decision-making functions at the UK state government level
	↓↑	
2.	Project Monitoring Committee (PMC)	Monitoring functions managed by UKPJN headquarters
	↓↑	
3.	Project Implementation Unit (PIU)	Execution, procurement, supervision and reporting functions in UKPJN Divisional Office

Source: The JST

Figure 3-8 Monitoring Structure of Water and Sewerage Projects Execution Phase

i. PMU

The PMU shall be structured under the DDW of the UK state and be represented by the Project Director selected from the state administrative officers. Generally, the unit meetings are held once a month.

Table 3-6 Outline of PMU Members

Members	Personnel in Charge	Job Description
Project Director	Officials assigned by the UK State	Head of overall project management
Director of Finance	Officials assigned by the UK State	Head of financial matters
Accountant	Staff assigned by a department under the UK State or by outsourcing	Preparation of invoices related to the project and documents required for their processing
Technical Experts	Staff dispatched from DWS-affiliated organizations	Advising on technical issues and assisting the project director
Procurement Expert	To be subcontracted	Head of procurement matters
Administrative Manager	To be subcontracted	Assistance in preparing documents and letters related to the project

ii. PMC

The PMC shall be headed by the Managing Director of UKPJN, and composed of the Chief Engineer, General Manager, etc. The PMC is in charge of choosing projects to be implemented, but since the final approval authority is the competent authority (i.e., the Secretary of the DDW), the decision could be overturned by the PMU. However, the PMC shall not be established in this project.

Table 3-7 Outline of PMC Members

Members	Personnel in Charge	Job Description
Managing Director	Managing Director of UKPJN	Responsible for technical and financial review of project planning, execution, and financing.
Chief Engineer	Chief Engineer of Civil Engineering Department	Supervises employees within jurisdiction area to ensure smooth facility design and construction management. Responsible for the development of the annual project budget.
Director/Chief Engineer	Except Chief Engineer of Civil Engineering Department	Responsible for the supervision of construction progress and expenditures incurred on the project.

iii. PIU

The PIU shall be structured in units of UKPJN Divisional Offices and shall be headed by an Executive Engineer. Unit members shall include Assistant Engineers, Junior Engineers, Accountants and other divisional office staff. The PIU holds discussions with the contractor, Public Works Department, Uttarakhand Power Corporation Limited, and other stakeholders as necessary. In addition, depending on site conditions, preparation of bid documents and tender support for consultant and contractor procurement shall be undertaken by the PIU.

Table 3-8 Outline of PIU Members

Members	Personnel in Charge	Job Description
Executive Engineer	Head of the district office	Responsible for project quality assurance, overall project expenses and construction process supervision.
Assistant Engineer	Assistant Engineer in the district office	Responsible for ensuring the construction work is executed in accordance with the approved cost estimates and design drawings, as well as conducting periodic inspections.
Junior Engineer	Junior Engineer in the district office	Responsible for the safety management of the construction site. Responsible for procurement of equipment and materials related to the project.

Accountant	Accountant in the district office	Responsible for the preparation of monthly accounting reports for each project. Responsible for project accounting/reimbursement of expenses.
Administrative Staff (1-2 staff members)	UKPJN internal staff or outsourced	Data input and administrative assistance.

3.5 Aid Trends for the UK State

3.5.1 Japan's Aid Trends and Previous Surveys

Japan has provided assistance in the UK state as shown in Table 3-9. Japan has provided assistance in disaster management, agricultural development, and forest resource management, and this is the first time for Japan to provide assistance in the water supply and sewerage sectors.

Table 3-9 Japan's aid trends

Business Form	Project Title	Implementation Period	Task Overview
Technical Cooperation Project	UK State Mountains Disaster Preparedness Project	March 2017 ～ March 2022	Reinforcement of the mountain disaster countermeasures implementation system through technical support for slope countermeasures and development of technical guidelines
Loan Assistance	UK State Integrated Horticultural Agriculture Development Project	March 2022 ～ Ongoing	Support for production of horticultural crops, supply chain development, and strengthening of the organizational structure of the UK state government in the four target prefectures of the project.
Loan Assistance	UK State Forest Resource Management Project	April 2014 ～ March 2022	Forest environment restoration activities (afforestation, wildlife protection and biodiversity conservation activities, etc.) and disaster prevention and countermeasure activities (mountain control projects, forest road restoration, evacuation facility improvement, etc.)

Source: Prepared by JST

3.5.2 Trends in Other Donors' Aid to the Water and Sewerage Sector

(1) Survey Summary

We conducted a survey on the status of assistance in water and sewerage projects of other donors. The survey covered WB, ADB, and KfW, and interviews were conducted with ADB and KfW.

The survey items on the questionnaire are listed below.

1. Overview of past and ongoing projects
    - Overview of past and ongoing projects

- Problems in project implementation

2. Projects in planning

- Summary of planned projects

(2) Results of the survey

(a) ADB

・Projects in planning

A summary of the projects currently underway is provided below Table 3-10. We have confirmed that there are no projects in the area that overlap with the area covered by this work.

Table 3-10 ADB project details

Item	Contents
Project name	Uttarakhand Integrated and Resilient Urban Development Project (UIRUDP)
Project implementing agency	Uttarakhand Urban Sector Development Agency (UUSDA)（Under the purview of the Department of Urban Development）
Project period	March 2023～June 2029
Purpose of the Project	The objective is to strengthen access to high quality and resilient water supply services in two areas, Dehradun and Nainital; in Dehradun, to improve access to high quality and resilient water supply and sanitation services; and in Nainital, to ensure sustainable sanitation services. Nainital aims to ensure sustainable sanitation services. The project format is a DBO approach, covering from design and construction to operation and maintenance.
Project Summary	（1） Water supply facilities development a） Maintenance of 136 km of water pipelines b） Installation of 5,400 water meters
	（2） Sewerage Facility Improvement a） Construction of STPs (17,000 ㎥/day and 12,000 m^3/day treatment plants (total 29,000 m^3/day) b） Maintenance of 256 km of sewer pipes c） Maintenance of 117 km of storm drainage pipes
	（3） Operation and Maintenance a) Building an information and communication technology (ICT)-based platform using SCADA（Supervisory Control And Data Acquisition）, GIS, etc. b） Recording of operating conditions c） Planning and implementation of preventive maintenance plans d） Establishment of consumer data management system

Item	Contents
	(4) Strengthening institutional capacity and knowledge a) O&M Manual Preparation b) Implement behaviour change programs to raise community awareness of water conservation, sanitation, hygiene practices, and creating a safe, clean, and healthy community environment c) Restructuring of water rates d) Strengthen the institutional capacity of UUSDA, UKPJN, UJS and Project ULB on sustainable urban infrastructure and services
Problems in project implementation	(1) Construction may be temporarily suspended due to climate change or natural disasters. (2) In the UK state, there are vast forested areas, making it difficult to secure land from the standpoint of environmental protection. Furthermore, illegal construction by illegal immigrants frequently occurs in urban areas, making it difficult to secure sites even in urban areas.

Source: Prepared by JST from Hearing

・Summary of planned projects

In Dehradun and Nainital, the number of immigrants is increasing, and the current water and sewage systems are not able to cover all residents. Therefore, plans are being made to build water and sewage facilities in areas that are not being supplied due to population growth.

(b) KfW

The following is a summary of the projects currently underway, including Shivalik Nagar in Haridwar as a target area, but confirming that none of the projects overlap with DPR's work.

Table 3-11 KfW project details (1)

Item	Contents
Project name	Environmentally friendly Urban Development in Ganga States
Project implementing agency	Uttarakhand Urban Sector Development Agency (UUSDA)
Project period	2019～June 2016 (planned)
Purpose of the Project	Two areas, Haridwar and Rishikesh, are already served by sewers, but due to population growth, they do not cover the entire town. Therefore, the project aims to extend the sewerage network to the entire town. The project form is DBO, but for some parts, such as the lending of equipment to residents, the project form is the normal method.

Item	Contents
Project Summary	(1) Rehabilitation and expansion of sewer network (360 km) (2) Rehabilitation of existing STPs (3) Construction of sewage pumping stations and small-scale sewage treatment facilities (4) Provide training on facility operation and maintenance techniques
Problems in project implementation	(1) Land was difficult to secure. The area is restricted when trying to secure land in an area where sufficient site can be secured and close to urban areas. In addition, it takes time to acquire land in forested areas from the perspective of environmental preservation. These land constraints caused some delays in the project. (2) Religious events will cause congestion on the roads, which will affect the construction progress. Therefore, it is important to organize events that are known in advance and include the information in the construction process.

Source: Prepared by JST from Hearing

Table 3-12 KfW project details（2）

Item	Contents
Project name	Rishikesh Integrated Urban Infrastructure Development (IUID) Program
Project implementing agency	Uttarakhand Urban Sector Development Agency (UUSDA)
Project period	From 2022 (planned)
Purpose of the Project	The project aims to improve the living conditions of residents and tourists in Rishikesh and surrounding areas, contribute to the sustainable and climate-adaptive development of the region, provide 24-hour water supply for the entire target area, and make the city more resilient to disasters.
Project Summary	(1) Development of water supply and sewage network (2) Flood and sediment control measures (3) Road maintenance, etc. to relieve urban congestion

Source: Prepared by JST from Hearing

・Summary of planned projects

The "Rishikesh Integrated Urban Infrastructure Development (IUID) Program" mentioned above has just started, but there are no other projects in the pipeline other than this project.

(c) WB

The following is a summary of the projects currently underway, confirming that none of the projects overlap with those of the DPR.

Table 3-13 WB project details（1）

Item	Contents
Project name	Gaujajali Uttar Cluster Water Supply Scheme
Project period	5 years (planned); Start year unknown
Purpose of the Project	The objective is to provide improved quality water supply to Gaujajali Uttar Peri Urban and adjacent areas of Gaujajali Bichli by constructing water supply facilities for Ninital (Block Haldwani and Tehsil Haldwani).
Project Summary	(1) Installation of two new water intake wells (1,300 lpm each) (2) Installation of 2,405 m (ϕ 150) and 1,657 m (ϕ 125) of water pipelines (3) Construction of a new 1,300 m^3 elevated water tank (4) Installation of 29,181 m of new distribution pipes (φ75-400) (5) Construction of 2 new pumping stations (6) Installation of x2,192 flow meters

Source: Prepared by JST from DPR

Table 3-14 WB project details（2）

Item	Contents
Project name	Uttarakhand Water Supply Program for Peri Urban Areas
Project period	January 2018～December 2023 (planned)
Purpose of the Project	The goal is to improve access to improved water supply services in peri-urban areas of the UK state. The urban water supply envisages that all households will be supplied with treated and pressurized water by 2030, and at least 60% will be connected to a meter.
Project Summary	(1) Urban water supply (2) Urban sanitation (3) Rural water supply (4) Rural Sanitation (5) Peri-urban water supply (6) Peri-urban sanitation The project is divided into the following 22 schemes

1	Bahadrabad water supply scheme
2	BANDIYA WATER SUPPLY
3	BHANGEDI MAHABATPUR WATER SUPPLY SCHEME
4	DHALWALA (CENSUS TOWN) WATER SUPPLY SCHEME
5	Dhandera water supply scheme
6	Gaujajali Uttar Cluster Water Supply Scheme
7	GUMANIWALA
8	HALDWANI TALLI WATER SUPPLY SCHEME
9	Jagjeetpur Water Supply Scheme
10	JEEVANGARH
11	KHARAKMAF
12	KUSUMKHERA WATER SUPPLY SCHEME
13	Maholiya Water Supply Scheme
14	MEHUWALA CLUSTER WATER SUPPLY SCHEME
15	MOHANPURA MOHAMMADPUR WATER SUPPLY SCHEME
16	NAGLA IMARTI WATER SUPPLY SCHEME
17	Nathanpur Peri-Urban Area water supply scheme
18	NATHUAWALA
19	PRATIT NAGAR
20	RISHIKESH DEHAT
21	SAIDPURA WATER SUPPLY SCHEME
22	Umru khurd Water Supply Scheme

※Problems in project implementation and projects to be implemented are unknown.

Source: Prepared by JST from DPR

3.5.3 Findings from Previous Projects of Other Aid Agencies

Findings from interviews with ADB and KfW personnel are presented below.

- Many of the projects of other donor agencies are DBO projects, and many of them have long project periods of up to 18 years.
- Many of the projects are located in urban areas with high benefit effects.
- In many cases, securing a site is a key issue in project implementation.
- Since it is not possible to set a standard for the scope of a project, it is determined according to the situation at that time. In setting the size of the project, it is important to check with UKPJN on past bids, etc., and to conduct a survey of trends not only in the UK state but also in the country as a whole.
- In many cases, ADB projects employ local India firms, while KfW projects employ international firms. The corporate structure employed by different aid agencies varies.
- Loan payments are made by the central government, so loan repayments are unlikely to be missed.

3.6 Impact and Efforts under a COVID-19 Pandemic

The impact of the COVID-19 pandemic on water supply and sewerage services was particularly significant in terms of operation and maintenance managed by UJS, with stagnation of financial activities and temporary closure of the revenue collection centre. Under these conditions, both UKPJN and UJS continued to operate the water and sewage services, utilizing digital tools and improved personnel allocation.

Based on the financial statements, tariff collection rate, and the interviews, it indicates that the negative financial impact of both UKPJN and UJS was limited. In UKPJN, the operational grant from the UK state is slightly increased in FY2020.

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Chapter 4 Current Status and Issues in the Water Supply Sector

4.1 Status of Water Supply Facilities

Table 4-1 shows the status of water supply in each region. All regions in the DPR have a planned water supply of 135 LPCD, but most regions do not even reach 100 LPCD at present.

Table 4-1 Status of water supply in each town

Town	Present Population	Current Rate of W/S (L/D)	Current Rate of total W/S (LPCD)
Berinag	9,475	265,300	49
Gangolihat	8,819	485,045	49
Bageshwar	11,258	1,114,542	99
Almora	42,315	2,708,160	64
Bhikiyasain	5,667	198,345	35
Ranikhet	22,129	1,305,611	49
Dwarahat	3,409	221,585	70
Gairsain	10,745	290,115	27
Tharali	5,558	233,436	42
Nandprayag	2,035	274,725	135
Joshimath	20,719	1,864,710	90
Pipalkoti	4,366	174,640	40
Gopeshwar	26,594	3,084,904	116
Barkot	8,333	441,649	53
Chiniyali saur	10,967	636,086	58
Purola	9,834	639,210	65
Naugaon	6,416	153,984	24
Chamiyala	6,579	388,161	59
Chamba	9,636	597,432	62
Ghansali	9,641	655,588	45
Lambgaon	2,889	104,004	40
Kirtinagar	1,881	148,599	30
New Tehri	29,777	3,156,362	20
Tilwara	3,596	61,132	17
Rudraprayag	11,548	1,131,704	98
Ukhimath	3,868	313,308	81
Augustmuni	9,135	648,585	71
Lohaghat	9,828	540,540	55
Bhawali	7,823	696,247	89
Bhimtaal	9,575	1,292,625	135
Kaladhungi	9,438	717,288	76
Jaspur	69,633	4,177,980	60
Piran Kaliyar	23,809	999,978	79.2
Shivalik Nagar	39,680	1,745,920	44
Bhagwanpur	21,302	1,235,516	58
Lakshar	31,935	3,225,435	101
Landhora	22,779	3,075,165	135
Jhabreda	13,871	1,872,585	135

※Areas achieving 135 MLD are shown in red and areas below 100 MLD are shown in blue

Source: Prepared by JST

4.2 Status of Existing Water Sources

4.2.1 Water Source Forms in Different Regions

Water Source Forms in Each Region Table 4-2 shows the status of water source utilization in the study area. Haridwar, Udham Aingh Nagar, and Naintal are plains areas, where groundwater can be easily accessed due to the lack of elevation differences within the area. Most of the surface water source use areas are in mountainous regions, and in many places, Gravity is used to take advantage of the difference in elevation.

Table 4-2 Water source use in the area covered in this study
(Left: groundwater; Right: surface water)

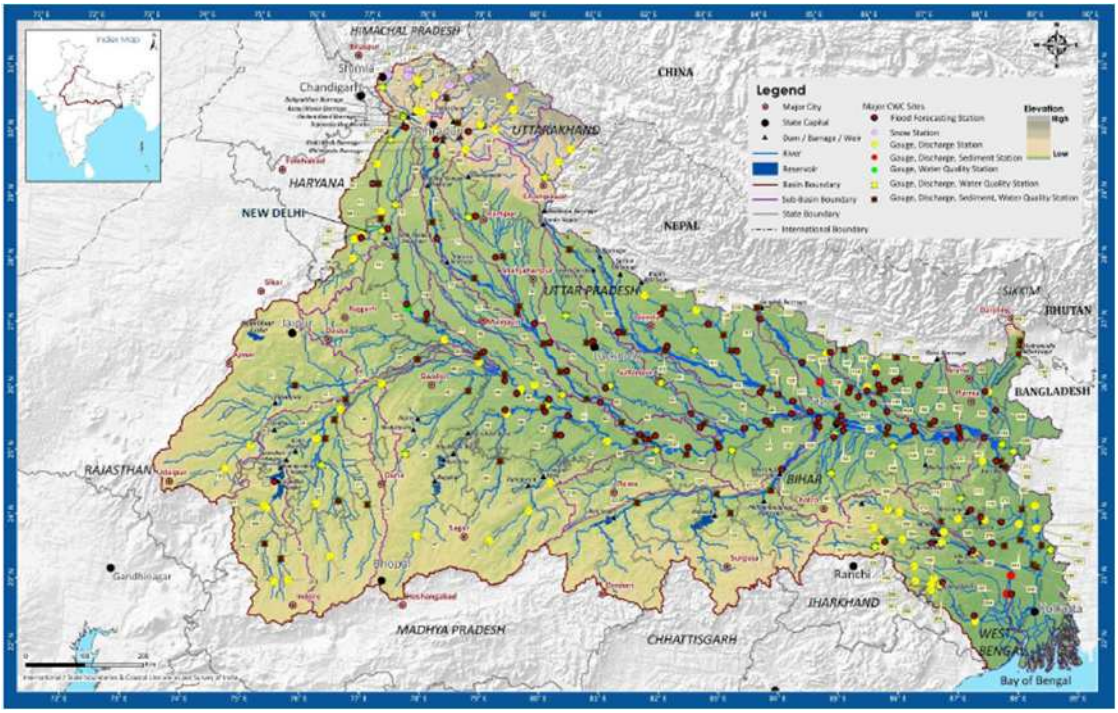
District	Town
Haridwar	Piran Kaliyar
	Shivalik Nagar
	Bhagwanpur
	Lakshar
	Landhora
	Jhabreda
Udham Singh Nagar	Jaspur
Nainital	Bhawali
	Bhimtal
	Kaladhungi

District	Town	System
Tehri	Chamiyala	Pumping
	Chamba	Pumping
	Ghansali	Pumping
	Lambgaon	Pumping
	Kirtinagar	Pumping
	New Tehri	Pumping
Uttarkashi	Barkot	Pumping
	Chiniyali saur	Gravity
	Purola	Pumping
	Naugaon	Pumping
Almora	Almora	Pumping
	Bhikiyasain	Pumping
	Ranikhet	Pumping
	Dwarahat	Pumping
Pithoragarh	Berinag	Pumping
	Gangolihat	Pumping
Bageshwar	Bageshwar	Pumping
Chamoli	Gairsain	Pumping
	Tharali	Gravity
	Nandprayag	Gravity
	Joshimath	Gravity
	Pipalkoti	Gravity
	Gopeshwar	Gravity
Rudraprayag	Tilwara	Gravity
	Rudraprayag	Pumping
	Ukhimath	Gravity
	Augustmuni	Gravity
Champawat	Lohaghat	Pumping

Source: Prepared by JST

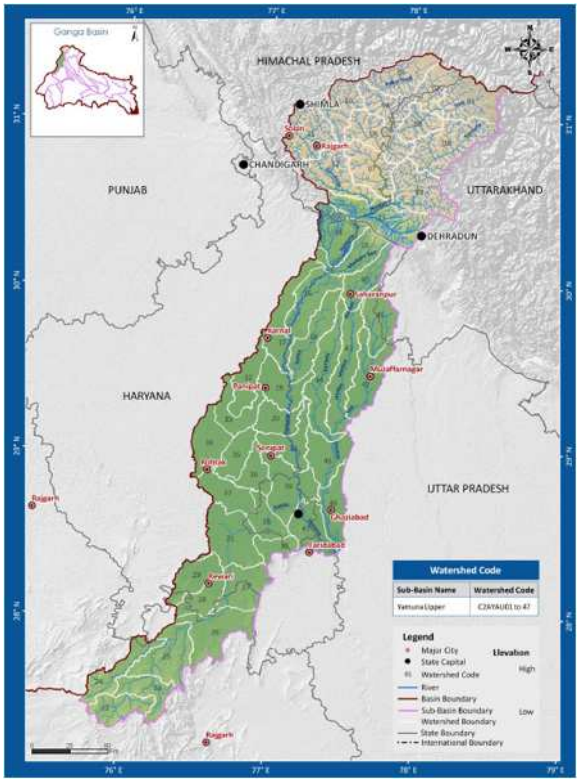
4.2.2 Distribution of Existing Water Sources in the State (Surface Water)

In the UK state, all surface waters are included in the Ganges River Basin[1] (Figure 4-1). These surface waters are divided into four sub-basins within the UK state, in order from the west: Yamuna Upper, Ramganga Confluence, Ramganga, and Ghaghara. The UK state is in the headwaters of each of these rivers (Figure 4-2 to Figure 4-5).



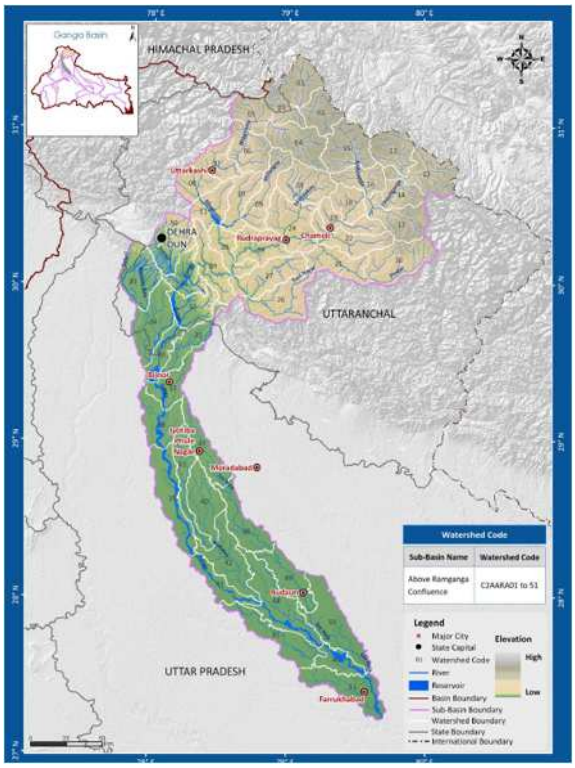
Source: Ministry of Water Resources (2014) *Ganges Basin*

Figure 4-1 Ganges river basin



Source: Ministry of Water Resources (2014) *Ganges Basin*

Figure 4-2 Yamuna upper sub-basin



Source: Ministry of Water Resources (2014) *Ganges Basin*

Figure 4-3 Ramganga confluence sub-basin



Source: Ministry of Water Resources (2014) *Ganges Basin*

Figure 4-4 Ramganga sub-basin



Source: Ministry of Water Resources (2014) *Ganges Basin*

Figure 4-5 Ghaghara sub-basin

The river systems in the UK state are shown in Figure 4-6[2]. The basin classification of the 28 sites using surface water in the 38 priority areas is shown in Table 4-3. Many DPR sites are included in the Alaknanda River watershed.



Source: NIDM (2015) *Uttarakhand Disaster 2013*

Figure 4-6 River systems in the UK state

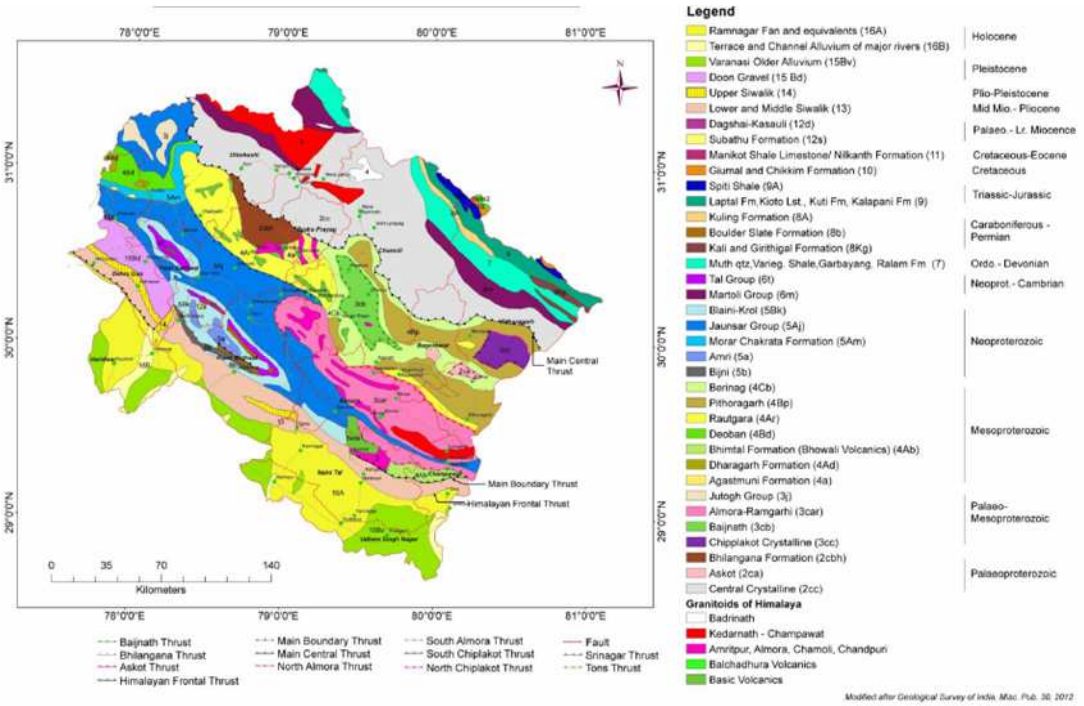
Table 4-3 Basin classification of DPR sites using surface water

Sub-basin	Main river	Number of sites	District	Name of DPR site
Yamuna Upper	Yamuna	3	Uttarkashi	Purola, Barkot, Naugaon
Ramganga Confluence	Ganga	5	Uttarkashi	Chiniyali saur
			Tehri	Lambgaon, Chamba, New Tehri, Chamiyala
	Alaknanda	11	Tehri	Ghansail, Kirtinagar
			Rudraprayag	Rudraprayag, Tilwara, Augustmuni, Ukhimath
			Chamoli	Gopeshwar, Nandprayag, Pipalkoti, Joshimath, Tharali
Ramganga	Ramganga	5	Chamoli	Gairsain
			Almora	Dwarahat, Bhikiyasain, Ranikhet, Almora
Ghaghara	Kali	4	Bageshwar	Bageshwar
			Pithoragarh	Berinag, Gangolihat
			Champawat	Lohaghat

Source: Prepared by JST

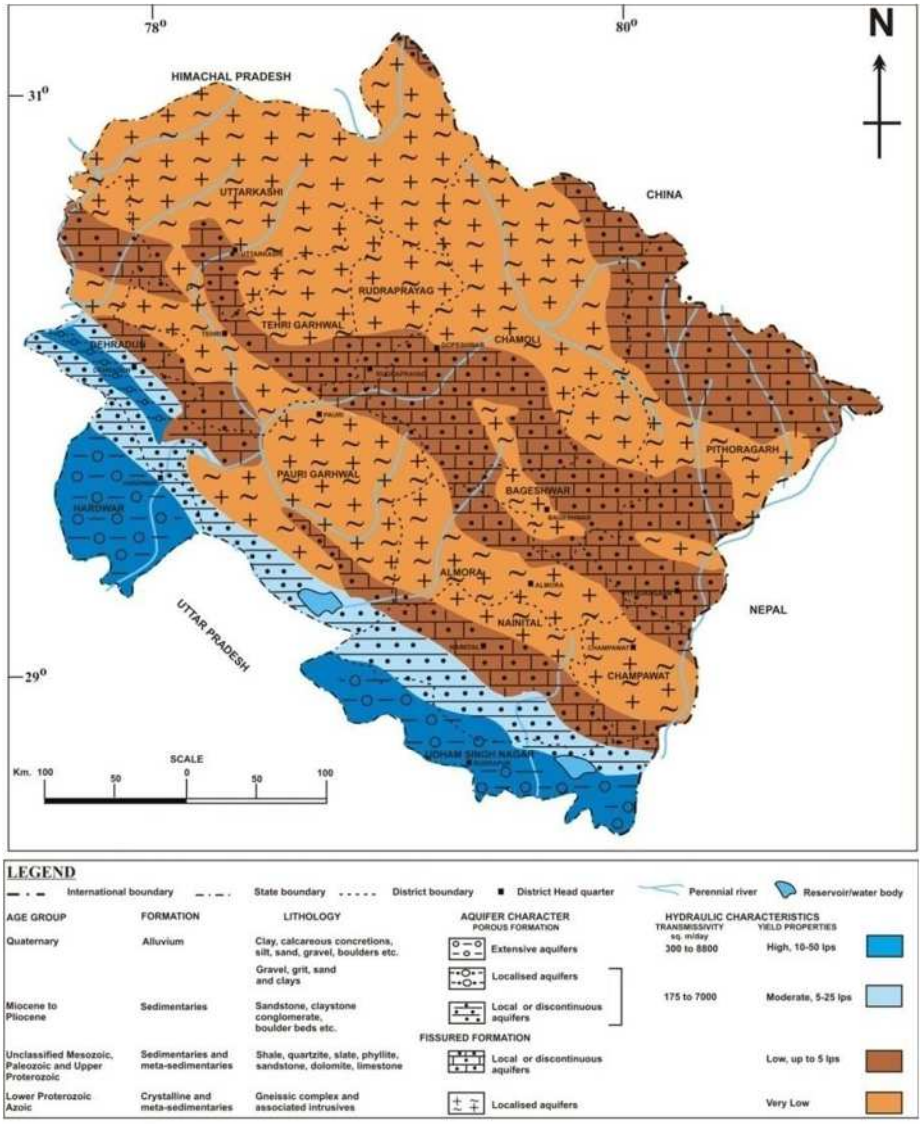
4.2.3 Distribution of Existing Water Sources in the State (Groundwater)

Groundwater in UK can be broadly classified into two types of topographic units: plains and mountains/hills. The topographic distribution is a northwest-southeast trending band of plains and mountains/hills. These landforms are strongly regulated by the geological structure that forms the Himalayas (Figure 4-7). The presence of groundwater in the aquifer is determined by the particles that make up the strata (gravel, sand, clay, etc.) and the fracture conditions of the rocks. The hydrogeological conditions and aquifer distribution characteristics of each area vary greatly depending on these topographic and geologic conditions[3] (Figure 4-8). Most mountain areas correspond to 'low' or 'very low' groundwater development potential.



Source: Geological Survey of India

Figure 4-7 Geological map of the UK state



Source: *Ground Water Year Book Uttarakhand* (2021-2022)

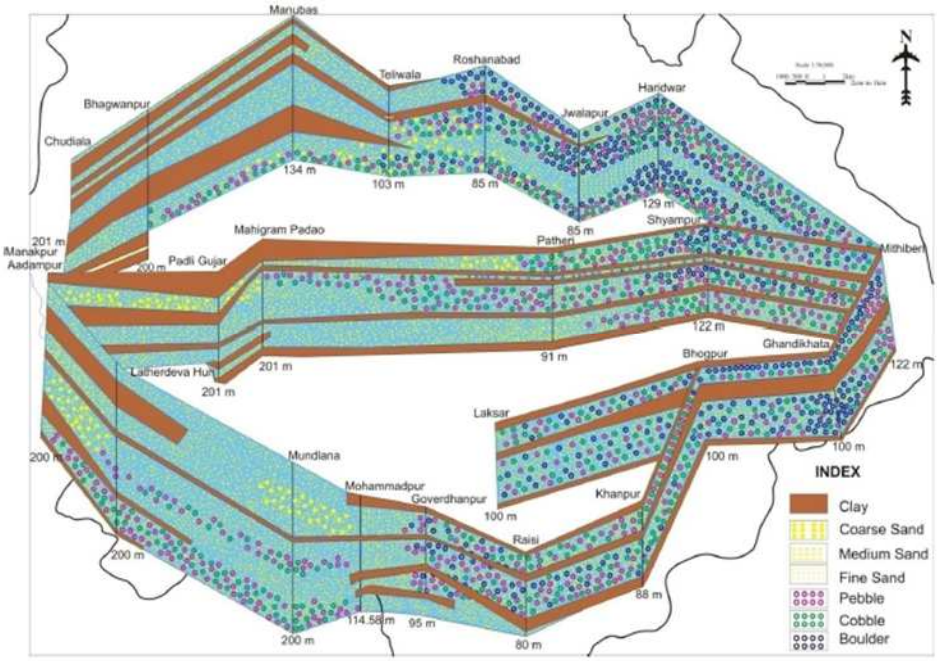
Figure 4-8 Hydrogeological map of the UK state

(1) Groundwater in the plain area

Groundwater in the plain area is mainly distributed in the Terai-Babar zone, which includes Haridwar and U.S. Nagar in the southern part of the state. Groundwater with similar hydrogeological conditions also exists in the lowlands of the mountain basins, including Dehradun.

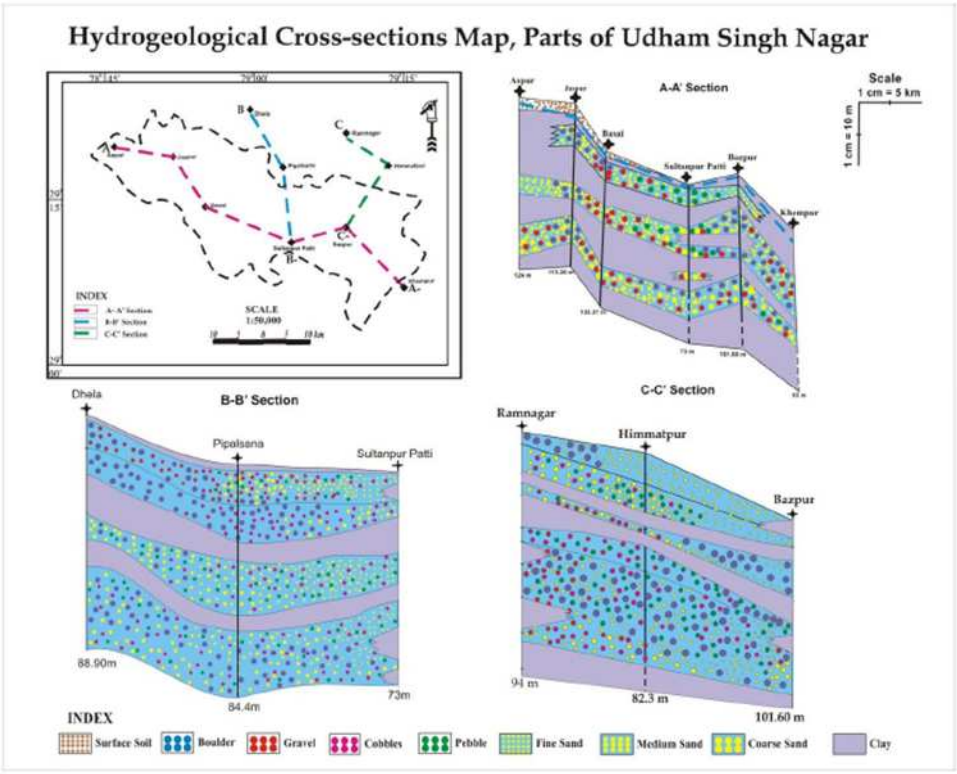
Groundwater in the Terai-Babar zone is contained in unconsolidated Quaternary alluvial deposits. Several layers of sand and gravel in the Alluvium are interbedded with clay layers and have been identified to a depth of about 200 m[4] [5] (Figure 4-9 to Figure 4-10). Groundwater in these aquifers flows in a northeast to southwest direction, mainly from spring water from the Siwalik Hills (Figure 4-11). Groundwater in mountain basins is contained mainly in coarse-grained sediments such as gravel beds.

Within individual basins, a closed groundwater flow system is formed.



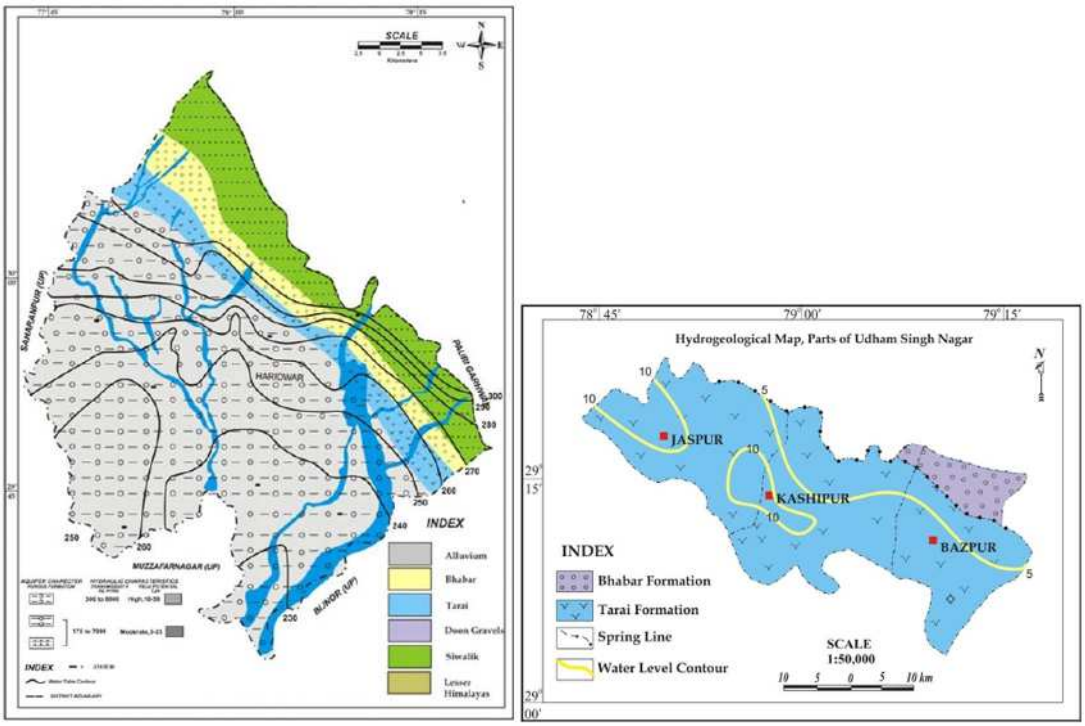
Source: *Aquifer Mapping and Ground Water Management Plan* (Haridwar District, Uttarakhand)

Figure 4-9 Distribution of aquifers in Haridwar district



Source: *Aquifer Mapping and Ground Water Management Plan* (Udham Singh Nagar District, Uttarakhand)

Figure 4-10 Distribution of aquifers in Udham Singh Nagar district



Source: *Aquifer Mapping and Ground Water Management Plan* (Haridwar District, Uttarakhand)
Aquifer *Mapping and Ground Water Management Plan* (Udham Singh Nagar District, Uttarakhand)

Figure 4-11 Hydrogeological Map of the plain area
(Left: Haridwar, Right: U.S Nagar)

(2) Groundwater in mountainous and hilly areas

In the mountainous and hilly areas that cover much of the UK state, groundwater is mainly contained in fractures in the rocks. Groundwater flow is strongly regulated by geological structures, and its distribution is localized.

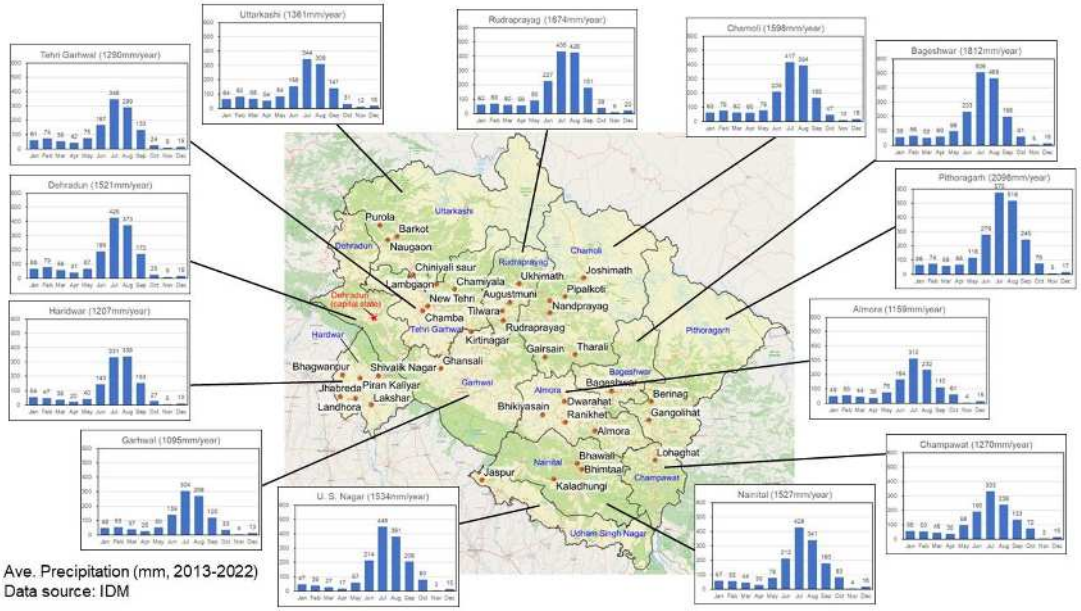
The Siwalik Hills, which border the Terai-Bavar belt in the southern part of the state, consist mainly of unconsolidated to semi-consolidated sand and gravel beds of Tertiary age sediments. Therefore, they have high rainwater infiltration capacity and are a source of groundwater recharge for the plains.

4.2.4 Capacity and Quality of Existing Water Sources

(1) Precipitation

The capacity of surface and groundwater sources is strongly influenced by the amount of precipitation in the recharge area. The distribution of precipitation (average values from 2013 to 2022) by district in the UK state is shown in Figure 4-12, and precipitation in the mountain regions is high. In particular, precipitation in Pithoragarh and Bageshwar in the north-eastern part of the state is extremely high, with 2,098 mm/year and 1,812 mm/year observed, respectively. On the other hand, Gharwar and Almora,

near the centre of the state, received less precipitation than the other regions, with 1,095 mm/year and 1,159 mm/year, respectively. Another characteristic common to all regions is that most of the annual precipitation is concentrated in the rainy season from June to September.



Source: Prepared by JST based on India Water Resources Information System

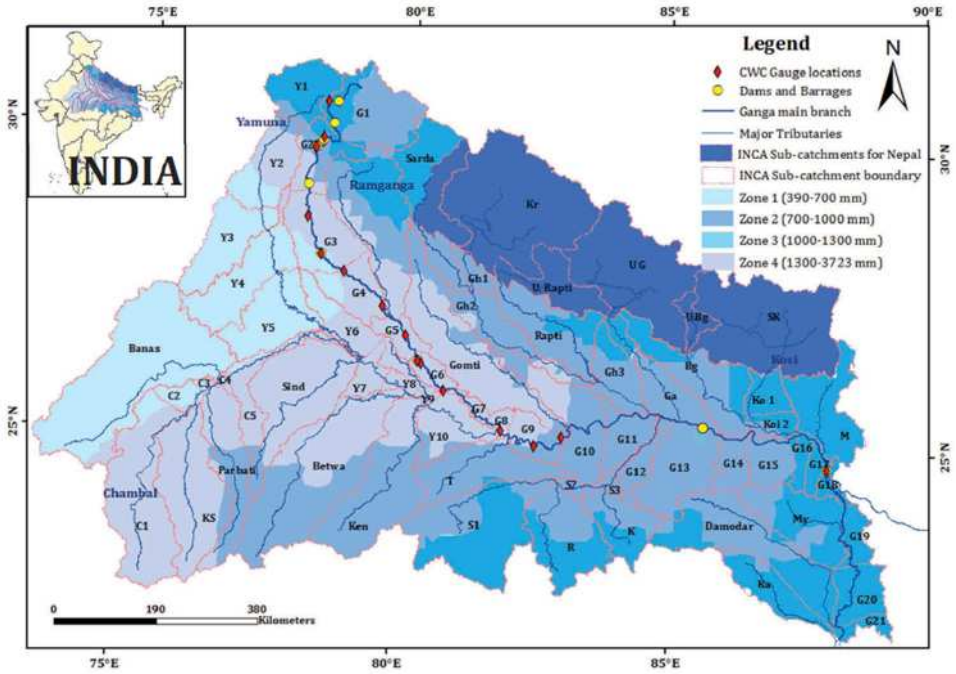
Figure 4-12 Distribution of Precipitation by District in UK State (average from 2013 to 2022)

(2) Capacity and quality of surface water

Due to the very high annual precipitation in the mountain areas of the UK state, surface water in the state is abundant throughout the year. Data from the upper Ganga River stations established by the CWC confirms enough dependable flow[6] (Figure 4-13, Table 4-4). Average annual flows in each river, including tributaries, are summarized based on existing data[7] (Table 4-5). According to Khan et al (2018), the flows that do not fall below 80% of the days per year (80% Dependable flow) are, in order from upstream of the Ganga River observation stations, 7.52 m^3/sec at Uttarkashi, 57.02 m^3/sec at Tehri, 80.02 m^3/sec at Devprayag, and 184.48 m3/sec at Rishikesh. Based on the results of interviews at the sites visited, the depths of rivers in May and June (the end of the drought season) were 15 to 20 m in the Ganga River (dammed lake) in the Tehri area and 8 m in the Alaknanda River in Kirtinagar district.

On the other hand, in terms of general river water quality, several sites in Dehradun, Rishikesh, Haridwar, and U.S. Nagar exceeded drinking water standards for coliform and TDS, Hardness, Alkalinity. In addition, there is a Fluoride exceedance at one site in U.S. Nagar (PCB： Pollution Control Board, measured in 2022). However, in the

38 priority areas where surface water is to be used, the conditions are generally good. As for heavy metals, iron has been detected above standard values in most areas except in Chamoli, Rudraprayag, and copper and zinc were detected, although within the standards (PCB, measured in 2022).



Source: Khan et al. (2018)

Figure 4-13 River water level observation points on the mainstream of the Ganga River

Table 4-4 River observation data in the upper reaches of the Ganga River (average values, from 1994 to 2011)

Sub-basin	River	Observation point	Dependable flow (m^3/s)			Average annual flow ($10^3m^3/s$)
			20%	50%	80%	
Ramganga Confluence	Ganga	Uttarkashi	280.06	45.66	7.52	50.12
		Tehri	433.54	128.00	57.02	90.78
		Devprayag	352.38	98.54	80.02	70.97
		Rishikesh	1320.80	342.75	184.48	283.21

Source: Khan et al. (2018)

Table 4-5 Average annual flow of rivers in UK state

Sub basin	River	Average annual flow ($10^3m^3/s$)
Yamuna Upper	Yamuna	220.00

	Tons	5.74
Ramganga Confluence	Ganga	656.00
	Nayar	32.67
	Pinder	94.26
	Alaknanda	287.00
	Dhauliganga	72.60
	Mandakani	105.00
	Bhagirathi	246.44
Ramganga	Kosi	8.90
	Ramganga	20.10
Ghaghara	Kali	420.70
	Saryu	195.50
	Goriganga	169.00

Source: Kumar et al., 2019

(3) Capacity and quality of groundwater

Three main aquifer systems are identified on the plain area, with groundwater contained in aquifers that are interbedded between thick clay layers about 10 to 30 meters. The first aquifer is mainly used for agricultural purposes, the second aquifer is often used for industrial purposes, and existing wells for piped water supply mainly target the third aquifer. All the plans to use groundwater in the plain area among the 38 priority areas are considering groundwater pumping from the third aquifer.

Pumping test results using exploratory boreholes in the Haridwar area of CGWB confirm that the transmissivity of the third aquifer ranges from 176 to 1,822 m^2/day. If the thickness of the third aquifer is hypothetically considered to be 50 m, the coefficient of permeability would be in the range of 10^{-3} to 10^{-2} cm/sec, indicating that the aquifer capacity is very high. In addition, valley-fill deposits in mountain basins are very permeable and contain abundant groundwater[8]. The data of existing wells in Bhimtal of Naintal district, shows the thick sand and gravel beds up to a depth of 90 meters.

Regarding groundwater quality, the 2022 data published by PCB confirms that the groundwater is generally in good condition, but lead is reported as exceeding drinking water standards in Pauri Garhwal and Haridwar and iron in almost all areas. The well depths are unknown for all data, but the "hand pump" noted at the sample collection point. On the other hand, groundwater levels in the 2nd and 3rd aquifers are trending slightly lower, and it was confirmed during the field investigation that the depths of these aquifers cannot physically be pumped by hand pumps. Based on these facts, it can be concluded that the water quality analysis results described are presumed to be

for the shallow Aquifer 1. The CGWB survey also found high concentrations of nitrate, chromium, and lead in Haridwar (Table 4-6). Although the well depths of these samples are also unknown, they are presumed to be in shallow Aquifer 1 because of possible contamination from fertilizers and industrial wastewater. As described above, no water quality problems have been identified in the third aquifer at the planned sites using groundwater in the 38 priority areas.

Table 4-6 Groundwater contamination in Haridwar

S. No.	Location	Nitrate (mg/L)	Chromium (mg/L)	Lead (mg/L)
1	Sahidwala Grant	147	0.095	-
2	Banjarewala	-	0.085	-
3	Ibrahimpur	-	0.070	0.060
4	Lamagrant	-	0.089	0.060
5	Roshanabad	-	-	0.080
6	Gangdaspur	-	-	0.070
7	Rawali Mehdood	100	0.062	0.070
8	Jamalpur Khurd	119	0.056	0.080
Permissible Limit		45	0.050	0.010

Source: CGWB (2016) *Aquifer Mapping and Ground Water Management Plan* (Haridwar District, Uttarakhand)

(4) Consideration

As described in this section, with regard to the perspective of 'abundance of available water sources', it is considered that there is a sufficient amount of available water, both surface water and groundwater, in the UK State.

The reasons for this are that, with regard to surface water, (i) precipitation, which is a source of water recharge, is abundant, (ii) sufficient amounts of 80% Dependable flow have been identified from existing data, and (iii) sufficient average annual flows for each river have also been identified from existing data. With regard to groundwater, (i) the high hydraulic conductivity of the third aquifer is estimated from the results of pumping tests in the plain areas, and (ii) existing data indicate that there is abundant groundwater in the mountain basins.

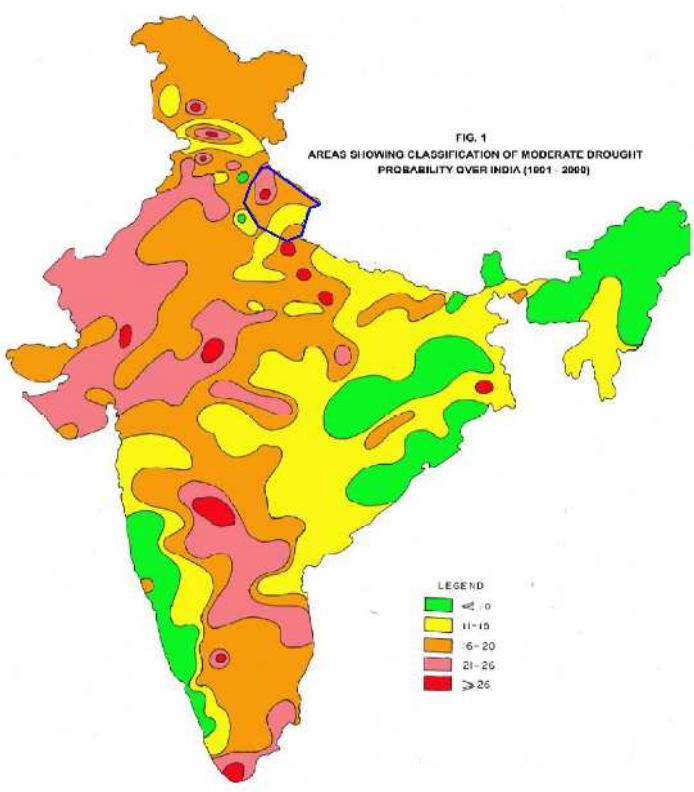
4.2.5 Drought Conditions in the Dry Season

(1) Drought conditions in the UK

The India Meteorological Department defines drought as a rainfall deficiency exceeding 26% of the long-term standard value over an extended period, further categorizing it into "Moderate Drought" (26% to 50%) and "Severe Drought" (over 50%). The "Climatic Features of Drought Occurrence in India" (2005, India Meteorological Department) calculates the

regional occurrence and probability of Moderate and Severe droughts based on data from 1875 to 2004, covering 130 years. According to this data, over the 130-year period from 1875 to 2004, Uttarakhand experienced 15 occurrences of Moderate Drought and 2 occurrences of Severe Drought, resulting in a drought occurrence probability of 13%. Additionally, there was one instance of consecutive drought occurrence in 1991-1992.

As per Figure 4-14, the drought rates in the UK (indicated by the blue border) generally range from 11% to 26%, with a higher concentration in the 11% to 26% category. Although there are relatively fewer areas in the state that meet the India Meteorological Department's definition of "drought," some areas in the western part of the state exceed the 26% threshold. During discussions with UKPJN, there have been no direct reports of severe drought damage. However, it is crucial to monitor future developments, given the increasing incidence of extreme weather phenomena, such as high temperatures and reduced rainfall, attributed to the impact of climate change.



Source: Climate Profile of India, 2010

Figure 4-14 Classification of drought-prone areas

(2) Drought conditions in rivers

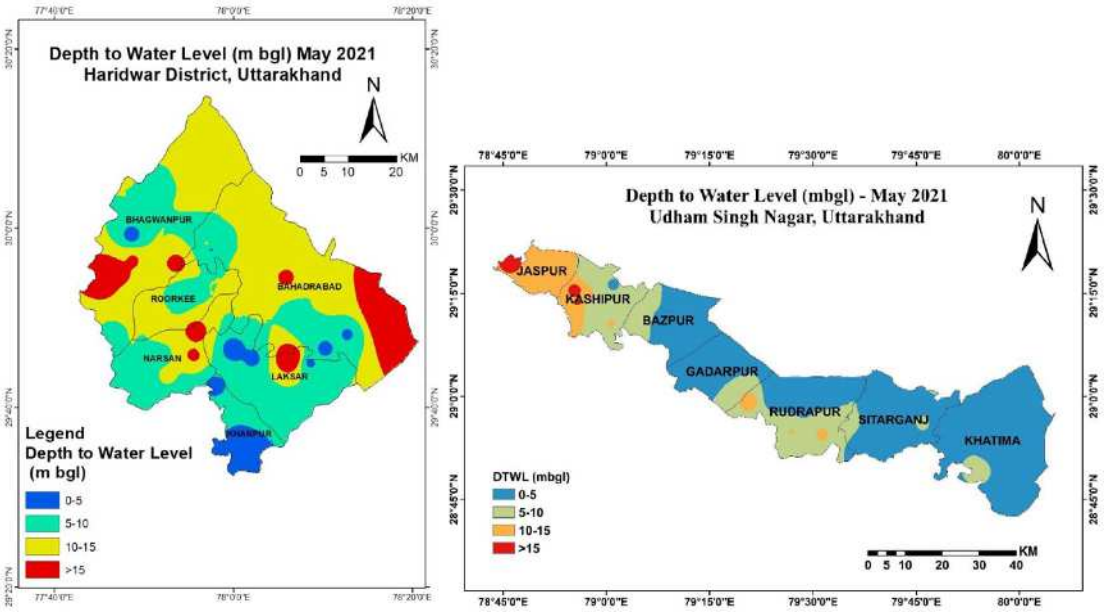
Based on the results of water quality monitoring in 2022 in the state, no dry season drought in rivers in mountainous and hilly areas has been confirmed, but drought

records are found in U.S. Nagar in the plains during the months of May-August and December.

However, in the planning area of U.S. Nagar, one of the 38 priority areas, the use of groundwater is planned, and the use of surface water is not considered.

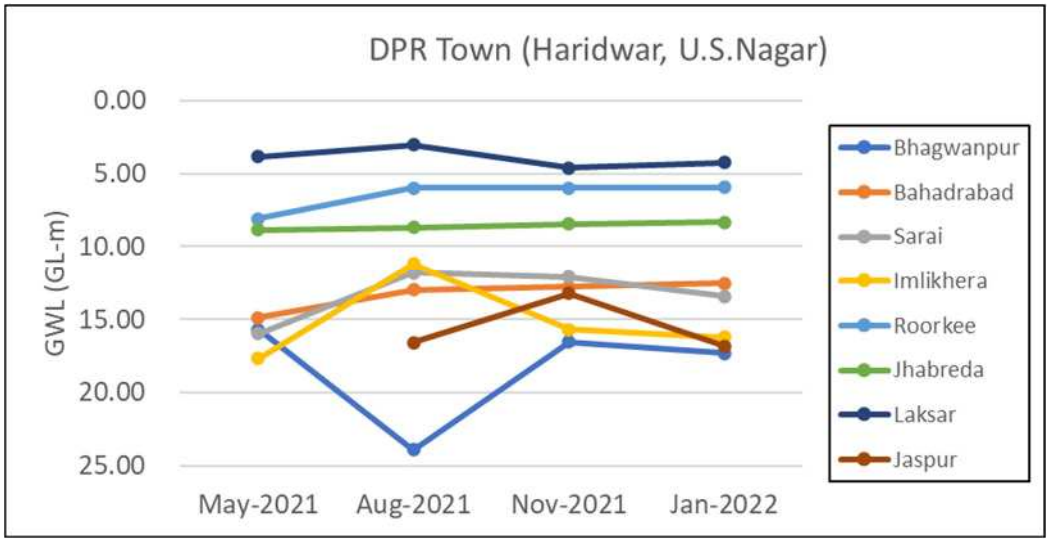
(3) Trend of groundwater level fluctuations

The CGWB reports that locally low areas of groundwater levels in the dry season have been identified in the plain area (Figure 4-15). At the planned sites using groundwater in the 38 priority areas, the trend of fluctuations in groundwater levels over the last year is shown in Figure 4-16. Currently, a drastic drawdown in groundwater levels during the dry season has not been confirmed. However, future trends should be monitored regularly, because groundwater levels deeper than minus 15 meters have been identified at several locations in the plain area.



Source: *Ground Water Year Book Uttarakhand* (2021-2022)

Figure 4-15 Groundwater level lowering situation of the plain area (Left: Haridwar, Right: U.S Nagar)



Source: Prepared by JST based on *Ground Water Year Book Uttarakhand* (2021-2022)

Figure 4-16 Groundwater level fluctuations in the plain area (DPR sites and nearby sites)

4.3 Current Status of Existing Waterworks Facilities and Issues

Since the existing DPR does not show sufficient information on the current status and issues with the existing water supply facilities, the acquired information based on the results of the field survey is shown as follows.

4.3.1 Water Intake Facilities

(1) Groundwater source

Groundwater is basically withdrawn by well pumps (submersible pumps). In Shivalik Nagar and Bhagwanpur, where field surveys had been conducted, the water intake facilities consisted of a well pump, a check valve, a discharge valve, and chlorine injection equipment (mainly diaphragm pumps). Flow meters and discharge pressure gauges, which are important for operation and maintenance, were not installed. Although the chlorine injection equipment was installed, it was not in operation at the time of the survey, and its operating time and frequency are supposed to be less. In Bhagwanpur, the groundwater level (static water level) is currently 18 to 20 meters below the ground surface in almost all areas, but 10 years ago it was about 4 meters, suggesting that the groundwater level has been lowering and the flow rate of well pumps has been decreased accordingly. At the two tube well sites in Shivalik Nagar, the effective height of the OHT (Over Head Tank) was 18 m and the groundwater level (static water level) was 25 m below the surface, while the total head of the well pumps was 110 m and 120 m. This indicates that the pump selection was inappropriate during the design planning stage.

Regarding points to be considered when installing groundwater intake facilities in this project, to install flow meters, discharge pressure gauges, air valves, and other equipment that must be installed for operation and maintenance, as well as washout pipe and valves for cleaning and water sampling. For selection of a pump, it is necessary to select a pump with appropriate specifications (especially total head) for the site conditions, and when groundwater level fluctuation (lowering) is expected, it is necessary to conduct sufficient design studies to prevent a decrease of flow rate of well pump due to insufficient total head of the well pump.



Source: Prepared by JST

Figure 4-17 Existing water intake facilities at Shivalik Nagar

(2) Surface water source

In Chamba, New Tehri and Kirtinagar, where field surveys were conducted, the intake facilities for dam water, river water and spring water were observed. Details are shown below.

(a) Intake pump system

At Chamba and New Tehri, several submersible pumps were installed in the intake towers which was located on the dam, and the installation positions were shifted vertically to allow selective intake according to changes of dam water levels and water quality. The difference of water level between the dry and rainy seasons is approximately 6 m, and the water depth at the time of the survey was 15 to 20 m. The facility consisted of a submersible pump, check valve, discharge valve (sluice valve), and discharge pressure gauge, neither flow meters nor air valves were installed. The specifications of the existing pumps could not be observed. As the countermeasures for water hammer, which occurs due to rapid increasing of pressure in case of power failure, (1) to install check valves on the transmission pipeline, (2) to install intake and exhaust valves at the required location, and (3) to ensure the required pipe thickness (adoption of API standards, etc.) has been implemented, and no particular problems have arisen so far.

Regarding points to be considered for installing intake pump facilities in this project, flow meters, air valves, and other required equipment/instrument must be installed for proper operation and maintenance, as well as washout pipes and valves for cleaning and water sampling. Moreover, in case that a high lift pump shall be installed according to the elevation of WTP (Water Treatment Plant), it is necessary to consider appropriate water hammer countermeasures, including the above existing measures.




Source: Prepared by JST

Figure 4-18 Existing water intake pumping facility at Chamba

(b) Infiltration gallery

The existing intake facility in Kirtinagar consisted of infiltration galleries and chambers (1m length x 1m width, two units) installed on the riverbed. Since water intake amount of the existing intake has been decreasing due to the flood damage in 2022, the new intake facility is currently under construction (out of the scope of this project) to be shifted to downstream. The existing water source located in the mountainous area has good water quality but low water quantity. Therefore, the new water intake facility to be constructed in this project will take water from the Alakananda River that flows through the city, and the intake well method will be applied, which is more stable than the existing method.



Source: Prepared by JST

Figure 4-19 Existing water intake facilities in Kirtinagar

4.3.2 Water Supply and Distribution Facilities

(1) OHT

Groundwater source water supply systems located in plain areas such as Shivalik Nagar and Bhagwanpur, pump up groundwater to an adjacent OHT by well pump and distribute clear water by gravity after chlorination. In Shivalik Nagar, a cylindrical OHT with the effective capacity of 800 m^3 constructed in 1996 and a cylindrical overhead water tank with the effective capacity of 200 m^3 constructed in 2004 in Zone-6 were observed. The effective height of both tanks was 18 m. The latter was equipped with a float-type water level gauge. The well pump was operated manually by checking the water level shown on the gauge.

In Mehuwala, the field survey for a construction site funded by World Bank (Peri-Urban Drinking Water Supply-Development of Water Supply Scheme at Mehuwala Cluster on Design, Built and Operate Frame Work) was conducted. The water supply facility consisted of a well pump and cylindrical OHT (effective capacity: 2,700 m^3) of which height is set to ensure a water supply pressure of 12 m at the end of distribution network. A RTU (Remote Terminal Unit) was installed on the well pump, and the pump operation status and groundwater level could be transmitted to a SCADA system (manufactured by CIMCON) thorough a GPRS (General Packet Radio Service) wireless network. The system is capable of monitoring operations. RTUs were also installed on the electromagnetic flow meters in the three District Metered Areas (DMAs), which can be monitored by the SCADA system.



Source: Prepared by JST

Figure 4-20 Existing OHT at Shivalik Nagar



Source: Prepared by JST

Figure 4-21 New OHT and SCADA system in Mehuwala

(2) Intermediate pumping station

In Chamba and New Tehri, treated water of the WTPs is pumped to the distribution reservoir at the top of the mountain through the intermediate pumping station. The existing intermediate pumping station in New Tehri was equipped with a receiving tank and seven high lift pumps (including one Kirloskar multistage centrifugal pump, 185 m3/h x 360 m x 200 kW). Since this is a high-lift pump with the total head of 360 m, there is a risk of damage to the pump body and pipework due to water hammer phenomenon. However, it is inferred that any particular damages/problems have not occurred by taking the aforementioned measures: (1) installation of check valves on the transmission pipeline, (2) installation of intake and exhaust valves at the required locations, and (3) securing the necessary pipe thickness. According to interviews with the operators, chlorine was not injected at the WTP, but was injected at the intermediate pumping station. However, no residual chlorine was detected by a simple test (pack test) conducted on-site.

Since a high-lift pump is to be installed in this project as well, it is necessary to ensure that the above measures against water hammer are implemented.



Source: Prepared by JST

Figure 4-22 Existing intermediate pumping station at New Tehri

4.3.3 Water Treatment Facilities

Existing water treatment facilities are categorized into coagulation-sedimentation-RSF (RSF) systems, SSF (slow sand filtration) systems, and groundwater chlorination systems. Details are mentioned below.

(1) Coagulation-sedimentation-RSF process

In Chamba and New Tehri, field surveys for Chamba, Gantakaran, and Behtogi WTPs applying coagulation-sedimentation-RSF process were conducted. Table 4-6 shows an overview of each WTP.

Table 4-7 Overview of the existing WTPs with coagulation-sedimentation-RSF system

Name of WTP	Raw water type	Design capacity (m3/day)	Treatment process	Operational conditions
Chamba WTP	River water	1,870	Receiving well→sedimentation tank × 2→Rapid sand filter (2 tanks)	No chemical injection due to good raw water quality
Gantakaran WTP	Dam water	6,000	Receiving well → pre-sedimentation tank (with plate settler) → chemical sedimentation tank → rapid sand filter (2 tanks)	Only post-chlorine injection (residual chlorine 0.6 mg/L)
Behtogi WTP	Dam water, spring water	6,300	Receiving well → 2 sedimentation tanks (with plate settler) → rapid sand filter (2 tanks)	Inject coagulant (Alum) only

Source: Prepared by JST

(a) Chamba Water Treatment Plant

Chamba WTP is the only existing WTP supplying water to Chamba City, located at the confluence of the Jijili and Nagini Rivers, taking water from both sources and treating it for purification. The treated water is also supplied to another water supply area (Ranichowri Pumping Water Supply Scheme) from this WTP. At the time of the field survey, the raw water quality was quite good, and no coagulant and chlorine were injected. According to the interview with operators, aluminium sulphate (Alum) is added as a coagulant during the monsoon season from July to August, when the raw water turbidity is highly increased. The treatment process is as described above, and all facilities and equipment are operated manually. The backwash water for rapid sand filters comes from the elevated tank and no surface or air washing system is installed. Seven units of high-lift pumps (typical specifications: KSB multistage centrifugal pump: 60 m^3/h x 440 m x 125 kW, Kirloskar multistage centrifugal pump: 39.6 m^3/h x 330 m x 75 kW) were installed to deliver treated water to the distribution reservoirs.



Source: Prepared by JST

Figure 4-23 Overview of existing Chamba WTP

(b) Gantakaran Treatment Plant

The Gantakaran WTP takes raw water from the Koteshuwar dam and supplies the treated water to another water supply area. The treatment process is as described above, and all facilities and equipment are operated manually. The pre-sedimentation tank with plate settler was installed to reduce raw water turbidity so that the used amount of coagulant can be saved.

The washing method of rapid sand filters is back washing from the OHT combined with air washing. Post-chlorine was injected to the treated water of rapid sand filter, and a simple test (pack test) detected about 0.6 mg/L of free residual chlorine. Three units of high-lift pumps (typical specification: Wilo multistage centrifugal pump: 108 m3/h x 660 m x 355 kW) were installed to pump up treated water to the distribution reservoir.






Source: Prepared by JST

Figure 4-24 Overview of the existing Gantakaran WTP

(c) Behtogi Water Treatment Plant

Behtogi WTP is the only existing WTP supplying treated water to New Tehri City. Raw water is taken from Koteshuwar Dam and mixed with spring water of good quality for water treatment. The treatment process is as described above, and all facilities and equipment are operated manually. Solid Alum as coagulant is directly put into the receiving well without dissolving, and raw water flow into two stages of chemical sedimentation tanks with plate settler. The rapid sand filters are washed twice a day by back washing from the OHT combined with air washing. According to an interview with the operators, the filter media is replaced every three months, and chlorine is injected at the distribution reservoir after the WTP. Five units of high-lift pumps (typical specification: KSB multistage centrifugal pump: 135 m3/h x 360 m x 250 kW) were installed to pump up treated water to the intermediate pumping station.



Source: Prepared by JST

Figure 4-25 Overview of the existing Behtogi WTP

(2) SSF process

The existing WTP in Kirtinagar applies SSF process. The design capacity is about 120 m^3/day, and the raw water is spring water with good quality. The treatment process is receiving well → sedimentation tank → slow sand filter (2 tanks) → clear water reservoir (circular, 2 tanks).

At the time of the field survey, one of the two slow sand filters was in operation. The treatment condition seemed to be good because a thin biofilm (mainly algae) was formed on the surface of the filter bed. This plant is operated intermittently, from 8:00 to 12:00 in a day. Treated water is distributed from the clear water reservoirs by gravity flow (water supply pressure is about 50-60 m). The operator manually injects post chlorine (sodium hypochlorite) to the clear water reservoirs during the above operation hours, but residual chlorine was not detected by a simple test (pack test).



Source: Prepared by JST

Figure 4-26 Overview of the existing WTPs in Kirtinagar

(3) Chlorine sterilization process

The treatment process of the groundwater systems located in the plain area of the UK state is commonly called chlorination sterilization process, which distributes groundwater only by chlorination without sand filtration or any treatment process. The details of this system have already been described above and are therefore omitted.

4.3.4 Facility Operation and Maintenance

The details of operation and maintenance for the water supply facilities in the UK state is described below based on the results of interviews with UJS conducted during the field survey (conducted on 7 June 2023) and the field survey for existing water supply facilities.

(1) Role of UJS Headquarters

Basically, UKPJN is responsible for the construction of new water supply and sewage facilities, while UJS is responsible for operation and maintenance and some expansion work of the facilities. After construction work is completed, the facilities are handed over to UJS.

In addition to water supply facilities, UJS also operates and maintains 44 STPs (Sewerage Treatment Plant) in 29 towns (including outsourcing). However, in some cases, operation and maintenance of existing water supply facilities in plain areas with groundwater sources are carried out by the committees organized by residents.

UJS has not yet achieved a self-sustaining accounting system, and the UK state government pays for electricity costs and provides financial support (subsidies) depending on the situation. Basically, UJS covers labour costs and other costs related to operation and maintenance. Details are shown in Chapter 6.

(2) Status of operation and maintenance

(a) Operation and maintenance, inspection and repair work

The operation and maintenance of water supply facilities are either directly managed or outsourced by UJS, while the sewage treatment facilities are basically managed by contractors under the Design Build Operation contract (operation and maintenance period is 15 years). Standard Operating Procedures (SOPs: Standard Operating Procedure) are prepared for each project, and operation, inspection, maintenance, and repair work are carried out based on these SOPs. For pumps, etc., energy audits are also conducted in cooperation with universities. Maintenance and repair of pipeline is mainly performed by UJS; however it is outsourced depending on the situation. Maintenance and repair of mechanical and electrical equipment is essentially outsourced (Some equipment are subject to service

contracts with suppliers or manufacturers.), and minor repairs are performed by UJS. Records of operation, inspection, and maintenance are paper-based, such as logbooks. The operation status of water supply facilities can be monitored by a SCADA system installed at UJS headquarters.

(b) Warehouse and workshop

UJS owns a warehouse each in Dehradun and Haldwani, and workshops at WTPs and STPs. The equipment and materials owned and managed by UJS include welding machines, cutting machines, water tankers (80 units), suction trucks (32 units), sewer line cleaning robots (with cameras), and mobile generators.

(c) Procurement of materials and equipment

Spare parts, chemicals, etc. are procured and managed centrally by UJS headquarters. Procurement is conducted through competitive tendering based on the procurement rules of the UK state government. In some cases, UJS conducts witness inspections of equipment at factory. As for chemicals, UJS basically procures them from the original manufacturer rather than suppliers. If it is impossible, they are procured through competitive tendering as described above.

In case of implementing expansion works for water supply and sewerage facilities, the implementing agency is essentially UKPJN, but in some cases UJS will be the implementing agency and runs a tender on the online system in accordance with the rules of the UK state government.

(d) Water quality monitoring and management

Although a UJS water quality database covering the rural area was developed and published through website, it is currently published through the website managed by the state. Moreover, GIS (Geographic Information System) is currently being developed to show the monitoring points. For raw water of water supply, the biological parameters are measured twice a year (before and after the monsoon season) and the chemical parameters are measured once a year, and there is 32 parameters in total, including 14 daily parameters and 18 periodic parameters. UJS collaborates with universities and private analytical institutions for water quality analysis.

There is one district laboratory in each of the 27 districts in the UK state. The field survey for one of the laboratories adjacent to the Dilaram Chowk WTP in Dehradun City, which is capable of measuring physico-chemical, biological, heavy metal, etc., was conducted.

Basically, 15 parameters are analysed for treated water of the WTPs in the district. Each analysis room was well organized and in good operating and management condition.

(3) Operation and maintenance status of each water supply facility

The field survey for the groundwater source facilities in Shivalik Nagar and Bhagwanpur, and surface water source facilities in Chamba, New Tehri, and Kirtinagar was conducted. Although aged deterioration of the facilities and equipment was observed, basic maintenance works seemed to being performed well since tools, etc. were well arranged, and replacement of damaged pumps and marks of repairing pipe was observed.

In terms of operational management, the overall condition of water treatment was good, but the management of chlorine and coagulant injection was inadequate. Although liquid sodium hypochlorite was used for chlorination, some problems were observed, such as storage tanks being empty and not refilled, and sodium hypochlorite deteriorating due to prolonged storage periods. In addition, in many sites, residual chlorine of treated water was not detected. As for coagulant, solid alum blocks were placed directly in receiving wells and aerators without being dissolved, which means that appropriate dosing management/control according to raw water turbidity is not performed.

(4) Operation and maintenance management issues

As a result of the interviews, UJS headquarters faces the following challenges in operation and maintenance.

① Inadequate capacity and performance of water supply and sewage facilities due to big differences between planned and actual population
② Lack of budget (especially water tariffs are set and controlled by the UK state government and therefore difficult to revise.)
③ Insufficient amount of water source in summer
④ Damage to water supply and sewage facilities due to flooding in the plain area and landslides in the mountain area
⑤ High concentrations of iron and hardness (magnesium) in some locations, as well as high turbidity of surface water during the monsoon season

In addition, the following issues are identified based on the results of the field survey.

⑥ Inadequate management/control of chlorine and coagulant injection
⑦ Inadequate study in the planning and design of the facility (e.g. The total head of the well pump is too high.)

Regarding the water source for this project, as described in "4.2.4 Existing Water Sources Capacity and Water Quality" it is noted that there is no observed water scarcity in the rivers of mountainous and hilly regions during the dry season, and abundant water is believed to be maintained throughout the year. However, since the Detailed Project Report (DPR) does not provide information on the water source quantity, it is considered difficult to determine the presence of water scarcity during the summer season.

4.3.5 Damage and repair history of the facility

The history of damage and repairs of the existing water supply facilities due to natural disasters such as landslides, earthquakes, and floods in the target areas of each DPR had been surveyed by subcontracting. However, any records or information were not found/obtained at the district offices of UKPJN and UJS having jurisdiction over the target areas, or the respective town offices.

4.4 Water Supply Status

4.4.1 Water Meters

The WB-supported project, Peri-Urban Drinking Water Supply - Development of Water Supply Scheme at Mehuwala Cluster on Design, Built and Operate Framework, has introduced the first smart meters in the UK and promoted a metered rate system and online payment system.

The project includes the following areas as Mehuwala Zone 1, Chandarbani Zone 2, and Arcadia Zone 3 (Blok Shaspur & Raipur) with a project start date of 4 November 2019 and a construction completion date of 31 March 2023.

- Pump houses: 2
- Tube Well: 20 (New) + 5 (Old)
- OHT: 6 (New) + 3 (Old)
- Total piping length: About 273 km
- Number of smart meter connections: About 25,000

UKPJN is eager to introduce smart meters, especially in mountainous areas, and intends to spread them throughout the entire region.

Each household, approximately 25,000 in total, is equipped with a smart meter consisting of a water meter (Waltman type water meter) and a communication function added AMR (Auto Meter Reading) device.

In AMR, data (accumulated values) from the mechanical water meters are read and stored in a non-contact manner. This data is then transmitted via LoRa WAN (Long Range Wide Area Network), a low-power, long-range wireless transmission standard, to gateway devices (nine locations) installed on top of Over Head Tanks (OHT) once daily. The data sent to the gateway is then transmitted to the UJS Water Billing Server, located in the data center of the UK state headquarters, via the GPRS (GSM: Global System for Mobile Communications -based General Packet Radio Service) mobile phone network once a month. This data is utilized for billing, analyzing fee collection status, and other purposes. Payment of fees can be made in cash at Billing Collection Centers (two locations) or online via the UKPJN or UJS portal website. As of June 2023, online payments account for approximately 38%, and NRW rates range from 15% to 21%.

AMR operates on battery power and can function for approximately 5 years, depending on the frequency of data transmission. It can store data for up to 90 days, and in case of data loss due to GPRS failure, direct data retrieval is possible from AMR. The gateway covers an area of 8-9 km via LoRa WAN with low power consumption and operates for around 4 hours

on rechargeable batteries. The gateway is powered by UPCL (Uttarakhand Power Corporation Limited) for its energy supply.

In areas where no water meters at each household is installed, such as Bhagwanpur and Shivalik Nagar in Haridwar district, the fee is collected on a flat rate of Rs. 150/month. In both Bhagwanpur and Shivalik Nagar towns, smart meters are planned to be installed in the project.

In the project area, there are currently no metered or regular water meters installed, and charges are collected as fixed fees. The installation of conventional mechanical water meters (Woltmann type) is very limited, and it is inferred that a method involving meter readers visiting each household and visually recording meter readings is used.

In the new project, the classification is as follows.

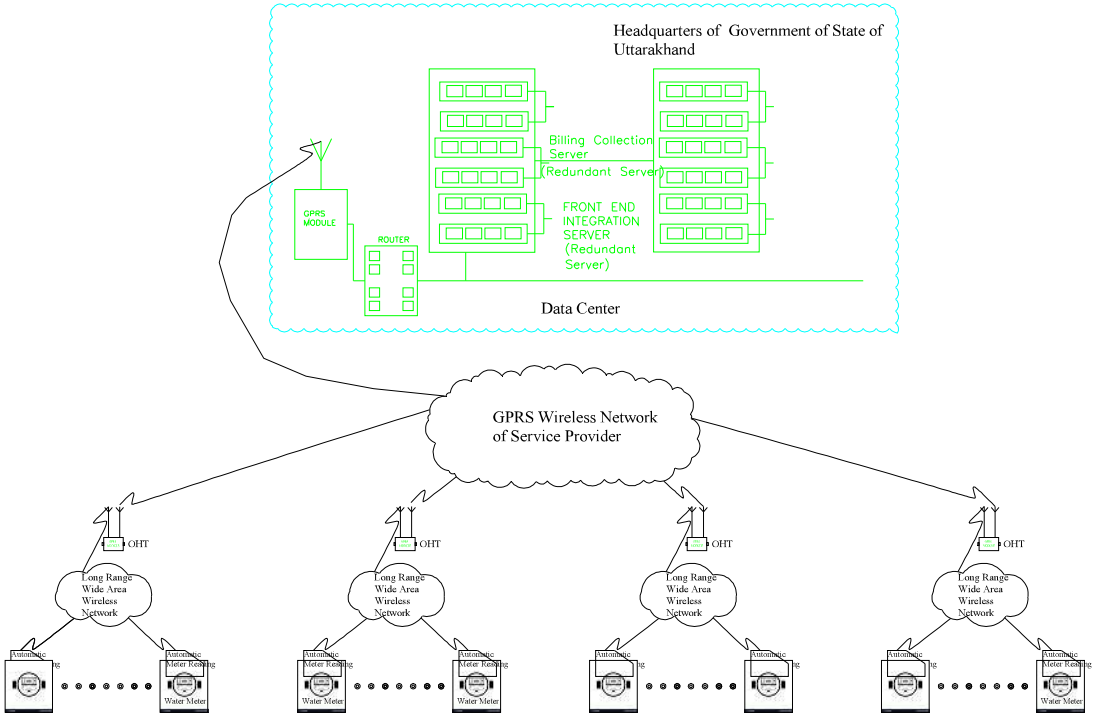
- Installation of water meters with AMR: 26 towns
- Water meters with AMR or unknown: 1 town
- Water meters without AMR: 3 towns
- No water meters installed: 8 towns

Below are the status of smart meter installation and an outline diagram of the smart meter system.



Source: Prepared by JST

Figure 4-27 Smart meter (left) and gateway (right)

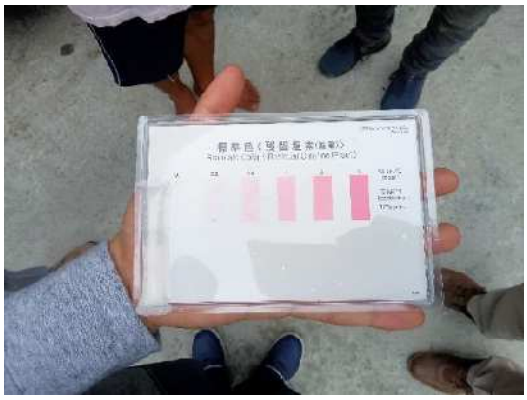


Source: Prepared by JST

Figure 4-28 Conceptual diagram of smart metering system

4.4.2 Water Quality at the Terminal Water Tap

During the field survey, residual chlorine was confirmed by a simple test (pack test) in the presence of UKPJN staff at the terminal tap of consumer supplied from the existing water supply facilities in Shivalik Nagar. As shown in the figure below, no residual chlorine was detected, suggesting that the chlorine injection control by the residents' organization was not appropriate.



Source: Prepared by JST

Figure 4-29 Residual chlorine measurement at the end of water supply in Shivalik Nagar

4.4.3 Leakage Conditions

The world average of non-revenue water is 30%, but the average non-revenue water in India is higher than this, i.e. at about 38%[9]. In reality, water meters are not installed in each area, or if installed, their operational status is unclear. Additionally, since charges are fixed, specific water usage quantities are unknown. Consequently, as the leakage situation cannot be assessed, an assumed non-revenue water rate is estimated.

Figure 4-30 shows a photo of a water pipe leak in Kirtinagar. There were other areas where leaks were observed, but they were only wrapped with cloth and not repaired.



Source: Prepared by JST

Figure 4-30 Leakage of existing water pipe in Kirtinagar

References for Chapter 4

[1] Ministry of Water Resources (2014) Ganges Basin

[2] NIDM (2015) Uttarakhand Disaster 2013

[3] Ground Water Year Book Uttarakhand (2021-2022)

[4] CGWB (2016) Aquifer Mapping and Ground Water Management Plan （Haridwar District, Uttarakhand)

[5] CGWB (2016) Aquifer Mapping and Ground Water Management Plan (Udham Singh Nagar District, Uttarakhand)

[6] Khan et al. (2018) Flows and sediment dynamics in the Ganga River under present and future climate scenarios

[7] Kumar et al. (2019) Technical report: Water at a glance, Uttarakhand, An assessment of Water Scarcity.

[8] CGWB (2010) District Groundwater Brochure of Nainital District, Uttarakhand

[9] Extent of Non-Revenue Water, Government of India, December 2021

Chapter 5 Current Status and Issues in the Sewerage Sector

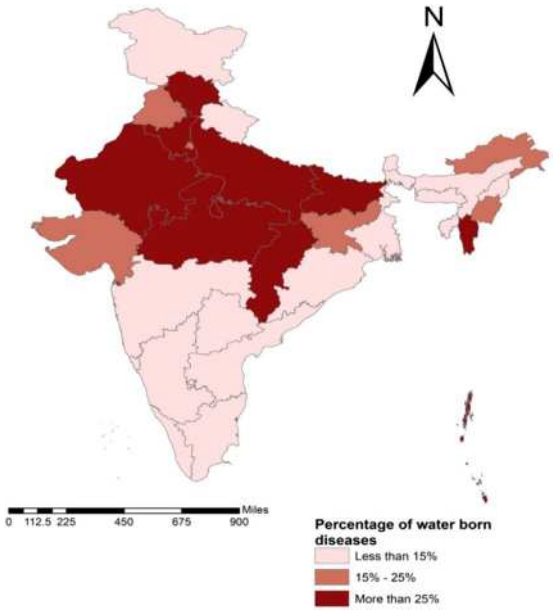
5.1 Current Situation of Waterborne Disease Risks

5.1.1 Waterborne Disease Risks in India

According to a survey conducted in India targeting the elderly population across the country (*Kumar et al.*, 2022)[1], the prevalence of waterborne diseases in rural areas with inadequate water supply facilities tends to be approximately twice as high as in urban areas. Geographically, the central Indian states such as Chhattisgarh and Madhya Pradesh exhibit high rates of waterborne diseases.

On the other hand, in the case of the UK state, the rural areas show slightly lower prevalence rates (rural areas: 11.6%, urban areas: 14.2%). Although not mentioned in the research, it can be inferred that factors such as the good quality of surface water sources in mountainous regions and the presence of slums and deteriorating river water quality in urban areas may be influencing these results. Comparing the prevalence rates of each state as shown in the table below, it can be said that the waterborne disease risk in the UK state is relatively low to moderate.

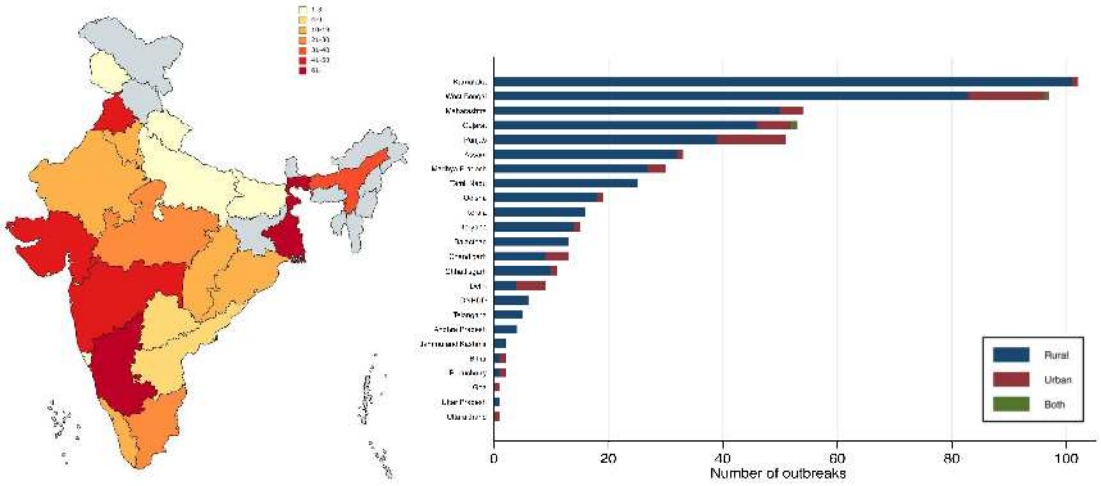
States	Rural (%)	Urban (%)	*p*-value
Jammu & Kashmir	10.4	6.6	<0.001
Himachal Pradesh	28.7	32.9	<0.001
Punjab	22.0	23.9	0.108
Chandigarh	0.0	11.5	<0.001
Uttarakhand	11.6	14.2	<0.001
Haryana	35.2	37.4	<0.001
Delhi	0.0	17.5	<0.001
Rajasthan	34.9	25.3	<0.001
Uttar Pradesh	33.5	28.7	<0.001
Bihar	33.7	30.3	<0.001
Arunachal Pradesh	24.5	0.9	<0.001
Nagaland	1.2	2.8	<0.001
Manipur	19.7	34.1	<0.001
Mizoram	34.5	36.1	<0.001
Tripura	13.5	8.6	<0.001
Meghalaya	9.5	5.5	<0.001
Assam	12.6	7.2	<0.001
West Bengal	14.9	10.1	<0.001
Jharkhand	18.1	12.5	<0.001
Odisha	11.1	8.1	<0.001
Chhattisgarh	38.5	30.4	<0.001
Madhya Pradesh	36.0	28.1	<0.001
Gujarat	22.3	14.5	<0.001
Daman & Diu	20.1	12.8	<0.001
Dadra & Nagar Haveli	44.9	42.0	<0.001
Maharashtra	12.8	4.9	<0.001
Andhra Pradesh	9.1	3.3	<0.001
Karnataka	14.5	1.9	<0.001
Goa	8.6	4.1	<0.001
Lakshadweep	7.3	1.5	<0.001
Kerala	3.9	3.5	0.665
Tamil Nadu	7.7	5.0	0.567
Puducherry	8.9	1.7	<0.001
Andaman & Nicobar Island	26.0	18.2	<0.001
Telangana	8.8	8.3	0.287
India	**22.5**	**12.2**	<0.001



Source: *Kumar et al.*, 2022

Figure 5-1 State-wise waterborne disease prevalence rates in India

Furthermore, according to a survey report[2] summarizing the occurrence of cholera outbreaks across India from 2011 to 2020, it can be observed that the frequency of cholera outbreaks in the UK state is relatively low compared to other states. Moreover, as shown in the table in the following section, there have been no reported cases of cholera within the state since 2017.

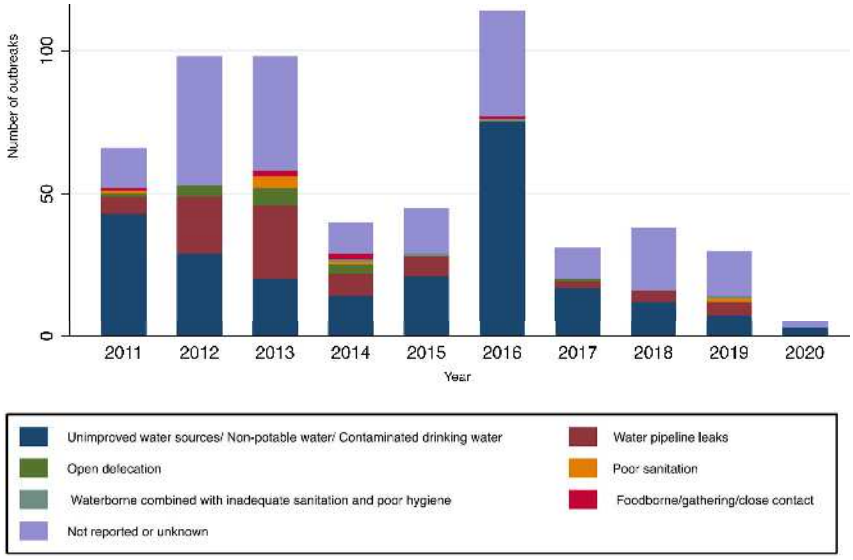


Source: *Basilua et al.*, 2022

Figure 5-2 State-wise case of cholera outbreaks in India from 2011 to 2020

As shown in Figure 5-3, the number of cholera outbreaks in India has been gradually decreasing in recent years. The sharp decline in 2020 may be attributed to a decrease in reported cholera cases during the COVID-19 pandemic. However, at least from 2017 to 2019, the number of outbreaks remained relatively low.

Among the contributing factors to cholera infections, the lack of adequate water supply and sanitation facilities has been identified as the most common. It is suggested that the progress in the improvement of these facilities in recent years has contributed to the decline in cholera cases.



Source: *Basilua et al.*, 2022

Figure 5-3 Number of cholera outbreaks in India from 2011 to 2020

5.1.2 Waterborne Disease Risks in the UK State

(1) District-wise cases of waterborne diseases

The following table shows the number of cases of waterborne diseases (Typhoid fever, Viral hepatitis A, Viral hepatitis E, Cholera) in each district from 2017 to 2022. These diseases are primarily transmitted through oral ingestion of bacteria and viruses excreted in the faeces of infected individuals, via water or contaminated food. The data serves as an indicator of the situation regarding insufficient sanitation facilities, faecal contamination of water bodies and soil, and deficiencies in water supply systems in the respective regions.

Table 5-1 District-wise cases of waterborne diseases (1/2)

Typhoid

DISTRICT	2017	2018	2019	2020	2021	2022
ALMORA	1851	2400	2121	278	423	1149
BAGESHWAR	896	1192	1460	1019	804	67
CHAMOLI	258	268	232	37	77	911
CHAMPAVAT	554	857	507	116	127	317
DEHRADUN	10045	9740	7186	1103	390	751
HARIDWAR	2703	1392	1679	443	374	388
NAINITAL	328	390	1059	440	642	1667
PAURI GARHWAL	2510	2591	2553	1310	1637	1024
PITHORAGARH	1022	2113	2071	1574	1385	1498
RUDRA PRAYAG	676	1049	1018	442	372	768
TEHRI GARHWAL	229	176	975	175	228	211
UDHAMSINGH NAGAR	1035	1498	5336	1727	776	193
UTTARKASHI	642	809	1028	285	445	210
Total	22749	24475	27225	8949	7680	9154

Table 5-1 District-wise cases of waterborne diseases (2/2)

Viral Hepatitis A

DISTRICT	2017	2018	2019	2020	2021	2022
ALMORA	0	0	0	0	0	0
BAGESHWAR	0	0	0	0	0	0
CHAMOLI	0	0	27	0	0	0
CHAMPAVAT	0	35	64	11	60	0
DEHRADUN	207	113	130	17	26	1
HARIDWAR	0	0	0	0	0	14
NAINITAL	0	26	38	11	1	72
PAURI GARHWAL	1	0	0	0	16	1
PITHORAGARH	0	0	16	0	0	0
RUDRA PRAYAG	0	0	0	0	0	0
TEHRI GARHWAL	0	0	0	0	0	0
UDHAMSINGH NAGAR	9	0	0	0	0	0
UTTARKASHI	0	1	0	0	0	0
Total	217	175	275	39	103	88

Viral Hepatitis E

DISTRICT	2017	2018	2019	2020	2021	2022
ALMORA	9	0	0	0	0	0
BAGESHWAR	0	0	0	0	0	0
CHAMOLI	0	0	0	0	0	0
CHAMPAVAT	0	0	0	0	0	0
DEHRADUN	162	77	36	1	6	1
HARIDWAR	0	0	0	0	0	9
NAINITAL	0	9	13	2	0	38
PAURI GARHWAL	0	0	0	0	0	0
PITHORAGARH	0	0	0	0	0	0
RUDRA PRAYAG	0	0	0	0	0	0
TEHRI GARHWAL	0	0	0	0	0	0
UDHAMSINGH NAGAR	0	0	0	0	0	0
UTTARKASHI	0	0	0	8	0	0
Total	171	86	49	11	6	48

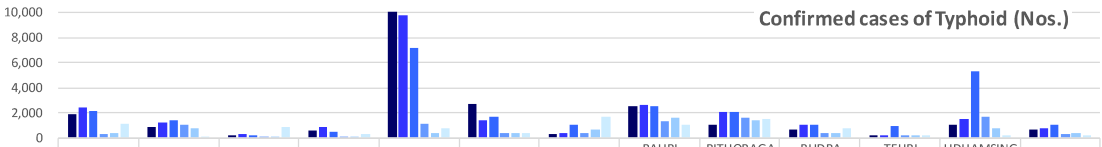
Cholera

DISTRICT	2017	2018	2019	2020	2021	2022
ALMORA	0	0	0	0	0	0
BAGESHWAR	0	0	0	0	0	0
CHAMOLI	0	0	0	0	0	0
CHAMPAVAT	0	0	0	0	0	0
DEHRADUN	0	0	0	0	0	0
HARIDWAR	0	0	0	0	0	0
NAINITAL	0	0	0	0	0	0
PAURI GARHWAL	0	0	0	0	0	0
PITHORAGARH	0	0	0	0	0	0
RUDRA PRAYAG	0	0	0	0	0	0
TEHRI GARHWAL	0	0	0	0	0	0
UDHAMSINGH NAGAR	0	0	0	0	0	0
UTTARKASHI	0	0	0	0	0	0
Total	0	0	0	0	0	0

Source: Directorate of Medical Health and Family Welfare, Uttarakhand

From the same Table 5-1, particularly noteworthy is the significant occurrence of typhoid fever infections, which have been reported throughout the entire UK state. Occurrences of viral hepatitis A and E have been observed locally, while there have been no reports of cholera cases since 2017.

To understand the recent trends in waterborne infectious diseases, Figure 5-4 focuses on the number of confirmed cases (typhoid fever) in district-wise. As an overall trend, there has been a sharp decline in the number of cases since 2020 (a similar trend is observed for Viral hepatitis A and E). While there is a possibility of a decrease in case reporting due to the COVID-19 pandemic, in Dehradun, there has been a reduction of approximately 2,500 cases compared to the previous year as of 2019. During 2018-2019, nine sewage treatment plants (totalling 33.5 MLD) were newly commissioned in the same region, which could have contributed to reducing the incidence of infectious diseases.

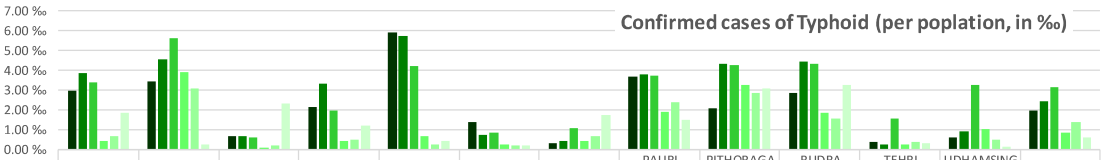


	ALMORA	BAGESHWAR	CHAMOLI	CHAMPAVAT	DEHRADUN	HARIDWAR	NAINITAL	PAURI GARHWAL	PITHORAGARH	RUDRA PRAYAG	TEHRI GARHWAL	UDHAMSINGH NAGAR	UTTARKASHI
2017	1,851	896	258	554	10,045	2,703	328	2,510	1,022	676	229	1,035	642
2018	2,400	1,192	268	857	9,740	1,392	390	2,591	2,113	1,049	176	1,498	809
2019	2,121	1,460	232	507	7,186	1,679	1,059	2,553	2,071	1,018	975	5,336	1,028
2020	278	1,019	37	116	1,103	443	440	1,310	1,574	442	175	1,727	285
2021	423	804	77	127	390	374	642	1,637	1,385	372	228	776	445
2022	1,149	67	911	317	751	388	1,667	1,024	1,498	768	211	193	210

Source: Prepared by JST

Figure 5-4 District-wise cases of typhoid from 2017 to 2022

Figure 5-5 shows the incidence rate (‰) of typhoid fever, considering the population size of each prefecture. From this figure, there are no clear differences observed based on the geographical classification of mountainous and plain regions. Referring to the period from 2017 to 2019, excluding the time of the COVID-19 pandemic, the following regions on the left side of the graph show relatively higher incidence rates: Almora, Bageshwar, Champavat, Dehradun, Pauri, Pithoragarh, Rudra Prayag, and Uttarkashi.



	ALMORA	BAGESHWAR	CHAMOLI	CHAMPAVAT	DEHRADUN	HARIDWAR	NAINITAL	PAURI GARHWAL	PITHORAGARH	RUDRA PRAYAG	TEHRI GARHWAL	UDHAMSINGH NAGAR	UTTARKASHI
2017	2.98 ‰	3.45 ‰	0.66 ‰	2.14 ‰	5.91 ‰	1.40 ‰	0.34 ‰	3.66 ‰	2.10 ‰	2.85 ‰	0.37 ‰	0.63 ‰	1.95 ‰
2018	3.86 ‰	4.59 ‰	0.69 ‰	3.30 ‰	5.73 ‰	0.72 ‰	0.41 ‰	3.77 ‰	4.35 ‰	4.43 ‰	0.29 ‰	0.91 ‰	2.45 ‰
2019	3.41 ‰	5.62 ‰	0.59 ‰	1.96 ‰	4.23 ‰	0.87 ‰	1.11 ‰	3.72 ‰	4.26 ‰	4.30 ‰	1.58 ‰	3.24 ‰	3.12 ‰
2020	0.45 ‰	3.92 ‰	0.09 ‰	0.45 ‰	0.65 ‰	0.23 ‰	0.46 ‰	1.91 ‰	3.24 ‰	1.87 ‰	0.28 ‰	1.05 ‰	0.86 ‰
2021	0.68 ‰	3.09 ‰	0.20 ‰	0.49 ‰	0.23 ‰	0.19 ‰	0.67 ‰	2.38 ‰	2.85 ‰	1.57 ‰	0.37 ‰	0.47 ‰	1.35 ‰
2022	1.85 ‰	0.26 ‰	2.33 ‰	1.22 ‰	0.44 ‰	0.20 ‰	1.75 ‰	1.49 ‰	3.08 ‰	3.24 ‰	0.34 ‰	0.12 ‰	0.64 ‰

Source: Prepared by JST

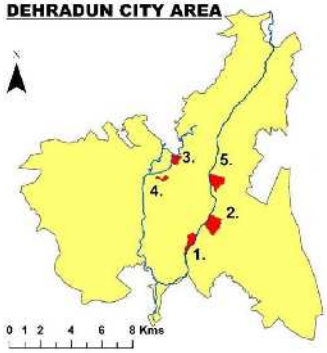
Figure 5-5 District-wise cases of typhoid per population from 2017 to 2022

(2) Waterborne disease risks in slum areas

In India, it is known that the risk of waterborne diseases increases during the monsoon season, which typically lasts from around May to September. This trend is also observed in the UK state. Within Dehradun, there are 128 slum areas, and a previous study (*Agarwal et al.*, 2023)[3] focused on the five of these areas reported an increase in the coliform count in drinking water during the monsoon period in August.

In the same survey, a questionnaire was administered to 150 children (aged 0-5) of 150 households. The reported incidence of waterborne infectious diseases, in descending order of the number of cases, includes diarrhoea, gastroenteritis, jaundice, urinary tract infections, dysentery, and typhoid as shown in Table 5-3.

Table 5-2 Coliform counts in drinking water in the slums (Pre- and post-monsoon)



Slum	Water Contamination Indicator			
	Average Total Coliforms		Average *E.coli*	
	Pre	Post	Pre	Post
Deep Nagar	326.6	2210.7	17.25	10.55
Rajeev Nagar	59.25	227.5	1.1	17.35
Indira Nagar Colony (INC)	284.2	2260.9	1.9	30.7
New Khurbura	97.5	625.8	57.7	38.75
Bhagat Singh Colony (BSC)	106.6	322.8	16.6	14.5
	174.8±112.3	1129.5±970.3	18.9±20.7	22.4±11.7

Source: *Agarwal et al.*, 2023

Table 5-3 Cases of waterborne diseases per 1000 population of children in the slums

Diseases	Cases per 1000 Population of Children				
	Deep Nagar	Rajeev Nagar	Indira Nagar Colony	New Khurbura	Bhagat Singh Colony
Diarrhea	404	386	367	357	278
Gastroenteritis	106	175	200	214	111
Jaundice	106	123	33	71	111
UTI	106	88	67	71	56
Dysentery	64	70	67	71	56
Typhoid	43	70	33	71	56

Source: *Agarwal et al.*, 2023

(3) Project contribution to reducing waterborne disease risks

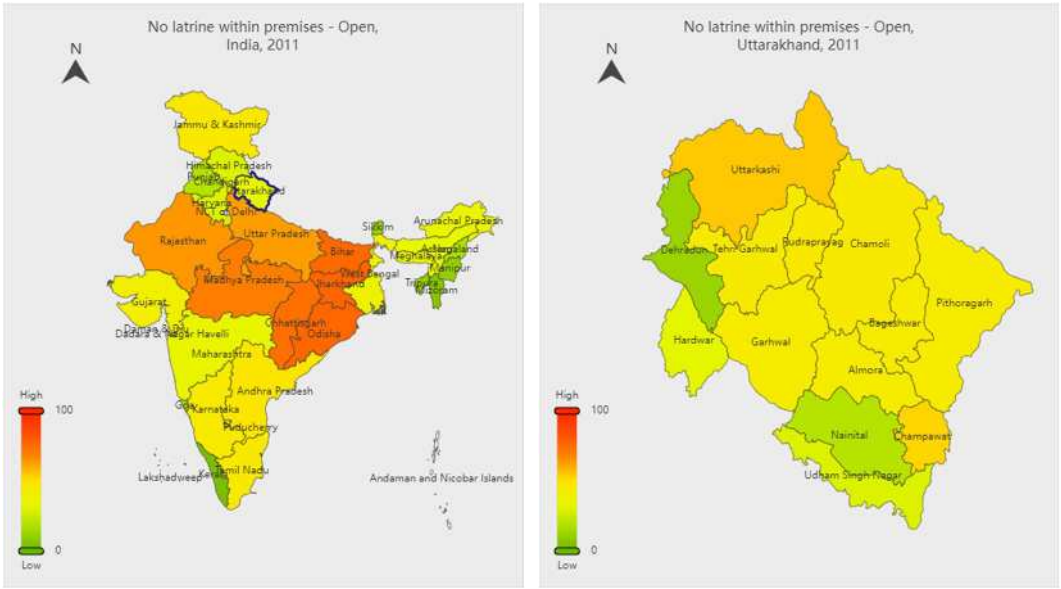
As shown in Figure 5.4, the recent decline in infectious disease cases over the past three years is likely a result of factors such as the disruptions caused by the COVID-19 pandemic, reduced healthcare visits, and improved hygiene awareness related to infection prevention. Therefore, to accurately assess the current situation, it is necessary to monitor data trends beyond 2023. While a quantitative evaluation of this project contribution to reducing waterborne infectious disease risks, especially those stemming from faecal contamination,

may not be possible, it is clear that developing a water supply system with ensured water quality and quantity primarily contributes to fundamental risk reduction. Urban areas must prioritize proper sewage treatment to protect residents from ongoing exposure to contamination risks. A comprehensive approach integrating water supply and sewage facilities is essential for effective mitigation.

5.2 Status of Sanitation Facilities

Figure 5-6 shows the percentage of households with open defecation in each state of India and districts within the UK state as of 2011. At that time, the UK state had relatively better sanitation facilities, and outdoor defecation was already minimal, particularly in urban areas and the plains.

In 2014, a national initiative called Swachh Bharat Mission was launched, aiming to eliminate open defecation. Through this program, more than 100 million toilets were constructed primarily in rural areas across India until 2019. It is worth noting that as of February 2018, open defecation was reported to be eradicated in all areas of the UK state[4].



Source: Census India 2011

Figure 5-6 The percentage of households with open defecation in India and the UK



Source: Situation Assessment Report, 2019

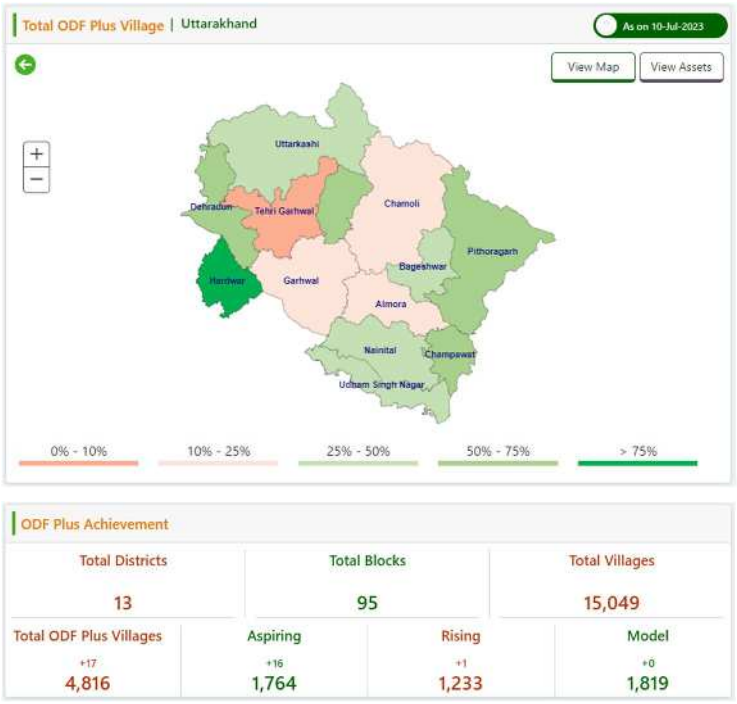
Figure 5-7 Examples of community toilets and portable temporary toilets for events

In the ongoing Swachh Bharat Mission (Phase-2), the objective is to achieve sustainable Open Defecation Free (ODF) status, and a concept called "ODF plus" has been introduced. The project has established three-stage classification criteria, as shown in the table below, with the ultimate goal of all local bodies aiming to achieve the "ODF plus Model."

Table 5-4 The criteria for "ODF plus" in the Swachh Bharat Mission (Phase 2)

Classification	Criteria
ODF Plus Aspiring	① All households have access to sanitation facilities. ② All schools, childcare centres, and government buildings have separate sanitation facilities for males and females. ③ Waste management or sewage treatment is carried out within the community.
ODF Plus Rising	① All households have access to sanitation facilities. ② All schools, childcare centres, and government buildings have separate sanitation facilities for males and females. ③ Waste management and sewage treatment are carried out within the community.
ODF Plus Model	① All households have access to sanitation facilities. ② All schools, childcare centres, and government buildings have separate sanitation facilities for males and females. ③ Waste management and sewage treatment are carried out within the community. ④ There is minimal evidence of waste dumping and water pollution within the community. ⑤ Residents are informed about ODF plus initiatives through signboards and other awareness materials.

Source: SBM Grameen



Source: SBM Grameen

Figure 5-8 Progress of ODF plus achievement in the UK state

5.3 Status of Sewage Treatment

5.3.1 Overview of the Sewerage Status in the UK State

(1) Generated sewage volume

This report considers the estimated sewage generation of 627 MLD as the latest value, based on calculations[5] by CPCB for the year 2020. This is in contrast to the UKPCB data, which provided a figure of 554 MLD (Urban: 329 MLD, Rural: 225 MLD) based on the Census 2011 population.

(2) Development status of sewage treatment plants

The combined treatment capacity, considering existing, under-construction, and planned facilities, amounts to 584 MLD. If all these facilities operate at their designed capacity, they will collectively treat 93% of the current sewage generation, which is based on the estimated value of 627 MLD as of now.

(3) Actual utilization status of sewage treatment plants

Of the existing facility capacity of 397 MLD, the actual sewage flow being treated at the sewage treatment plants, after completion of pipeline infrastructure and household connections, amounts to 235 MLD (59% of the existing facility capacity). The remaining 162 MLD capacity is expected to be effectively utilized, depending on the progress of household connections in the future.

(4) Status of onsite treatment

Based on the above information, the actual sewage flow being treated at the sewage treatment plant is 235 MLD, which accounts for 37% of the total sewage generation. The remaining 392 MLD (or 63% of the total) is likely to be either managed through on-site treatment such as septic tanks or soak pits at individual households or released untreated into the environment.

Table 5-5 Summary of Sewage treatment plants in the UK State

Item	MLD	%	Source
Generated sewage volume	**627**	100%	CPCB
STP Capacity : Exsting, On-going, Proposed	**584**	93%	UKPCB
STP Capacity : Exsting	397	-	UKPCB
STP Capacity : On-going	146	-	UKPCB
STP Capacity : Proposed	41	-	UKPCB
Actual sewage flow into the STPs	**235**	37%	UKPCB

Source: Prepared by JST

(5) Estimated sewage volume

Based on the population projections[6] made by the Indian government in 2020, the population of the UK state is expected to increase by approximately 1.14 times from 2021 to 2036. While this is a simple calculation, it is estimated that the sewage generation at that time would increase to 714 MLD (= 627 MLD × 1.14). Considering the current treatment capacity of 584 MLD, which includes proposed facilities, the sewage treatment rate would remain around 80%. Therefore, it can be concluded that there will be a need for additional expansion plans for sewage treatment facilities in the future.

5.3.2 On-site Treatment Systems

(1) Status of onsite treatment

Based on the Water Supply and Sewerage Byelaws issued by UJS in 2008, each household within the UK state is required to be connected to the sewerage system or install a septic tank[7]. Domestic sewage and effluent from septic tanks are either drained into roadside drains or infiltrated into the soil through soak pits on the premises. There are fewer households with soak pits in areas with a high-water table[8].

Even in Dehradun city, where sewage infrastructure is being developed, the sewerage connection rate is still only 34% as of 2020[9]. Households not connected to the sewerage system manage their sewage with septic tanks. However, untreated effluent from poorly maintained septic tanks and raw sewage from unconnected households is being discharged into roadside drains and eventually into rivers and Nalas.

Furthermore, as shown in Figure 5-9, houses along the riverbanks are directly discharging sewage into the rivers through sewage pipes protruding from the embankments. As a result, the rivers within the city are severely polluted, as illustrated in Figure 5-18.



Source: Prepared by JST based on the data from UKPCB

Figure 5-9 Examples of sewage disposal into River Bindal in Dehradun city

(2) Maintenance status of septic tanks

In order for septic tanks to function at their designated capacity, regular tank cleaning (removal of accumulated sludge) is essential. However, in some regions, due to septic tank cleaning being carried out based on individual household requests, there are areas where maintenance has been neglected for as long as 10 to 15 years[9].

For septic tank cleaning, each local municipality should possess vacuum trucks and be responsible for the cleaning tasks for each household's septic tanks. However, many municipalities are facing financial constraints and cannot secure these vacuum trucks. In such cases, private companies with vacuum trucks are subcontracted for the cleaning services[8]. The fees for sludge removal by the municipalities or private companies typically range from approximately INR 1,000 to 3,500 per cleaning, and in some areas, the charges offered by private companies might even be lower. Additionally, there seems to be a tendency to add extra charges for remote locations[8].

On the other hand, despite the Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, 1993, which prohibits manual scavenging, some regions continue to employ this practice. In such cases of not only manual scavenging but also cases where residents directly hire private companies without involving the local municipality, the sludge removed is reportedly being illegally dumped on some other property, roadside drains, or within the local water bodies[8].

When residents request cleaning services, it is often in urgent situations where septic tank issues (such as overflowing or toilets not flushing) have arisen. Despite the urgency, residents are required to visit the municipal office and make a pre-payment to apply for septic tank cleaning, and in many cases, the actual cleaning work is scheduled for the next day or even the day after. As a result, residents tend to prefer directly contacting private companies that can promptly respond to their needs.



Source: SCBP

Figure 5-10 vacuum trucks (Left: UJS Dehradun, Right: UJS New Tehri)

(3) Treatment status of septage sludge

In areas where sewage treatment plants and septage sludge treatment facilities are not established, septage sludge is transported to neighbouring regions' treatment facilities for processing. However, in such cases, the transportation costs for septage sludge can become significant, particularly for remote areas. To address this situation, UJS is considering the installation of septage sludge treatment facilities in each region, seen as a pressing priority.

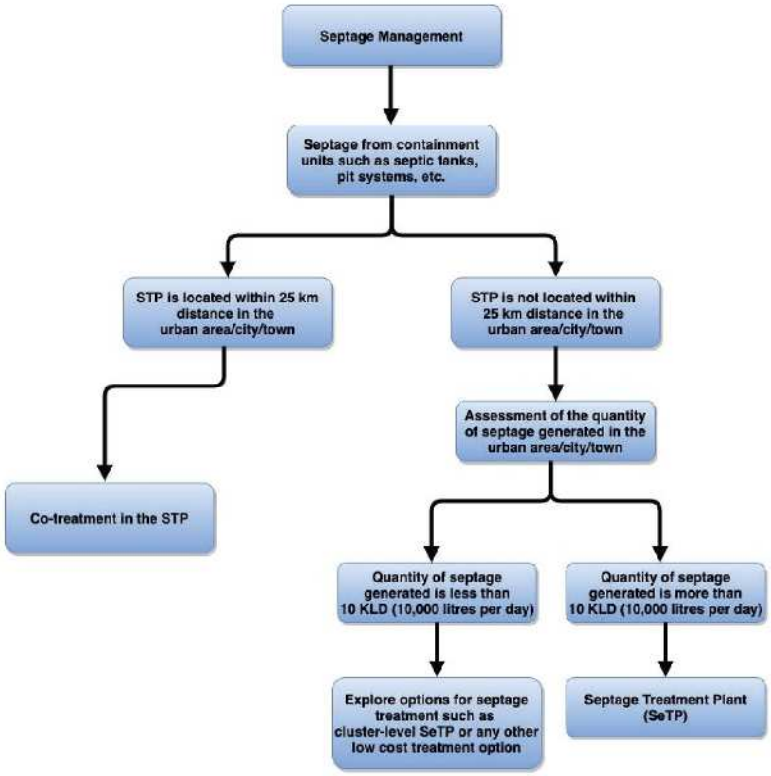
(4) Current trends in septage sludge treatment development

In pursuit of improving septic tank sludge management, the Urban Development Department of the UK state issued the "Protocol for Septage Management" in May 2017. The supplementary document[10] outlines an efficient facility development plan based on regional conditions and the amount of generated septage sludge, as illustrated in Figure 5-11. The main points of the chart are as follows. The responsibility for preparing DPR for these facility development plans lies with UKPJN.

① If an existing sewage treatment plant is located within 25 km from the area of septage sludge generation, the sludge is transported and processed at the treatment plant. For example, septage sludge generated within Chamba is transported to the existing sewage treatment plant in New Tehri, where it is treated together with the sewage sludge.

② For locations situated more than 25 km away, the plan involves developing septage sludge treatment facilities within the respective region to handle the sludge. In cases where the volume of septage sludge is less than 10 KLD, co-treatment facilities are established in neighbouring areas.

③ In regions where regular transportation of septage sludge by vacuum trucks is impractical due to extremely poor accessibility, the plan explores the development of small-scale decentralized sewage treatment facilities (not explicitly shown in the flowchart but mentioned in the document).



Source: Protocol for Septage Management

Figure 5-11 Selection flow format for septage sludge treatment facility development

5.3.3 Off-site Treatment Systems

(1) List of sewage treatment plants in the UK state

Regarding the sewage treatment plants in the UK state, tables compiled based on the information provided by UKPCB (as of October 2022) are attached on the following pages. Table 5-6 includes the existing sewage treatment plants, while Table 5-7 lists the currently on-going (under construction) and proposed sewage treatment plants.

Table 5-6 List of the existing sewage treatment plants in the UK state

Sl.	City / Town	Location of STP	Date of Commissioning	Installed Capacity of STP (In MLD)	Actual Utilization of installed Capacity (In MLD)	System
Ext-01	Chamoli	Badrinath (Banni Gaon)	2017	0.26	0.050	SBR
Ext-02	Chamoli	Badinath (Near Temple)	2019	0.01	0.005	MBBR
Ext-03	Chamoli	Badrinath (NearsuspensionBridge)	2019	1.00	0.200	SBR
Ext-04	Chamoli	Joshimath (Pokhri)	2019	1.08	0.421	SBR
Ext-05	Chamoli	Gopeshwar (Chamoli Ghat)	2018	0.76	0.050	EC
Ext-06	Chamoli	Gopeshwar (Near Suspension Bridge)	2018	0.05	0.010	EC
Ext-07	Chamoli	Gopeshwar (Vivekanand Colony)	2019	1.19	0.500	EC
Ext-08	Chamoli	Gopeshwar (Deen Dayal Upadhyak)	2019	1.12	0.075	EC
Ext-09	Chamoli	Gopeshwar (Pokhari Band)	2019	1.25	0.500	EC
Ext-10	Chamoli	Nandprayag (Sangam Road)	2018	0.05	0.015	EC
Ext-11	Chamoli	Nandprayag (Forest Office)	2018	0.10	0.090	EC
Ext-12	Chamoli	karan Prayag (Police Chowki)	2018	0.05	0.050	EC
Ext-13	Chamoli	karan Prayag (Purana Pull)	2018	0.10	0.080	EC
Ext-14	Chamoli	karan Prayag (Ward number 1 &3)	2018	0.10	0.035	EC
Ext-15	Chamoli	karan Prayag (Subhash Nagar)	2019	0.05	0.020	EC
Ext-16	Chamoli	karan Prayag (Naya Pull)	2019	0.05	0.005	EC
Ext-17	Rudraprayag	Rudraprayag (Near Anoop Negi School)	2019	0.08	0.075	EC
Ext-18	Rudraprayag	Rudraprayag (Near Rudra Complex)	2019	0.10	0.080	EC
Ext-19	Rudraprayag	Rudraprayag (Near Bus Stand)	2019	0.08	0.075	EC
Ext-20	Rudraprayag	Rudraprayag (Near SBI & Maszid)	2019	0.10	0.090	EC
Ext-21	Rudraprayag	Rudraprayag (Near Steel Bridge)	2019	0.13	0.125	EC
Ext-22	Rudraprayag	Rudraprayag (Belani)	NA	0.05	0.025	NA
Ext-23	Tehri Garhwal	Kirtinagar (BRO Bridge)	2018	0.05	0.030	MBBR
Ext-24	Tehri Garhwal	Kirtinagar (Near Temple)	2018	0.01	0.010	MBBR
Ext-25	Tehri Garhwal	New Tehri (Bhagirathipuram)	2006	5.00	2.500	SBR
Ext-26	Tehri Garhwal	Dhalwala (Chorpani)	NA	5.00	4.200	MBBR
Ext-27	Tehri Garhwal	Dhalwala (Chandreshwar Ghat)	NA	7.50	6.500	MBBR
Ext-28	Tehri Garhwal	Rishikesh (Tapovan)	2016	3.50	1.100	SBR
Ext-29	Tehri Garhwal	Devprayag (Shanti bazar)	2017	0.08	0.040	SBR
Ext-30	Tehri Garhwal	Devprayag (Sangam bazar)	2017	0.15	0.150	SBR
Ext-31	Uttarkashi	Devpravag (Baah Bazar)	2016	1.40	0.040	SBR
Ext-32	Uttarkashi	Uttarkashi (Gyansu)	2012	2.00	1.783	MBBR
Ext-33	Uttarkashi	Uttarkashi (Gangotri)	NA	1.00	0.200	SBR
Ext-34	Pauri Garhwal	Srinagar (Nursery Road)	2009	3.50	1.500	MBBR
Ext-35	Pauri Garhwal	Srinagar (Near ITI)	2019	1.00	0.500	SBR
Ext-36	Pauri Garhwal	Srikot (Taulia)	NA	0.05	0.008	NA
Ext-37	Pauri Garhwal	Srikot (Near JH school)	NA	0.08	0.070	NA
Ext-38	Pauri Garhwal	Rishikesh (Swargashram)	2010	3.00	2.120	SBR
Ext-39	Dehradun	Rishikesh (Lakkarghat)	2020	26.00	12.300	SBR
Ext-40	Haridwar	Haridwar (Jagjeetpur)	2010	27.00	27.000	SBR
Ext-41	Haridwar	Haridwar (Jagjeetpur)	1990	18.00	18.000	SBR
Ext-42	Haridwar	Haridwar (Jagjeetpur)	2020	68.00	45.020	SBR
Ext-43	Haridwar	Haridwar (Sarai-I)	2013	18.00	18.000	SBR
Ext-44	Haridwar	Haridwar (Sarai-II)	2013	14.00	13.020	SBR
Ext-45	Haridwar	Roorkee (Saliyar)	NA	33.00	20.000	SBR
Ext-46	Dehradun	Dehradun (Motharawala-I)	2016	20.00	13.520	SBR
Ext-47	Dehradun	Dehradun (Motharawala-II)	2018	20.00	11.000	SBR
Ext-48	Dehradun	Dehradun (Kargi)	2015	68.00	13.000	SBR
Ext-49	Dehradun	Dehradun (Vijay Colony)	2019	0.42	0.300	SBR
Ext-50	Dehradun	Dehradun (Salawala)	2019	0.72	0.350	SBR
Ext-51	Dehradun	Dehradun (Indira Nagar)	2019	5.00	5.000	SBR
Ext-52	Dehradun	Dehradun (Jakhan)	2016	1.00	0.140	SBR
Ext-53	Dehradun	Mussoorie (Bhattafall)	2019	3.12	0.800	SBR
Ext-54	Dehradun	Mussoorie (Happy Vally)	2019	1.20	0.200	SBR
Ext-55	Dehradun	Mussoorie (Landour, South)	2019	1.30	0.100	SBR
Ext-56	Dehradun	Mussoorie (Landour, North)	2019	0.80	0.035	SBR
Ext-57	Dehradun	Mussoorie (Kulri Bazaar)	2019	0.90	0.350	SBR
Ext-58	Nainital	Nainital (Hari Nagar)	2016	0.45	0.250	SBR
Ext-59	Nainital	Nainital (Krishnapur)	2016	0.80	0.450	SBR
Ext-60	Nainital	Nainital (Bheemtal)	2009	1.25	0.810	UASB
Ext-61	Nainital	Almora (Bakh)	NA	2.00	1.650	NA
Ext-62	Nainital	Rusi Pond,Nainital	2009	10.00	6.750	Pond
Ext-63	Pithoragarth	Pithoragarth (Acholi)	2020	5.00	1.000	SBR
Ext-64	Pithoragarth	Pithoragarth (Mirada)	2020	1.25	0.800	SBR
Ext-65	Nainital	Ramnagar (Transport Nagar)	NA	7.00	2.500	NA
Ext-66	Nainital	Ramnagar (Puchdi)	NA	1.50	0.150	NA
Ext-67	Nainital	Nainital (Narayan Nagar)	NA	0.45	-	NA
Total				**397.22**	**235.82**	

Source: Prepared by JST based on the data from CPCB and UKPCB

Table 5-7 List of the On-going and proposed sewage treatment plants in the UK state

Sl.	City / Town	Location of STP	Date of Commissioning	Installed Capacity of STP (In MLD)	Actual Utilization of installed Capacity (In MLD)	Project progress (%)	System	Status
Og-01	Dehradun	Dehradun (Kolagarth)	(2022, Dec)	3.00	-	70%	NA	Under Const.
Og-02	Chamoli	Joshimath (Marwari)	(2022, Dec)	2.70	-	99%	NA	Under Const.
Og-03	Nainital	Haldwani (Indira Nagar)	(2022, Dec)	28.00	-	99%	NA	Trial run
Og-04	U.S Nagar	Kashipur	(2024, Jan)	18.00	-	85%	NA	Under Const.
Og-05	U.S Nagar	Kashipur	(2024, Jan)	10.00	-	15%	NA	Under Const.
Og-06	U.S Nagar	Kashipur (Mukhandpur)	(2024, Jan)	0.50	-	0%	NA	Work started
Og-07	U.S Nagar	Kashipur (Gularia)	(2024, Jan)	0.30	-	0%	NA	Work started
Og-08	U.S Nagar	Kashipur (Jaspur Kurd)	(2024, Jan)	1.00	-	15%	NA	Under Const.
Og-09	U.S Nagar	Kashipur (Hempurlsmile)	(2024, Jan)	2.00	-	0%	NA	Under Land acq.
Og-10	U.S Nagar	Kashipur (Beljudi)	(2024, Jan)	0.50	-	0%	NA	Work started
Og-11	U.S Nagar	Bazpur	(2024, Jan)	10.00	-	0%	NA	Work started
Og-12	U.S Nagar	Rudrapur (Kichha)	(2024, Jan)	3.00	-	0%	NA	Work started
Og-13	U.S Nagar	Sitarganj	(2024, Jan)	3.00	-	0%	NA	Under Land acq.
Og-14	Nainital	Nainital (Roosi Pond)	(2025, May)	17.50	-	0%	NA	Under DD review
Og-15	Dehradun	Dehradun (Nakronda)	NA	17.50	-	0%	NA	Under DD review
Og-16	Dehradun	Dehradun (Daurwala)	(2025, June)	18.00	-	0%	NA	Under DD review
Og-17	Dehradun	Dehradun (Banjarawala)	(2025, June)	11.00	-	0%	NA	Under DD review
P-01	U.S Nagar	Rudrapur	NA	0.25	-	-	NA	DPR preparation (Namami Gange)
P-02	Dehradun	Mussoorie	NA	0.70	-	-	NA	Tender process
P-03	Dehradun	Mussoorie	NA	1.10	-	-	NA	Tender process
P-04	Dehradun	Mussoorie	NA	0.70	-	-	NA	Tender process
P-05	Dehradun	Mussoorie	NA	0.70	-	-	NA	Tender process
P-06	Dehradun	Mussoorie	NA	0.05	-	-	NA	Tender process
P-07	Almora	Pandeykhaula	NA	1.50	-	-	NA	Tender process
P-08	Uttarkashi	Uttarkashi (Gyansu)	NA	4.00	-	-	NA	DPR prepared
P-09	Dehradun	Rishikesh (Khadri)	NA	5.00	-	-	NA	Proposed under KfW
P-10	Tehri Garhwal	Rishikesh (Muni Ki Reti)	NA	5.00	-	-	NA	Tender process
P-11	Pauri Garhwal	Rishikesh (Swargashram)	NA	3.00	-	-	NA	Tender process
P-12	Pauri Garhwal	Rishikesh (Neelkanth)	NA	1.50	-	-	NA	Tender process
P-13	Nainital	Haldwani	NA	10.50	-	-	NA	DPR preparation (funded under ADB)
P-14	Nainital	Haldwani (Septage co-tretment plant)	NA	0.14	-	-	NA	DPR preparation (funded under ADB)
P-15	Dehradun	Vikasnagar	NA	7.00	-	-	NA	DPR preparation (funded under ADB)
P-16	Dehradun	Dehradun (Septage co-tretment plant)	NA	0.01	-	-	NA	DPR preparation (funded under ADB)

Source: Prepared by JST based on the data from UKPCB

(2) Status of sewerage facilities

Based on the results of the site survey, the following are examples of distinctive sewerage facilities in the UK state.

(a) Interceptor drains and sewage pumping stations

In Jwalapur, located in Haridwar district, there are no sewage treatment plants within the area. However, the untreated sewage from each household, which contaminates the Nala, is intercepted and directed towards the sewage pumping station before flowing into the Ganga Canal. From there, it is pumped to the nearby sewage treatment plant.

During rainy season, the flow of the Nala increases, surpassing the capacity of the interceptor drains. In such cases, the excess water overflows the weirs and flows directly into the Ganga Canal.

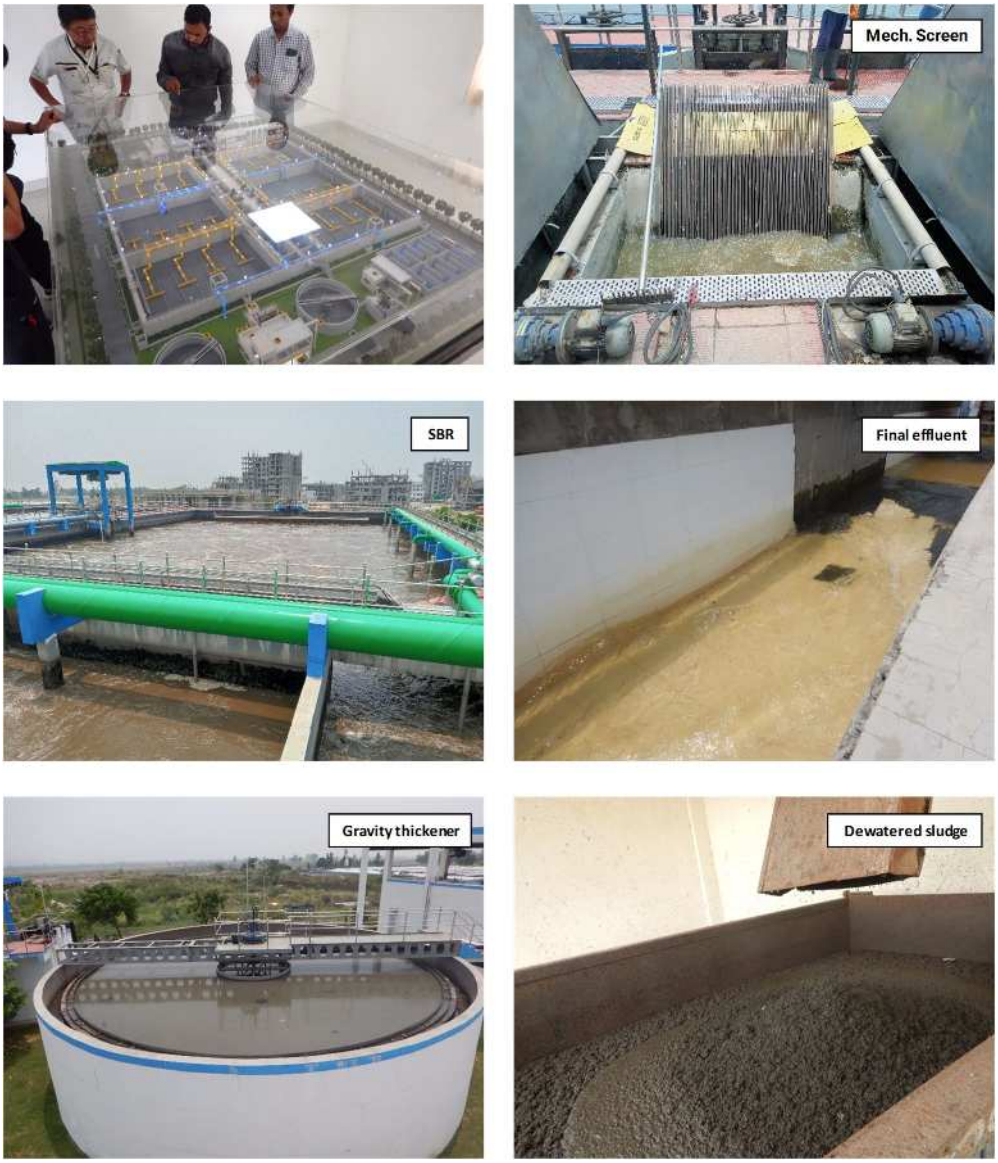


Source: JST

Figure 5-12 Interceptor drains and sewage pumping stations in Jwalapur

(b) Jagjeetpur 68 MLD STP (The largest STP in the UK state)

The largest sewage treatment plant in the UK state, located in Haridwar district, utilizes the Sequencing Batch Reactor (SBR) method, which has been widely successful in India. This plant began operations in 2020, and the current inflow rate is close to the planned capacity. Sludge treatment involves gravity thickening followed by centrifugal dewatering. Approximately 18 m^3 of dewatered sludge is generated daily, which nearby farmers transport to their own agricultural lands, where it is dried and utilized as compost (without composting treatment process at present). The plant's premises are well-maintained, and the operation and management are efficiently handled.



Sewage treatment flow: Grid chamber, SBR, Sedimentation, Chlorination, Irrigation and discharge

Sludge treatment flow: Gravity thickener, Centrifugal dewatering, Utilization to local agriculture

Source: JST

Figure 5-13 Jagjeetpur STP (68 MLD, Haridwar district)

(c) Rishikesh 7.5 MLD STP (Compact multi-Stage STP)

This sewage treatment plant began operations in 2020 and is located in close proximity to the Ganges River. During the rainy season, the water level in the river rises, making the front riverbank area unavailable for use, and imposing constraints on the available land for the facility. As a result, a compact design was adopted, consisting of three layers (1st floor: Equalization tank and grid chamber, 2nd floor: sedimentation tank and blowers, 3rd floor: MBBR tank) to optimize space utilization.



Sewage treatment flow:

Grid chamber, Equalization tank, MBBR, Sedimentation, Disk filter, Chlorination, discharge

Sludge treatment flow: Centrifugal dewatering, Incineration at nearby plant

Source: JST

Figure 5-14 Rishikesh 7.5 MLD STP

(d) New Tehri 5 MLD STP (STP in mountainous regions)

In mountainous regions with limited flat land, flat lands like terraced fields are established on the slopes to secure space for sewage treatment plant facilities. Each facility is strategically positioned considering the water level and topography. This spatial arrangement is also applied to water treatment plants, reflecting a well-planned facility layout tailored to the terrain conditions. The plant was commissioned in 2005 and uses an extended aeration process. Chemical dosing with Alum and Lime is carried out for phosphorus removal and pH adjustment, respectively.



Sewage treatment flow: Grid chamber, Extended aeration, Sedimentation, Chlorination, Soil infiltration
Sludge treatment flow: Gravity thickener, Centrifugal dewatering, Utilization to local agriculture

Source: JST

Figure 5-15 New Tehri 5 MLD STP

(e) Online Continuous Emissions/Effluents Monitoring Systems (OCEMS)

The effluent quality at each sewage treatment plant is continuously monitored in real-time using Online Continuous Emissions/Effluents Monitoring Systems (OCEMS). The monitoring data is promptly transmitted to the CPCB for regular assessment and surveillance of water quality. This system enables efficient and timely monitoring of the environmental impact of the treated water, ensuring compliance with regulatory standards and facilitating prompt corrective actions if required.





Source: JST

Figure 5-16 OCEMS at Rishkesh 26 MLD STP

(f) Technical issues on current sewage treatment operations

While relatively good operational management is observed at each sewage treatment plant, the findings from the site survey conducted by JST reveal some technical issues related to sewage treatment operations, as summarized in Table 5-8.

Table 5-8 Technical issues on current sewage treatment operations

Description	Issue
Rainwater inflow	Rishikesh 26 MLD STP (SBR) The current sewage inflow during the dry season is approximately 17 MLD, lower than the designed capacity of 26 MLD. In the future, it is anticipated that the sewage inflow will increase as more households are connected to the sewer system. However, although the facility is designed with a separate sewer system, the inflow volume during rainy season can increase to around 23 MLD due to the rainwater inflow from open drains. This raises concerns about potential strain on future treatment capacity, especially the sewage pumping capability, and a possible decline in treatment efficiency. Once all households connect their sewage pipes to the open drains, the open drains will be entirely covered, and it is expected that no further infiltration will occur. However, considering that open drains cannot be entirely sealed when covered, there are concerns that infiltration may still occur even after the connections are completed.
Effluent quality	New Tehri 5 MLD STP (Extended aeration) The treatment process is based on surface mechanical aeration with HRT of 24 hours. However, there are concerns regarding the appearance of black-coloured activated sludge within the aeration tank, and the effluent quality was not meeting the desired standards. Based on the data observed on site, it appears the BOD level exceeds the regulatory limit of 10 mg/L. The black-coloured activated sludge is commonly attributed to insufficient oxygen levels within the tank or the accumulation of anaerobic sludge within the system. To address this issue and improve treatment efficiency, operational adjustments are necessary. These adjustments may include increasing the aeration rate or adjusting the sludge withdrawal rate to lower the MLSS concentration within the tank. Jagjeetpur 68 MLD STP (SBR) In SBR process, there is no final sedimentation tank, which means that the sedimentation performance is affected by that within the aeration tank. In this plant, scum derived from the SBR is observed in the effluent even after the chlorine mixing tank, requiring measures to prevent scum discharge. Rishikesh 7.5 MLD STP (MBBR) The final sedimentation tank contains black-coloured sludge and a significant amount of scum, resulting in a strong odour. The effluent after the chlorine mixing tank also shows a dark colour, indicating a probable lack of sufficient removal of excess sludge from the final sedimentation tank.
Composts	Jagjeetpur 68 MLD STP (SBR) New Tehri 5 MLD (Extended aeration) The nearby farmers individually utilize the sewage sludge as compost free of charge after sun-drying on their own land. However, unlike the composting process where temperatures can rise to 70-80°C, which would lead to the expected elimination of pathogens, there is a concern about the possibility of residual pathogens during the sun-drying process, which may pose a problem.

Source: Prepared by JST

(3) Status of effluent quality

(a) Effluent standard for sewage treatment plants

The National Green Tribunal (NGT) ordered the stringent enforcement of effluent standards on 30 April 2019. The new standards for effluent will be applicable to all existing, under-construction, and proposed sewage treatment plants.

Table 5-9 Effluent standard for sewage treatment plants

Parameters	pH	BOD (mg/L)	TSS (mg/L	Faecal Coliform (MPN/100 mL)	COD (mg/L)	Total-Nitrogen (mg/L)	Total Phosphorus (mg/L)
Standards notified by the MoEF&CC	6.5-9.0	30	<100	<1000	--	--	--
Standards prescribed by the Hon'ble NGT	5.5-9.0	10	20	230	50	10	1.0

Source: UKPCB

(b) Compliance status with the effluent standards

Each sewage treatment plant has its own water quality testing laboratory, and the water quality data, measured by the plant operators, is periodically reported to the UKPCB and CPCB for monitoring and management. According to the UKPCB records, as of October 2022, among the 64 operational sewage treatment plants in the UK state, one facility does not comply with the old standards, and 22 facilities do not meet the new standards.

Table 5-10 Compliance status of the operational STPs with the effluent standards in the UK state (1 of 2)

Sl.	City / Town	Location of STP	Date of Commissioning	Installed Capacity of STP (In MLD)	Actual Utilization of installed Capacity (In MLD)	System	Status	Compliance Status (MoEF&CC)	Compliance Status (NGT)
Ext-01	Chamoli	Badrinath (Banni Gaon)	2017	0.26	0.050	SBR	Operational	Complying	Non-Complying
Ext-02	Chamoli	Badinath (Near Temple)	2019	0.01	0.005	MBBR	Operational	Complying	Non-Complying
Ext-03	Chamoli	Badrinath (NearsuspensionBridge)	2019	1.00	0.200	SBR	Operational	Complying	Non-Complying
Ext-04	Chamoli	Joshimath (Pokhri)	2019	1.08	0.421	SBR	Non-Operational	-	-
Ext-05	Chamoli	Gopeshwar (Chamoli Ghat)	2018	0.76	0.050	EC	Operational	Complying	Complying
Ext-06	Chamoli	Gopeshwar (Near Suspension Bridge)	2018	0.05	0.010	EC	Operational	Complying	Complying
Ext-07	Chamoli	Gopeshwar (Vivekanand Colony)	2019	1.19	0.500	EC	Operational	Complying	Complying
Ext-08	Chamoli	Gopeshwar (Deen Dayal Upadhyak)	2019	1.12	0.075	EC	Operational	Complying	Complying
Ext-09	Chamoli	Gopeshwar (Pokhari Band)	2019	1.25	0.500	EC	Operational	Complying	Complying
Ext-10	Chamoli	Nandprayag (Sangam Road)	2018	0.05	0.015	EC	Operational	Complying	Complying
Ext-11	Chamoli	Nandprayag (Forest Office)	2018	0.10	0.090	EC	Operational	Complying	Complying
Ext-12	Chamoli	karan Prayag (Police Chowki)	2018	0.05	0.050	EC	Operational	Complying	Complying
Ext-13	Chamoli	karan Prayag (Purana Pull)	2018	0.10	0.080	EC	Operational	Complying	Complying
Ext-14	Chamoli	karan Prayag (Ward number 1 &3)	2018	0.10	0.035	EC	Operational	Complying	Complying
Ext-15	Chamoli	karan Prayag (Subhash Nagar)	2019	0.05	0.020	EC	Operational	Complying	Complying
Ext-16	Chamoli	karan Prayag (Naya Pull)	2019	0.05	0.005	EC	Operational	Complying	Complying
Ext-17	Rudraprayag	Rudraprayag (Near Anoop Negi School)	2019	0.08	0.075	EC	Non-Operational	-	-
Ext-18	Rudraprayag	Rudraprayag (Near Rudra Complex)	2019	0.10	0.080	EC	Operational	Complying	Complying
Ext-19	Rudraprayag	Rudraprayag (Near Bus Stand)	2019	0.08	0.075	EC	Operational	Complying	Complying
Ext-20	Rudraprayag	Rudraprayag (Near SBI & Maszid)	2019	0.10	0.090	EC	Operational	Complying	Complying
Ext-21	Rudraprayag	Rudraprayag (Near Steel Bridge)	2019	0.13	0.125	EC	Operational	Complying	Complying
Ext-22	Rudraprayag	Rudraprayag (Belani)	NA	0.05	0.025	NA	Operational	Complying	Complying
Ext-23	Tehri Garhwal	Kirtinagar (BRO Bridge)	2018	0.05	0.030	MBBR	Non-Operational	-	-
Ext-24	Tehri Garhwal	Kirtinagar (Near Temple)	2018	0.01	0.010	MBBR	Operational	Complying	Non-Complying
Ext-25	Tehri Garhwal	New Tehri (Bhagirathipuram)	2006	5.00	2.500	SBR	Operational	Complying	Complying
Ext-26	Tehri Garhwal	Dhalwala (Chorpani)	NA	5.00	4.200	MBBR	Operational	Complying	Complying
Ext-27	Tehri Garhwal	Dhalwala (Chandreshwar Ghat)	NA	7.50	6.500	MBBR	Operational	Complying	Complying
Ext-28	Tehri Garhwal	Rishikesh (Tapovan)	2016	3.50	1.100	SBR	Operational	Complying	Complying
Ext-29	Tehri Garhwal	Devprayag (Shanti bazar)	2017	0.08	0.040	SBR	Operational	Complying	Non-Complying
Ext-30	Tehri Garhwal	Devprayag (Sangam bazar)	2017	0.15	0.150	SBR	Operational	Complying	Complying
Ext-31	Uttarkashi	Devpravag (Baah Bazar)	2016	1.40	0.040	SBR	Operational	Complying	Complying
Ext-32	Uttarkashi	Uttarkashi (Gyansu)	2012	2.00	1.783	MBBR	Operational	Complying	Complying
Ext-33	Uttarkashi	Uttarkashi (Gangotri)	NA	1.00	0.200	SBR	Operational	No-monitored	No-monitored
Ext-34	Pauri Garhwal	Srinagar (Nursery Road)	2009	3.50	1.500	MBBR	Operational	Complying	Complying
Ext-35	Pauri Garhwal	Srinagar (Near ITI)	2019	1.00	0.500	SBR	Operational	Complying	Complying
Ext-36	Pauri Garhwal	Srikot (Taulia)	NA	0.05	0.008	NA	Operational	Complying	Complying
Ext-37	Pauri Garhwal	Srikot (Near JH school)	NA	0.08	0.070	NA	Operational	Complying	Complying

Source: Prepared by JST based on the UKPCB documents

Table 5-10 Compliance status of the operational STPs with the effluent standards in the UK state (2 of 2)

Sl.	City / Town	Location of STP	Date of Commissioning	Installed Capacity of STP (In MLD)	Actual Utilization of installed Capacity (In MLD)	System	Status	Compliance Status (MoEF&CC)	Compliance Status (NGT)
Ext-38	Pauri Garhwal	Rishikesh (Swargashram)	2010	3.00	2.120	SBR	Operational	Complying	Complying
Ext-39	Dehradun	Rishikesh (Lakkarghat)	2020	26.00	12.300	SBR	Operational	Complying	Complying
Ext-40	Haridwar	Haridwar (Jagjeetpur)	2010	27.00	27.000	SBR	Operational	Complying	Complying
Ext-41	Haridwar	Haridwar (Jagjeetpur)	1990	18.00	18.000	SBR	Operational	Complying	Complying
Ext-42	Haridwar	Haridwar (Jagjeetpur)	2020	68.00	45.020	SBR	Operational	Complying	Complying
Ext-43	Haridwar	Haridwar (Sarai-I)	2013	18.00	18.000	SBR	Operational	Complying	Complying
Ext-44	Haridwar	Haridwar (Sarai-II)	2013	14.00	13.020	SBR	Operational	Complying	Complying
Ext-45	Haridwar	Roorkee (Saliyar)	NA	33.00	20.000	SBR	Operational	Complying	Non-Complying
Ext-46	Dehradun	Dehradun (Motharawala-I)	2016	20.00	13.520	SBR	Operational	Complying	Non-Complying
Ext-47	Dehradun	Dehradun (Motharawala-II)	2018	20.00	11.000	SBR	Operational	Non-Complying	Non-Complying
Ext-48	Dehradun	Dehradun (Kargi)	2015	68.00	13.000	SBR	Operational	Non-Complying	Complying
Ext-49	Dehradun	Dehradun (Vijay Colony)	2019	0.42	0.300	SBR	Operational	Complying	Non-Complying
Ext-50	Dehradun	Dehradun (Salawala)	2019	0.72	0.350	SBR	Operational	Complying	Non-Complying
Ext-51	Dehradun	Dehradun (Indira Nagar)	2019	5.00	5.000	SBR	Operational	Complying	Non-Complying
Ext-52	Dehradun	Dehradun (Jakhan)	2016	1.00	0.140	SBR	Operational	Non-Complying	Non-Complying
Ext-53	Dehradun	Mussoorie (Bhattafall)	2019	3.12	0.800	SBR	Operational	Complying	Complying
Ext-54	Dehradun	Mussoorie (Happy Vally)	2019	1.20	0.200	SBR	Operational	Complying	Non-Complying
Ext-55	Dehradun	Mussoorie (Landour, South)	2019	1.30	0.100	SBR	Operational	Complying	Complying
Ext-56	Dehradun	Mussoorie (Landour, North)	2019	0.80	0.035	SBR	Operational	Complying	Complying
Ext-57	Dehradun	Mussoorie (Kulri Bazaar)	2019	0.90	0.350	SBR	Operational	Complying	Complying
Ext-58	Nainital	Nainital (Hari Nagar)	2016	0.45	0.250	SBR	Operational	Complying	Non-Complying
Ext-59	Nainital	Nainital (Krishnapur)	2016	0.80	0.450	SBR	Operational	Complying	Non-Complying
Ext-60	Nainital	Nainital (Bheemtal)	2009	1.25	0.810	UASB	Operational	Complying	Non-Complying
Ext-61	Nainital	Almora (Bakh)	NA	2.00	1.650	NA	Operational	Complying	Non-Complying
Ext-62	Nainital	Rusi Pond,Nainital	2009	10.00	6.750	Pond	Non-Operational	-	-
Ext-63	Pithoragarth	Pithoragarth (Acholi)	2020	5.00	1.000	SBR	Operational	Complying	Non-Complying
Ext-64	Pithoragarth	Pithoragarth (Mirada)	2020	1.25	0.800	SBR	Operational	Complying	Non-Complying
Ext-65	Nainital	Ramnagar (Transport Nagar)	NA	7.00	2.500	NA	Operational	Complying	Non-Complying
Ext-66	Nainital	Ramnagar (Puchdi)	NA	1.50	0.150	NA	Operational	Complying	Non-Complying
Ext-67	Nainital	Nainital (Narayan Nagar)	NA	0.45	-	NA	Operational	Complying	Non-Complying

Source: Prepared by JST based on the UKPCB documents

5.4 Pollution Status of Water Bodies

5.4.1 Designated Best Use Water Quality Criteria

The classification of environmental water quality standards for water bodies is based on the following table established by the CPCB. It is divided into five categories depending on the designated use of the water body, with each category having its specific water quality criteria.

Table 5-11 Water quality standards by designated best use water quality criteria

	Water Quality Criteria						
	pH	DO (mg/L)	BOD_5 (mg/L)	Total Coliforms (MPN/100mL)	Free Ammonia (mg/L)	Boron (mg/L)	EC (µmhos/cm)
A	6.5-8.5	6 <	2 >	50 >	-	-	-
B	6.5-8.5	5 <	3 >	500 >	-	-	-
C	6.5-8.5	4 <	3 >	5,000 >	-	-	-
D	6.5-8.5	4 <	-	-	1.2 >	-	-
E	6.5-8.5	-	-	-	-	2 >	2,250 >

Source: CPCB

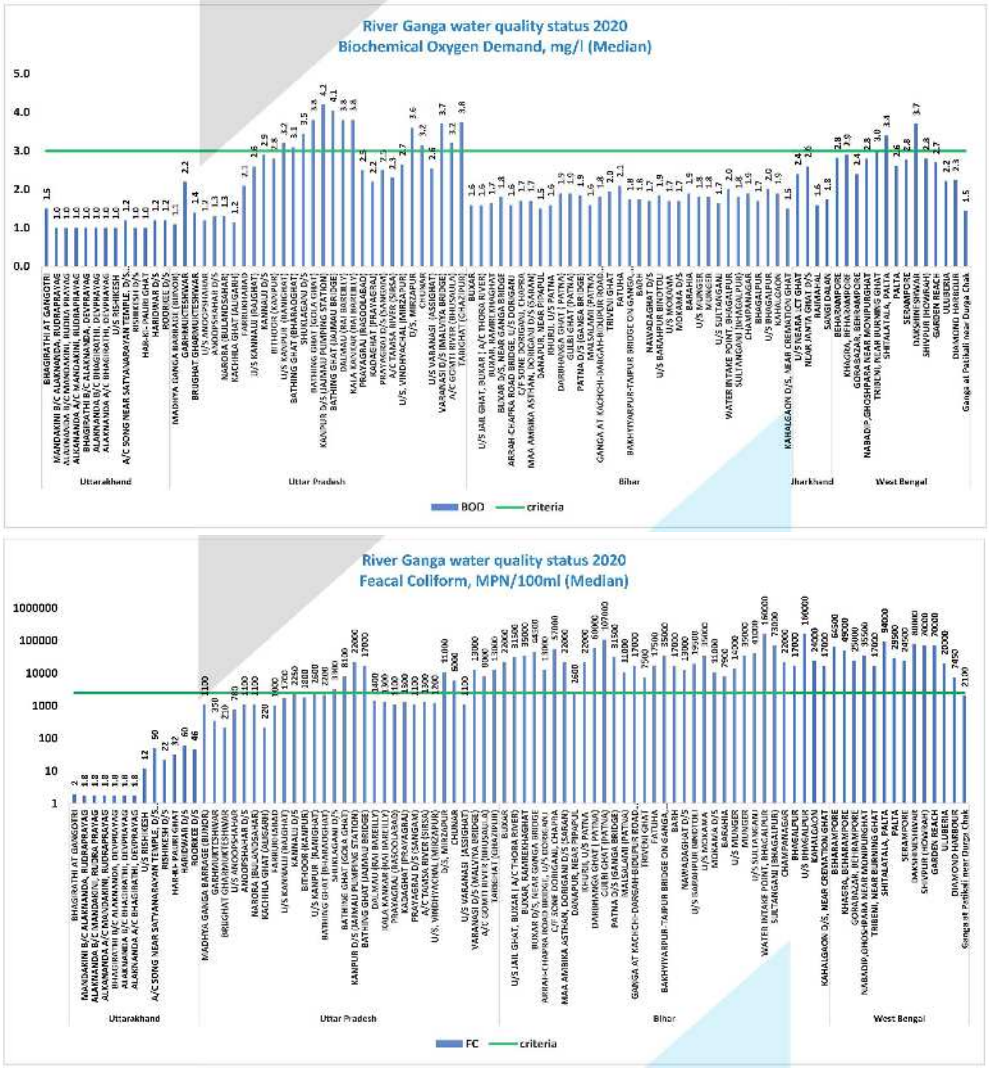
A: Drinking water source without conventional treatment but after disinfection
B: Outdoor bathing (organized)
C: Drinking water source after conventional treatment and disinfection
D: Propagation of wild life and fisheries
E: Irrigation, industrial cooling, controlled waste disposal

5.4.2 Pollution Status of Rivers and Ponds

(1) Ganges river

Under the National Water Quality Monitoring Programme (NWMP), water quality monitoring is conducted at 97 locations across five states in the Ganges River Basin. The UK state includes the uppermost reaches of the Ganges River, extending as far as Gangotri, which is situated close to the border with China.

In the mountainous regions, the water quality can be considered good compared to the middle to lower reaches of the Ganges River, as shown in Figure 5-17. The faecal coliform increase slightly after the point of Rishikesh, where there is a high concentration of population due to tourism and frequent bathing activities. However, the levels of faecal coliform remain below the water quality target value (with a target of 500 MPN/100mL or below) and below the permissible limit (with a limit of 2,500 MPN/100mL or below) in the UK state.



Source: Annual Report 2020-21, CPCB

Figure 5-17 Water quality of the Ganges River (BOD and faecal coliform)

(2) Rivers in the state

The UKPCB conducts their own water quality monitoring at a total of 76 locations across the entire UK state, on a monthly basis (as shown in Table 5-12 and Figure 5-18 for the rivers within Dehradun city).

In Dehradun city, the water bodies are classified based on their worst condition almost through the year. Figure 5-19 shows the current situation at the monitoring site. Within the city, there are two rivers flowing in the southern direction, and both of them experience significant deterioration in water quality due to the inflow of untreated sewage as they pass through the city. As indicated in Table 5-2, several slum areas have formed along the riverbanks, and slum dwellers living on the riverbanks are evident, contributing to an unsanitary environment.

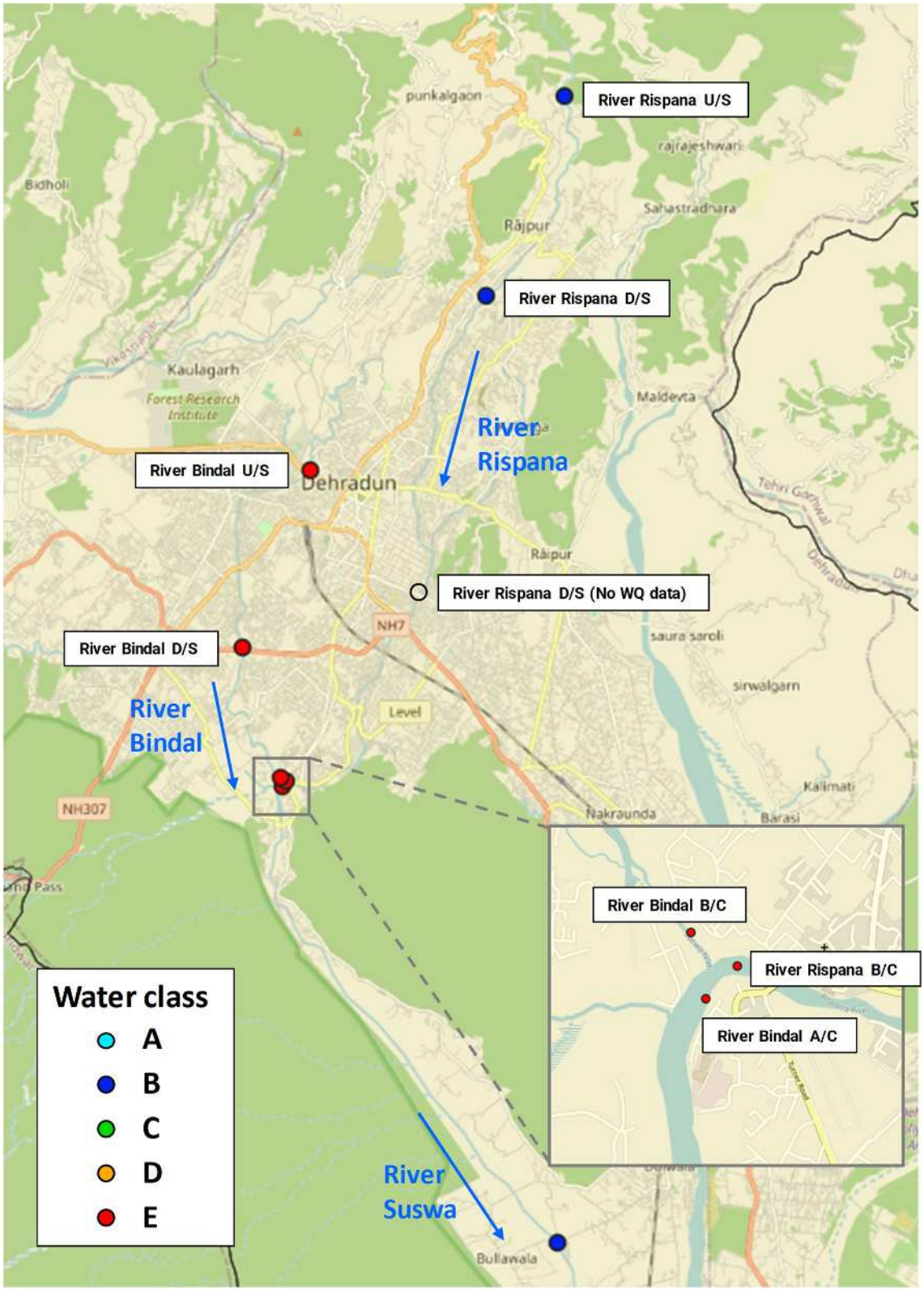
Table 5-12 River water quality classifications within Dehradun cities as of 2022

Month	Temp	pH	DO	BOD (mg/l)	TC	FC (MPN/100 ml)	DBU class
River Rispana U/S at Shikhar Fall							
May-22	22°C	7.76	7.6	1.8	58	48	B
Jun-22	24°C	7.6	7	2	63	43	B
Jul-22	14°C	8.37	7.8	1.4	70	47	B
Aug-22	21°C	7.2	8.4	1.2	63	48	B
Sep-22	20°C	8.28	8	1.2	110	79	B
Oct-22	22°C	7.49	8.2	1	94	63	B
Nov-22	15°C	7.3	8.8	1	84	69	B
Dec-22	15°C	7.8	8.6	1	79	63	B
River Rispana D/S Near IT Park							
May-22	River Was Dry						
Jun-22	River Was Dry						
Jul-22	18°C	8.15	5.6	1.6	84	58	B
Aug-22	23°C	7.03	6.8	1.4	94	63	B
Sep-22	20°C	7.69	6.6	1.5	130	84	B
Oct-22	20°C	7.29	7	1.3	110	70	B
Nov-22	17°C	7.8	7.8	1.2	94	63	B
Dec-22	16°C	7.6	7.4	1.3	84	63	B
River Rispana B/C to River Bindal at Mothorowala							
May-22	20°C	6.8	2.6	20	≥1600	≥1600	E
Jun-22	23°C	6.59	2.2	22	≥1600	≥1600	E
Jul-22	17°C	7.05	3.6	18	≥1600	≥1600	E
Aug-22	22°C	7.27	4.8	14	≥1600	≥1600	D
Sep-22	20°C	7.92	3.4	20	≥1600	≥1600	E
Oct-22	23°C	7.27	4.4	16	≥1600	≥1600	D
Nov-22	16°C	7.32	4.8	14	≥1600	≥1600	D
Dec-22	12°C	7.12	4.6	16	≥1600	≥1600	D

Month	Temp	pH	DO	BOD (mg/l)	TC	FC (MPN/100 ml)	DBU class
River Bindal U/S at Bindal Bridge							
May-22	22°C	6.92	NIL	52	1600	920	E
Jun-22	24°C	6.52	NIL	54	1600	920	E
Jul-22	20°C	7.6	1.2	36	≥1600	≥1600	E
Aug-22	24°C	6.82	4.2	22	≥1600	≥1600	D
Sep-22	21°C	8.1	2	28	≥1600	≥1600	E
Oct-22	23°C	6.97	3.2	24	≥1600	≥1600	E
Nov-22	16°C	6.99	3.8	20	≥1600	≥1600	E
Dec-22	12°C	6.83	3.6	22	≥1600	≥1600	E
River Bindal D/S Near Kargi Chowk							
May-22	20°C	7.22	1	46	≥1600	≥1600	E
Jun-22	23°C	6.72	NIL	52	≥1600	≥1600	E
Jul-22	20°C	7.45	1.6	38	≥1600	≥1600	E
Aug-22	22°C	6.65	4.4	20	≥1600	≥1600	D
Sep-22	21°C	7.37	3	24	≥1600	≥1600	E
Oct-22	24°C	6.68	3.8	20	≥1600	≥1600	E
Nov-22	17°C	6.93	4.2	18	≥1600	≥1600	D
Dec-22	12°C	6.97	3.2	24	≥1600	≥1600	E
River Bindal B/C to River Rispana at Mothorowala							
May-22	20°C	6.9	1.2	30	≥1600	≥1600	E
Jun-22	23°C	6.78	0.9	35	≥1600	≥1600	E
Jul-22	18°C	7.24	2.6	28	≥1600	≥1600	E
Aug-22	22°C	7.32	4.6	19	≥1600	≥1600	D
Sep-22	20°C	7.25	3.2	23	≥1600	≥1600	E
Oct-22	24°C	6.85	4	18	≥1600	≥1600	D
Nov-22	17°C	6.65	4.4	16	≥1600	≥1600	D
Dec-22	12°C	6.9	3.4	20	≥1600	≥1600	E

Note: U/S (Upper stream), D/S (Downstream), B/C (Before confluence), A/C (After confluence)

Source: Prepared by JST based on the data from UKPCB



Source: Prepared by JST based on the data from UKPCB

Figure 5-18 Water quality monitoring points and each classification (Dehradun)

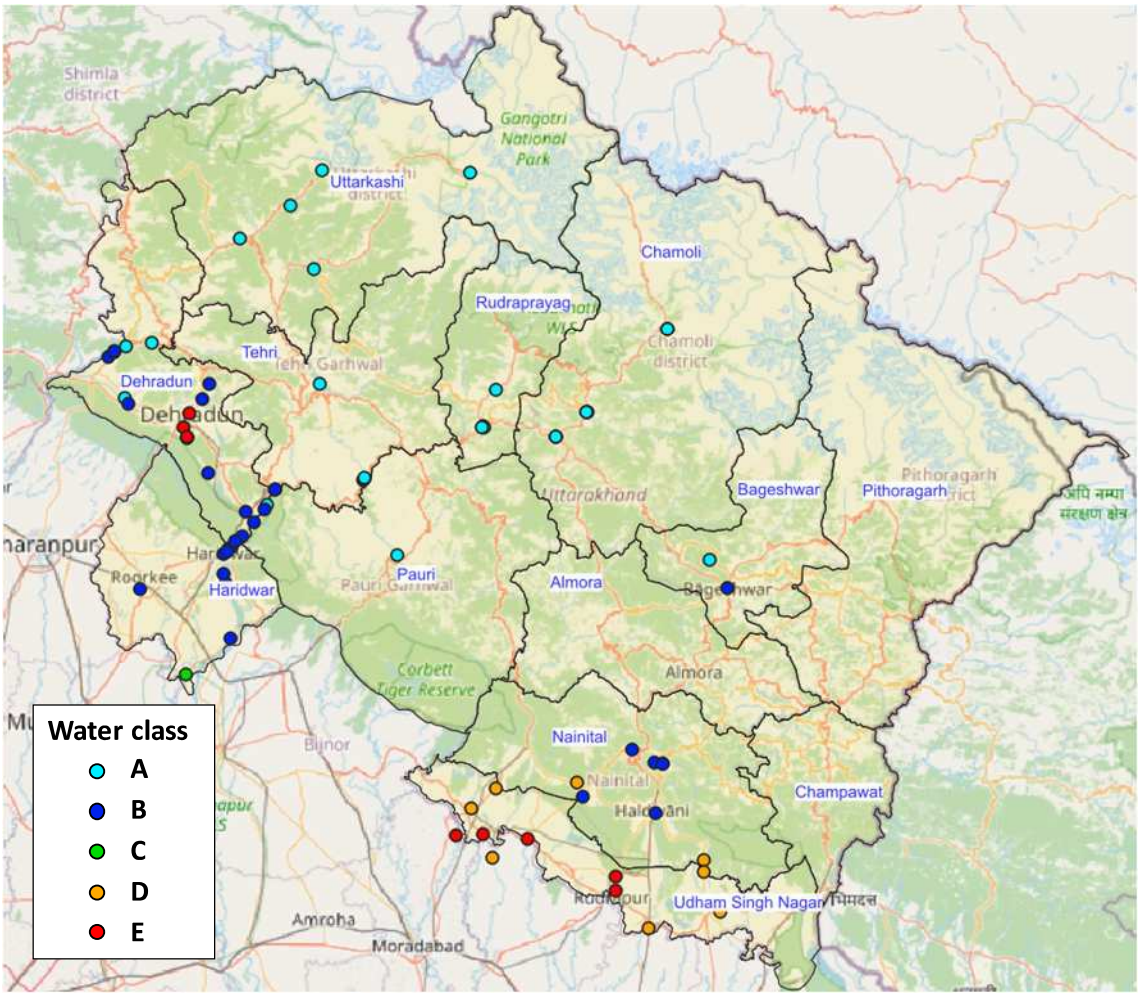


Source: JST

Figure 5-19 Water quality monitoring points by UKPCB within Dehradun city

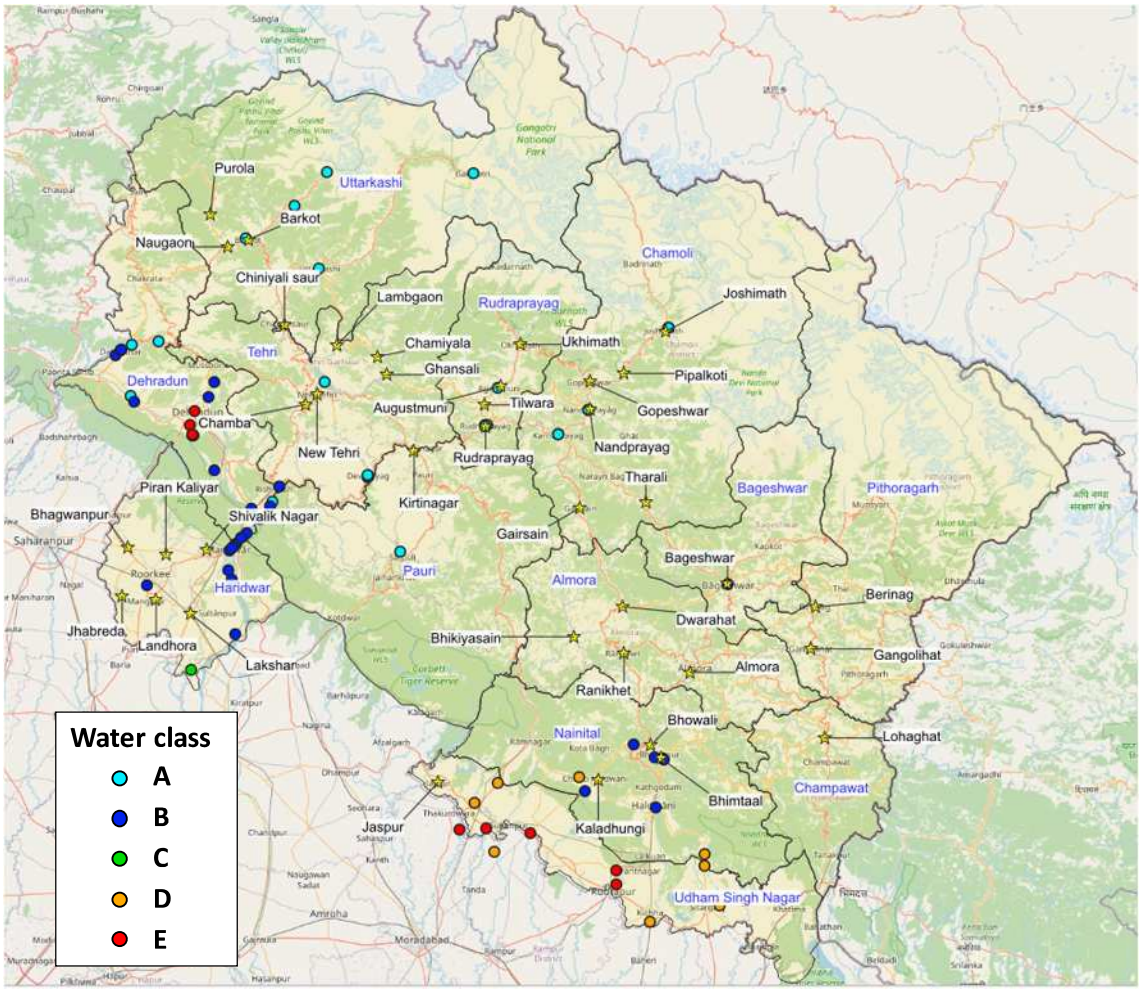
Figure 5-20 shows the current status of water quality classification throughout the UK state. Areas classified as Class A to C are considered suitable for use as a drinking water source. In the mountainous regions, all areas are classified as Class A or B, with the majority falling into Class A throughout the year, indicating that surface water sources in this region are deemed suitable for drinking water use (see Figure 5-21).

Apart from Dehradun as mentioned earlier, U.S. Nagar district is another area with water quality classifications of Class D or E as per Figure 5-20. These areas rely on groundwater sources for water supply. Therefore, there is no immediate concern about direct water source contamination. However, particularly in U.S. Nagar, nitrate contamination of groundwater has been reported (described in 5.4.3), making it crucial to take urgent sewage system development.



Source: Prepared by JST based on the data from UKPCB

Figure 5-20 Water quality monitoring points and each classification (UK state)



Source: Prepared by JST based on the data from UKPCB

Figure 5-21 Water quality monitoring points and target areas in this project

(3) Local ponds

As mentioned earlier, water quality monitoring is conducted at various locations along the state's major rivers. However, it does not include small local streams (Nalas) and scattered ponds within the region.

For instance, Bhagwanpur, which is a part of the UUWSP, lacks a proper sewage system. Untreated sewage flows through rudimentary roadside drains and ultimately enter nearby ponds, along with litter and debris discarded on the streets. This has resulted in severe water pollution, with evidence of anaerobic fermentation in the accumulated sediment at the bottom of the ponds.

Similarly, in Shivalik Nagar, also located within Haridwar district, there is evident water pollution in the Nala (see Figure 5-25). Given these circumstances, shallow wells in Haridwar district show the presence of nitrates tends to be more pronounced as well as U.S. Nagar district.



Source: JST

Figure 5-22 Water pollution situation of local pond in Bhagwanpur

5.4.3 Pollution Status of Groundwater

(1) Nitrate contamination risk to groundwater sources

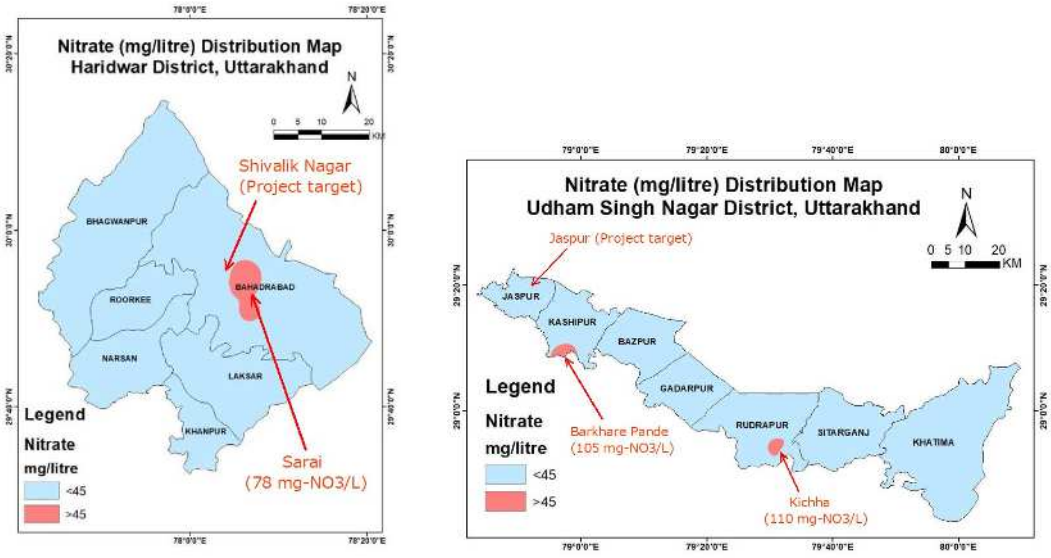
The case of high nitrate detection in natural groundwater is rare, and if high levels exceeding the environmental standard value of 10 mg-N/L (approximately 45 mg-NO^3/L) are found in groundwater, it is generally considered to be a result of human activities[11]. The main causes for this are attributed to: 1) excessive fertilizer application, 2) improper handling of livestock excreta, and 3) infiltration of sewage into the groundwater. Additionally, nitrates have high solubility in water and are easily transported along with groundwater, leading to relatively broad contamination ranges exceeding 10 mg/L.

Nitrate nitrogen itself is not highly toxic, but after being reduced to nitrite nitrogen by microorganisms in the stomachs of infants, it is absorbed into the body and binds with haemoglobin in the blood, causing oxygen deficiency (known as methemoglobinemia).

(2) Nitrate distribution in groundwater sources (shallow wells) in the UK state

According to past surveys[12] in the UK state, nitrate contamination in groundwater (shallow wells) has been reported in Haridwar and U.S. Nagar districts. The report focuses on the plain regions of Dehradun, Haridwar, U.S. Nagar, and Nainital districts in the UK state, where primarily groundwater sources are utilized for drinking water. The report organizes the presence of nitrate contamination based on the Indian standard (IS 10500) with a threshold of 45 mg-NO^3/L.

The area with the highest concentration of nitrate was found in Kiccha, located within U.S. Nagar district, where a concentration of 110 mg-NO^3/L was reported, exceeding the standard by more than double.



Source: Ground Water Yearbook Uttarakhand, 2022

Figure 5-23 Nitrate distribution map in Haridwar and U.S. Nagar as of May 2021

On the other hand, the tube well facilities in the UUWSP are deep wells. The report also conducted surveys on the groundwater quality from deep wells, and it was found that there are no issues with various water quality parameters, including nitrate. Therefore, it can be concluded that this project will not have any impact on the water quality from the deep wells.

However, in the same region, many households rely on shallow wells (hand pumps) due to intermittent water supply status. As mentioned earlier, there are concerns about potential health risks associated with nitrate contamination in the shallow wells used by these households.

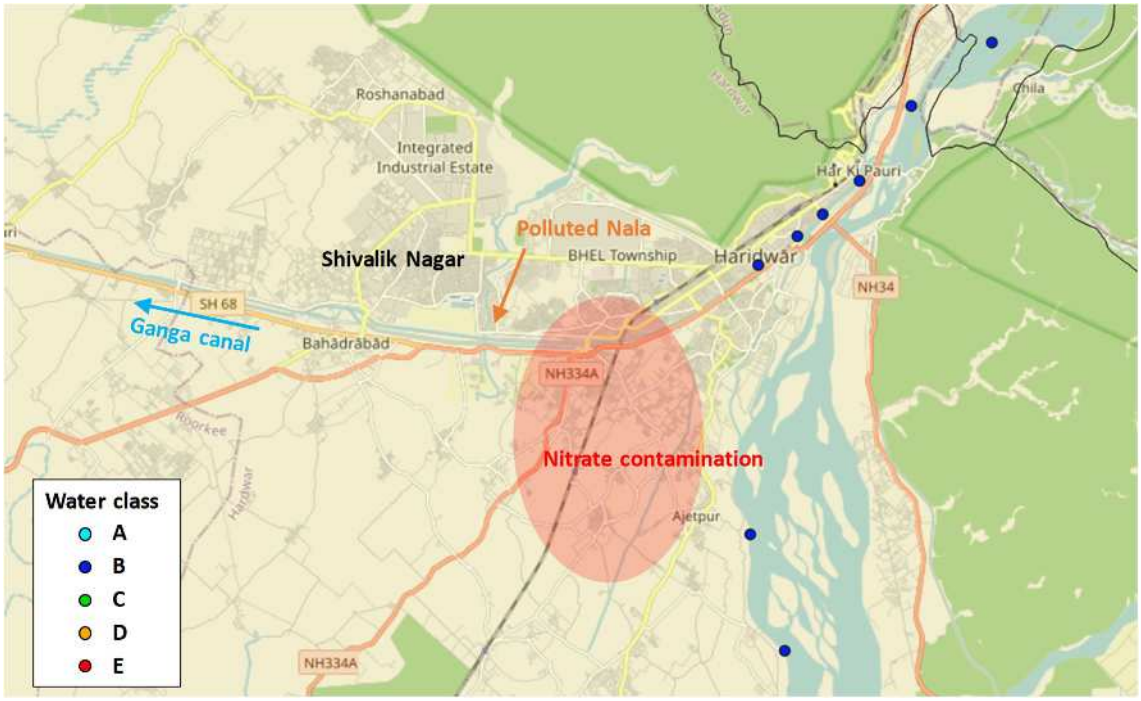
(3) Contamination status of surface water in areas with high nitrate concentrations

The following figure shows the water quality classification of surface water overlaid on the areas where high concentrations of nitrate were detected, as presented in Figure 5-23.

(a) Haridwar district

Regarding the nitrate contamination area in Haridwar district, it is located in proximity to the targeted area, Shivalik Nagar. According to the water quality classification provided by UKPCB, the nearby Ganga Canal and Ganges River are classified as Class B, indicating no contamination in the surface water.

However, in Shivalik Nagar, there is no sewage treatment plant, and sewage flows into the rivers that run through the area, and then downstream in the southern direction. Although there is no available water quality data for these nalas, as shown in Figure 5-25, they are severely polluted. While it cannot be conclusively stated based on the current data, one possible hypothesis for the presence of high nitrate concentrations is that this sewage infiltrates the soil and contaminates shallow groundwater.



Source: JST

Figure 5-24 Shivalik Nagar and nitrate contamination area in Haridwar district

This polluted nala crosses over the Ganga canal to the south of Shivalik Nagar, as shown in Figure 5-26. The Ganga Canal diverts water from the main stream of the Ganges River and is used as irrigation water for vast agricultural lands, extending through the UK and UP states.

Upon confirmation with UKPJN officials on site, it was explained that the elevated waterway is constructed with concrete, completely isolated from the Ganga Canal, and there are no concerns about sewage mixing. However, it is still not desirable to have the irrigation waterway undercrossing severely polluted river water.

It is worth noting that for Shivalik Nagar, a sewerage system development is currently planned as part of the KfW project.



Source: JST

Figure 5-25 Polluted river running through Shivalik Nagar

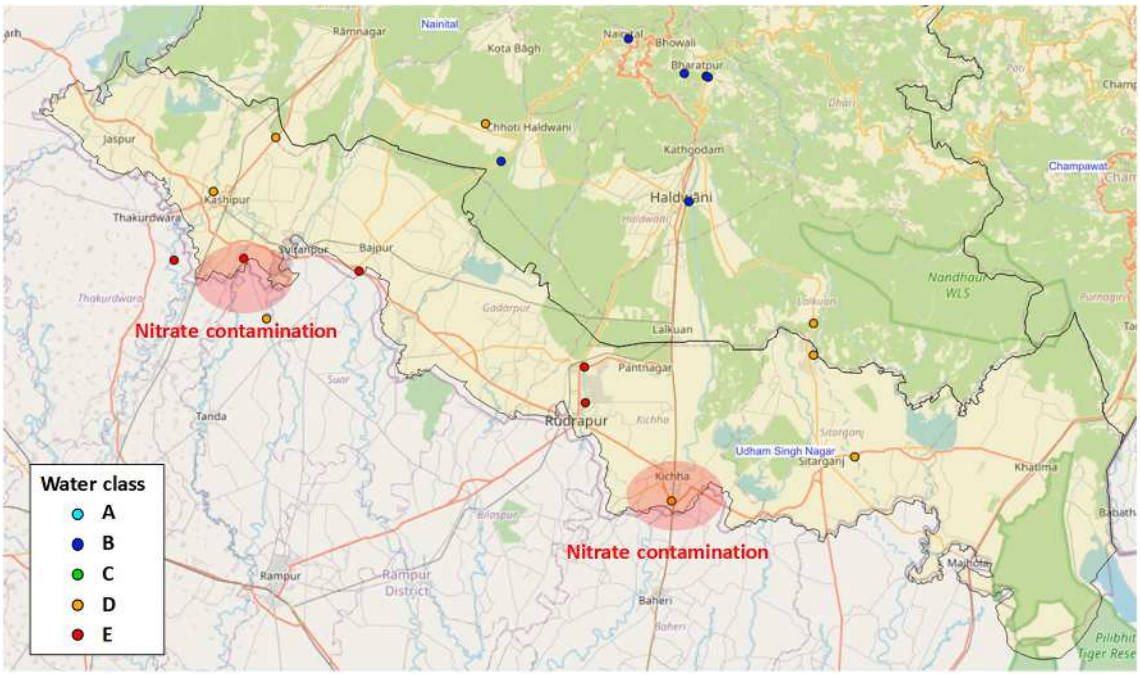


Source: JST

Figure 5-26 Polluted river running over the Ganga Canal

(b) U.S. Nagar district

In the areas of U.S. Nagar district where high concentrations of nitrate were detected, the nearby surface water quality is classified as Class D and Class E. This case suggests a link between the contamination status of groundwater and surface water. On the other hand, in other areas that are classified in the same water quality classes, high concentrations of nitrate have not been detected. For example, in Rudrapur (Figure 5-27), which is classified as Class E, nitrate concentrations were found to be below the detection limit.



Source: JST

Figure 5-27 Surface water quality and nitrate contamination area in U.S. Nagar

The water quality survey mentioned in the same report[12] is conducted by measuring groundwater quality in only one shallow well in each area. Therefore, there is a possibility that the contamination situation is not fully reflected. In addition, a review of other groundwater quality data published by UKPCB found that while slightly elevated nitrate levels are observed in Haridwar district, such high concentrations of nitrate are not detected. It is possible that local factors, such as geological conditions including the presence of impermeable layers, could lead to the localized accumulation of high nitrate concentrations.

Regardless, in areas where high nitrate concentrations are detected in groundwater, concerns about soil contamination from the surface are valid. Hence, these areas should be considered as requiring concentrated sewage management efforts.

5.5 Climate Change Impact Risks in Sewerage Projects

(1) Climate risk matrix

In this section, an evaluation is conducted on the regional impact of climate change on sewerage projects in the UK, as indicated in Chapter 2, Section 3. Using a climate risk matrix, consideration is given to adaptation measures. The climate risk matrix created in this study is presented in the table below. Currently, there is no significant information regarding the impact of natural disasters such as droughts, floods, and landslides—identified as hazards that may intensify the impact on sewerage projects due to climate change. Therefore, no current impact is assumed based on the lack of substantial disaster reports.

Table 5-13 Climate risk matrix for sewerage projects in the UK

			Climate Hazard					
			H1	H2	H3			
			Drought	Flood	Sediment Disasters			
		Frequency - ~ + +	+	++	++	Vulnerability	Climate Risk	Adaptation Options
		Future risk	↗	↗	↗			
Exposure	E1	Water Quality Environment in Public Water Bodies	0 No significant impact at present	0 No significant impact at present	0 No significant impact at present	・Diminishing Dilution Effect Due to Reduced River Flow ・Due to the prevalence of interceptor-type sewage collection, rainwater, including sewage exceeding the capacity of rainwater outlets, contributes to the deterioration of river water quality.	・Diminishing dilution effect during the dry season leading to prolonged water quality deterioration. ・Increased opportunities for overflow from rainwater outlets due to the rise in intense rainfall, resulting in river water quality degradation.	・Reduction of untreated sewage through sewage system improvement. ・Transition to separate-systems from interceptor-systems is not feasible, and the installation of rainwater retention tanks is challenging due to land constraints. For the time being, continuous water quality monitoring will be maintained.
	E2	Sewage Pipeline	0 No significant impact at present	0 No significant impact at present	0 No significant impact at present	・Occurrence of Intense Rainfall Beyond Pipeline Capacity ・Pipeline damage due to sediment disasters (mountainous areas)	・Inland flooding during intense rainfall events. ・Occurrence of areas discharging untreated sewage due to pipeline ruptures.	・Enlargement of rainwater pipes/combined pipes, installation of rainwater storage tanks. ・Protection of cliff faces in hilly areas. ・Development of sewage system BCP (Business Continuity Plan) for emergency temporary sewage treatment systems.
	E3	PS and STP	0 No significant impact at present	0 No significant impact at present	0 No significant impact at present	・Inundation of various facilities during flooding ・Facility damage caused by sediment disasters	・Extended facility breakdown and prolonged facility downtime due to sediment disasters and flood-related damages.	・Waterproofing of each facility. ・Development of sewage system BCP for natural disaster preparedness.

Source: JST

(2) Potential climate risks in the future

As highlighted in the earlier section "2.3.3 (2) Climate change impact in the UK states", the predominant climate change impact risks in the UK include an increased frequency of droughts during the dry season and an elevated occurrence of floods associated with concentrated heavy rainfall during the rainy season. While sewage treatment facilities are typically planned in low-lying areas, the installation of sewage treatment facilities on the sloping terrain of mountainous areas, as exemplified by the New Tehri STP mentioned earlier, is also notable in the UK. Therefore, not only are low-lying areas at heightened risk of floods, but the risk of sediment disasters is similarly high.

Regarding water scarcity, in cases where the period of reduced river flow is prolonged, hazards have been documented when anticipating a scenario in regions where untreated

sewage, presently diluted by river flow, could experience a diminishing effect, leading to water quality deterioration.

(3) Consideration of adaptation measures

Soft measures for adaptation include the development of Business Continuity Plans (BCP) in water supply and sewage projects (detailed in section 9.3.3). On the hardware side, potential measures include enhancing the rainwater drainage and storage capacity of sewage pipelines, as well as waterproofing measures (especially for electrical facilities) in pumping stations and sewage treatment facilities.

References for Chapter 5

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Chapter 6 Institutional Framework and Financial Situation

6.1 Water Supply and Sewerage Service Structure

There are two main organizations responsible for implementing water supply and sewerage services in Uttarakhand state, namely UKPJN and UJS.

The major differences between UKPJN and UJS are "Role and Scope of Responsibility," "Main Revenue Source," and " Whether or not it is a PSU. The following is a comparison table for each organization.

Table 6-1 Role and Responsibility of UKPJN and UJS

	Role and Responsibility	Main Revenue Source	PSU
UKPJN	Planning, Design, Construction, and Supervision of "Urban/Rural Water Supply Facilities" and "Urban Sewage Facilities".	・Capital Grant ・Centage Charge from each Development Project ・Service and commission fees ・Operational Grant (pensions, balance due)	Applicable
UJS	Operation and Maintenance of Urban/Rural Water Supply and Sewerage Facilities after Completion of Construction.	・Water Tariff ・Operational Grant (Repair, Maintenance and utilities costs, etc.)	Not Applicable (Autonomous Body)

*Note: Both organizations have separate financial accounts from the state government's general account, and UJS allocates revenue from water and sewerage tariffs to staff salaries and other expenses (equivalent to civil servants).

Source: Prepared by JST

6.1.1 Infrastructure Development Sector: UKPJN

(1) Organizational Structure of UKPJN

UKPJN is headed by a Chairman and a Managing Director, and has ten major departments under them: 1) Civil Engineering Department, 2) Construction Wing, 3) Finance Department, 4) Externally Aided Project Department, 5) Namami Gange Project Department, 6) Research and Development Training Department, 7) Administration Department, 8) Appraisal and Planning Department, 9) Project Implementation Unit, 10) Bhoojal and Survey Department. Figure 6-1 shows the allocation of each department in the UKPJN organizational chart.

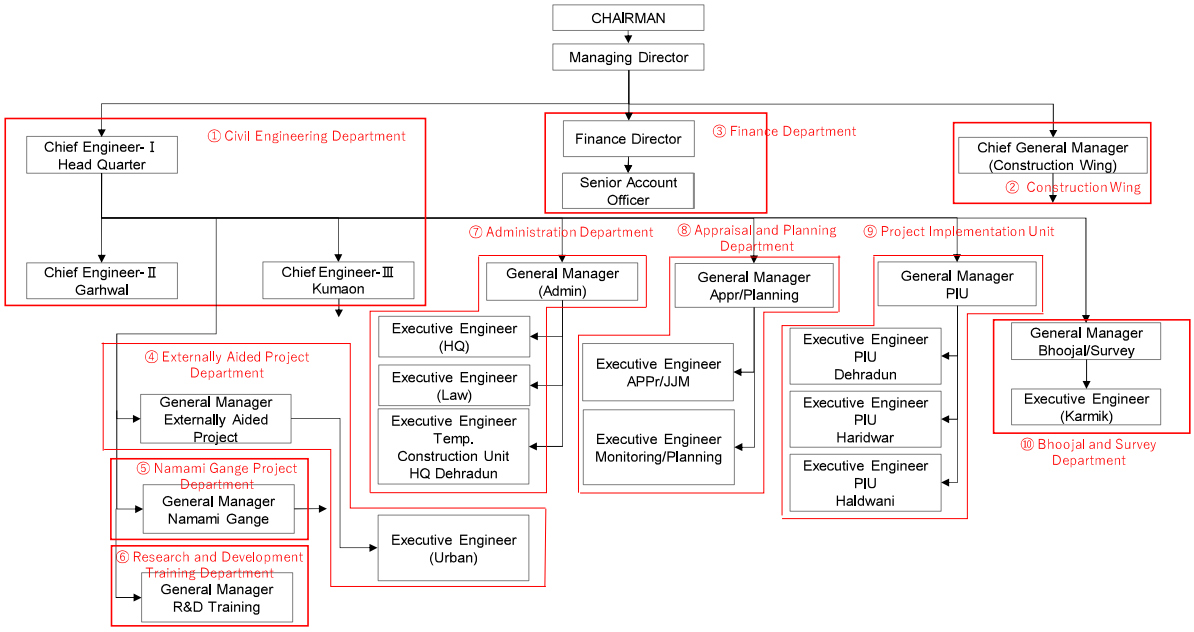


Figure 6-1 Ten Major Departments in the UKPJN

The members of UKPJN Board of Directors, constituted under the Uttar Pradesh Water Supply and Sewer System Act of 1975, are listed below. (*Note: Uttarakhand State was made independent from Uttar Pradesh state in 2001.)

i.	Secretary, Department of Drinking Water, Government of Uttarakhand
ii.	Secretary, Finance Department, Government of Uttarakhand
iii.	Secretary, Planning Department, Government of Uttarakhand
iv.	Secretary, Urban Development Department, Government of Uttarakhand
v.	Mayor Haldwani-Kathgodam Municipal Corporation
vi.	President, Nagar, Kirtinagar, Tehri Garhwal
vii.	President, Nagar Panchayat Jhabreda, Haridwar
viii.	Director General Medical and Health Department, Government of Uttarakhand
ix.	Finance Director, Uttarakhand Pey Jal Nigam, Dehradun
x.	Managing Director, Uttarakhand Pey Jal Nigam, Dehradun
xi.	Chief General Manager, Uttarakhand Jal Sansthan

Source: Prepared by JST

Figure 6-2 List of UKPJN Board Members

The following table shows the job descriptions for the water supply and sewerage services in UKPJN. Currently, sewerage services are being developed in the urban parts of the Namami Gange project area (Srinagar, Haridwar, Rishikesh, and Gopeshwar), and the "Namami Gange Project Department" is responsible for them. The engineers are not assigned exclusively to the water supply sector or sewerage sector, but may rotate between the water supply sector and sewerage sector due to personnel change.

Table 6-2 Job Descriptions in UKPJN

Job Description	Department	Notes
Financial Planning and Fundraising	- Finance Department - Externally Aided Project Department	
Bidding Support	- Civil Engineering Department	
Contract Review and Drafting	- Administration Department * The Law Department, under the Administration Department, is in charge.	
Groundwater Survey	- Bhoojal Survey Department	
Planning and Design of Projects	- Civil Engineering Department - Appraisal and Planning Department	Preparation of DPR
Project Assessment	- Appraisal and Planning Department	
Construction Supervision	- Civil Engineering Department - Project Implementation Unit	Civil Engineering Department (field level management), Project Implementation Unit (upper-level progress management)
Personnel and Human Resources Development	- Administration Department - Research and Development Training Department	Personnel management is handled by the Administration Department.
Sewerage and Wastewater Treatment	- Namami Gange Project Department	Planning, design and construction supervision of STPs and sewer pipe laying in urban areas.
Design	- Construction Wing	Design work has been ordered by other ministries and agencies.

Source: Prepared by JST

The headquarters of UKPJN function at the head office in Dehradun, while the branch functions are divided into two major areas, the Garhwal Division and the Kumaon Division. The West (Garhwal) and East (Kumaon) areas of Uttarakhand have one Chief Engineer (hereinafter referred as to “CE”), and under the CE there is a Superintending Engineer (hereinafter referred as to “SE”) for each Circle Office, which is responsible for multiple divisions. The Divisional Office under the Circle Offices is managed by Executive Engineers (hereinafter referred as to “EE”), who is responsible for project execution, and engineers at each level cooperate with each other.

The following table shows the organizational hierarchy of UKPJN.

Table 6-3 Organizational Hierarchy of UKPJN's Engineers

Headquarter			
Chief Engineer (CE)	Chief Engineer Office (HQ @Dehradun)	Chief Engineer Office (Garhwal @Pauri)	Chief Engineer Office (Kumaon @Nainital)
Superintending Engineer (Civil) (Civil SE)	Circle Office (Monitoring for each project, Procurement support) *Established in cities in major Districts		
Superintending Engineer (SE) (Electrical and Mechanical SE)	Two Superintending Engineers are assigned to Garhwal Division, and one to Kumaon Division.		
Executive Engineer (EE)	Divisional Office (Project Executing Body) *Established in major cities and towns		
Assistant Engineer (AE)			
Junior Engineer (JE)			

Source: Prepared by JST

Table 6-4 summarizes the authorities granted by organizational hierarchy (by position). The EE is empowered to manage certain procurement, disbursements, and petty cash as the project execution section, and has its own account for the Divisional Office. All other accounts are managed in a centralized account at the head office.

Table 6-4 Approving Authority in UKPJN

Amount (INR)	Authorizer	Notes
7.5 million or less	Executive Engineer (Divisional Office)	If EE is the approver, EE shall sign the contract.
7.5 – 25 million	Superintending Engineer (Circle Office)	If MD, CE, or SE is the approver, SE shall sign the contract.
25 – 50 million	Chief Engineer	Authorizer
50 – 250 million	Managing Director (HQ)	Authorizer
250 million or more	Chairman (HQ) = Secretary, DDW	

Source: Prepared by JST

A list of UKPJN staff (excluding the Chairman) is shown in Table 6-5. In the six managerial posts (Group A), including the MD, 79 of the 97 posts are occupied, for an 81% occupancy rate. For the subordinate posts of engineers, technical and administrative staff, 1,316 of the 3,371 positions are occupied, for an occupancy rate of 39%. This low occupancy rate is being handled by hiring temporary staff for a limited period and outsourcing to subcontractors to supplement the manpower, and at present there do not appear to be any significant obstacles to the planning and construction supervision of water supply and sewerage projects.

Table 6-5 List of UKPJN Staff (as of May 2023)

		Sanctioned Post	Working	Vacant Post	Occupancy rate
Group A					
1	Managing Director	1	0	1	
2	Chief Engineer	4	1	3	
3	Superintending Engineer	21	19	2	
4	Executive Engineer	68	58	10	
5	Finance Director	1	1	0	
6	Senior Finance Director	2	0	2	
	Sub Total (Group A)	**97**	**79**	**18**	**81%**
Group B					
7	Assitant Engineer	219	111	108	
8	Accountant Officer	3	1	2	
	Sub Total (Group B)	**222**	**112**	**110**	**50%**
Group C					
9	Additional Assitant Engineer & Junior Engineer	602	386	216	
10	Computer Operator	73	8	65	
11	Cartographer	42	0	42	
12	Chemist	2	0	2	
13	Assistant Account Officer	4	0	4	
14	Senior Auditor Grade-1	1	0	1	
15	Senior Auditor	1	0	1	
16	Auditor	2	0	2	
17	Congregatoinal Accountant	49	0	49	
18	Chief Administrative Officer	31	22	9	
19	Senior Administrative Officer	41	17	24	
20	Administrative Officer	42	26	16	
21	Head Assistant	94	38	56	
22	Chief Personal Officer	4	3	1	
23	Personal Officer	10	1	9	
24	Senior Personal Assistant	24	0	24	
25	Personal Assistant	30	0	30	
26	Senior Assistant	146	51	95	
27	Junior Assistant	166	95	71	
28	Store Superintendent	1	0	1	
29	Store Deputy Superintendent	2	0	2	
30	Store Keeper	2	0	2	
31	Driver	72	2	70	
	Sub Total (Group C)	**1,441**	**649**	**792**	**45%**
Group D					
32	Officer	37	21	16	
33	Peon	277	14	263	
	Sub Total (Group D)	**314**	**35**	**279**	**11%**
	Total (A+B+C+D)	**2,074**	**875**	**1,199**	**42%**
34	Establishment Regular Staff (Field) *Regular Employees	1,394	520	874	
	Grand Total	**3,468**	**1,395**	**2,073**	**40%**

Source: Prepared by JST based on UKPJN Organogram

(2) Staff Qualifications and Technical Level

In UKPJN, there is no personnel appraisal system that comprehensively evaluates employees' performance, abilities, and work attitudes. The job descriptions required for each post are summarized in "UKPJN Staff's Duties and Responsibilities," and promotions for technical staff are evaluated in accordance with the conditions shown in Table 6-6.

Table 6-6 Requirements to be Satisfied by UKPJN Managerial and Technical Staff

Post	Conditions
Managing Director (MD)	Ideally, the MD would be promoted from CE or GM, but the current MD was appointed by the state government.
General Manager (hereinafter referred to as "GM")	In the Construction Wing, a GM is assigned under the Chief General Manager (CGM), but this post is equivalent to a SE.
Chief Engineer (CE)	CE is assigned to the Headquarters, Garhwal Division, and Kumaon Division, respectively. Basically, CE has at least 20 years of work experience and at least 2 years of experience as an SE.
Superintending Engineer (SE)	The SE works in the Circle Office and manages project progress by receiving reports from the Divisional Office of the assigned area. Basically, SE has at least 5 years of work experience as an EE.
Executive Engineer (EE)	The EE works in the Divisional Office and has the role of project executive body. Basically, EE has at least 7 years of experience as an AE.
Assistant Engineer (AE)	The AE is basically required to have a degree holder (4 years of education). Currently, 50% of AEs are Degree holders, and the remaining are specially promoted among the Diploma holders (3 years of education).
Junior Engineer (JE)	The JE is in charge of instructing the contractor and managing the Quality Control of the project in the field. The basic requirement is a Diploma holder (3 years of education).

Source: Prepared by JST

In UKPJN, a total of 575 engineers are working on the preparation of DPRs and construction supervision for water supply and sewage projects, and 189 engineers have completed Degrees (bachelor's degrees). Diploma holders are ranked as JE, while Degree holders are ranked as AE, and promotion from these posts is determined by the number of years of work experience (Refer to Table 6-7).

However, in some cases, Diploma holders are specially promoted to AE in evaluation of their skills, even if they have not completed the Degree. In addition, a total of 520 technical staff works at the field level under the supervision of engineers. Educational background and work experience of engineers in UKPJN are shown in Table 6-7.

Table 6-7 Educational Background and Work Experience of Engineers in UKPJN

Educational Background	Post (Engineers)	Staff Number	Work Experience
Degree Holder	Chief Engineer (CE)	1	Managerial positions, with sufficient work experience (at least 7 years as AE)
	Superintending Engineer (SE)	19	
	Executive Engineer (EE)	58	
	Assistant Engineer (AE)	111	Some engineers have not been promoted, even though they have sufficient work experience
Diploma Holder	Junior Engineer (JE)	386	
	Total	**575**	

Source: Prepared by JST

(3) Human Resource Development

"General Manager Research and Development Training" is established at the Roorkee branch as a department in charge of human resources development. The UKPJN has a training centre in Roorkee, where training for new employees, technical training for engineers, and financial and accounting training for staff are held on an irregular basis. In addition, employees who are nominated within the UKPJN regularly attend training courses for the water supply sector organized by the UK state government.

A support program is also offered to employees who apply for a master's or doctoral degree, with 50% of their salary being paid for three years while they study at the university.

6.1.2 Operation and Maintenance Section: UJS

(1) Organizational Structure of UJS

UJS is headed by a Chairman and a Chief General Manager, with four major departments under them: 1) Civil Engineer Department, 2) Administration Department, 3) Technical Review and Material Procurement Department 4) Finance Department.

The members of UJS Board of Directors, constituted under the Uttar Pradesh Water Supply and Sewer System Act of 1975, are listed below.

i.	Secretary, Department of Drinking Water, Government of Uttarakhand
ii.	Secretary, Finance Department, Government of Uttarakhand
iii.	Secretary, Planning Department, Government of Uttarakhand
iv.	Secretary, Urban Development Department, Government of Uttarakhand
v.	Mayor Dehradun, Municipal Corporation
vi.	President, Nagar Municipal Council, Tanakpur, Champawat
vii.	President, Nagar Panchayat, Satpuli, Pauri
viii.	President, Nagar Panchayat, Dineshpur, Udham Singh Nagar
ix.	Director General, Medical and Health Department, Government of Uttarakhand
x.	Finance Director, Uttarakhand Jal Santhan, Dehradun
xi.	Chief General Manager, Uttarakhand Jal Santhan, Dehradun
xii.	Managing Director, Uttarakhand Pey Jal Nigam

Source: Prepared by JST

Figure 6-3 List of UJS Board Members

The following table shows the job descriptions for the water supply and sewerage services in UJS. The Civil Engineering Department handles most of the services, but some are outsourced, such as operation and maintenance of the facilities, leakage repair, water quality analysis, and other services.

Table 6-8 Job Descriptions in UJS

Job description	Department	Notes
Financial Planning and Fundraising	- Finance Department	
Procurement Support, Contractor Selection	- Civil Engineering Department	Headquarters manages and procures equipment for the entire UJS and provides it to branches and sub-contractors.
Material Procurement, Storage Management	- Technical Review and Material Procurement Department	
Accounting, Water/Sewerage Tariff Setting	- Finance Department	
Billing and Collection of Tariffs	- Civil Engineering Department	Bills are issued by headquarters, and distribution and tariff collection are handled by the branch offices.
Operation and Maintenance of Water Supply Facilities	- Civil Engineering Department	Partially Outsourced
Operation and Maintenance of Sewerage Facilities	- Civil Engineering Department	Partially Outsourced
Leakage Control and Repairs	- Civil Engineering Department	Partially Outsourced
Water Quality Analysis and Management	- Civil Engineering Department	Partially Outsourced, especially for the Sewerage Service
Monitoring System (SCADA)	- Civil Engineering Department	
Outsourcing Management	- Civil Engineering Department	Each Divisional Office selects a subcontractor, and the EE manages the subcontractor, while the AE or JE directs day-to-day operations.
Personnel and Human Resources Development	- Administration Department	

Source: Prepared by JST

The headquarters of UJS function at the head office in Dehradun, while the branch functions are divided as follows. Firstly, a GM is assigned to each of the five offices, and a SE, responsible for several Divisions, works in the Circle Office under the GM. Underneath of the Circle Office, the Divisional Office is managed by the EE, who is responsible for project execution. The Sub-Divisional Office is managed by the AE, who is in charge of operation

and maintenance. The Unit Office is managed by the JE, who supervises field staff and subcontractors, and engineers at all levels.

Basically, there are several sub-divisional offices within the jurisdiction of the divisional office, and several unit offices are located within the jurisdiction of the sub-divisional office. However, if the jurisdiction of the divisional office is small, the functions of the unit offices are consolidated at the sub-divisional office. Depending on the area size, number of clients, number of facilities, etc., the offices are established.

The following table shows the organizational hierarchy of UJS. In Haridwar City, water supply and sewage service are managed by separate offices, while in other cities, they are managed in the same office.

Table 6-9 Organizational Hierarchy of UJS's Engineers

Headquarters	
General Manager (GM)	General Manager Office (5 Offices): 1) Chief General Manager Office, 2) Dehradun (Headquarters), 3) Pauri, 4) Nainital, 5) Pithoragarh
Superintending Engineer (SE)	Circle Office (9 Offices): Monitoring for each project *Established in cities in major Districts
Executive Engineer (EE)	Divisional Office (31 Offices): Project executing body, which includes bidding for subcontractors, salary allocation, and preparation of monthly reports. *Established in major cities and towns
Assistant Engineer (AE)	- Sub-Divisional Office: The Division is divided into multiple areas and operates and maintains in coordination with the JE. In addition, the AE is responsible for new connection applications. - The Sub-Divisional Office has a "Revenue Collection Centre/ Computer Centre" that collects water/sewerage tariffs in cash.
Junior Engineer (JE)	- Unit Office: The JE is responsible for the operation and maintenance of the facilities by instructing on-site staff (e.g., pump operator, pipeline fitter, billing distribution staff) and subcontractors. - Some Unit Office has a "Revenue Collection Centre/ Computer Centre" that collects water/sewerage tariffs in cash.

Source: Prepared by JST

A list of UJS staff (excluding the Chairman) is shown Table 6-10. Managerial posts are 100% occupied, while the post occupancy rates for engineers, administrative staff, and field staff are 69%, 88%, and 68%, respectively. Although there is a shortage of field workers, this does not seem to be a major difficulty since the operation and maintenance of the facilities has been outsourced.

Table 6-10 List of UJS Staff (as of May 2023)

		Sanctioned Post	Working	Vacant Post	Occupancy Rate
Managerial Staffs					
1	Chief General Manager	1	1	0	
2	General Manager	5	5	0	
3	Secretary (Administration)	1	1	0	
4	Secretary (Appraisal)	1	1	0	
	Sub Total	**8**	**8**	**0**	**100%**
Engineers					
5	Superintending Engineer	9	10	-1	
6	Executive Engineer	32	32	0	
7	Assitant Engineer	112	85	27	
8	Additional Assistant Engineer	224	160	103	
9	Junior Engineer	39			
	Sub Total	**416**	**287**	**129**	**69%**
Administrative Staffs					
10	Finance Director	1	1	0	
11	Ar. Accounts Officer / Sr. Examining Officer	3	3	0	
12	Accounting Officer / Auditing Officer	5	5	0	
13	Assistant Accounts Officer / Assistant Audit Officer	5	6	-1	
14	Accountant / Senior Auditor	44	26	18	
15	Assistant Accountant / Junior Auditor	68	34	34	
16	Law Officer	1	1	0	
17	Chief Administrative Officer	18	19	-1	
18	Senior Administrative Officer	24	14	10	
19	Administration Officer	24	16	8	
20	Head Assistant	54	42	12	
21	Senior Assistant	84	82	2	
22	Junior Assistant	97	125	+52	
23	Data Entry Operator	91	51	40	
24	Computer	17	16	1	
25	Chief Personal Officer	2	3	-1	
26	Personal Officer	5	9	-4	
27	Senior Personal Officer	13	8	5	
28	Personal Assistant	16	7	9	
29	Tax and Revenue Assessment Officer Grade-1	1	1	0	
30	Tax and Revenue Assessment Officer	4	6	-2	
31	Assistant Tax and Revenue Superintendent	9	11	-2	
32	Tax and Revenue Inspector	12	7	5	
33	Assistant Writer	0	26	0	
34	Peon	0	10	0	
	Sub Total	**598**	**529**	**133**	**88%**

Field Staffs					
35	Retainer / Watchman	95	64	31	
36	Senior Chemist	2	1	1	
37	Chemist	15	5	10	
38	Pump House Superintendent	7	5	2	
39	Shift Incharge (Head Pump Operator)	36	22	14	
40	Pump Operator	228	156	72	
41	Pump Attendant	57	21	36	
42	Pump House Superintendent (Electrical)	2	1	1	
43	Head Election	6	1	5	
44	Electricity	25	8	17	
45	Filter House Superintendent	2	1	1	
46	Foreman Fitter House	4	2	2	
47	Filter Operator	8	5	3	
48	Filter Attendant	22	9	13	
49	Pipe Line Superintendent	5	3	2	
50	Head Fitter	25	22	3	
51	Pipe Line Fitter	368	316	52	
52	Junior Fitter 'Assistant Line Man'	917	608	309	
53	Assistant Line Man				
54	Vehicle Driver Grade-1	0	3	-3	
55	Vehicle Driver Grade-2	7	8	-1	
56	Vehicle Driver Grade-3	7	3	4	
57	Vehicle Driver Grade-4	4	2	2	
58	Sewer Superintendent	1	5	-4	
59	Cleaning Supervisor	8	7	1	
60	Sewer Repairman	20	19	1	
61	Sewer Backer	80	41	39	
62	Mater Superintendent	2	1	1	
63	Meter Inspector	4	1	3	
64	Assistant Meter Inspector	14	9	5	
65	Meter Reader	27	10	17	
66	Catographer	0	0	0	
67	Head Works Attendant	1	1	0	
68	Head Bradma* Operator (Bill Prepartion)	1	1	+1	
69	Bradma* Operator	0	0	0	
70	Foreman Workshop	1	1	0	
71	Meter Mechnic	13	8	5	
72	Work Supervisor	2	2	0	
73	Bill Distributor	11	8	3	
74	Gardener	2	2	0	
75	Secretarial	1	1	0	
76	Oil man	0	1	0	
77	Pump Cleaner	0	1	0	
	Sub Total	**2,030**	**1,385**	**647**	**68%**
	Grand Total	**3,052**	**2,209**	**909**	**72%**

Source: Prepared by JST based on UJS Organogram

(2) Staff Qualifications and Technical Level

In UJS, there is no personnel appraisal system that comprehensively evaluates employees' performance, abilities, and work attitudes. The job description required for each position is summarized in “UJS Powers and Duties of Officers and Employees”.

As for the educational backgrounds and work experience of the engineers, the engineering staff structure is similar to that of UKPJN. As shown in the table below, a total of 266 engineers are in charge of operation and maintenance of water supply and sewerage facilities, and 82 of them are Degree holders (bachelor's degrees). However, daily operation and maintenance of the water supply and sewerage facilities are either directly managed or outsourced to private companies.

Table 6-11 Educational Background and Work Experience of Engineer in UJS

Educational Background	Post (Engineers)	Staff Number	Work Experience
Degree Holder	Chief Engineer (CE)	1	Managerial positions, with sufficient work experience (at least 7 years as AE)
	Superintending Engineer (SE)	10	
	Executive Engineer (EE)	32	
	Assistant Engineer (AE)	85	Some engineers have not been promoted, despite having sufficient work experience
Diploma Holder	Junior Engineer (JE)	160	
	Total	**288**	

Source: Prepared by JST

(3) Human Resources Development

There is no department assigned to human resources development and no in-house training programme like the UKPJN. However, with the support of the Uttarakhand State Council of Science and Technology, training programmes for water quality managers are being organized. In addition, nominated staff within UJS regularly attend trainings for the water supply sector organized by the UK state government.

The UK state government owns the Administrative Training Institute in Nainital, which provides training in all infrastructure services. Two to three candidates will be nominated by the relevant organizations to participate in the training, in accordance with the training application guidelines. The training is held online or face-to-face, and the training participation fee is covered by the state government. Training topics for the water sector include general water supply services and community mobilization, and are lectured by university professors, retired engineers, and others.

(4) Outsourcing

UJS has outsourced some work related to the operation and maintenance to private contractors. Major subcontracted work includes "operation of WTP, WWTP and STP, operating pump stations, controlling electrical systems, analysing water quality, switching valves for hourly water supply, leakage repairing, pipe installation, and bill distribution. The outsourcing situation is affected by the number of staff and their capabilities in each district, but larger population cities tend to outsource "opening and closing valves and repairing water leakage".

Subcontractors are selected by the Divisional Office through the prescribed procurement process, which takes approximately three months. The contractor needs to be registered in advance according to the subcontractor category as described in the "Regulations: Classification and Enlistment of Contractor" to be entitled to bidding. Registered contractors are allowed to apply for the bidding on either UKPJN or UJS.

In principle, the contract period with subcontractors is set at one year. However, in some cases, such as contracts for daily maintenance and management services, the contract is actually for three years taking into consideration efficiency and sustainability. At the end of the contract, the same or a different contractor will be selected through the procurement process in accordance with the regulations. Table 6-12 shows the classification of the contractor. The higher the category, the more rigorous the assessment is based on the work experience and educational background which are mentioned in the application requirements.

Table 6-12 Classification of Contractors

Categories	Conditions
Category A	List of contractors managed by the headquarters Registration Fee: INR. 10,000
Category B	List of contractors managed by the Chief Engineer / General Manager Registration Fee: INR. 7,500
Category C	List of contractors managed by the Executive Engineer Registration Fee: INR. 5,000
Category D	List of contractors managed by the Executive Engineer Registration Fee: INR. 2,500

Source: Prepared by JST

6.2 Operations and Maintenance Expenses

Based on the operating expenses in UJS's income and expenditure statement, operation and maintenance expenses are summarized as shown in Table 6-13 and Figure 6-4, which does not include depreciation. Operation and maintenance expenses have increased 58.9% from INR 43,073 Lakh to INR 68,441 Lakh over the five-year period from FY2015 to FY2019, with an average annual growth rate of 12.3%.

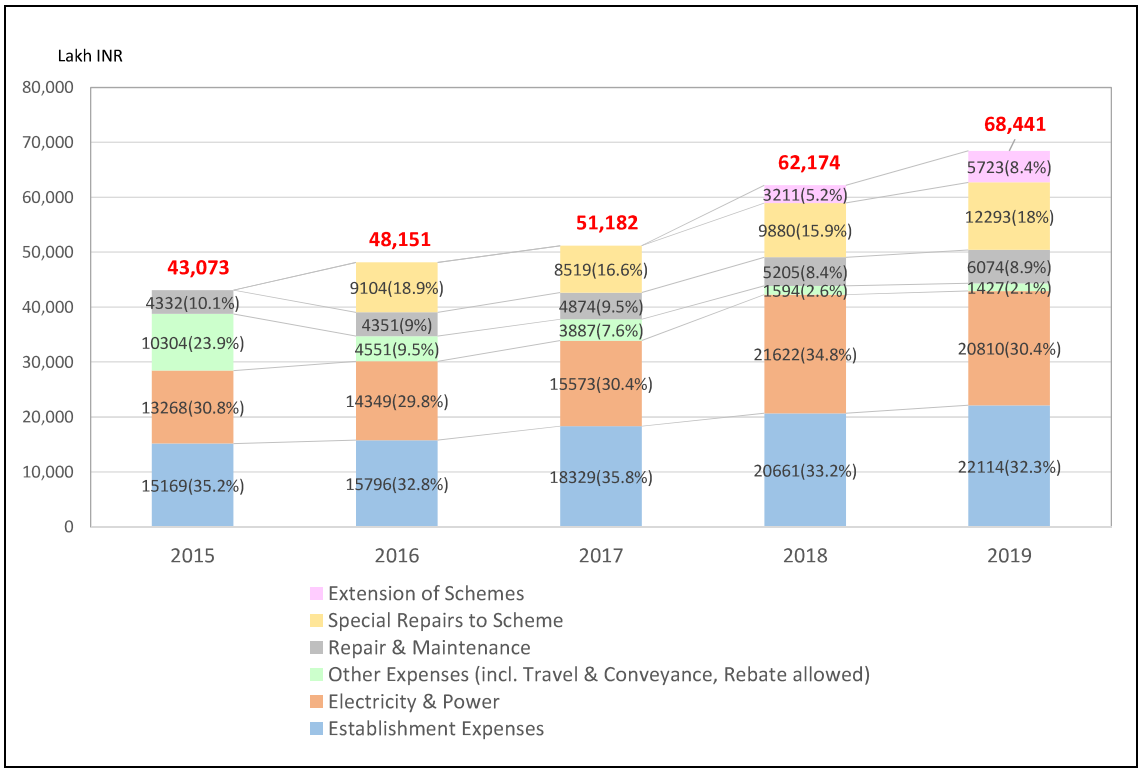
The largest portion of operation and maintenance expenses is establishment expenses (equivalent to personnel expenses) at 30 to 35%, followed by electricity and power expenses also at 30 to 35%. After FY2016, special repairs expenses range from 16% to 19%, and after FY2018, extension expenses have accrued.

With the exception of operating expenses, all expense items are on an upward trend due to the increase in electricity and energy costs, measures to address ageing facilities and equipment, the expansion of water supply and service pipes to accommodate the growing number of new customers, and the high price of commodities. Increasing revenues through appropriate water/sewerage tariff collection on a metered basis, initiatives to reduce expenditures, and improving the efficiency of services are issues for the future.

Table 6-13 Operation and Maintenance Expenses (INR Lakh) and Percentage Change

O&M Expenses	2015	2016	2017	2018	2019	-
Establishment Expenses	15,169	15,796	18,329	20,661	22,114	-
Electricity & Power	13,268	14,349	15,573	21,622	20,810	-
Other Expenses (incl. Travel & Conveyance, Rebate allowed)	10,304	4,551	3,887	1,594	1,427	-
Repair & Maintenance	4,332	4,351	4,874	5,205	6,074	-
Special Repairs to Scheme	0	9,104	8,519	9,880	12,293	-
Extension of Schemes	0	0	0	3,211	5,723	-
Total	**43,073**	**48,151**	**51,182**	**62,174**	**68,441**	-
Percentage Change	FY15-FY16	FY16-FY17	FY17-FY18	FY18-FY19	5yrs	CAGR
Establishment Expenses	4.1%	16.0%	12.7%	7.0%	45.8%	9.9%
Electricity & Power	8.1%	8.5%	38.8%	-3.8%	56.8%	11.9%
Other Expenses (incl. Travel & Conveyance, Rebate allowed)	-55.8%	-14.6%	-59.0%	-10.5%	-86.2%	-39.0%
Repair & Maintenance	0.4%	12.0%	6.8%	16.7%	40.2%	8.8%
Special Repairs to Scheme	-	-6.4%	16.0%	24.4%	-	-
Extension of Schemes	-	-	-	78.2%	-	-
Total	**11.8%**	**6.3%**	**21.5%**	**10.1%**	**58.9%**	**12.3%**

Source: Prepared by JST based on UJS's Financial Statements



Source: Prepared by JST based on UJS's Financial Statements

Figure 6-4 Trends and Breakdown of Operation and Maintenance Expenses

6.3 Business Plan / Strategy

UKPJN as a PSU does not prepare an annual or medium-term business plan but prepares corresponding documents upon request from the Department of Drinking Water (DDW). For example, in March 2023, UKPJN prepared "Roadmap 2025" with a simple list as shown in section 3.2.9, consisting of identified problems/issues, potential solutions/initiatives, activities, outputs, measurable indicators, strategy, timelines, targets, and required structural policy / governance / scheme reforms, with the short term set for 1 year, the medium term set for 3 years and the long term set for 2030.

As an issue, UKPJN will be required to work with UJS to formulate a business plan and strategy that comprehensively covers the sustainable management cycle of the entire water supply and sewerage services.

In addition, every year DDW prepares the “Outcome Budget Plan” for budget request and execution, which includes the budget for each development project, grants/subsidies to UKPJN and UJS, etc.

6.4 Status of Water/Sewerage Tariff Revenue and Cost Structure

6.4.1 Cost Structure

In Uttarakhand state, water tariffs are based on a base rate set in 2013 and is increased annually by a certain percentage. Until 2016, the rate was 15% per annum, but since then it has been 9% per annum, in line with the state government's intention to reduce the burden on citizens.

As for the sewerage tariff, the base rate is 27 INR/toilet, set in 2013, and automatically increased at a rate of 15% per year until 2016 and 9% per year thereafter. The proposals for rate revisions are submitted by UJS to the state government but cannot be enforced unless approved.

Water tariffs are classified into the following three categories based on the three water distribution methods: (1) gravity, (2) pumping (high water head of 100 m or less), and (3) pumping (low water head of 100 m or more).

A) Metered Connection: Fixed rate based on property tax (annual valuation of building)
B) Non-Metered Connection: Billing based on meter reading (consumption volume)
C) In case of Rural Water Supply: Fixed rate based on number of water connections

The following table shows a comparison of "water rates as of 1 April 2013" and "water rates as of 1 April 2023" for each category. The Low Head for pumping shall be less than 100 m, and the High Head shall be 100 m or more.

Domestic water supply is categorized as A, B, or C. For non-domestic water supply, water tariffs are categorized by sector type, such as "industrial areas," "commercial facilities," "government institutions," "military institutions," and "rural areas".

Table 6-14 Category A: Fixed Rate based on Property Tax (Annual Valuation of Building)

No.	Annual valuation of building (Based on Property Tax)	Monthly Rate (Unit: INR)					
		Rates effective as on 01.APR 2013 (basic rates)			Rates effective from 01.APR 2023		
		gravity	lowhead	highhead	gravity	lowhead	highhead
1	up to INR 360	90	95	102	176.4	186.2	199.92
2	from INR 361 to 2,000	95	102	110	186.2	199.92	215.6
3	from INR 2,001 to 3,500	112	120	135	219.52	235.2	264.6
4	from INR 3,501 to 6,000	150	164	187	327	357.52	407.66
5	from INR 6,001 to 8,000	179	187	224	390.22	407.66	488.32
6	from INR 8,001 to 10,000	209	224	239	455.62	488.32	521.02
7	from INR 10,001 to 12,000	224	239	260	488.32	521.02	566.8
8	from INR 12,001 to 14,000	239	260	275	521.02	566.8	599.5
9	above INR 14,001	325	350	375	708.5	763	817.5

Note: Applicable to domestic water supply in urban areas where water meters are not installed.

Source: Prepared by JST based on water tariff table

Table 6-15 Category B: Billing based on Meter Reading (Domestic Water Supply)

No.	Area	Rates (Unit: Kiloliter/month)					
		Rates effective as on 01.APR 2013 (basic rates)			Rates effective from 01.APR 2023		
		gravity	lowhead	highhead	gravity	lowhead	highhead
1	Urban area	4	5.5	6.25	10	13.75	15.63
2	Rutal area	3.1	4.7	6.25	7.75	11.75	15.63

Note: Applicable to domestic water supplies in urban and rural areas where meters are installed.

Source: Prepared by JST based on water tariff table

Table 6-16 Category B: Monthly Water Rate categorized by Sector Type (Non-Domestic Water Supply)

No.	Description	Monthly Rates					
		Rates effective as on 01.APR 2013 (basic rates)			Rates effective from 01.APR 2023		
		gravity	lowhead	highhead	gravity	lowhead	highhead
1	Municipal Council Area						
	a) Special Category and Industrial	415	550	700	1,037.5	1,375	1750
	b) Other Business Establishments	380	450	520	950	1,125	1,300
	C) Government, Semi Government and Institutional Establishments/ Cantonment board	375	425	484	937.5	1,062.5	1,212.5
2	Urban Council Area/ Municipal Multipurpose	235	315	350	587.5	787.5	875
3	Rural Area	175	195	235	437.5	487.5	587.5

Note: Applicable to non-domestic water systems where meters are installed.

Source: Prepared by JST based on water tariff table

Table 6-17 Category B: Billing based on Meter Reading categorized by Sector Type (Non-Domestic Water Supply)

No.	Description	Rates (Unit: Kiloliter/month)					
		Rates effective as on 01.APR 2013 (basic rates)			Rates effective from 01.APR 2023		
		gravity	lowhead	highhead	gravity	lowhead	highhead
1	Municipal Council Area						
	a) Special Category and Industrial	12.5	15.6	18.75	31.25	39	46.88
	b) Other Business Establishments	11	12.5	16.5	27.5	31.25	41.25
	C) Government, Semi Government and Institutional Establishments/ Cantonment board	10.5	12	16.5	26.25	30	41.25
2	Urban Council Area/ Municipal Multipurpose	10.5	10.5	16.5	26.25	26.25	41.25
3	Rural Area	10.5	10.5	16.5	26.25	26.25	41.25

Note: Applicable to non-domestic water systems where meters are installed. In addition to the basic monthly rates listed in Table 6-16, the customer is charged a rate based on the amount of water used.

Source: Prepared by JST based on water tariff table

Table 6-18 Category C: Fixed Rate based on the Number of Water Connections

No.	Description	Monthly Rate (Unit: INR)					
		Rates effective as on 01.APR 2013 (basic rates)			Rates effective from 01.APR 2023		
		gravity	lowhead	highhead	gravity	lowhead	highhead
1	1 spout water fitting	55	60	67	107.8	117.6	131.32
2	2 spout water fitting	67	75	90	131.32	147	176.4
3	3 spout water fitting	90	112	135	196.2	244.16	294.3
4	4 or more than 4 spout water fitting	112	135	150	244.16	294.3	327

Note: Applicable to rural domestic water supply where no water meter is installed and where there is no annual valuation of building.

Source: Prepared by JST based on water tariff table

Sewerage tariffs for households with sewerage connections are charged at a fixed rate based on property taxes (annual valuation of building). For non-domestic users, a monthly rate is determined per toilet or other sanitary facility.

Table 6-19 Fixed Rate based on Property Taxes (Annual Valuation of Building)

No.	Annual valuation of building (Based on Property Tax)	Monthly Rate (Unit: INR)	
		Rates effective as on 01.APR 2013 (basic rates)	Rates effective from 01.APR 2023
1	up to INR 360	12	23.52
2	from INR 361 to 2,000	18	35.28
3	from INR 2,001 to 3,500	27	52.92
4	from INR 3,501 to 6,000	30	75
5	from INR 6,001 to 8,000	35	87.5
6	from INR 8,001 to 10,000	40	100
7	from INR 10,001 to 12,000	45	112.5
8	from INR 12,001 to 14,000	50	125
9	above INR 14,001	60	150

Source: Prepared by JST based on sewerage tariff table

Table 6-20 Monthly Rate is determined per Toilet or Other Sanitary Facility

No.	Description	Monthly Rate (Unit: INR / Toilet)	
		Rates effective as on 01.APR 2013 (basic rates)	Rates effective from 01.APR 2023
1	Sewer Facility Charge	27	67.5

Source: Prepared by JST based on sewerage tariff table

In addition, for development costs for water and sewerage projects, unit costs per m^2 of plot area are defined in the table below.

Table 6-21 Water and Sewerage Development Costs to be charged to the Customer

Development Cost for Water Supply Project (Unit: INR)

Area	Gravity				LowHead				HighHead			
	Rates effective as on 01.APR 2013 (basic rates)		effective rates from 01.APR 2023		Rates effective as on 01.APR 2013 (basic		Effective rates from 01.APR 2023		Rates effective as on 01.APR 2013 (basic		Effective rates from 01-04-23	
	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge
Urban	11	1,100	27.5	2,750	15	1,500	37.5	3,750	22	2,200	55	5,500
Rural	4	400	10	1,000	7.25	725	18.13	1,812.5	11	1,100	27.5	2,750

Development Cost for Sewerage Project (Unit: INR)

Area	Gravity				LowHead				HighHead			
	Rates effective as on		effective rates from		Rates effective as on		Effective rates from		Rates effective as on		Effective rates from	
	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge	Rates per $1m^2$	minimum charge
urban	11	1,100	27.5	2,750	15	1,500	37.5	3,750	22	2,200	55	5,500

Source: Prepared by JST based on water and sewerage tariff table

6.4.2 Tariff Collection System

The billing of the water and sewerage services is carried out through the distribution of a bill once every four months. For billing purposes, meter reading data or customer information is compiled and updated at the Divisional Office level. After that, the bill is prepared at UJS headquarters and distributed to each household under the supervision of the JE.

Payment options include cash, bank transfer, or online payment.

(1) Revenue Collection Centre

Water and sewerage tariffs can be paid in cash at the Revenue Collection Centre located in each Sub-Divisional Office (in some areas, located in the Unit Office). This centre is open Monday to Saturday from 10:00 a.m. to 5:00 p.m. (closed every second Saturday).

The collected water and sewerage tariffs at the Revenue Collection Centre are deposited into the divisional office's bank account, and the payment status is managed in a common system among UJS. However, the billing information can only be edited at the head office.

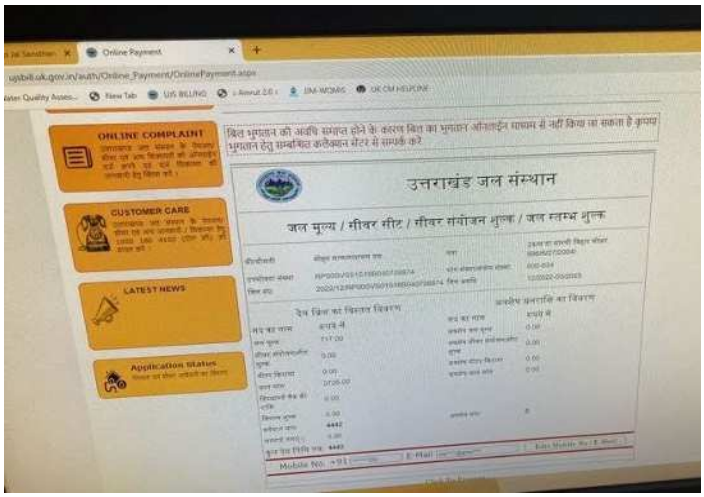
The payment status at the Revenue Collection Centre was reported to be that approximately 30 customers would come daily to pay during the billing month, but that thereafter the number of customers would decrease.

(2) Online Payment System

The online payment system is developed by the National Informatics Centre and customers are able to pay the tariffs via website and mobile apps. Payment options include credit cards, Electronic Money, and bank transfers.

This service was launched in 2013, and as of 2021, the number of users was approximately 10%. However, with the increase of Internet coverage and the spread of smartphones in recent

years, approximately 38% of the customers are currently using online payment, and further growth in the number of users is expected in the future.



Source: Prepared by JST

Figure 6-5 Online Payment System

6.4.3 Status of Tariff Collection

The water/sewerage tariffs collected from the Revenue Collection Centre or online payment system are centralized at the UJS headquarters, and UJS-wide collected revenue is compiled annually.

In addition, UJS sets annual targets for water/sewerage tariff revenue based on the calculation of [(number of current customers) + (number of expected new customers for existing facilities) + (number of expected new customers for newly constructed facilities)]. Table 6-22 shows the actual and target tariff revenue for the past four years, as well as the transition in the target achievement rate.

Table 6-22 Target and Actual Water/Sewerage Tariff Revenue for the past Four Years

Unit: Million INR

	2019-20			2020-21			2021-22			2022-23		
	Target	Collection	Achievement Rate	Target	Collection	Achievement Rate	Target	Collection	Achievement Rate	Target	Collection	Achievement Rate
Dehradun	1,262.22	1,042.12	82.6%	1,578.19	1,147.01	72.7%	1,378.78	1,193.04	86.5%	1,440.38	1,332.10	92.5%
Haridwar	304.87	173.59	56.9%	441.14	173.77	39.4%	391.18	261.65	66.9%	391.89	234.35	59.8%
Tehri Garhwal	113.10	86.43	76.4%	146.16	96.11	65.8%	125.60	101.56	80.9%	129.58	112.06	86.5%
Uttarkashi	101.71	60.01	59.0%	147.91	93.57	63.3%	121.21	82.33	67.9%	125.86	95.58	75.9%
Pauri Garhwal	183.91	169.96	92.4%	229.44	202.20	88.1%	219.06	219.08	100.0%	231.74	224.12	96.7%
Chamoli	81.46	65.78	80.8%	103.34	71.17	68.9%	88.70	71.08	80.1%	93.37	66.99	71.7%
Rudraprayag	38.29	30.10	78.6%	53.62	37.26	69.5%	45.77	35.05	76.6%	46.16	38.23	82.8%
Nainital	575.47	459.58	79.9%	709.98	584.45	82.3%	696.16	600.40	86.2%	726.48	665.25	91.6%
Udham Singh Nagar	98.09	53.07	54.1%	146.91	62.80	42.7%	95.91	66.01	68.8%	101.26	78.64	77.7%
Almora	118.93	81.93	68.9%	148.04	103.10	69.6%	123.69	114.88	92.9%	133.28	125.18	93.9%
Bageshwar	32.79	21.21	64.7%	42.74	25.29	59.2%	33.54	27.55	82.1%	34.39	31.57	91.8%
Pithoragarh	108.56	64.55	59.5%	137.05	76.37	55.7%	104.39	82.57	79.1%	107.49	98.41	91.6%
Champawat	52.02	29.81	57.3%	69.34	35.18	50.7%	49.47	35.24	71.2%	51.49	50.88	98.8%
Total	**3,071.40**	**2,338.13**	**76.1%**	**3,953.85**	**2,708.27**	**68.5%**	**3,473.44**	**2,890.43**	**83.2%**	**3,613.38**	**3,153.35**	**87.3%**

Source: Excerpts from the Uttarakhand Commercial Analysis

Reminder letters are issued to customers who are delinquent in paying bills. In particularly malicious cases (e.g., prolonged delinquency or unauthorized water/sewerage connection in spite of disconnection), the District Administration Office shall send a complaint letter to the customer, and the legal proceedings shall be initiated.

6.5 Customer Service

The customer service provided by UJS includes question/complaint reception desk on the website, and these customer opinions are collected in the system and responses are recorded. At district offices, questions and complaints received by phone or face-to-face are recorded in notebooks, which are then consolidated at the branch level and entered into the system for information sharing and improvement with the head office.

6.6 Related Grants, Subsidies, and other Funding Programs

Grants and subsidies related to water and sewerage services in Uttarakhand state are listed as follows:

- Capital grants from the central and state governments to UKPJN
- Operating grants from the state government to UKPJN, in case the centage charge is insufficient to cover the operating costs.
- Operating grants for operation and maintenance from the state government to UJS
- Grants agreed on the project basis by development partners (e.g., the first phase of the loan project by KfW).

6.7 Financial Status

The financial status related to water supply and sewage services in Uttarakhand State is summarized below by the following organizations.

- UKPJN: Infrastructure development
- UJS: Operation and maintenance
- Uttarakhand state government: Sector governance and management through DDW, and grant provision to UKPJN and UJS

6.7.1 UKPJN

The financial status of UKPJN is summarized as follows based on income and expenditure statement and balance sheets for the five-year period from FY2017 to FY2021.

(1) Profit and Loss Statement

The income and expenditure statement and the percentage change in the main account items are shown in Table 6-23 and Table 6-24 respectively. For the past five years, UKPJN has operated in deficit with expenditure exceeding income, except for FY2018. The basic income sources of UKPJN are "Centage charge" which is charged at a fixed rate in the implementation of water supply and sewerage projects, and "Survey and project fee" in building construction for other departments and agencies. These accounted for 26.7% of the total income in FY2021. Other incomes consist of 59.4% from development project-based grants and 11.8% from revenue grants from the state government for pensioners and balance between income and expenditure.

The annual growth rate of income is 6.1% while that of expenditure is 6.8%, indicating that expenditure tends to exceed income. The deficit was about INR 3,500 Lakh in FY 2019 but has remained at about INR 2,000 Lakh thereafter. This could be considered due to the dependence on revenue grants from the state government to cover a balance between income and expenditure.

Table 6-23 UKPJN's Income and Expenditure Statement (INR Lakh)

	2017	2018	2019	2020	2021
Income					
(a) Income from operation					
Centage Charges	8,247.68	7,795.78	7,317.61	8,374.91	13,861.17
Survey & Project Fees	1,656.68	8,431.96	1,241.91	322.79	812.60
Grant from Govt. for work Non IDA Completed Work	19,661.91	17,782.10	15,279.24	17,947.08	21,346.80
Grant Utilised under SWAP	7.97	2.70	9.60		
Grant Utilised under SWAP (Additional Finance)	(4.50)	(11.37)			
Grant Utilised under Peri Urban Areas	416.24	1,445.41	1,981.91	8,217.21	11,236.97
Revenue from Urban WSS-Pipe Owned by Jal Nigam	4.10				
Revenue from Rural WSS-Pipe Owned by Jal Nigam	349.04	374.02	453.35	369.79	381.50
Revenue from Sewerage works owned by Jal Nigam	2.54	0.34	11.01		
Income from Issue of Material	2.72	1.63	1.31	0.52	0.12
Income from Sale of Material	0.43		(0.77)	0.12	
Profit or Loss on sale of Fixed Assets		0.00	0.03	0.06	0.11
Rent from Employees or Other Parties	20.17	12.44	17.02	9.40	10.56
Leave Salary contran of deputationists received	18.46	3.51	5.31	9.61	6.74
Pension contran of deputationists rec	37.90	5.97	18.23	23.51	22.10
Sale of Tender Forms	64.84	89.34	88.78	271.45	225.68
Fines and Penalities Levied	1.98	38.35	37.85	145.68	144.20
Central Stores division charges	0.16	0.61	0.25	0.80	0.06
Reimbursement under Apprentice Act					
Misc Receipt - Peri Urban		1.20	1.07	4.43	5.99
Misc Receipt - SWAP (Additional Finance)		11.37			
Other Income	146.77	220.06	665.34	418.35	308.41
Revenue Grant from GoUK for Pensioners	2,500.00	3,000.00	2,500.00	3,500.00	2,500.00
Revenue Grant from GoUK for Diff	7,489.67	6,800.00	6,600.00	7,000.00	4,000.00
Sub-Total	**40,624.76**	**46,005.41**	**36,229.04**	**46,615.72**	**54,863.04**
(b) Income from Financing Activities					
Interest against Deposit Work	27.45	61.57	67.50	111.14	65.60
Interest earned against Establishment					68.69
Interest income (GPF) (HQ)	9.59	1.17	7.29		
Interest income (NPS) (HQ)	6.17	4.18	2.89	3.91	4.15
Interest income GPF/PF Saving A/c	630.55	700.61	716.24	569.42	521.69
Sub-Total	**673.76**	**767.53**	**793.91**	**684.47**	**660.14**
Total Income	**41,298.52**	**46,772.94**	**37,022.95**	**47,300.19**	**55,523.18**
Expenditure					
(a) Operating Expenses	**41,350.82**	**46,729.42**	**40,487.32**	**49,319.06**	**57,426.66**
(b) Depreciation	**38.68**	**37.66**	**33.66**	**30.10**	**26.93**
Total Expenditure	**41,389.50**	**46,767.08**	**40,520.98**	**49,349.15**	**57,453.58**
Deficit/Surplus for the Year	**(90.99)**	**5.86**	**(3,498.03)**	**(2,048.96)**	**(1,930.41)**

Source: UKPJN's Financial Statements

Table 6-24 Percentage Change in major Account Items of UKPJN's Income and Expenditure Statement

	FY17-FY18	FY18-FY19	FY19-FY20	FY20-FY21	5yrs	CAGR
Income						
(a) Income from operation	**13.2%**	**-21.3%**	**28.7%**	**17.7%**	**56.4%**	**6.2%**
(b) Income from Financing Activities	**13.9%**	**3.4%**	**-13.8%**	**-3.6%**	**-12.0%**	**-0.4%**
Total Income	**13.3%**	**-20.8%**	**27.8%**	**17.4%**	**54.9%**	**6.1%**
Expenditure						
(a) Operating Expenses	**13.0%**	**-13.4%**	**21.8%**	**16.4%**	**61.6%**	**6.8%**
(b) Depreciation	**-2.6%**	**-10.6%**	**-10.6%**	**-10.5%**	**-37.7%**	**-7.0%**
Total Expenditure	**13.0%**	**-13.4%**	**21.8%**	**16.4%**	**61.4%**	**6.8%**

Source: Prepared by JST based on UKPJN's Financial Statements

(2) Balance Sheet and Financial Indicators

The balance sheet, the percentage change in major account items and the financial indicators are shown in Table 6-25, Table 6-26 and Table 6-27 respectively.

With capital grants from the central and state governments, assets (as well as equity and liabilities) have increased at an annual growth rate of 13.4%, and the equity ratio is 74.5% in FY2021, indicating that UKPJN has a positive financial strength.

However, current liabilities (including provisions) have been increasing at an annual growth rate of 15.1%, and the current ratio is 49.5% below 100% in FY2021, which means that short-term solvency issues are present. Meanwhile, current assets also grew at an annual growth rate of 31.1%, suggesting that UKPJN has stabilized its cash flow by carrying over payables and debts to the next financial year to avoid cash shortages.

Non-current liabilities from unsecured loans by state governments have remained since before FY2017, but the amount is small, and both the ratio of non-current assets to equity and the ratio of non-current assets to non-current liabilities and equity are extremely low, at less than 1%. Fixed assets (acquisition cost) and depreciation reserve have remained at a low level without changes, while the account item "Project" consisting of mainly construction in progress accounts for 80-90% of assets. The background is that water supply and sewerage facilities have been constructed by UKPJN and then transferred to UJS as assets.

In terms of financial profitability, Earnings before Interest, Taxes, Depreciation, and Amortization (hereinafter referred to as “EBITDA”) has been negative, except for FY2018, due to continued loss-making operations.

UKPJN has no revenue stream from water and sewerage tariffs and relies on grants from the central and state governments. However, it is expected to have growth potential as its assets and sales are likely to continue to increase with the development of water supply and sewerage infrastructure in Uttarakhand, as has been the case over the past five years.

Table 6-25 UKPJN's Balance Sheet (INR Lakh)

FY	2017	2018	2019	2020	2021
1. Capital Grant from Government					
a. From Government of U.P for Project	46,949.71	46,942.82	46,942.82	46,942.82	46,942.82
b. From Government of U.K. (Work Non I.D.A)	69,722.60	68,181.18	68,887.53	69,576.52	68,280.38
c. Funds Balance Rural WSS Program (SWAP)	253.66	253.18	244.77	245.96	247.12
d. Funds Balance Rural WSS Program (SWAP) Add.Financ	(3.75)	7.61	7.61	7.61	7.61
e. Funds Balance Peri Urban Areas	60.84	537.93	3,604.09	432.83	11,216.92
f. From Central Government	111,937.96	144,253.56	168,855.44	184,033.50	189,074.69
g. From State Government (NRDWP)	26,983.68	25,438.76	24,646.81	22,341.20	22,200.82
h. From Central Govt. (NRDWP)	23,225.63	30,800.42	37,304.04	34,830.10	34,182.72
i. From State Govt. (NABARD HQ)	24,399.64	42,677.81	62,931.31	66,523.27	74,356.45
j. Interest Income (From Central Government)	1,624.40	1,516.24	1,962.56	1,674.55	1,674.88
k. Grant from U.K. Urban Water Supply		7,302.94	13,186.14	12,502.58	20,703.06
l. Grant from Centage form U.K. Govt.		4,002.62	7,115.52	8,625.26	15,106.69
m. Grant from U.K. Govt. Jal Jeevan Mission (State Share)				1,499.25	6,210.44
n. Grant from U.K. Govt. Jal Jeevan Mission (Central Share)				14,790.59	59,575.35
Sub-Total	**305,154.35**	**371,915.08**	**435,688.65**	**464,026.04**	**549,779.98**
2. Reserve					
Depreciation Reserve	721.74	757.88	826.08	854.52	879.97
Sub-Total	**721.74**	**757.88**	**826.08**	**854.52**	**879.97**
3. Loans Funds					
a. Secured Loan from LIC					
b.Unsecured Loan					
From Govt. of U.P	5,444.76	5,444.76	5,444.76	5,444.76	5,444.76
Loan from U.K Government (Non I.D.A)	2,101.70	2,101.70	2,101.70	2,101.70	2,101.70
Sub-Total	**7,546.46**	**7,546.46**	**7,546.46**	**7,546.46**	**7,546.46**
4.Current Liablities & Provision	**103,108.06**	**112,700.61**	**129,110.73**	**163,262.57**	**208,687.84**
5.Deficit & Surplus					
Opening Balance and	(23,193.71)	(23,284.70)	(23,278.84)	(26,776.86)	(28,825.82)
Add:Deficit for the year	(90.99)	5.86	(3,498.03)	(2,048.96)	(1,930.41)
Sub-Total	**(23,284.70)**	**(23,278.84)**	**(26,776.86)**	**(28,825.82)**	**(30,756.23)**
Eqyuity & Liabilities Total	**393,245.91**	**469,641.19**	**546,395.06**	**606,863.76**	**736,138.01**
1. Fixed Assests	**1,305.13**	**1,303.61**	**1,338.15**	**1,336.41**	**1,334.89**
2. Fixed Deposit with Scheduled Banks (including Investm	**14,025.48**	**12,917.91**	**13,049.46**	**12,584.24**	**13,027.64**
3. Project					
a.Material	2,016.20	1,903.26	1,782.43	1,758.31	1,725.40
b.Work in Progress	343,872.42	394,886.96	446,878.32	507,677.15	615,193.99
Sub-Total	**345,888.62**	**396,790.22**	**448,660.75**	**509,435.45**	**616,919.39**
4. Current Assets	**26,769.64**	**60,642.50**	**74,174.15**	**79,200.35**	**103,365.74**
5. Loans & Advance					
To Jal Sansthan	1,144.29	1,144.29	1,144.29	1,144.29	1,144.29
To Local Bodies	2,078.90	2,078.90	2,078.90	2,078.90	2,078.90
To Inter Fund Current A/C	(15,619.73)	(22,865.55)	(13,275.74)	(20,174.70)	(24,131.76)
To Inter Divisional Transaction	17,653.59	17,629.31	19,225.09	21,258.82	22,398.92
Sub-Total	**5,257.04**	**(2,013.04)**	**9,172.54**	**4,307.31**	**1,490.35**
Assets Total	**393,245.91**	**469,641.19**	**546,395.06**	**606,863.76**	**736,138.01**

Source: UKPJN's Financial Statements

Table 6-26 Percentage Change in the major Account Items of UKPJN's Balance Sheet

FY	FY17-FY18	FY18-FY19	FY19-FY20	FY20-FY21	5yrs	CAGR
1. Capital Grant from Government	**21.9%**	**17.1%**	**6.5%**	**18.5%**	**80.2%**	**15.9%**
2. Reserve	**5.0%**	**9.0%**	**3.4%**	**3.0%**	**28.3%**	**5.1%**
3. Loans Funds	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**-2.1%**	**0.0%**
4.Current Liablities & Provision	**9.3%**	**14.6%**	**26.5%**	**27.8%**	**69.7%**	**15.1%**
5.Deficit	**0.0%**	**15.0%**	**7.7%**	**6.7%**	**32.6%**	**5.7%**
Eqyuity & Liabilities Total	**19.4%**	**16.3%**	**11.1%**	**21.3%**	**94.2%**	**13.4%**
1. Fixed Assests	**-0.1%**	**2.6%**	**-0.1%**	**-0.1%**	**3.6%**	**0.5%**
2. Fixed Deposit with Scheduled Banks	**-7.9%**	**1.0%**	**-3.6%**	**3.5%**	**-7.9%**	**-1.5%**
3. Project	**14.7%**	**13.1%**	**13.5%**	**21.1%**	**85.9%**	**12.3%**
4. Current Assets	**126.5%**	**22.3%**	**6.8%**	**30.5%**	**256.1%**	**31.0%**
5. Loans & Advance	**-**	**-**	**-53.0%**	**-65.4%**	**-45.9%**	**-22.3%**
Assets Total	**19.4%**	**16.3%**	**11.1%**	**21.3%**	**94.2%**	**13.4%**

Source: Prepared by JST based on UKPJN's Financial Statements

Table 6-27 Financial Indicators of UKPJN

	2017	2018	2019	2020	2021	–
Financial Strength						
Equity Ratio *Excluding depreciation	77.7%	79.3%	79.9%	76.6%	74.8%	-
Deficit to Operating Income Ratio	57.3%	50.6%	73.9%	61.8%	56.1%	-
Short-term Solvency						
Current Ratio	26.0%	53.8%	57.5%	48.5%	49.5%	-
Long-term Solvency						
Non-Current Assets to Equity Ratio	0.2%	0.1%	0.1%	0.1%	0.1%	-
Non-Current Assets to Non-Current Liabilities & Equity Ratio	0.2%	0.1%	0.1%	0.1%	0.1%	-
Financial Profitability						
Net Profit Margin *Before depreciation	Unable to calculate due to cumulative deficit					
ROA (Return on Assets) *Before depreciation	Unable to calculate due to cumulative deficit					
EBITDA (INR Lakh)	(52.31)	43.52	(3,464.37)	(2,018.87)	(1,903.48)	-
Financial Growth Potential	FY17-FY18	FY18-FY19	FY19-FY20	FY20-FY21	5yrs	CAGR
Assets Growth Ratio	19.4%	16.3%	11.1%	21.3%	94.2%	13.4%
Sales Growth Ratio	13.3%	-20.8%	27.8%	17.4%	54.9%	6.1%

Source: Prepared by JST based on UKPJN's Financial Statements

6.7.2 UJS

The financial status of UJS is summarized as follows based on income and expenditure statements and balance sheets for the five-year period from FY2015 to FY2019. Data for FY2020 and beyond were not provided due to non-audit. Since the statements for FY2020 and beyond have not been audited, they have not been disclosed.

(1) Income and Expenditure Statement

The income and expenditure statement and the percentage change in the main account items are shown in Table 6-28 and Table 6-29 respectively.

For the five-year period 2015-2019, UJS has operated at a deficit where expenditure including depreciation, etc. exceeds net income. However, with the exception of the 2016 financial year, income and expenditure before depreciation have been in surplus, so there does not appear to be any concern on a cash basis. Unlike UKPJN, UJS's main revenue source is water charges, which account for 79.8% of operating income in FY2019, whereas sewerage charges account for only 2.4%.

However, as of FY2019, the operating income accounted for only 43.8% of the total income, with the remaining 56.2% coming from grants (transfers) from the state government for routine repairs and maintenance, special repairs, and electricity and power, etc. The proportion of the grants has ranged from 50% to 60%, although the total amount has increased at an annual growth rate of 9.9%.

On the other hand, establishment costs (personnel costs) and electricity and energy costs have accounted for more than 30% of expenditure excluding depreciation, followed by special repairs at 18.0%. These proportions have not changed significantly over the five-year period. Due to the topographical characteristics of the Uttarakhand state, electricity and power costs have been constantly high due to the pumping and boosting of water, and 70% to 100% of these costs have been covered by grants (transfers) from the state government.

UJS is given accounting and financial independence as an autonomous body, but the income from water and sewerage charges can cover only less than half of the expenditure even though water and sewerage tariffs have increased year by year. This means that the overall balance has been sustained by financial support from the state government. Operating income has covered the expenditure required for operation and maintenance excluding special repairs, expansion, electricity and power, etc. that are subsidized by the state government.

Table 6-28 UJS's Income and Expenditure Statement (INR Lakh)

	2015	2016	2017	2018	2019
Operating Income					
Water Charges incl. Meter Rent	13,309.76	15,777.80	18,687.50	20,169.66	25,248.28
Stand Post Charges	209.11	249.27	250.52	252.23	251.92
Sewerage Charges	380.99	516.82	669.82	712.42	746.74
Other Receipt	3,368.43	4,833.09	6,811.70	4,702.30	4,081.24
Interest	722.13	1,212.82	1,126.68	889.35	1,292.06
Community Contributions	3.48				32.47
Excess Provision	68.59	15.12			
Sub-Total	**18,062.49**	**22,604.92**	**27,546.22**	**26,725.96**	**31,652.71**
Grant Utilized					
General Repairs & Maintenance	14,636.41	3,714.07	3,172.38	5,818.70	7,675.01
Special Repairs to Scheme		9,104.45	8,518.50	9,880.14	12,293.35
Expansion of Schemes				3,211.24	5,721.84
Electricity & Power	13,268.02	11,242.19	15,573.38	21,621.83	14,955.42
Sub-Total	**27,904.43**	**24,060.71**	**27,264.26**	**40,531.91**	**40,645.62**
Total Income	**45,966.92**	**46,665.63**	**54,810.48**	**67,257.87**	**72,298.33**
Less: Provision for Doubtful Receivable				77.31	
Net Income	**45,966.92**	**46,665.63**	**54,810.48**	**67,180.56**	**72,298.33**
Operating Expenses					
Establishment Expenses	15,169.04	15,796.16	18,329.04	20,661.45	22,113.91
Other Expenses	9,839.90	4,051.78	2,890.76	975.40	742.61
Repair & Maintenance	4,331.84	4,350.96	4,873.79	5,205.10	6,074.47
Special Repairs to Scheme		9,104.45	8,518.50	9,880.14	12,293.35
Extension of Schemes				3,211.24	5,722.53
Travel & Conveyance	248.19	253.35	272.73	285.66	277.07
Electricity & Power	13,268.02	14,348.57	15,573.38	21,621.83	20,810.00
Rebate Allowed	215.98	245.83	723.51	332.70	407.16
Total Expenditure	**43,072.97**	**48,151.10**	**51,181.71**	**62,173.52**	**68,441.10**
Deficit/Surplus					
Deficit/Surplus (before Depreciation)	2,893.95	(1,485.47)	3,628.77	5,007.04	3,857.23
Depreciation	4,355.26	4,549.77	5,888.61	6,591.64	7,140.82
Deficit/Surplus for the Year	**(1,461.31)**	**(6,035.24)**	**(2,259.84)**	**(1,584.60)**	**(3,283.59)**
Prior Period Adjustments (Net)		5,802.76	(26.75)	(311.86)	(42.42)
Net Deficit/Surplus	**(1,461.31)**	**(232.48)**	**(2,286.59)**	**(1,896.46)**	**(3,326.01)**

Source: UJS's Financial Statements

Table 6-29 Percentage Change in the major Account Items of UJS's Income and Expenditure Statement

	FY15-FY16	FY16-FY17	FY17-FY18	FY18-FY19	5yrs	CAGR
Operating Income	**25.1%**	**21.9%**	**-3.0%**	**18.4%**	**75.2%**	**15.1%**
Grant Utilized	**-13.8%**	**13.3%**	**48.7%**	**0.3%**	**45.7%**	**9.9%**
Total Income	**1.5%**	**17.5%**	**22.7%**	**7.5%**	**57.3%**	**12.0%**
Net Income	**1.5%**	**17.5%**	**22.6%**	**7.6%**	**57.3%**	**12.0%**
Total Expenditure	**11.8%**	**6.3%**	**21.5%**	**10.1%**	**58.9%**	**12.3%**
Depreciation	4.5%	29.4%	11.9%	8.3%	64.0%	13.2%

Source: Prepared by JST based on UJS's Financial Statements

(2) Balance Sheet and Financial Indicators

The balance sheet, the percentage change in major account items and the financial indicators are shown in Table 6-30, Table 6-31 and Table 6-32 respectively.

With capital grants from the central and state governments, assets (as well as equity and liabilities) have increased at an annual growth rate of 12.6%, and the equity ratio is 77.1% in FY2019, indicating that UJS has a positive financial strength.

Current liabilities have decreased from FY2015 to FY2017 but have increased since FY2018. However, the current ratio is 183.3% above 100% in FY2019, indicating that short-term solvency is ensured.

On the other hand, there is no non-current liabilities such as loan and long-term debt, and both the ratio of non-current (fixed) assets to equity and the ratio of non-current (fixed) assets to non-current liabilities and equity are below 100%, ranging from 70% to 80%. Water supply and sewerage facilities constructed by UKPJN are transferred to UJS as fixed assets.

In terms of financial profitability, with the exception of FY2016, the net profit margin (before depreciation) has been maintained at over 5% and the return on assets (before depreciation) of at 1-2%, and EBITDA has been positive on a cash basis.

Similarly to UKPJN, UJS has operated with a certain amount of grants from the state government, but all indicators such as assets, sales and before-depreciation profit on a cash basis indicate that UJS has financial growth potential.

Table 6-30 UJS's Balance Sheet (INR Lakh)

	2015	2016	2017	2018	2019
Capital Fund	**77,994.71**	**84,625.97**	**130,152.37**	**140,296.04**	**152,553.19**
Accumulated Fund	**2,265.62**	**899.40**	**1,007.42**	**888.33**	**1,483.63**
Depreciation Reserve Fund	**60,002.20**	**64,551.97**	**70,440.58**	**77,344.08**	**84,527.32**
Current Liabilities					
Power & Electricity Dues	4,275.91	1,474.17	283.00		5,353.58
Outstanding Liabilities	1,410.10	1,252.45	1,430.91	1,531.63	1,578.98
Consumer Security	748.75	729.56	725.49	610.19	592.54
Unutilised Grant	15,532.75	12,998.72	10,806.68	13,157.10	17,572.81
Deposit Work	3,442.96	5,486.28	6,210.51	9,859.61	9,607.51
Other Liabilities	7,327.07	4,878.93	4,181.28	4,342.37	5,754.82
Pension & Granuity	3,681.88	4,136.45	5,026.81	4,717.98	5,281.77
Sub-Total	**36,419.42**	**30,956.56**	**28,664.68**	**34,218.88**	**45,742.01**
Total	**176,681.95**	**181,033.90**	**230,265.05**	**252,747.33**	**284,306.15**
Fixed Assets	**123,551.46**	**128,055.89**	**173,435.18**	**184,581.49**	**200,470.79**
Current Assets					
UPCL (Power & Electricity)	1,680.76	2,170.37	2,274.93	501.00	0.00
Stores & Spares	8,402.96	7,129.21	8,009.90	10,388.91	11,083.47
Consumer Receivables	8,583.97	10,151.39	11,372.36	12,490.29	17,303.30
Other Receivables	2,392.83	2,230.93	1,646.88	2,020.13	3,358.88
Head Office / Inter Unit				2,035.87	1,108.96
Cash & Bank Balances	31,844.30	31,040.22	33,362.20	40,523.34	50,716.14
Temp. & Permanent Imp.	225.69	255.90	163.63	206.31	264.60
Sub-Total	**53,130.51**	**52,978.02**	**56,829.90**	**68,165.85**	**83,835.35**
Total Expenditure	**176,681.97**	**181,033.91**	**230,265.08**	**252,747.34**	**284,306.14**

Source: UJS's Financial Statements

Table 6-31 Percentage Change in the major Account Items of UJS's Balance Sheet

	FY15-FY16	FY16-FY17	FY17-FY18	FY18-FY19	5yrs	CAGR
Capital Fund	**8.5%**	**53.8%**	**7.8%**	**8.7%**	**38.1%**	**18.3%**
Accumulated Fund	**-60.3%**	**12.0%**	**-11.8%**	**67.0%**	**40.9%**	**-10.0%**
Depreciation Reserve Fund	**7.6%**	**9.1%**	**9.8%**	**9.3%**	**25.2%**	**8.9%**
Current Liabilities	**-15.0%**	**-7.4%**	**19.4%**	**33.7%**	**61.5%**	**5.9%**
Total	**2.5%**	**27.2%**	**9.8%**	**12.5%**	**62.3%**	**12.6%**
Fixed Assets	**3.6%**	**35.4%**	**6.4%**	**8.6%**	**9.9%**	**12.9%**
Current Assets	**-0.3%**	**7.3%**	**19.9%**	**23.0%**	**58.2%**	**12.1%**
Total Expenditure	**2.5%**	**27.2%**	**9.8%**	**12.5%**	**56.5%**	**12.6%**

Source: Prepared by JST based on UJS's Financial Statements

Table 6-32 Financial Indicators of UJS

	2015	2016	2017	2018	2019	-
Financial Strength						
Equity Ratio *Excluding depreciation	68.8%	73.4%	82.1%	80.5%	77.1%	-
Deficit to Operating Income Ratio	8.1%	1.0%	8.3%	7.1%	10.5%	-
Short-term Solvency						
Current Ratio	145.9%	171.1%	198.3%	199.2%	183.3%	-
Long-term Solvency						
Non-Current Assets to Equity Ratio	79.2%	74.3%	78.5%	76.0%	75.3%	-
Non-Current Assets to Non-Current Liabilities & Equity Ratio	79.2%	74.3%	78.5%	76.0%	75.3%	-
Financial Profitability						
Net Profit Margin *Before depreciation	6.3%	–	6.6%	7.5%	5.3%	-
ROA (Return on Assets) *Before depreciation	1.6%	–	1.6%	2.0%	1.4%	-
EBITDA (INR Lakh)	2,893.9	(1,485.5)	3,628.8	5,007.0	3,857.2	-
EBITDA Margin	6.3%	–	6.6%	7.5%	5.3%	-
Financial Growth Potential	FY15-FY16	FY16-FY17	FY17-FY18	FY18-FY19	5yrs	CAGR
Assets Growth Ratio	2.5%	27.2%	9.8%	12.5%	56.5%	12.6%
Sales Growth Ratio	1.5%	17.5%	22.6%	7.6%	57.3%	12.0%
Before-Depreciation Profit Growth Ratio	-	-	38.0%	-23.0%	33.3%	7.4%
Other	2015	2016	2017	2018	2019	-
PPE Depreciation Rate (Provisional)	48.56%	50.41%	40.61%	41.90%	42.16%	-

Source: Prepared by JST based on UJS's Financial Statements

6.7.3 Consolidated Financial Statement of UKPJN and UJS (Reference only)

Assuming that UKPJN for development and UJS for operation and maintenance, operating in the same service area, are considered as one water supply and sewerage utility and that the financial statements are consolidated, the financial situation would be summarized as follows. It should be noted that the three overlapping financial years from 2017 to 2019 are covered, and it is assumed that there are no transactions between the organisations.

(1) Consolidated Income and Expenditure Statement (Reference only)

Table 6-33 shows the consolidated income and expenditure statement and percentage change based on the combined major account items. Even if consolidated, the net income and expenditure would still be in deficit, but the surplus before depreciation of UJS makes it positive as well as helps to stabilise the cash flow of UKPJN alone. In FY2019, the surplus before depreciation is lower than in other years.

However, the ratio of grants to the total income is 30%-40%. Therefore, their dependence on government grants remains unchanged.

Table 6-33 Consolidated Income and Expenditure Statement (INR Lakh) and Percentage Change

	2017	2018	2019	FY17-FY18	FY18-FY19	3yrs	CAGR
Operating Income	68,170.98	72,731.37	67,881.75	6.7%	-6.7%	-0.4%	-0.2%
Financial Income	673.76	767.53	793.91	13.9%	3.4%	17.8%	8.6%
Grant utlized for O&M (UJS)	27,264.26	40,531.91	40,645.62	48.7%	0.3%	49.1%	22.1%
Less: Provision for Doubtful Receivable	0.00	77.31	0.00	-	-	-	-
Income Total	**96,109.00**	**113,953.50**	**109,321.28**	**18.6%**	**-4.1%**	**13.7%**	**6.7%**
Expenditure Total	**92,532.53**	**108,902.94**	**108,928.42**	**17.7%**	**0.0%**	**17.7%**	**8.5%**
Deficit/Surplus (before Depreciation)	**3,576.46**	**5,050.56**	**392.86**	**41.2%**	**-92.2%**	**-89.0%**	**-66.9%**
Depreciation	5,927.29	6,629.30	7,174.48	11.8%	8.2%	21.0%	10.0%
Deficit/Surplus for the Year	**(2,350.83)**	**(1,578.74)**	**(6,781.62)**	**-32.8%**	**329.6%**	**188.5%**	**69.8%**
UJS: Prior Period Adjustments (Net)	(2.68)	(31.19)	(4.24)	-	-	-	-
Net Deficit/Surplus	**(2,353.50)**	**(1,609.92)**	**(6,785.86)**	**-31.6%**	**321.5%**	**188.3%**	**69.8%**

Source: Prepared by JST based on the Financial Statements of UKPJN and UJS

(2) Consolidated Balance Sheet and Financial Indicators (Reference only)

The consolidated balance sheet with percentage change and the consolidated financial indicators are shown in Table 6-34 and Table 6-35 respectively.

The assets (as well as equity and liabilities) have increased at an annual growth rate of 15.4% and its financial strength is positive with the equity ratio of 79.1% in FY2019.

The current ratio is 90.4% below 100% in FY2019 but is in an upward trend.

On the other hand, the amount of non-current liabilities such as loans and long-term debt is small, and both the ratio of non-current assets to equity and the ratio of non-current assets to non-current liabilities and equity are around 20% each, i.e. less than 100%.

In terms of financial profitability, net profit margin (before depreciation) and return on assets (before depreciation) are not good in FY 2019, but EBITDA is still positive on a cash basis.

Both assets and sales indicate growth potential, but the before-depreciation profit growth ratio on a cash basis tends to be declining. In particular, UKPJN's deficit in FY2019 has a large impact, but the growth ratio for UJS alone is positive.

Table 6-34 Consolidated Balance Sheet (INR Lakh) and Percentage Change

	2017	2018	2019	FY17-FY18	FY18-FY19	3yrs	CAGR
Capital or equivalent	436,314.14	513,099.45	589,725.47	17.6%	14.9%	35.2%	16.3%
Depreciation Reserve	71,162.32	78,101.96	85,353.40	9.8%	9.3%	19.9%	9.5%
Fixed Liabilities	7,546.46	7,546.46	7,546.46	0.0%	0.0%	0.0%	0.0%
Current Liabilities	131,772.74	146,919.49	174,852.74	11.5%	19.0%	32.7%	15.2%
Deficit & Surplus	(23,284.70)	(23,278.84)	(26,776.86)	-	-	-	-
Equity & Liabilities Total	**623,510.96**	**722,388.52**	**830,701.21**	**15.9%**	**15.0%**	**33.2%**	**15.4%**
Fixed Assets	174,740.31	185,885.10	201,808.94	6.4%	8.6%	15.5%	7.5%
Fixed Deposit with Scheduled Banks	14,025.48	12,917.91	13,049.46	-7.9%	1.0%	-7.0%	-3.5%
Project (Work in Progress)	345,888.62	396,790.22	448,660.75	14.7%	13.1%	29.7%	13.9%
Current Assets	83,599.54	128,808.35	158,009.50	54.1%	22.7%	89.0%	37.5%
Loans & Advance	5,257.04	(2,013.04)	9,172.54	-	-	74.5%	32.1%
Assets Total	**623,510.99**	**722,388.53**	**830,701.20**	**15.9%**	**15.0%**	**33.2%**	**15.4%**

Source: Prepared by JST based on the Financial Statements of UKPJN and UJS

Table 6-35 Consolidated Financial Indicators

	2017	2018	2019	-
Financial Strength				
Equity Ratio *Excluding depreciation	79.0%	79.6%	79.1%	-
Deficit to Operating Income Ratio	34.2%	32.0%	39.4%	-
Short-term Solvency				
Current Ratio	63.4%	87.7%	90.4%	-
Long-term Solvency				
Non-Current Assets to Equity Ratio	23.7%	21.0%	19.7%	-
Non-Current Assets to Non Current Liabilities & Equity Ratio	23.3%	20.7%	19.5%	-
Financial Profitability				
Net Profit Margin *Before depreciation	3.7%	4.4%	0.4%	-
ROA (Return on Assets) *Before depreciation	0.6%	0.7%	0.0%	-
EBITDA (INR Lakh)	3,576.5	5,050.6	392.9	-
EBITDA Margin	3.7%	4.4%	0.4%	-
Financial Growth Potential	FY17-FY18	FY18-FY19	3yrs	CAGR
Assets Growth Ratio	15.9%	15.0%	33.2%	15.4%
Sales Growth Ratio	18.6%	-4.1%	13.7%	6.7%
Before-Depreciation Profit Growth Ratio	41.2%	-92.2%	-89.0%	-66.9%
Other	2017	2018	2019	-
PPE Depreciation Rate (Provisional)	40.72%	42.02%	42.29%	-

Source: Prepared by JST based on the Financial Statements of UKPJN and UJS

6.7.4 Uttarakhand State Government

The financial status of Uttarakhand state government is summarized as follows based on the "State Finances Audit Report" issued by the Comptroller and Auditor General of India and the "Annual Financial Statement" issued by the Uttarakhand state government for the five-year period from FY2016 to FY2020 and additionally unaudited FY2021. Note that there are some differences in the amount of revenue (receipt) and expenditure amounts between these two sources of financial data due to different accounting entries for some items (As a result, the amounts of revenue balance, fiscal balance and primary balance are the same between them), but the data from the former source are basically adopted.

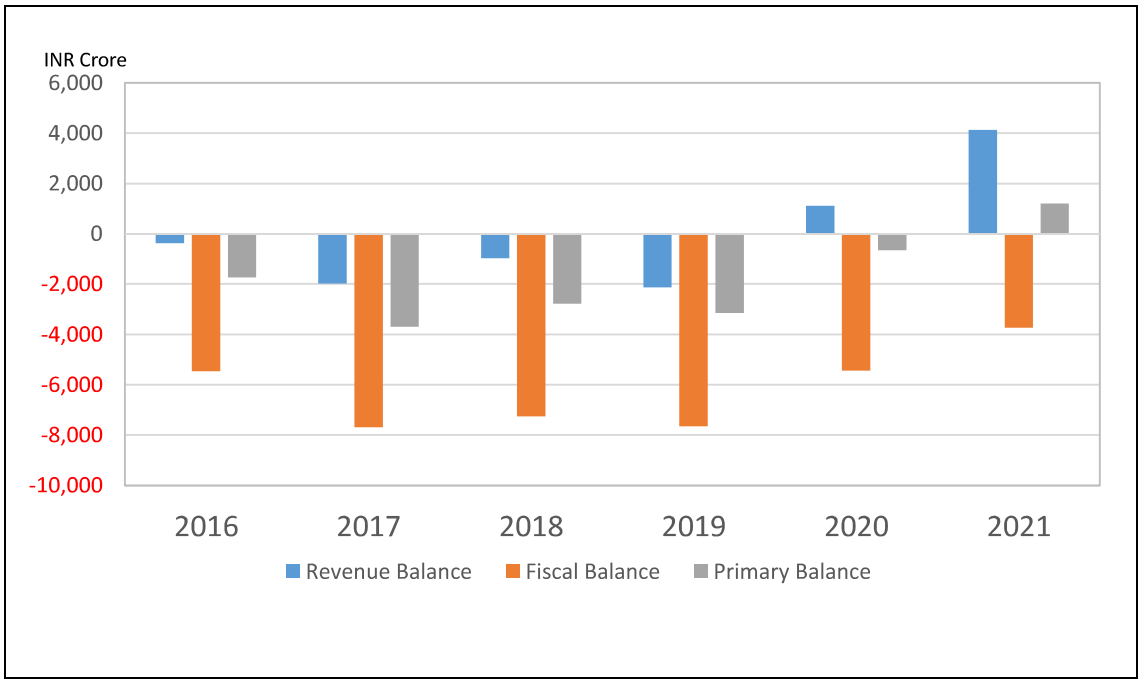
(1) Income and Expenditure Statement

Table 6-36 shows the receipt and expenditure statement of the Uttarakhand state government.

For the six-year period, the total receipts have increased at an annual growth rate of 9.0%, compared to an annual growth rate of 6.9% for gross state domestic product (hereinafter referred to as "GSDP"). Behind this trend is the year-on-year increase in revenue (tax revenue, share of Union Taxes, grants-in-aid and contributions, etc.), which accounts for 92.0% of total revenue in FY2021 (unaudited). The capital receipts, which account for 8.0% of the total receipts in FY2021 (unaudited), are mostly from borrowing (e.g. public bonds), and are trending down.

Meanwhile, the total expenditure to be balanced with the total revenue is increasing at an annual growth rate of 9.0%, with revenue expenditure accounting for 83.2% of total expenditure and capital expenditure accounting for 16.8% in FY2021 (unaudited).

Based on the above trends, the revenue balance has turned from deficit to surplus since FY2020, and the fiscal deficit is also on a downward trend. The fiscal deficit for FY2021 (unaudited) is 1.37% of the GSDP, and the fiscal deficit has been within 3.5% since FY2018, which is the target maximum percentage defined by the Fifteenth Finance Commission of India (hereinafter referred to as "FFC or XV-FC"). Furthermore, the primary balance has also shifted from deficit to surplus in FY2021 (unaudited), indicating that the State's fiscal conditions are improving. Figure 6-6 shows trends in major financial bottom line of the Uttarakhand state government.



Source: Prepared by JST based on "State Finances Audit Report" and "Annual Financial Statement"

Figure 6-6 Trends on Major Financial Bottom Line of the Uttarakhand State Government

Table 6-36 Receipt & Expenditure Statement of the Uttarakhand State Government

		2016		2017		2018		2019		2020		2021(Unaudited)			
		Actual (Crore INR)	% of Actual to GSDP	Actual (Crore INR)	% of Actual to GSDP	Actual (Crore INR)	% of Actual to GSDP	Actual (Crore INR)	% of Actual to GSDP	Actual (Crore INR)	% of Actual to GSDP	Actual (Crore INR)	% of Actual to GSDP		
1 Tax Revenue		10,897.32	5.58%	10,165.00	6.27%	12,188.09	5.15%	11,513.45	4.54%	11,937.59	5.02%	14,176.12	5.21%		
2 Non-Tax Revenue		1,345.82	0.69%	1,770.00	1.12%	3,309.88	1.40%	3,998.81	1.58%	4,170.57	1.75%	2,755.96	1.01%		
3 Share of Union Taxes		6,411.55	3.29%	7,085.00	3.23%	8,011.59	3.38%	6,901.54	2.72%	6,568.72	2.76%	9,906.25	3.64%		
4 Grants-in-aid and Contributions		6,234.27	3.20%	8,085.00	3.74%	7,706.87	3.26%	8,308.76	3.28%	15,527.48	6.53%	16,218.67	5.96%		
5 Revenue Receipts	1+2+3+4	**24,888.97**	**12.76%**	**27,105.00**	**14.36%**	**31,216.44**	**13.18%**	**30,722.57**	**12.11%**	**38,204.36**	**16.07%**	**43,056.99**	**15.82%**		
6 Recovery of Loans and Advances		34.85	0.02%	283.50	0.12%	26.92	0.01%	18.92	0.01%	23.05	0.01%	17.08	0.01%		
7 Other Receipts		-	-	-	-	0.01	0.00%	0.00	-	0.20	0.00%	0.00	-		
8 Borrowings and other Liabilities		5,467.00	2.80%	7,686.00	3.64%	7,320.00	3.09%	7,657.00	3.02%	5,439.00	2.29%	3,735.84	1.37%		
9 Capital Receipts	6+7+8	**5,501.85**	**2.82%**	**7,969.50**	**3.76%**	**7,346.93**	**3.10%**	**7,675.92**	**3.03%**	**5,462.25**	**2.30%**	**3,752.92**	**1.38%**		
10 Total Receipts	5+9	**30,390.82**	**15.58%**	**35,074.50**	**18.12%**	**38,563.37**	**16.29%**	**38,398.49**	**15.14%**	**43,666.61**	**18.37%**	**46,809.91**	**17.20%**		
11 Revenue Expenditure		**25,271.50**	**12.95%**	**29,082.69**	**14.34%**	**32,196.02**	**13.60%**	**32,858.80**	**12.95%**	**37,091.03**	**15.60%**	**38,928.95**	**14.30%**		
12 Interest Payments (of which)		3,723.05	1.91%	3,987.29	2.00%	4,474.82	1.89%	4,504.02	1.78%	4,773.07	2.01%	4,938.83	1.81%		
13 Capital Expenditure		**5,119.27**	**2.62%**	**5,991.20**	**3.82%**	**6,310.42**	**2.67%**	**5,539.96**	**2.18%**	**6,575.76**	**2.77%**	**7,880.96**	**2.90%**		
14 Capital Outlay		4,954.22	2.54%	5,914.37	2.51%	6,184.42	2.61%	5,414.18	2.13%	6,538.21	2.75%	7,533.50	2.77%		
15 Loan and Advances		165.05	0.08%	76.83	0.11%	126.00	0.05%	125.78	0.05%	37.55	0.02%	347.46	0.13%		
16 Total Expenditure	11+13	**30,390.77**	**15.58%**	**35,073.89**	**18.17%**	**38,506.44**	**16.26%**	**38,398.76**	**15.14%**	**43,666.79**	**18.37%**	**46,809.91**	**17.20%**		
17 Revenue Deficit (-) / Surplus (+)	5-11	**(382.53)**	**-0.20%**	**(1,977.69)**	**0.02%**	**(979.58)**	**-0.41%**	**(2,136.23)**	**-0.84%**	**1,113.33**	**0.47%**	**4,128.04**	**1.52%**		
18 Fiscal Deficit	16-(5+6+7)	**5,466.95**	**2.80%**	**7,685.39**	**3.69%**	**7,263.07**	**3.07%**	**7,657.27**	**3.02%**	**5,439.18**	**2.29%**	**3,735.84**	**1.37%**		
19 Primary Deficit	18-12	**1,743.90**	**0.89%**	**3,698.10**	**1.68%**	**2,788.25**	**1.18%**	**3,153.25**	**1.24%**	**666.11**	**0.28%**	**(1,202.99)**	**-0.44%**		
GSDP		**195,125.00**		**219,954.00**		**236,768.00**		**253,666.00**		**237,747.00**		**272,159.48**			
Composition Ratio		**2016**		**2017**		**2018**		**2019**		**2020**		**2021(Unaudited)**			
1 Tax Revenue		43.8%		37.5%		39.0%		37.5%		31.2%		32.9%			
2 Non-Tax Revenue		5.4%		6.5%		10.6%		13.0%		10.9%		6.4%			
3 Share of Union Taxes		25.8%		26.1%		25.7%		22.5%		17.2%		23.0%			
4 Grants-in-aid and Contributions		25.0%		29.8%		24.7%		27.0%		40.6%		37.7%			
5 Revenue Receipts		**81.9%**		**77.3%**		**80.9%**		**80.0%**		**87.5%**		**92.0%**			
6 Recovery of Loans and Advances		0.6%		3.6%		0.4%		0.2%		0.4%		0.5%			
7 Other Receipts		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%			
8 Borrowings and other Liabilities		99.4%		96.4%		99.6%		99.8%		99.6%		99.5%			
9 Capital Receipts		**18.1%**		**22.7%**		**19.1%**		**20.0%**		**12.5%**		**8.0%**			
10 Total Receipts		**100.0%**		**100.0%**		**100.0%**		**100.0%**		**100.0%**		**100.0%**			
11 Revenue Expenditure		**83.2%**		**82.9%**		**83.6%**		**85.6%**		**84.9%**		**83.2%**			
12 Interest Payments (of which)															
13 Capital Expenditure		**16.8%**		**17.1%**		**16.4%**		**14.4%**		**15.1%**		**16.8%**			
14 Capital Outlay		96.8%		98.7%		98.0%		97.7%		99.4%		95.6%			
15 Loan Payment		3.2%		1.3%		2.0%		2.3%		0.6%		4.4%			
16 Loan and Advances		**100.0%**		**100.0%**		**100.0%**		**100.0%**		**100.0%**		**100.0%**			
Percentage Change		**FY16-Y17**		**FY17-Y18**		**FY18-19**		**FY19-FY20**		**FY20-FY21**		**5yrs**		**CAGR**	
1 Tax Revenue		-6.7%		19.9%		-5.5%		3.7%		18.8%		30.1%		5.4%	
2 Non-Tax Revenue		31.5%		87.0%		20.8%		4.3%		-33.9%		104.8%		15.4%	
3 Share of Union Taxes		10.5%		13.1%		-13.9%		-4.8%		50.8%		54.5%		9.1%	
4 Grants-in-aid and Contributions		29.7%		-4.7%		7.8%		86.9%		4.5%		160.2%		21.1%	
5 Revenue Receipts		**8.9%**		**15.2%**		**-1.6%**		**24.4%**		**12.7%**		**73.0%**		**11.6%**	
6 Recovery of Loans and Advances		713.4%		-90.5%		-29.7%		21.8%		-25.9%		-51.0%		-13.3%	
7 Other Receipts		-		-		-		-		-		-		-	
8 Borrowings and other Liabilities		40.6%		-4.8%		4.6%		-29.0%		-31.3%		-31.7%		-7.3%	
9 Capital Receipts		**44.9%**		**-7.8%**		**4.5%**		**-28.8%**		**-31.3%**		**-31.8%**		**-7.4%**	
10 Total Receipts		**15.4%**		**9.9%**		**-0.4%**		**13.7%**		**7.2%**		**54.0%**		**9.0%**	
11 Revenue Expenditure		**15.1%**		**10.7%**		**2.1%**		**12.9%**		**5.0%**		**54.0%**		**9.0%**	
12 Interest Payments (of which)		7.1%		12.2%		0.7%		6.0%		3.5%		32.7%		5.8%	
13 Capital Expenditure		**17.0%**		**5.3%**		**-12.2%**		**18.7%**		**19.8%**		**53.9%**		**9.0%**	
14 Capital Outlay		19.4%		4.6%		-12.5%		20.8%		15.2%		52.1%		8.7%	
15 Loan Payment		-53.5%		64.0%		-0.2%		-70.1%		825.3%		110.5%		16.1%	
16 Total Expenditure		**15.4%**		**9.8%**		**-0.3%**		**13.7%**		**7.2%**		**54.0%**		**9.0%**	
17 Revenue Deficit (-) / Surplus (+)		**-**		**-**		**-**		**-**		**-**		-		-	
18 Fiscal Deficit		**40.6%**		**-5.5%**		**5.4%**		**-29.0%**		**-31.3%**		**-31.7%**		**-7.3%**	
19 Primary Deficit		**112.1%**		**-24.6%**		**13.1%**		**-78.9%**		**-**		-		-	
GSDP		**12.7%**		**7.6%**		**7.1%**		**-6.3%**		**14.5%**		**39.5%**		**6.9%**	

Source: Prepared by JST based on "State Finances Audit Report" and "Annual Financial Statement"

Furthermore, the ratio of internal to external financial resources for both revenue and capital remains at 35-40%, as shown in Table 6-37, and although it cannot be said that the autonomy and stability of the state government is necessarily high, the UK state government utilizes stable share of union taxes and grants-in-aid and contributions from the Central Government, as well as borrowing (public bonds, etc.) for administrative management. In addition, the ordinary balance ratio, which indicates the elasticity of the fiscal structure, has generally remained around 100%, although there are cases where it was high based on the fiscal year 2021 budget, which was affected by COVID-19.

Table 6-37 Internal/External Financial Resources Ratio of UK State Government

	2016		2017		2018		2019		2020		2021(Unaudited)	
	Actual (Crore INR)	Proportion	Actual (Crore INR)	Proportion	Actual (Crore INR)	Proportion	Actual (Crore INR)	Proportion	Actual (Crore INR)	Proportion	Actual (Crore INR)	Proportion
Independent (Internal)	12,243.14	49.2%	11,935.00	44.0%	15,497.97	49.6%	15,512.26	50.5%	16,108.15	42.2%	16,932.08	39.3%
Dependent (External)	12,645.82	50.8%	15,170.00	56.0%	15,718.46	50.4%	15,210.30	49.5%	22,096.20	57.8%	26,124.92	60.7%
Revenue Receipt	**24,888.97**		**27,105.00**		**31,216.44**		**30,722.57**		**38,204.36**		**43,056.99**	
Independent (Internal)	34.85	0.6%	283.50	3.6%	26.93	0.4%	18.92	0.2%	23.25	0.4%	17.08	0.5%
Dependent (External)	5,467.00	99.4%	7,686.00	96.4%	7,320.00	99.6%	7,657.00	99.8%	5,439.00	99.6%	3,735.84	99.5%
Capital Receipt	**5,501.85**		**7,969.50**		**7,346.93**		**7,675.92**		**5,462.25**		**3,752.92**	
Independent (Internal)	12,278.00	40.4%	12,218.50	34.8%	15,524.90	40.3%	15,531.18	40.4%	16,131.40	36.9%	16,949.16	36.2%
Dependent (External)	18,112.82	59.6%	22,856.00	65.2%	23,038.46	59.7%	22,867.30	59.6%	27,535.20	63.1%	29,860.75	63.8%
Total Receipt	**30,390.82**		**35,074.50**		**38,563.37**		**38,398.49**		**43,666.61**		**46,809.91**	

Source: JST based on State Finances Audit Report and Annual Financial Statement

Table 6-38 Ordinary Balance Ratio of UK State Government

	2018		2019		2020		2021		2022		2023	
	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)
Commited Expenditure												
Salaries	13,765	12,900	14,514	13,054	15,907	13,704	16,423	14,511	17,350	-	18,820	-
Pensions	5,353	5,396	5,943	5,507	6,305	6,168	6,400	6,364	6,703	-	7,602	-
Interest Payment	4,906	4,475	5,332	4,504	5,892	4,773	6,053	4,939	6,018	-	6,161	-
Loans	192	183	283	126	251	38	150	347	150	-	298	-
Total	**24,216**	**22,954**	**26,072**	**23,191**	**28,355**	**24,683**	**29,026**	**26,161**	**30,221**	**-**	**32,881**	**-**
Actuals / BE	**94.8%**		**88.9%**		**87.0%**		**90.1%**		**-**		**-**	
Ordinary Revenue Receipt												
Tax Revenue	14,964	12,188	14,737	11,513	13,761	11,938	12,754	14,176	15,371	-	19,983	-
Non-Tax Revenue	3,471	3,310	4,255	3,999	3,539	4,171	3,294	2,756	5,521	-	4,762	-
Share of Union Taxes	8,291	8,012	8,885	6,902	8,657	6,569	7,441	9,906	9,130	-	11,420	-
Total	**26,725**	**23,510**	**27,877**	**22,414**	**25,958**	**22,677**	**23,489**	**26,838**	**30,022**	**-**	**36,164**	**-**
Actuals / BE	**88.0%**		**80.4%**		**87.4%**		**114.3%**		**-**		**-**	
Ordinary Balance Ratio	**90.6%**	**97.6%**	**93.5%**	**103.5%**	**109.2%**	**108.8%**	**123.6%**	**97.5%**	**100.7%**	**-**	**90.9%**	**-**

Source: JST based on State Finances Audit Report and Annual Financial Statement

(2) Status of Outstanding Public Debt

Table 6-39 shows the status of outstanding public debt (liabilities) of the Uttarakhand state government.

With the exception of FY2021, for which data are not available, outstanding public debt (liabilities) has increased by 62.2% over the five-year period. On the other hand, the GSDP has increased by 21.8%, reversing the upward trend until FY2019 to a downward trend in FY2020 due to the impact of COVID-19. The GSDP for FY2021 is INR 272,159 Crore, which is higher than that of FY2019.

In terms of debt-to-GSDP ratio, it has been around 20%, except for FY2020 when the impact of COVID-19 needs to be taken into account.

Table 6-39 Status of Outstanding Public Debt of the Uttarakhand State Government

		2016	2017	2018	2019	2020	5yrs
1	Outstanding Public Debt (INR Crore)	35,210	41,015	46,233	50,250	57,115	-
2	Growth Rate of Outstanding Public Debt	18.0%	16.5%	12.7%	8.7%	13.7%	62.2%
3	GSDP (INR Crore)	195,125	219,954	236,768	253,666	237,747	-
4	Growth Rate of GSDP	10.1%	12.7%	7.6%	7.1%	-6.3%	21.8%
5	Debt to GSDP Ratio	18.0%	18.6%	19.5%	19.8%	24.0%	

Source: State Finances Audit Report

For comparison, Figure 6-7 shows a summary of the state-wise debt-to-GSDP ratio in India. This figure, based on data from the States' budget estimates for FY2021, shows Uttarakhand's position among the States and indicates that Uttarakhand is below the average level (34%) of the state-wise debt-to-GSDP ratio.



Remarks: Based on data on FY2021 state budget estimates.

Source: Reserve Bank of India and PRS Legislative Research

Figure 6-7 State-wise Debt to GSDP Ratio in India

(3) Budget Estimate and Actual Expenditure of Water Supply and Sanitation Sector

From FY2018 to FY2023, for which data are available, Table 6-40 shows the budget estimate and the actual expenditure (settlement amount) for the UK state government as a whole and by sector. Table 6-41 shows composition ratios in the budget estimate and the actual expenditure, and Table 6-42 shows the year-on-year comparison (increase/decrease ratio) in the budget estimate and the actual expenditure.

The budget estimate of the state government as a whole has increased by more than 1.5 times from FY2018 to FY2023 from 42,403 Crore INR to 66,180 Crore INR, and the actual expenditure against the budget estimate in comparable financial years for both the UK state government as a whole and by sector remains at around 90% every year.

The total amount of the budget estimate and the actual expenditure by sector accounts for around 60% of that of the entire UK state government, of which the budget estimate and actual expenditure for the water supply and sanitation sector under the State's Department of Drinking Water (DDW) account for between 3.3% and 5.8%. Although the composition ratio is small compared to other sectors, it is important to note that the operating income (excluding grants) of UKPJN and UJS is not included. Additionally, the budget estimate and the actual expenditure for the water supply and sanitation sector increased by 74.5% and 46.0%

respectively from FY2020 to FY2021. It is presumed that this was due to the grant. It is presumed that the state government provided grants to UKPJN and UJS in response to COVID-19 as a background.

Table 6-40 Budget Estimate and Actual Expenditure for UK State Government as a whole and by Sector

	2018		2019		2020		2021		2022		2023	
	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)	BE (Crore INR)	Actuals (Crore INR)
Net Expenditure												
Revenue Expenditure	35,627	32,196	38,933	32,859	42,390	37,091	44,036	38,929	49,013	-	52,748	-
Capital Outlay	6,584	6,184	6,572	5,414	7,383	6,538	8,973	7,534	10,840	-	13,134	-
Loans given by the State	192	126	283	126	251	38	150	347	150	-	298	-
Total	**42,403**	**38,506**	**45,788**	**38,399**	**50,024**	**43,667**	**53,159**	**46,810**	**60,003**	**-**	**66,180**	**-**
Actuals / BE	**90.8%**		**83.9%**		**87.3%**		**88.1%**		**-**		**-**	
Sector-wise Expenditure												
Education, Sports, Arts, and Culture	-	-	-	7,878	9,385	8,411	9,744	8,694	10,896	-	10,907	-
Agriculture and Allied Activities	-	-	-	2,894	3,401	2,845	3,545	3,612	4,059	-	5,037	-
Rural Development	-	-	-	2,666	3,217	3,581	3,439	3,378	4,922	-	4,845	-
Social Welfare and Nutrition	-	-	-	2,079	2,750	2,850	3,406	3,188	4,572	-	4,558	-
Health and Family Welfare	-	-	-	2,101	2,680	2,489	3,439	3,020	4,416	-	4,435	-
Transport	-	-	-	1,249	2,123	1,662	2,390	1,988	2,184	-	2,708	-
Police	-	-	-	1,794	2,094	1,832	2,220	2,001	2,333	-	2,447	-
Irrigation and Flood Control	-	-	-	769	1,311	699	1,354	721	1,365	-	1,507	-
Water Supply and Sanitation	-	-	-	1,050	1,085	1,048	1,893	1,530	1,279	-	1,283	-
Urban Development	-	-	-	580	1,945	1,205	1,000	487	886	-	1,258	-
All Sectors	**-**	**-**	**-**	**23,060**	**29,991**	**26,622**	**32,430**	**28,619**	**36,912**	**-**	**38,985**	**-**
Actuals / BE	**-**		**-**		**88.8%**		**88.2%**		**-**		**-**	
% of Total Expenditure on All Sectors	**-**	**-**	**-**	**60.1%**	**60.0%**	**61.0%**	**61.0%**	**61.1%**	**61.5%**	**-**	**58.9%**	**-**

Remarks: Actual expenditures by sector for FY2018 and FY2019 are not included in the analysis due to lack of data or different sector classifications. Actual expenditures for FY2022 and FY2023 have not been released.

Source: Uttarakhand Budget Analysis, PRS Legislative Research

Table 6-41 Composition Ratio in Budget Estimate and Actual Expenditure for UK State Government as a whole and by Sector

	2018		2019		2020		2021		2022		2023	
	BE	Actuals	BE	Actuals	BE	Actuals	BE	Actuals	BE	Actuals	BE	Actuals
Net Expenditure												
Revenue Expenditure	84.0%	83.6%	85.0%	85.6%	84.7%	84.9%	82.8%	83.2%	81.7%	-	79.7%	-
Capital Outlay	15.5%	16.1%	14.4%	14.1%	14.8%	15.0%	16.9%	16.1%	18.1%	-	19.8%	-
Loans given by the State	0.5%	0.3%	0.6%	0.3%	0.5%	0.1%	0.3%	0.7%	0.2%	-	0.5%	-
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**-**	**100%**	**-**
Sector-wise Expenditure										-		-
Education, Sports, Arts, and Culture	-	-	-	34.2%	31.3%	31.6%	30.0%	30.4%	29.5%	-	28.0%	-
Agriculture and Allied Activities	-	-	-	12.5%	11.3%	10.7%	10.9%	12.6%	11.0%	-	12.9%	-
Rural Development	-	-	-	11.6%	10.7%	13.5%	10.6%	11.8%	13.3%	-	12.4%	-
Social Welfare and Nutrition	-	-	-	9.0%	9.2%	10.7%	10.5%	11.1%	12.4%	-	11.7%	-
Health and Family Welfare	-	-	-	9.1%	8.9%	9.3%	10.6%	10.6%	12.0%	-	11.4%	-
Transport	-	-	-	5.4%	7.1%	6.2%	7.4%	6.9%	5.9%	-	6.9%	-
Police	-	-	-	7.8%	7.0%	6.9%	6.8%	7.0%	6.3%	-	6.3%	-
Irrigation and Flood Control	-	-	-	3.3%	4.4%	2.6%	4.2%	2.5%	3.7%	-	3.9%	-
Water Supply and Sanitation	-	-	-	4.6%	3.6%	3.9%	5.8%	5.3%	3.5%	-	3.3%	-
Urban Development	-	-	-	2.5%	6.5%	4.5%	3.1%	1.7%	2.4%	-	3.2%	-
All Sectors	**-**	**-**	**-**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**-**	**100%**	**-**

Source: Uttarakhand Budget Analysis, PRS Legislative Research

Table 6-42 Year-on-year Comparison (Increase/Decrease Ratio) in Budget Estimate and Actual Expenditure for UK State Government as a whole and by Sector

	2018⇒2019		2019⇒2020		2020⇒2021		2021⇒2022		2022⇒2023	
	BE	Actuals	BE	Actuals	BE	Actuals	BE	Actuals	BE	Actuals
Net Expenditure										
Revenue Expenditure	9.3%	2.1%	8.9%	12.9%	3.9%	5.0%	11.3%	-	7.6%	-
Capital Outlay	-0.2%	-12.5%	12.3%	20.8%	21.5%	15.2%	20.8%	-	21.2%	-
Loans given by the State	47.4%	-0.2%	-11.3%	-70.1%	-40.2%	825.3%	0.0%	-	98.7%	-
Total Expenditure	**8.0%**	**-0.3%**	**9.3%**	**13.7%**	**6.3%**	**7.2%**	**12.9%**	**-**	**10.3%**	**-**
Sector-wise Expenditure										
Education, Sports, Arts, and Culture	-	-	-	6.8%	3.8%	3.4%	11.8%	-	0.1%	-
Agriculture and Allied Activities	-	-	-	-1.7%	4.2%	27.0%	14.5%	-	24.1%	-
Rural Development	-	-	-	34.3%	6.9%	-5.7%	43.1%	-	-1.6%	-
Social Welfare and Nutrition	-	-	-	37.1%	23.9%	11.9%	34.2%	-	-0.3%	-
Health and Family Welfare	-	-	-	18.5%	28.3%	21.3%	28.4%	-	0.4%	-
Transport	-	-	-	33.1%	12.6%	19.6%	-8.6%	-	24.0%	-
Police	-	-	-	2.1%	6.0%	9.2%	5.1%	-	4.9%	-
Irrigation and Flood Control	-	-	-	-9.1%	3.3%	3.1%	0.8%	-	10.4%	-
Water Supply and Sanitation	-	-	-	-0.2%	74.5%	46.0%	-32.4%	-	0.3%	-
Urban Development	-	-	-	107.8%	-48.6%	-59.6%	-11.4%	-	42.0%	-
All Sectors	**-**	**-**	**-**	**15.4%**	**8.1%**	**7.5%**	**13.8%**	**-**	**5.6%**	**-**

Source: Uttarakhand Budget Analysis, PRS Legislative Research

Table 6-43 shows the breakdown of the water supply and sanitation sector budget (1,283 Crore INR in total) for FY2023.

Table 6-43 Breakdown of Water Supply and Sanitation Sector Budget

	Scheme	Purpose	Revenue Expenditure (Lakh INR)	Capital Outlay (Lakh INR)	Total (Lakh INR)
1	Jal Jeevan Mission	Providing safe and adequate drinking water through individual household tap connections by 2024 to all households in rural India	1,000.01	15,320.03	16,320.04
	State Sector Rural	Providing drinking water to the residents in rural area	0	1,000.00	1,000.00
	National Bank for Agriculture and Rural Development (NABARD)	Providing drinking water to the residents in rural area	0	3,800.00	3,800.00
	Others	Providing drinking water to the residents in rural area	17,395.03	1,053.00	18,448.03
2	Aided Project	Adequate drinking water supply system	2,000.00	11,806.00	13,806.00
		Drinking water supply system as per the standards in urban areas (including JICA loan)	1,000.00	1,500.00	2,500.00
		Urban sewerage system	0	12,000.00	12,000.00
3	State Sector Urban Drinking Water and Sewerage Schemes	Providing drinking water and sewerage system to the public in urban areas	6,100.02	9,870.01	15,970.03
4	Namami Ganga	Making rivers pollution free	0	0	0
		Making rivers pollution free (selected 9 river basins)	2,400.00	0.02	2,400.02
5	Clean India Mission (Swachh Bharat Mission)	Providing individual domestic toilets for all families in the rural areas	747.00	9,796.75	10,543.75

		Solid and liquid waste management in rural areas			
		Construction of community sanitation complexes at rural public places			
6	Payment of electricity bills, payment of gratuity	Payment of electricity bills, payment of gratuity	31,500.00	0	31,500.00
	Total		**62,142.06**	**66,145.81**	**128,287.87**

Source: Uttarakhand Budget 2023-2024

Chapter 7 Suitable Systems for the Target Area

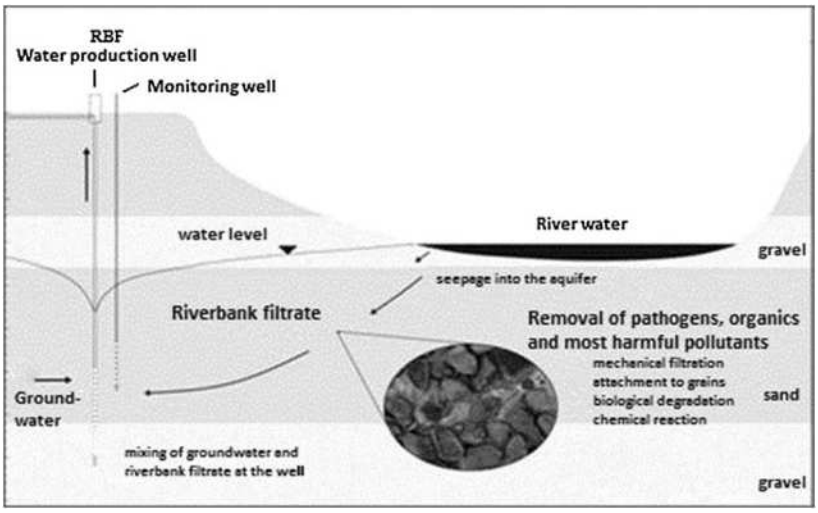
7.1 Suitable Systems for Water Intake and Conveyance

7.1.1 River Bank Filtration

River Bank Filtration (RBF), also known as Shusui-sei or Manshu-ido in Japan, is a method of water intake where a vertical well is constructed near a riverbank, allowing the river water to seep through the bank and reach the groundwater level within the well. During this process, natural filtration occurs within the subsurface, resulting in an improved water quality compared to direct intake from the river as a surface water source.

This RBF method has shown positive results[1] in adoption cases in the UK state, and it is still being applied to newly established water intake facilities in recent years. As an example, a facility utilizing RBF is installed along the Ganges River in Haridwar district, as shown in Figure 7-2. This facility was put into operation in 1998, and the dimensions of the RBF well are approximately φ15m in diameter and 14m deep (with the water level inside the well, being about 6m below the bottom of the well).

It should be noted that the application of RBF requires favourable geological conditions that allow filtration through the riverbank. As such, it is feasible to apply this method in natural river areas along the riverbanks. However, in the case of artificial canals like the Ganga Canal, the application of RBF is generally not feasible due to the lack of suitable geological conditions.



Source: *Tyagi et al.*, 2013

Figure 7-1 Conceptual diagram of RBF



Source: Prepared by JST

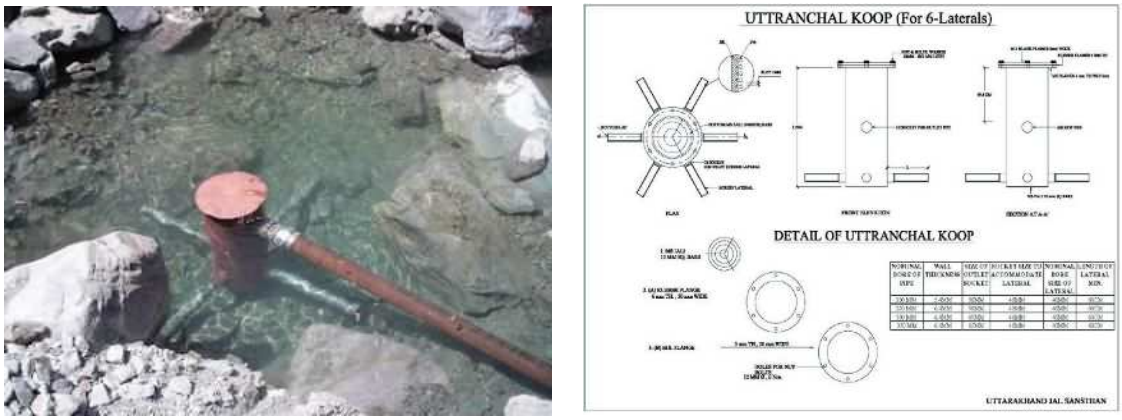
Figure 7-2 RBF in Haridwar

7.1.2 Uttaranchal Koop

In the case of concrete structured water intake facilities, there is a risk of damage and functional failure due to flood hazards. In contrast, the method known as "Uttaranchal Koop" involves embedding the intake openings into the riverbank along with crushed stone and gravel to facilitate filtration during water intake (Figure 7-3). This approach offers advantages such as reducing the risk of damage from disasters, lower installation costs as no concrete structure is required, and the ability to obtain good water quality.

This "Uttaranchal Koop" system is based on the French well technology and was developed independently by UJS, utilizing Johnson Screens. UJS headquarters have displayed three different samples of the system, showcasing the evolutionary improvements made over time (Figure 7-4, Figure 7-5). However, as the surroundings of the installed device are filled with crushed stone, the actual appearance of the installed product cannot be directly observed.

The adoption of this method has not encountered significant issues in the locations where it has been implemented. Nevertheless, the capacity of each unit is limited, allowing only approximately 100 LPM (about 0.14 MLD) of water intake per unit, making it suitable for small-scale water supply purposes only. For the current DPR project, it was determined that the application of this system would be impractical due to its limited intake capacity.



Source: UJS HP

Figure 7-3 Uttaranchal Koop (before filling) and product design drawing



Source: Prepared by JST

Figure 7-4 Appearance of Uttaranchal Koop (Left: initial, Right: improved model)



Source: Prepared by JST

Figure 7-5 Appearance of Uttaranchal Koop (The latest model)

7.1.3 Decentralized Water Resource System Using Solar Power Generation

In the UK state, decentralized irrigation water system is being implemented, utilizing solar power generation. In this approach, irrigation water is pressurized from a water intake weir in the river using pump facilities powered by solar panels. By adopting this method in regions where rain-fed agriculture was traditionally predominant, the supply of irrigation water has increased, enabling the expansion of high-yield crop cultivation. This success has also contributed to creating a demand for migration to the area. Additionally, the system is used for drinking and household water, leading to improvements in gender gaps related to women's labour in water fetching[2].

Since it does not involve the establishment of WTPs, the system's efficacy depends on the water quality available in the region. While it may face challenges in catering to medium to large-scale water demands, it proves particularly useful in economically vulnerable and mountainous rural areas where industrial infrastructure is limited.



Source: NITI Aayog, 2019

Figure 7-6 Decentralized water resource system using solar power generation

7.1.4 Micro-hydropower Generation

The applicable water supply system for micro-hydropower generation facilities consists of numerous electric motor loads at water purification plants, and the water intake is gravity-fed through natural flow. The installation position of the micro-hydropower generation facilities is located just before the intake well.

Upon confirmation through on-site investigation, it was found that in Chamba, which has an existing water purification plant and conducts water intake through natural flow, water is conveyed to the intake well, but there is little surplus pressure. It is also believed that there is little surplus pressure in other target areas.

Table 7-1 shows the power generation capacity when a provisional residual pressure of 5m is obtained.

Table 7-1 Expected output from Micro-hydropower generation (kW)

Sl No.	Town/WTP	District	Residual Pressure (m)	Flow Rate (m^3/s)	Expected Output (kW)
9	Tharali/ 0.32 MLD WTP	Chamoli	5.0	0.0037	0.12
	Tharali/ 0.46 MLD WTP			0.0053	0.18
	Tharali/ 0.58 MLD WTP			0.0067	0.22
10	Nandprayag			0.0124	0.41
11	Joshimath/ 0.42 MLD WTP			0.0049	0.16
	Joshimath/ 0.66 MLD WTP			0.0076	0.25
	Joshimath/ 1.01 MLD WTP			0.0117	0.39
	Joshimath/ 0.49 MLD WTP			0.0057	0.19
12	Pipalkoti			0.0205	0.68
13	Gopeshwar			0.0291	0.97
15	Chiniyalisaur/ Nagun Gadhera WTP	Uttarkashi		0.0698	2.32
	Chiniyalisaur/ Kalani Gadhera WTP			0.0484	1.61
	Chiniyalisaur/ Bhunu Gadhera WTP			0.0031	0.10
24	Tilwara	Rudraprayag		0.0208	0.69
26	Ukhimath			0.0179	0.59
27	Augustmuni			0.0405	1.34

Source: Prepared by JST

In the JICA-assisted project at Melamchi WTP in Nepal, a residual head of 14.4m and a flow rate of $2m^3/s$ were available upstream of the receiving well. This condition has allowed the installation of two 100kW micro-hydropower facilities, with each generator achieving power generation ranging from 66kW to 75kW. Figure 7-7 depicts the installation status of the micro-hydropower facilities implemented at the Melamchi WTP.



Source: Prepared by JST

Figure 7-7 Micro-hydropower facilities at the Melamchi WTP

7.2 Appropriate Technology for Water Purification Facilities

7.2.1 SSF

SSF（Slow Sand Filtration）is a treatment process to capture, oxidize and decompose suspended and dissolved substances in the raw water by the physical and biochemical function of biological filtration membrane formed by microorganisms including algae, etc. on the surface of the filter bed. SSF is suitable for raw water with good quality such as spring water and infiltrated water, and is applicable in case the raw water turbidity is generally less than 10 degrees (kaolin).

The advantage of SSF is to avoid using chemicals such as coagulants and chlorine (for pre-chlorination), as well as electric power required for mechanical and electrical equipment. On the other hand, the disadvantage is the relatively lower design filtration rate compared to rapid sand filtration (hereafter referred to RSF). The “Design Criteria for Water Supply Facilities” (Japan Water Works Association, 2012) recommends a rate of 4-5 m/day, while the design guideline of India, "Manual on Water Supply and Treatment" (Central Public Health and Environmental Engineering Organization, 1999), recommends 2.4 m/day. This results in a larger required filtration area compared to RSF, and a lot of labour for scraping work when filter resistance increases.

In the UK state, SSF of the existing WTP in Kirtinagar, where the first field survey was conducted, is operational. It is suitable for regions with poor electricity conditions, especially in mountainous areas, and is considered as an excellent technology for energy-saving. On the other hand, it is applicable only to good quality spring and groundwater sources, and its application is limited to small-scale WTPs due to lower design filtration rate.



Source : Prepared by JST

Figure 7-8 Slow sand filter at the existing WTP (Kirtinagar)

7.2.2 RSF

RSF（Rapid Sand Filtration）is a treatment method to remove suspended solids in raw water by the adhesion and sieving action of filter sand after coagulation and sedimentation processes.

RSF can treat higher raw water turbidity levels than the SSF because it involves coagulation and sedimentation treatment. The advantage of RSF is that it has a higher filtration rate than SSF and thus requires a smaller filtration area. According to the Japanese design criteria, the filtration rate is described as 120-150 m/day for a single filter layer configuration and 120-240 m/day for a double layer configuration, whereas the Indian CPHEEO manual describes it as 115-144 m/day. On the other hand, the disadvantage is the need for periodic backwashing to wash and remove turbid matters trapped in the filter bed, which consumes power and treated water.

In the UK state, RSF is in operation at the existing WTPs in Chamba and New Tehri, where the first field survey was conducted. RSF is widely applicable to medium and large-scale WTPs using river water, dam water, etc. as raw water as it is less affected by raw water quality.



Source: Prepared by JST

Figure 7-9 Rapid sand filter in the existing WTP (New Tehri)

7.3 Suitable Systems for Sewage Treatment

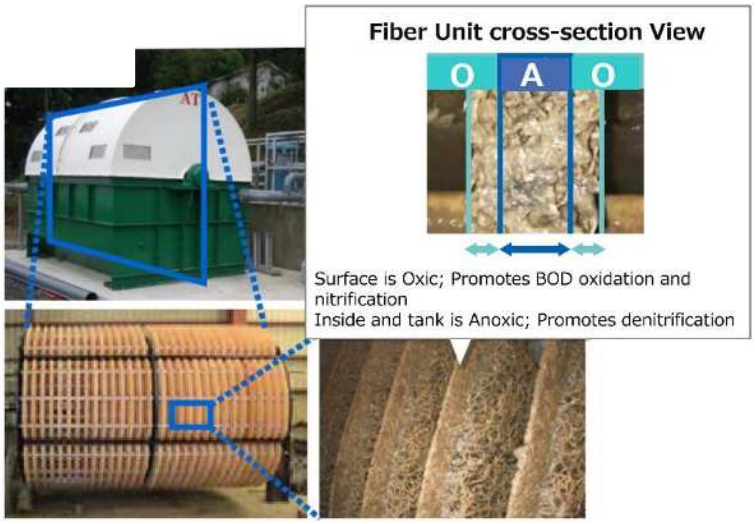
7.3.1 AT-BC System

(1) System overview

The rotating fibre unit (AT-BC system) is a wastewater treatment device based on the rotating biological contact method that uses bacteria of the Bacillus genus. In this system, numerous disc-shaped bodies are fixed to a central axis within the device. These discs are partially submerged in the sewage, and they undergo low-speed rotation to facilitate the treatment process.

In this technology, organic matter in the sewage that adheres during submersion is decomposed by the biofilm formed on the disc surfaces. The oxygen required for this decomposition is naturally obtained from the air, eliminating the need for aeration, which is a distinctive feature of this method.

The device is installed as a supplementary unit for sewage treatment, positioned before the reaction tank. It achieves approximately 60% removal of BOD from the influent. As a result, the organic matter load entering the reaction tank is significantly reduced.



Source: Toshiba Water Solutions Private Limited

Figure 7-10 Appearance of the AT-BC system

(2) Application methods and introduction effects

When applied to existing sewage treatment facilities, the AT-BC system is expected to enhance treatment capacity and improve the treated water quality. It can be employed during the renovation period to compensate for any reduction in treatment capacity. For proposed STPs, the AT-BC system enables the reduction of required aeration tank capacity from the planning stage, allowing for space-saving facility arrangements.

Moreover, as the organic load into the reactor tank is reduced, the aeration air volume can be minimized, resulting in approximately a 30% reduction in power consumption.



Source: Toshiba Water Solutions Private Limited

Figure 7-11 Advantages of the AT-BC system

(3) Suitability to the target areas

The capacity of a AT-BC unit is approximately 1 MLD (1,000 m^3/d/unit), making it suitable for small to medium-scale applications, with a target treatment volume of up to around 20 MLD. About 90% of the STPs in the state meet these conditions, indicating the potential applicability of this technology.

In particular, in mountainous regions like the UK state, the available flat land area is limited, making it challenging to secure additional space for expansion within existing waste WTPs or for new installations. Additionally, with the recent stringent standards for treated water quality, some STPs in the state may not fully comply with these criteria. In such facilities facing these challenges, the AT-BC system proves to be highly beneficial.

Furthermore, as a secondary effect of installing this AT-BC system, the sewage sludge generated in the facilities contains Bacillus bacteria. Utilizing this sludge as compost is reported to lead to increased yield in agricultural production. In the UK state, agricultural use of sewage sludge is common not only in urban areas but also in rural regions. Particularly in mountainous rural areas with agriculture-dependent industries, the demand for such compost is expected to be high.

7.4 Examples of DX Technology Implementation

7.4.1 Remote Presence and Business Monitoring Systems

(1) Examples of use in Japan

The Ministry of Land, Infrastructure, Transport and Tourism's "Draft Implementation Guidelines for Remote Observation at Construction Sites", issued in March 2023, defines a remote observation system as using video and audio acquired by a video camera (e.g., wearable camera) to perform "stage confirmation", "material confirmation" and "witnessing" from a remote location via a web conference system or similar.

Recently, remote site attendance has been applied to basically all construction works, with the aim of "reducing the waiting time associated with stage confirmation and simplifying confirmation documents" for the contractor and "efficient use of time by reducing on-site visits" for the employer (supervisor). The equipment configuration and specifications for use include cameras for video recording (e.g. wearable cameras) and web conferencing systems, and these specifications are required to be described.

The following examples of remote presence at construction sites are presented as case studies (March 2023).

Table 7-2 Hidaka Expressway improvement works

Construction overview		Details of the trial		
Trial period	2021/6/11-2021/12/16	System components	Items to be confirmed by remote presence	Points of ingenuity
Construction work	Extension of construction: L=3,100 m Road construction: Embankment V=20,000m^3 culvert construction Concrete: V=400m^3 Rebar: W=30t	Record: Smartphone Distribution: ASP (Base page) Web meeting system	・Rebar formwork inspection ・Confirmation of ready-mixed concrete placement status ・Compressive strength test ・Roadbed inspection	・Use stabilisers to prevent camera shake. ・An earphone microphone is used as a countermeasure against conversation obstruction due to ambient noise. Wired type instead of Bluetooth type is used to

Construction overview		Details of the trial		
Trial period	2021/6/11-2021/12/16	System components	Items to be confirmed by remote presence	Points of ingenuity
				minimise communication problems during the inspection process.

Source: Ministry of Land HP



Status of attendance



Anti-shake

Stabilizer



Status of attendance
(Director's side)



Status of attendance
(Director's side)

Source: Ministry of Land HP

Figure 7-12 Case study photographs of remote on-site witnessing situations (Hidaka Expressway improvement works)

Table 7-3 Kiso River Bridge Lower Fortifications

Construction overview		Details of the trial		
Construction period Trial period	2020/9/7-2022/3/18 2021/6/11-2021/12/16	System components	Items to be confirmed by remote presence	Points of ingenuity
Construction work	inverted-T abutment: 2 Stakes planted in place Φ2000, L=21m 6 Stakes planted in place Φ2000, L=31m 6 Road geotechnical: 1 Temporary structure: 1	Record: Web Camera Distribution: Web site	・Real-time video transmission to check the construction status of abutment concrete during placement (concrete quality check, transport status, placement sequence, weather conditions)	・Use fixed-point cameras that are easy to install. ・Three fixed-point cameras were installed to check the entire pouring area.

Source: Ministry of Land HP



Source: Ministry of Land HP

Figure 7-13　Case study photographs of remote on-site witnessing situations （Kiso River Bridge Lower Fortifications）

(2) Examples of use within India

In Bengaluru, India, the JICA-assisted Bengaluru Water Supply and Sewerage Project Stage V (Phase III as JICA assisted project) has achieved remote presence with the Project Monitoring System developed exclusively for the project, as well as online design, approval and management of shop drawings, as-built drawings and other documents.

The Project Monitoring System enables online project progress monitoring through the following menu/ modules shown in the dashboard of the system below.

① Cost Chart:

The module monitors project progress by reviewing and approving invoices from contractors and managing payment status.

② Status of Design, Drawings & Documentation:

The module supervises the progress of relevant documents online through the contractor's review and approval of design and shop drawings, technical documents and documents such as O&M manuals.

③ Synchronization Detail

The module monitors the progress of proper payment online by collating invoices and payment certificates between the contractor and consultant.

④ Open Issues

Any problems that occur at each construction site are monitored online by this module until they are resolved by the proposed solution, at which point the problem case is closed.

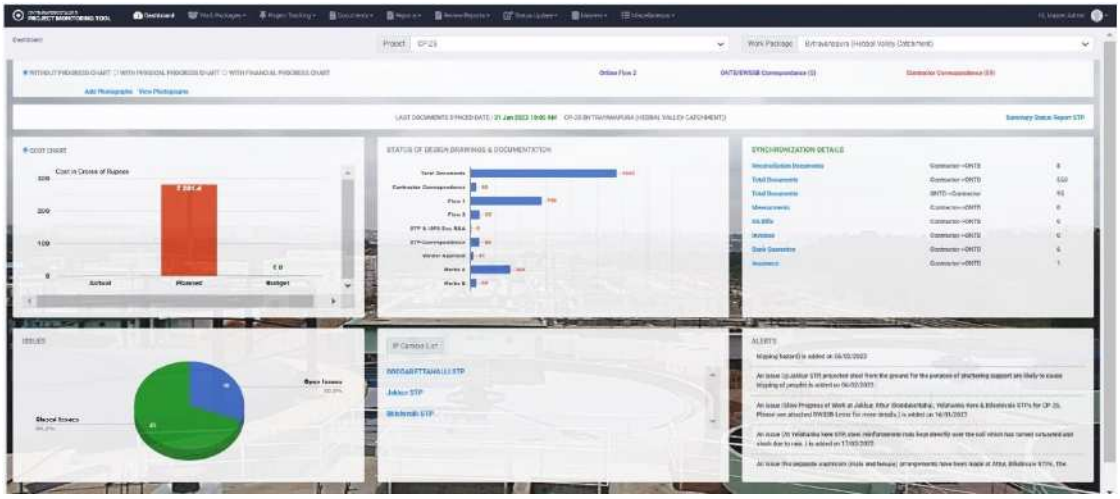
⑤ IP Camera List

In this module, construction supervision tasks conducted by the client or their representatives at each construction site are remotely and in real-time performed from the project headquarters. Video or audio data acquired through fixed cameras or wearable cameras installed at each construction site is transmitted to the Remote Monitoring System server at the project headquarters via GPRS devices and the wireless data network of the mobile phone service provider. By facilitating collaborative efforts between on-site supervisors and headquarters supervisors, remote online construction supervision is achieved.

⑥ Alerts

This module allows the following indications.

1) Milestones achieved or not achieved in specific work activities.
2) “Unresolved” or “ongoing” safety or other construction site issues
3) Failure to meet the scheduled submission alerts or the scheduled submission date in relation to the submission of drawings and designs in accordance with the Construction Programme.
4) Depending on the needs of the PMC (Project Management Consultant), contractor or client dashboard, many other details captured in the system can be displayed on the Alerts tab.



Source: NJS EI

Figure 7-14 Bengaluru Stage V Water and Sewerage Project MIS dashboard screen

(3) Applicability to the project

The remote presence system is basically introduced by the contractor. By using the system, the consultants' responsible for construction supervision on behalf of the employer can receive benefits of "reducing waiting times associated with stage inspections and simplifying confirmation of documents" as well as "efficient utilization of time by reducing on-site inspections." Especially, in case that construction sites are scattered in remote and inaccessible mountainous areas, the employer (the Indian side) can reap significant benefits. Therefore, the need to introduce the remote presence system is high.

On the other hand, a disadvantage of the system is that its connectivity and stability will be influenced by the usage environment, such as the quality of the internet connection. The anticipated communication lines for this project are data lines via mobile phone networks (GPRS/4G). However, during the first field survey, it was confirmed that mobile phones can be used without any issues in the residential areas where the proposed water treatment plants and tube wells are planned to be constructed. Therefore, it is inferred that the system will function smoothly.

As a specific approach for the implementation of this project, it is suggested to include "utilization of remote presence system for construction and project management" as a condition in the bidding specifications and allow contractors to submit technical proposals for evaluation. Considering the advantages mentioned above, it is recommended to apply this approach to the packages which includes mountainous areas such as Pithoragarh and Tehri, listed in the shortlist as shown in Chapter 10.

7.4.2 Supervisory Control and Data Acquisition (SCADA) System

(1) SCADA systems for existing water supply facilities

The SCADA systems installed at existing water supply facilities as per the field survey conducted between 30 May and 9 June 2023 are shown in Table 7-4. A similar system to the local SCADA system that has been installed for each project/scheme has been installed in the SCADA room at UJS headquarters, which enables monitoring of water supply facilities across the UK state where SCADA systems have already been installed.

Table 7-4 SCADA systems for existing water supply facilities

Name of water supply facility	Water supply facilities overview	SCADA system overview
Mehuwala, Dehradun suburb	TW: Existing 21, New 3 OHT: 6, DMA: 3 Groundwater taken at each TW is chlorinated, pumped to six OHTs and distributed naturally from the OHTs.	CIMCON SCADA system, Wifi/ web-based access Pump operating status, groundwater levels, pressure, flow rates, etc. collected at each TW (Tube Well) or RTU (Remote Terminal Unit) installed at each DMA are transmitted to the local SCADA system and UJS main office building via GPRS (data communication system using mobile phone networks) for monitoring.
Dehradun Urban Area	TW: 206 + OHT	SCADA system manufactured by Simplex Controls Equipment Co, using SIEMENS SIMA TIC Win CC as application. Data update: Every 3 minutes Data on pump operating status, groundwater levels, pressure, flow rates, etc. acquired by the RTUs (Remote Terminal Units) installed at each TW are transmitted to the local SCADA system and UJS headquarter central SCADA system via GPRS (a data communication system using mobile phone networks) for monitoring.
Srinagar Area	WTP: 3 (6 MLD, 2.75 MLD, and 2 MLD) Sedimentation ponds + sand filtration + water purification ponds + water pumps	SCADA system manufactured by Simplex Controls Equipment Co, using SIEMENS SIMA TIC Win CC as application. Date update: Every 1-3 minutes Data collected by the Programmable Logic Controller (PLC) installed at each WTP, such as operating status of each process, water level, pressure and flow rate, is transmitted to UJS headquarter central SCADA system via GPRS (data communication system using mobile phone networks) for monitoring.
Udham Singh Nagar	TW: 78 + OHT	System integrators and SCADA applications are similar to Dehradun Urban Area above Date update: Every 2 hours System configuration is the same as in the Dehradun Urban Area above.
Dehradun Rural	TW: 108 + OHT	Same as above (Udham Singh Nagar)
1-Ramnagar/ 3-Kotdawar	TW: 63 + OHT TW: 17 + OHT	Same as above (Dehradun Rural Area)
Rishikesh	TW: 33 + OHT	Same as above (1-Ramanagar/ 3-Kordawar)
Karnaprayag/ Gauchar	TW: 2 + OHT TW: 2 + OHT	Same as above (Rishikesh)
Pitthuwala	TW: 27 + OHT	CIMCON SCADA systems Date update: Every 2 hours Same as above for system configuration. (Karnaprayag/ Gauchar)
Raipur	TW: 14 + OHT	Same as above (Pitthuwala)
Peri Urban Area	TW: 17 + OHT	RG Industries SCADA system Date update: Every 1-2 minutes Same as above for system configuration.（Raipur）
Haridwar	TW: 99 + OHT	Same as Pitthuwala above.

Source: Prepared by JST

(2) SCADA systems for existing sewerage facilities

Based on the on-site survey, the existing SCADA system installed in the wastewater facilities is shown in Table 7-5. The SCADA system is installed at the waste WTPs and functions solely for control and monitoring purposes at these treatment plants. The data on the operational status of each treatment plant's processes is not transmitted to the SCADA room at the UJS headquarters building.

Table 7-5 SCADA systems for existing sewerage facilities

Name of STP	STP overview	SCADA system overview
Jagjeetpur 68 MLD STP	Automatic screen → Grid Chamber → distribution tank → SBR (6 ponds) → chlorine mixing tank (liquid chlorine) → discharge Sludge treatment: 18m^3/day, Sludge thickening tank → Centrifugal dehydrator, SBR operation: 8 Cycle/day (= 3 hours/cycle)	HNG SCADA system System configuration: Operator Stations, Database, Ethernet Switches, printers, duplexed PLCs, Remote IO panels, etc. On-line water quality instrument data for the treated water is collected by the PLC and the data is transferred to the CPCB on a real-time basis and shared with the relevant authorities. Pumping stations are installed in the sewage pipe network, but the pumping stations are not connected to the treatment plant SCADA system and are operated automatically by PLCs installed at the pumping stations.
Rishikesh 26 MLD STP	Coarse screen (automatic residue scrapers) → Grid chamber (with reciprocating sediment scrapers) → SBR (4 ponds) → Discharge pump → (sand filtration) → Chlorine mixing tank (liquid chlorine) → Discharge Sludge thickening tank → Centrifugal dehydrator	A PLC-based SCADA system (C-TECH) dedicated to the SBR and PLC-based SCADA systems for other plants are responsible for the control and monitoring of the entire plant. For treated water quality, data from an on-line water quality meter is taken into the PLC and transferred to the CPCB.
Rishikesh 7.5 MLD STP	Start of operation in 2020 NANAMI GANGA Coarse screen (automatic residue scrapers) → lift pumps (3 units) → fine screen (automatic residue scrapers) → Grid chamber (with mixer and	Single PLC-based SCADA system, large screen, web viewable with ID number and password access for interested parties, treated water quality data from online water quality meters transferred to CPCB via GPRS and shared with relevant agencies.

Name of STP	STP overview	SCADA system overview
	screw conveyor type sediment scrapers) → flow equalization tank → anaerobic tank → MBBR reaction tank (DO control) → final sedimentation tank → disc filter → chlorine mixing tank (hypochlorite) → discharge into the Ganges River Sludge treatment: final sedimentation tank draw-off sludge → centrifugal dewatering machine	

Source: Prepared by JST

(3) SCADA systems to be developed in future

Local SCADA systems for control and monitoring of water supply facilities in each of the regions planned under the project will be installed on a project-by-project basis as before. On the other hand, for the installation of the Central SCADA system at the UJS headquarters, the plan is to retain the existing system as it is for the time being and gradually transition to a cloud-based IoT system.

The system for centralized monitoring of water supply facilities will be a cloud-based monitoring system accessible through a website. Stakeholders, mainly UKPJN and UJS staff, will be able to access real-time facility monitoring of the facilities using a password.

The IoT（Internet of Things）system utilizing the cloud is as follows:

① Web server

By responding to inquiries from each terminal (users/stakeholders) and presenting the necessary graphics, data, etc., through the SCADA server, real-time monitoring of water supply facilities is achieved.

② Historian server

It serves as an interface with the local SCADA system for remotely located water supply facilities and acts as a server responsible for data collection and compressed storage. The data is stored in files called data archives, and these files contain all the tag data collected during specific time periods.

It performs system security and audit trail, manages messaging, handles write and read requests from distributed clients, performs final data compression, and manages archive files, among others.

③ SCADA server

It is a server that, in response to inquiries from the web server, serves as the server for monitoring all town water supply facilities, enabling an integrated centralized monitoring system.

④ Operator station (user terminal)

It is a terminal used by stakeholders through the web server, achieving the monitoring function of water supply facilities in remote locations through data such as equipment operating status, process values, alarms, etc.

⑤ Engineering server

A server that provides the setup and modification of various server configuration devices on the cloud, as well as operator training simulations.

⑥ Large screen

A screen set up at UKPJN and the UJS headquarters to share the same screen with all visitors or stakeholders present.

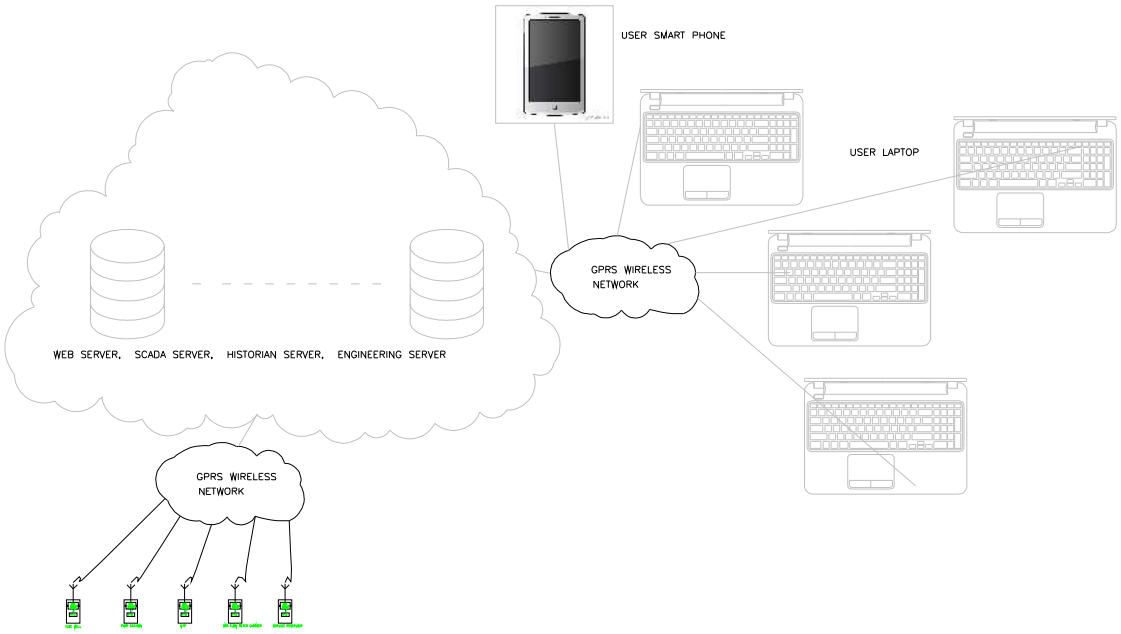
⑦ Online printers

It is used to output daily, monthly, annual and other reports, alarm history, etc.

⑧ GPRS module

It functions as a data transmission medium, connecting remote water supply facilities and user terminals to a cloud-based web server through a data communication network utilizing mobile phone networks.

The image below represents the centralized monitoring system utilizing an IoT system with cloud integration.



Source: Prepared by JST

Figure 7-15 Conceptual diagram of the monitoring system based on IoT

The IoT system can be described as a SCADA system utilizing the cloud. Regarding the installation location of the IoT system, in water facilities where water purification plants or Tube Wells are used as water sources, the main pump station can have a control room equipped with desktops, printers, UPS, GPRS modules, etc., for monitoring and control. Additionally, stakeholders (UKPJN and UJS staff) can monitor water supply facilities via a web server built on the cloud.

For the time being, the SCADA system for sewerage facilities will continue as before, with each project planning to install a local SCADA system for control and monitoring of the relevant sewerage facilities. However, it will be the policy that treated water quality data from each STP will be transmitted to the CPCB in real time and shared with the relevant authorities. In the future, this will also include monitoring pump stations within the treatment zone of the wastewater treatment plant and incorporating them into the IoT system.

7.4.3 Smart Metering and Tariff Payment Apps

In the WB-assisted project, Peri-Urban Drinking Water Supply - Development of Water Supply Scheme at Mehuwala Cluster on Design, Build and Operate Framework, the smart meters were installed for the first time in the UK state. The smart meters installed in this project are planned to be installed in the study area in the future.

In each household (approximately 25,000 connections), a mechanical water meter and an AMR (Auto Meter Reading) device are installed. The data read and accumulated by the AMR

is transmitted via Lora WAN (Long Range Wide Area Network), a low-power, long-distance wireless transmission standard, to the gateway device installed on top of the Over Head Tank (OHT) once per day. The data sent to the gateway is then transmitted to UJS Water Billing Server, which is located in the data centre of the UK state headquarters, once a month, using the GPRS (General Packet Radio Service) mobile phone wireless network. This data is utilized for automatic billing invoice generation.

Each user can access UKPJN or UJS portal site by PC or smartphone and pay online.

References for Chapter 7

[1] Studies of River Water Quality Using River Bank Filtration in Uttarakhand, India, Tyagi et al., Water Qual Expo Health, 5:139–148, 2023

[2] Composite Water Management Index, NITI Aayog, 2019

Chapter 8 Necessity of the DPR projects

8.1 Outline of the DPR Projects

The outline of the DPR projects is as presented in Table 8-1 and Table 8-2. However, it should be noted that the preparation years for each DPR are slightly different, which may result in variations within the range of designed baseline years, 2023-2025. As there is no significant need to standardize the multi-year difference in each DPR, the designed baseline years of the current DPRs are considered valid.

Table 8-1 Outline of the UUWSP

Project name	Uttarakhand Urban Water Supply Project (UUWSP)
Designed period	30 years
Target area	11 districts, 38 towns
Project objectives	✓ To achieve 135 LPCD of water supply for all households with 24-hour supply ✓ To reduce non-revenue water rate (from current 40-50% to 30%) ✓ To ensure stable water pressure in the water supply system

Source: Prepared by JST

Table 8-2 Outline of each DPR (1 of 2)

Sl. No.	District	Town	Terrain	Proposed W/S system	Current Rate of W/S (LPCD)	Population		
						Present Year	Base Year	Design Year
1	Pithoragarh	Berinag	Hilly	Pumping	28	9,475	11,194	21,346
2	Pithoragarh	Gangolihat	Hilly	Pumping	55	8,819	10,419	19,868
3	Bageshwar	Bageshwar	Hilly	Pumping	99	11,258	13,300	25,362
4	Almora	Almora	Hilly	Pumping	64	42,315	49,990	95,326
5	Almora	Bhikiyasain	Hilly	Pumping	35	5,667	6,695	12,767
6	Almora	Ranikhet	Hilly	Pumping	59	22,129	26,143	49,852
7	Almora	Dwarahat	Hilly	Pumping	65	3,409	4,027	7,679
8	Chamoli	Gairsain	Hilly	Pumping	27	10,745	12,693	24,204
9	Chamoli	Tharali	Hilly	Gravity	42	5,558	6,566	12,521
10	Chamoli	Nandprayag	Hilly	Gravity	135	2,035	2,404	4,584
11	Chamoli	Joshimath	Hilly	Gravity	90	20,719	24,477	46,675
12	Chamoli	Pipalkoti	Hilly	Gravity	40	4,366	5,158	9,836
13	Chamoli	Gopeshwar	Hilly	Gravity	116	26,594	31,418	59,911
14	Uttarkashi	Barkot	Hilly	Pumping	53	8,333	9,844	18,772
15	Uttarkashi	Chiniyali saur	Hilly	Gravity	58	10,967	12,956	24,706
16	Uttarkashi	Purola	Hilly	Pumping	65	9,834	11,618	22,154
17	Uttarkashi	Naugaon	Hilly	Pumping	24	6,416	7,580	14,454
18	Tehri	Chamiyala	Hilly	Pumping	59	6,579	7,773	14,822
19	Tehri	Chamba	Hilly	Pumping	62	9,636	11,384	21,708
20	Tehri	Ghansali	Hilly	Pumping	68	9,641	11,390	21,720
21	Tehri	Lambgaon	Hilly	Pumping	36	2,889	3,413	6,508
22	Tehri	Kirtinagar	Hilly	Pumping	79	1,881	2,222	4,238
23	Tehri	New Tehri	Hilly	Pumping	106	29,777	35,179	67,083
24	Rudraprayag	Tilwara	Hilly	Gravity	17	3,596	4,248	8,101
25	Rudraprayag	Rudraprayag	Hilly	Pumping	98	11,548	13,643	26,016
26	Rudraprayag	Ukhimath	Hilly	Gravity	81	3,868	4,570	8,715
27	Rudraprayag	Augustmuni	Hilly	Gravity	71	9,135	10,792	20,580
28	Champawat	Lohaghat	Hilly	Pumping	55	9,828	11,611	22,141
29	Nainital	Bhawali	Hilly	Tube Well	89	7,823	9,242	17,624
30	Nainital	Bhimtal	Hilly	Tube Well	135	9,575	11,312	21,571
31	Nainital	Kaladhungi	Plain	Tube Well	76	9,438	11,149	21,260
32	U.S. Nagar	Jaspur	Plain	Tube Well	60	69,633	80,077	152,146
33	Haridwar	Piran Kaliyar	Plain	Tube Well	42	23,809	28,128	53,637
34	Haridwar	Shivalik Nagar	Plain	Tube Well	44	39,680	46,877	89,390
35	Haridwar	Bhagwanpur	Plain	Tube Well	58	21,302	25,166	47,989
36	Haridwar	Lakshar	Plain	Tube Well	101	31,935	37,727	71,942
37	Haridwar	Landhora	Plain	Tube Well	135	22,779	26,911	51,317
38	Haridwar	Jhabreda	Plain	Tube Well	135	13,871	16,387	31,248

Source: Prepared by JST

Table 8-3 Outline of each DPR (2 of 2)

Sl. No.	District	Town	Terrain	Proposed W/S system	Proposed W/S schemes				
					Capacity (MLD)	Storage (KL)	Storage (Nos.)	Network (Km)	Connection (Nos.)
1	Pithoragarh	Berinag	Hilly	Pumping	3.16	1,100	2	55	1,103
2	Pithoragarh	Gangolihat	Hilly	Pumping	2.91	1,100	2	43	2,207
3	Bageshwar	Bageshwar	Hilly	Pumping	4.79	400	1	59	6,814
4	Almora	Almora	Hilly	Pumping	21.50	24	43	298	2,344
5	Almora	Bhikiyasain	Hilly	Pumping	0.86	830	6	24	1,103
6	Almora	Ranikhet	Hilly	Pumping	4.90	1,180	3	39	752
7	Almora	Dwarahat	Hilly	Pumping	0.55	700.00	3	20.00	780
8	Chamoli	Gairsain	Hilly	Pumping	1.56	800	2	17	1,220
9	Chamoli	Tharali	Hilly	Gravity	0.97	710	3	40	1,220
10	Chamoli	Nandprayag	Hilly	Gravity	1.06	1,070	5	22	1,030
11	Chamoli	Joshimath	Hilly	Gravity	5.60	2,480	9	48	3,812
12	Chamoli	Pipalkoti	Hilly	Gravity	1.56	1,590	5	41	1,764
13	Chamoli	Gopeshwar	Hilly	Gravity	2.51	2,558	9	37	4,840
14	Uttarkashi	Barkot	Hilly	Pumping	8.71	1,900	1	20	6,617
15	Uttarkashi	Chiniyali saur	Hilly	Gravity	9.20	1,750	2	39	1,467
16	Uttarkashi	Purola	Hilly	Pumping	2.41	950	2	133	1,308
17	Uttarkashi	Naugaon	Hilly	Pumping	1.54	885	7	137	1,185
18	Tehri	Chamiyala	Hilly	Pumping	1.09	650	1	16	1286
19	Tehri	Chamba	Hilly	Pumping	8.20	2,880	3	37	3,410
20	Tehri	Ghansali	Hilly	Pumping	1.7	1,000	1	16	2015
21	Tehri	Lambgaon	Hilly	Pumping	1.80	2	1	10	390
22	Tehri	Kirtinagar	Hilly	Pumping	1.24	1,103	3	16	475
23	Tehri	New Tehri	Hilly	Pumping	11.23	3250.00	3	102.63	5200
24	Rudraprayag	Tilwara	Hilly	Gravity	1.80	810	4	15	920
25	Rudraprayag	Rudraprayag	Hilly	Pumping	6.18	2,060	7	175	1,846
26	Rudraprayag	Ukhimath	Hilly	Gravity	1.55	2,070	3	18	629
27	Rudraprayag	Augustmuni	Hilly	Gravity	3.21	1,780	7	58	1,407
28	Champawat	Lohaghat	Hilly	Pumping	2.82	3,050	3	17	1,555
29	Nainital	Bhawali	Hilly	Tube Well	4.31	350	5	23	2,991
30	Nainital	Bhimtal	Hilly	Tube Well	5.89	350	4	48	3891
31	Nainital	Kaladhungi	Plain	Tube Well	2.23	1,100	2	28	1,358
32	U.S. Nagar	Jaspur	Plain	Tube Well	24.82	9,850	7	135	16,328
33	Haridwar	Piran Kaliyar	Plain	Tube Well	5.95	1,200	2	34	4,315
34	Haridwar	Shivalik Nagar	Plain	Tube Well	11.96	4,150	5	182	8,086
35	Haridwar	Bhagwanpur	Plain	Tube Well	7.41	2,150	4	65	3,912
36	Haridwar	Lakshar	Plain	Tube Well	11.00	2,000	3	74	3,612
37	Haridwar	Landhora	Plain	Tube Well	5.76	1,250	1	23	3,429
38	Haridwar	Jhabreda	Plain	Tube Well	3.25	1,250	2	20	1,187

Source: Prepared by JST

8.2 Population Projections

8.2.1 Recent Demographic Trends in Each Region

Table 8-4 summarizes the Census demographics and population growth rates (10-year growth rates) for each region. Overall, there is an upward trend, with most of the 10-year growth rates around 100%, but some areas, such as Rudraprayag and Bhimtal, have significantly higher 10-year growth rates. Conversely, some areas, such as New Tehri, have seen a decline.

Table 8-4 DPR demographics and population growth in each town

Town	Item	1971	1981	1991	2001	2011
Berinag	Population			2,647	3,745	7,641
	Increase				141%	204%
Gangolihat	Population			2,647	3,745	7,112
	Increase				141%	190%
Bageshwar	Population	7,753	9,532	13,976	19,399	25,045
	Increase		123%	147%	139%	129%
Almora	Population	19,691	20,738	16,001	30,153	39,820
	Increase		105%	77%	188%	132%
Bhikiyasain	Population			2,246	3,070	3,275
	Increase				137%	107%
Ranikhet	Population		18,190	16,875	19,055	18,886
	Increase			93%	113%	99%
Dwarahat	Population	1,782	2,326	2,810	2,543	2,749
	Increase		131%	121%	90%	108%
Gairsain	Population		3,656	4,885	5,972	8,665
	Increase			134%	122%	145%
Tharali	Population		2,269	3,244	3,957	4,649
	Increase			143%	122%	117%
Nandprayag	Population		1,103	1,262	1,647	2,688
	Increase			114%	131%	163%
Joshimath	Population			11,488	13,204	16,709
	Increase				115%	127%
Pipalkoti	Population			2,314	2,595	3,521
	Increase				112%	136%
Gopeshwar	Population		7,455	12,436	16,336	18,490
	Increase			167%	131%	113%
Barkot	Population		2,072	3,214	6,095	6,627
	Increase			155%	190%	109%
Chiniyali saur	Population			5,627	6,403	10,822

Town	Item	1971	1981	1991	2001	2011
	Increase				114%	169%
Purola	Population				6,003	7,586
	Increase					126%
Naugaon	Population				5,174	5,773
	Increase					112%
Chamiyala	Population					5,347
Chamba	Population		3,620	5,730	9,198	11,457
	Increase			158%	161%	125%
Ghansali	Population					8,375
Lambgaon	Population				1,061	2,200
	Increase					207%
Kirtinagar	Population					4,525
New Tehri	Population	5,480	12,248	20,224	25,423	24,014
	Increase		224%	165%	126%	94%
Tilwara	Population			2,106	3,146	3,801
	Increase				149%	121%
Rudraprayag	Population			2,473	2,575	9,313
	Increase				104%	362%
Ukhimath	Population			2,749	3,278	3,866
	Increase				119%	118%
Augustmuni	Population			3,177	5,060	6,406
	Increase				159%	127%
Lohaghat	Population	1,538	2,583	3,891	5,829	7,932
	Increase		168%	151%	150%	136%
Bhawali	Population	2,193	3,212	4,364	5,512	6,309
	Increase		146%	136%	126%	114%
Bhimtal	Population	2,096	2,871	4,225	5,875	14,882
	Increase		137%	147%	139%	253%
Kaladhungi	Population		3,112	4,663	6,126	7,611
	Increase		155%	150%	131%	124%
Jaspur	Population		21,242	30,831	38,937	56,156
	Increase			145%	126%	144%
Piran Kaliyar	Population		5,258	8,161	12,605	19,424
	Increase			155%	154%	154%
Shivalik Nagar	Population				18,622	33,600
	Increase					180%
Bhagwanpur	Population		5,781	8,197	11,859	17,179

Town	Item	1971	1981	1991	2001	2011
	Increase			142%	145%	145%
Lakshar	Population		13,643	15,622	18,242	25,754
	Increase			115%	117%	141%
Landhora	Population		8,077	12,195	16,036	18,370
	Increase			151%	131%	115%
Jhabreda	Population		5,453	7,633	9,384	11,186
	Increase			140%	123%	119%

※Blank columns indicate no data.

Source: Prepared by JST based on DPR

8.2.2 DPR Population Estimation Methodology

The population estimation methods used in the DPR for this study are as follows.

(a) AM: Arithmetical method

Calculation Formula: P (2011) + no.of decade*x

Calculate average population growth from historical records and add it to the current population to obtain the next population.

(b) II: Incremental increase method

Calculation Formula: P (2011)+n*x+n(1+n)y/2

The incremental arithmetic increase is obtained from the past decades and the average is added to the average increase.

(c) GM: Geometrical method

Calculation Formula: P (2011) * (1+rg) ^ (no.of decade)

Assume that the rate of increase is the growth rate, the average rate of increase is used to determine the future population growth rate.

(d) DGR: District Growth Rate

Calculation Formula: P (2011) * (1+rg) ^ (no.of decade)

District growth rate.

(e) TGRM: Tehsil growth rate method

It is stated that the calculation is based on 1.43% of Kirtinagar's 2011 data, but details are not available.

(f) SGM: Simple Graph Method

A method of prediction by an experienced person from a graph of Census date.

(g) ADGM: Average Decadal Growth method

Calculation Formula: P (2011) * (1+Average of Decadal Growth) ^ (0.1*(projected year-census year))

Calculated from the average of decadal growth rates.

(h) LDGM: Last Decadal Growth method

Calculation Formula: P (2011)* (1+Decadal Growth) ^ (0.1* (projected year-census year))

Calculated based on the growth rate of the most recent 10 years.

(i) UPIM: Uniform Percentage Increase method

Calculation Formula: exp (In (P (2011)+Average Growth Rate*(0.1*(projected year-census year))

Calculated assuming that the rate of increase is proportional to population.

(j) LSM: Least Square method

Calculation Formula: Constant*(0.1*(projected year-census year))+Slope

A technique that minimizes the sum of offsets or residuals of a point from a plotted curve.

(k) SLM: Semi Log method

A common way to plot data, with a small amount of data plotted on one axis and a large amount of data plotted on the other axis.

(l) WDM: Ward Density method

A method of calculation in which districts are divided into smaller areas and the population density of each is calculated.

(m) PDM: Population Density method

A method of calculation in which districts are divided into smaller areas and the population density of each is calculated.

(n) GPM: Geomatrical Progression Method

A method of calculation using a geometric progression.

(o) ETM: Exponential Trend Method

A method for forecasting univariate time series data. It involves assigning exponentially decreasing weights to past observations to calculate the forecast.

(p) PGM: Power Graph Mathod

The method of calculating, analyzing, and visually representing a power graph from a graph (network).

The formulas for each method are expressed below.

Table 8-5 Population estimation methodology

人口推計手法	計算式
(a) AM: Arithmetical method	P (2011) +no.of decade*x
(b) II: Incremental increase method	P (2011) +n*x+n (1+n) y/2
(c) GM: Geometrical method	P (2011) * (1+rg) ^ (no.of decade)
(d) DGR: District Growth Rate	P (2011) * (1+rg) ^ (no.of decade)
(e) TGRM: Tehsil growth rate method	Unidentified
(f) SGM: Simple Graph Method	Calculated from graphs
(g) ADGM: Average Decadal Growth method	P (2011) * (1+Average of Decadal Growth) ^ (0.1* (projected year-census year))
(h) LDGM: Last Decadal Growth method	P (2011) * (1+Decadal Growth) ^ (0.1* (projected year-census year))
(i) UPIM: Uniform Percentage Increase method	exp (In (P (2011) +Average Growth Rate* (0.1* (projected year-census year))
(j) LSM: Least Square method	Constant* (0.1* (projected year-census year)) +Slope
(k) SLM: Semi Log method	Calculated from graphs
(l) WDM: Ward Density method	Unidentified
(m) PDM: Population Density method	Unidentified
(n) GPM: Geometrical progression method	Geometric progression
(o) ETM: Exponential Trend Method	Calculated from graphs
(p) PGM: Power Graph Method	Calculated from graphs

Source: Prepared by JST based on DPR

8.2.3 Population Estimates for Each DPR

Table 8-6 summarizes the population estimation methods used in each DPR and the results of the population estimation for the next 30 years from the design base year (DPR estimated population). In the same table, we have estimated the 10-year average growth rate based on the DPR population estimates (covering approximately 30 years from 2011 to 2040).

In order to verify the validity of the results, we compare the actual Census population trends to date with the future demographic trends based on population estimates, by comparing (1) the latest 10-year growth rate from 2001 to 2011 based on the Census results (Table 8-4) and (2) the 10-year growth rate from 2011 to 2040 based on population estimates (Table 8-6). For convenience, here, we refer to ① as "Decadal Growth Rate, Census" and ② as "Decadal Growth Rate, Estimated."

While most DPR estimation results indicate that the actual and estimated growth rates are similar, there are some areas where the discrepancy is large.

For example, Berinag has an actual growth rate of 204% while the estimated growth rate is calculated to be 123%. Similarly, Rudraprayag and Bhimtal show a lower estimated growth

rate than the actual growth rate through 2011. On the other hand, in Chamba, while the actual growth rate has been slowing down (Table 8-4), the estimated growth rate is as high as 141%.

In this way, although there is a discrepancy when comparing the Decadal Growth Rate, Census, and the Decadal Growth Rate, Estimated, this is because each region is conducting population forecasts for the future, taking into account not only past performance but also population growth due to future development and trends.

Furthermore, as a reference,

Table 8-7 presents population estimates compiled by the Ministry of Housing and Urban Affairs (MoHUA) as part of the City Water Balance Plan (CWBP). When compared to Table 8-6, there is a disparity in population figures. However, considering the perspective mentioned above, it is deemed appropriate to adopt the population estimates from the DPR for this occasion.

Table 8-6 Population estimation results for each town

Town	Method	Present Year 2019/2020"	Base Year 2026	Mid-Year 2041"	Design Year 2056	Decadal Growth Rate (Estimated)	Decadal Growth Rate (Census)
Berinag	AM		11,387	15,132	18,878	126%	204%
	GM		111,588	17,574	26,652	132%	
	II		16,633	31,920	53,503	161%	
Gangolihat	AM		10,461	13,810	17,158	125%	190%
	GM		10,786	16,357	24,807	132%	
	II		14,715	27,424	45,237	157%	
Bageshwar	AM	30,233	31,097	37,582	44,066	114%	129%
	II	31,934	33,263	44,871	59,380	121%	
	GM	35,314	37,395	57,457	88,282	132%	
Almora	AM		45,064	50,307	55,551	108%	132%
	II		50,160	63,185	79,593	117%	
	GM		47,018	56,561	68,448	112%	
	SGM		51,609	64,276	76,943	117%	
	PDM		51,805	63,790	75,700	117%	
Bhikiyasain			5,723	6,815	7,905	128%	107%
Ranikhet	AM		19,234	19,582	19,930	101%	99%
	II		20,308	23,020	27,021	107%	
	GM		20,134	21,465	22,884	104%	
	SGM		19,300	19,600	20,000	101%	
	SLGM		19,080	19,500	19,800	101%	
Dwarahat		3,737	3,748	3,804	3,862	3,737	108%
Gairsain	II	10,794	12,232	17,647	24,708	127%	145%
	AM	10,168	11,003	13,507	16,012	116%	
	GM	11,148	12,823	19,516	29,702	131%	
	ADGM	11,253	13,012	20,116	31,099	132%	
	LDM	12,113	14,592	25,504	44,576	143%	
	UPJM	8,894	9,024	9,425	9,844	103%	
	LSM	4,827	5,632	8,049	10,465	98%	
	SGM	9,658	10,463	12,878	15,293	114%	
	SLGM	29,727	34,177	51,936	78,922	182%	

Town	Method	Present Year 2019/2020"	Base Year 2026	Mid-Year 2041"	Design Year 2056	Decadal Growth Rate (Estimated)	Decadal Growth Rate (Census)
Tharali	AM	5,363	5,760	6,950	8,140	114%	117%
	II	5,242	5,522	6,149	6,459	110%	
	GM	5,799	6,438	8,354	10,270	122%	
	ADGM	5,785	6,532	9,405	13,540	126%	
	LDGM	5,375	5,827	7,421	9,452	117%	
	GMP	5,702	6,387	8,976	12,615	125%	
Nandprayag	AM	4,412	4,676	5,469	6,261	127%	163%
	II	5,598	5,036	7,490	11,139	141%	
	GM	5,184	4,806	6,510	8,994	134%	
	TGRM	2,712	2,726	2,766	2,806	101%	
Joshimath	AM	26,956	28,261	32,177	36,093	124%	127%
	II	31,742	29,518	38,760	50,896	132%	
	GM	30,835	28,932	37,544	50,181	131%	
	TGRM	16,859	16,943	17,194	17,444	101%	
Pipalkoti	AM	7,978	8,280	9,185	10,090	138%	136%
	II	9,458	8,769	11,645	15,465	149%	
	GM	8,917	8,453	10,574	13,736	144%	
	TGRM	3,553	3,570	3,623	3,676	101%	
Gopeshwar	AM	21,800	23,640	29,157	34,675	116%	113%
	II	20,592	21,265	21,164	17,882	105%	
	GM	23,452	26,763	39,775	59,112	129%	
	ADGM	24,562	28,760	46,168	74,114	136%	
	LDM	20,673	21,995	26,491	31,905	113%	
	UPJM	18,996	19,283	20,171	21,099	103%	
	LSM	11,460	13,310	18,862	24,413	101%	
	SGM	22,559	24,409	29,959	35,509	117%	
	SLGM	19,909	23,128	36,260	56,849	125%	
Barkot	Average	8,140	8,672	10,482	12,002	117%	109%
	AM	8,269	8,889	11,213	13,537	119%	
	II	8,011	8,455	9,751	10,466	114%	
Chiniyali saur	GM	11,927	18,059	28,167	43,932	138%	169%
	AM	11,927	16,337	21,061	25,786	125%	
	II	11,927	24,313	47,910	82,189	164%	
Purola	AM	9,169	9,802	12,177	13,760	117%	126%
Naugaon	AM	5,923	6,884	7,913	8,943	111%	112%
Chamiyala		6,045	6,501	8,452	12,683	116%	-
Chamba	AM		15,376	19,294	23,213	119%	125%
	II		15,469	19,592	23,827	120%	
	GM		19,849	34,388	59,578	144%	
	SGM		19,450	32,400	62,000	141%	
Ghansali			9,468	13,246	19,876	117%	-
Lambgaon	AM	2,460	3,160	5,959	7,358	139%	207%
Kirtinagar	TGRM		5,496	6,675	8,107	114%	-
New Tehri	AM	29,427	31,137	35,410	39,684	114%	94%
	II	28,707	29,992	32,795	35,009	111%	
	GM	61,456	76,710	153,988	309,115	186%	
	DGRM	27,701	30,469	38,659	49,050	108%	
Tilwara	AM	4,564	4,988	6,259	7,530	118%	121%
	II	4,235	4,341	4,082	7,530	102%	

Town	Method	Present Year 2019/2020"	Base Year 2026	Mid-Year 2041"	Design Year 2056	Decadal Growth Rate (Estimated)	Decadal Growth Rate (Census)
	GM	4,882	5,610	8,515	12,923	131%	
	TGRM	3,831	3,854	3,911	3,968	101%	
Rudraprayag	AM	24,209	25,919	31,049	36,179	149%	362%
	II	31,261	27,904	42,728	65,429	166%	
	GM	30,167	27,182	41,156	62,710	164%	
	TGRM	6,464	6,496	6,592	6,688	89%	
Ukhimath	AM	4,369	4,648	5,486	6,323	112%	118%
	II	4,419	4,747	5,819	7,024	115%	
	GM	4,507	4,908	6,337	8,183	118%	
	ADGM	4,508	4,909	6,340	8,189	118%	
	LDGM	4,484	4,868	6,232	7,979	117%	
	UPIM	3,926	3,959	4,061	4,166	102%	
	LSM	2,684	2,964	3,802	4,641	99%	
	SGM	4,362	4,642	5,482	6,322	112%	
	SLM	9,053	9,859	12,732	16,442	149%	
Augustmuni	AM	7,859	8,666	11,088	13,510	120%	127%
	II	7,400	7,764	8,051	7,139	108%	
	GM	8,655	10,230	16,893	27,896	138%	
	TGRM	6,464	6,496	6,592	6,688	101%	
Lohaghat	AM		10,330	12,729	15,128	124%	136%
	II		10,992	14,847	19,496	123%	
	GM		14,119	26,493	48,940	149%	
Bhawali	GM	8,089	10,372	13,299	17,052	128%	114%
	AM	7,338	8,367	9,396	10,425	114%	
	II	7,264	8,145	8,952	9,685	112%	
	SGM	7,478	8,531	9,584	10,637	115%	
	SLGM	8,941	11,657	15,199	19,817	134%	
Bhimtal	II	20,261	22,174	34,606	51,819	132%	253%
	AM	17,808	18,605	22,594	26,582	115%	
	GM	23,370	26,431	48,908	90,499	149%	
Kaladhungi	II		9,497	12,185	15,564	117%	124%
	AM		9,255	11,016	12,777	113%	
	GM		11,608	18,246	28,679	134%	
	SGM		8,900	11,000	13,200	113%	
	SLGM		10,000	16,000	25,000	128%	
Jaspur	WDM		81,641	113,519	145,310	126%	144%
	AM		70,122	87,579	105,036	116%	
	II		75,157	106,635	146,695	124%	
	GM		82,250	132,529	213,543	133%	
	DGRM		82,135	114,609	147,083	127%	
	Average		78,261	110,974	151,533	125%	
Piran Kaliyar	AM	25,090	30,178	33,590	40,673	120%	154%
	II	27,675	30,178	45,338	64,903	133%	
	GM	32,760	37,333	71,754	137,911	155%	
	TGRM	22,459	23,218	27,011	30,805	112%	
Shivalik Nagar	TGRM	106,980	115,209	166,912	241,814	171%	180%
Bhagwanpur	AM	21,738	22,878	28,577	34,276	118%	145%
	II	23,655	25,601	37,289	52,245	129%	

Town	Method	Present Year 2019/2020"	Base Year 2026	Mid-Year 2041"	Design Year 2056	Decadal Growth Rate (Estimated)	Decadal Growth Rate (Census)
	GM	26,554	29,609	51,033	87,957	144%	
	SLM	25,360	27,737	41,583	58,696	134%	
	ETM	26,466	29,517	50,933	87,888	144%	
Lakshar	AM	25,007	25,819	29,877	33,936	105%	
	II	26,023	27,261	34,494	43,458	110%	
	GM	26,201	27,447	34,620	43,668	110%	141%
	SLM	26,921	28,388	36,761	46,866	113%	
	ETM	25,882	27,114	34,211	43,166	110%	
Landhora	AM	22,487	23,517	28,663	33,810	116%	
	II	21,310	21,844	23,311	22,771	108%	
	GM	24,841	26,787	39,061	56,959	129%	115%
	SLM	20,350	20,629	20,820	19,003	104%	
	PGM	21,831	22,581	26,111	29,350	112%	
Jhabreda	AM	13,479	14,053	16,919	19,786	115%	
	II	13,230	13,698	15,785	17,447	112%	
	GM	14,764	15,824	22,385	31,667	126%	119%
	SLM	12,960	13,367	15,146	16,500	111%	
	PGM	12,601	12,969	14,677	16,214	109%	

※The methods used are indicated in red.

Source: Prepared by JST based on DPR

Table 8-7 CWBP population estimates

Town	Population			
	2021	2025	2030	2050
Berinag	11,951	12,094	12,274	12,991
Gangolihat	11,037	11,147	11,285	11,837
Bageshwar	31,302	35,453	40,641	61,394
Almora	39,627	41,688	44,263	54,566
Bhikiyasain	3,841	4,150	4,536	6,080
Ranikhet	5,100	5,581	6,183	8,590
Dwarahat	2,955	3,051	3,170	3,649
Gairsain	12,998	15,598	18,847	31,845
Tharali	6,044	6,769	7,676	11,302
Nandprayag	10,723	10,723	10,723	10,723
Joshimath	22,320	24,463	27,141	37,855
Pipalkoti	8,039	8,682	9,486	12,702
Gopeshwar	22,168	24,207	26,757	36,954
Barkot	26,799	28,756	31,203	40,990
Chiniyali saur	N/A	N/A	N/A	N/A
Purola	9,173	10,070	11,192	15,677
Naugaon	5,928	6,361	6,902	9,067

Town	Population			
	2021	2025	2030	2050
Chamiyala	5,719	6,039	6,440	8,041
Chamba	15,457	16,817	18,517	25,319
Ghansali	8,864	9,360	9,981	12,463
Lambgaon	2,460	2,588	2,748	3,387
Kirtinagar	4,877	5,156	5,505	6,899
New Tehri	35,401	38,799	43,048	60,040
Tilwara	8,181	8,901	9,801	13,400
Rudraprayag	24,209	26,339	29,002	39,654
Ukhimath	6,879	7,484	8,241	11,268
Augustmuni	15,475	16,837	18,539	25,348
Lohaghat	10,484	11,139	11,959	15,236
Bhawali	12,113	13,179	14,511	19,841
Bhimtal	15,759	17,020	18,596	24,899
Kaladhungi	9,632	10,595	11,798	16,612
Jaspur	77,500	89,466	104,424	164,254
Piran Kaliyar	19,439	20,451	21,717	26,779
Shivalik Nagar	42,007	46,261	51,580	72,852
Bhagwanpur	21,370	22,483	23,874	29,439
Lakshar	32,522	35,816	39,933	56,402
Landhaura	21,801	22,936	24,356	30,033
Jhabreda	13,097	13,779	14,632	18,042

※Chiniyali saur has no data.

Source: Prepared by JST based on CWBP

8.2.4 Validity of Population Estimates

Most DPRs use population estimation methods with estimated growth rates of 100-130%, while Pipalkoti, Chiniyali saur, Chamba, and Rudraprayag show slightly higher rates.

In these areas, Pipalkoti has determined that AM is more appropriate than the other methods, given historical population trends. Chiniyali saur follows a similar policy, adopting GM, which has an intermediate estimated growth rate among the results of each method. Since Chamba has a commercial area nearby, the population of the Chamba area is assumed to increase as the area develops, and the GM with the highest growth rate is used. Rudraprayag has also adopted AM as appropriate in light of past population growth.

Thus, although there is a discrepancy between the actual and estimated growth rates by region, it is considered that this reflects, among other things, the unique development policies of

each region, the way population growth is viewed by each ULB, and the migration of population to urban areas, among other reasons. From this perspective, the study team believes that the selection of the population estimation methodologies based on each DPR and the results are appropriate.

8.3 Water Demand Projections

8.3.1 Water Demand Setting in DPR

Table 8-8 presents the content of water demand setting values in each DPR. In all regions, the water demand is set at 135 LPCD and the non-revenue water rate (UFW) is set at 15%. The water demand for the respective region is established based on these parameters, with the target of achieving 100% household connections. Additionally, in some regions, the DPRs also consider a 10% loss rate as a loss in the water distribution and purification processes.

Based on the specifications regarding water demand setting for each DPR as described in the same table, we present the calculated planned water supply quantity in the "Calc. Water Demand" column and the planned water supply quantity specified in the DPR in the "Water Demand in DPR" column in this survey.

Table 8-8 Setting water demand in the DPR

Town	LPCD	Water Demand (MLD) Design Year 2056	UFW	Losses Intake to WTP	Calc. Water Demand (MLD)	Water Demand in DPR (MLD)
Source	DPR	DPR	DPR	DPR	JST	DPR
Berinag	135	2.89	15%	N/A	3.40	3.66
Gangolihat	135	2.65	15%	N/A	3.12	3.35
Bageshwar	135	8.89	15%	N/A	10.46	7.00
Almora	135	13.28	15%	N/A	15.62	16.00
Bhikiyasain	135	1.07	15%	N/A	1.26	1.23
Ranikhet	135	4.09	15%	N/A	4.81	4.90
Dwarahat	135	0.52	15%	10%	0.61	0.66
Gairsain	135	3.34	15%	N/A	3.92	8.11
Tharali	135	1.22	15%	10%	1.43	1.56
Nandprayag	135	0.91	15%	N/A	1.07	1.05
Joshimath	135	4.87	15%	N/A	5.73	5.60
Pipalkoti	135	1.36	15%	10%	1.60	1.70
Gopeshwar	135	4.79	15%	N/A	5.64	5.90
Barkot	135※	7.36	15%	10%	8.65	8.70
Chiniyali saur	135	9.47	15%	10%	11.14	10.48
Purola	135※	2.23	15%	10%	2.62	2.46
Naugaon	135※	3.26	15%	10%	3.84	3.45
Chamiyala	135	2.21	15%	N/A	2.61	2.12
Chamba	135	8.54	15%	N/A	10.05	10.80
Ghansali	135	2.68	15%	N/A	3.16	3.35
Lambgaon	135※	1.49	15%	10%	1.76	1.84

Town	LPCD	Water Demand (MLD) Design Year 2056	UFW	Losses Intake to WTP	Calc. Water Demand (MLD)	Water Demand in DPR (MLD)
Source	DPR	DPR	DPR	DPR	JST	DPR
Kirtinagar	135	1.09	15%	10%	1.29	1.38
New Tehri	135※	6.62	15%	10%	8.66	11.5
Tilwara	135	2.60	15%	10%	3.40	2.00
Rudraprayag	135	4.88	15%	10%	6.38	6.18
Ukhimath	135	1.34	15%	10%	1.76	1.70
Augustmuni	135	2.85	15%	N/A	3.36	3.60
Lohaghat	135	2.46	15%	N/A	2.89	3.23
Bhawali	135	3.77	15%	N/A	4.44	4.00
Bimetal	135	8.79	15%	N/A	10.34	10.24
Jaspur	135	20.01	15%	N/A	23.54	24.93
Piran Kaliyar	135	10.72	15%	N/A	12.61	13.80
Shivalik Nagar	135	32.64	15%	N/A	38.41	37.99
Bhagwanpur	135	9.48	15%	N/A	11.15	11.15
Lakshar	135	8.38	15%	N/A	9.86	9.88
Landhora	135	5.54	15%	N/A	6.52	6.57
Jhabreda	135	3.19	15%	N/A	3.75	3.82

Source: Prepared by JST based on DPR

※On its own, it sets the amount of water for schools, hotels, and other facilities.

8.3.2 Validity of Water Demand Setting

From Table 8-8, it is apparent that there is a disparity between the calculated planned water supply quantity in this survey and the planned water supply quantity mentioned in the DPRs. However, there is no significant difference. This difference arises because, in addition to the values specified in Table 8-8, we have also considered non-revenue water rates that are not detailed in the DPRs, leading to the disparity.

Furthermore, regions with high water demand are typically those with higher population growth rates, as organized in the previous section. Therefore, we consider the population estimation methodology to be valid, making the water demand setting appropriate for these regions.

8.4 Condition of the Existing Facilities and Necessity of Renovation and Expansion

In the 38 target areas, there is an urgent need to increase water supply capacity due to population growth and increased water demand. The main challenges are insufficient capacity of existing water supply facilities including intake, water treatment and distribution facilities, as well as inadequate and unstable water availability from existing sources. Therefore, the necessity to develop the existing facilities is extremely high.

Regarding the condition of existing facilities, the results of detailed diagnostics and evaluations are not shown in the DPRs. However, the civil structure of the existing intake facility (Intake Well) constructed in 2010 will be used continuously and additional intake pumps will be installed to meet the increasing water demand in Chamba. In New Tehri, one of the two existing intake facilities will continue to be used, while the other will be renovated. For other target areas, the justification for the construction and expansion of facilities is based on the deterioration of the existing facilities beyond the design life of the civil structures of the intake and treatment facilities, which is 30 years as specified in the CPHEEO Manual.

Some of the DPRs for the target areas consider not only the design life specified in the CPHEEO Manual as a criterion but also the results of visual inspection to decide whether to continue using the existing facilities or to carry out renovation or rehabilitation. This approach is considered reasonable.

Chapter 9 Review of the DPR Projects

9.1 Checking Design Specifications

9.1.1 Overview

In general, water supply systems are designed in accordance with the criteria and parameters specified in the CPHEEO (Central Public Health and Environmental Engineering Organisation) Manual on Water Supply/Water Treatment issued in 1999 and the relevant I.S. Codes issued by the Bureau of Indian Standards.

9.1.2 Design Period

Basically, the Detailed Project Report (DPR) for water supply system improvements is designed for a 30-year period with 2026 as the base year. The intermediate and final years are 2041 and 2056, respectively. The design periods considered for the various components of the water supply system are as follows.

Table 9-1 Design standard

Number	Item	Design period (years)
1	Water intake facility	30
2	Pumping facilities (Civil engineering works)	30
3	Electric motors and pumps (as agreed by E&M personnel)	15
4	Raw water and treated water delivery pipes	30
5	Water Distribution Reservoirs and Pressure Reducing Tanks	30
6	Water distribution system	30
7	Water treatment facility	30

Source: DPR

9.1.3 Water Supply System

(1) Water demand

The parameters used to forecast water demand are specified in the CPHEEO manual and conform to those actually used by UKPJN.

- Permanent population@135 LPCD (Including peri-urban areas)

- Hotel tourist @180ℓ/bed/day
- Day-trippers@45ℓ/day
- Facility Population@45ℓ/day
- Hospitals @450ℓ/bed/day (For beds of 100 or more)
- Hospitals @340ℓ/bed/day (If the number of beds is less than 100)

(2) Non-revenue water ratio

The CPHEEO regulations specify a 15% non-revenue water rate generated by the water supply system, which is reflected in the water demand projections.

(3) Water for firefighting

Water for firefighting is calculated by applying the following formula.

Fire Demand (KL) = $100\sqrt{P}$

P = Population per 1000

9.1.4 Water Distribution System and Piping Installation

The objective of the water distribution system is to provide the required amount of water at sufficient pressure to all designated locations, taking into account the pattern of the road network, the topography of the site, and the degree and extent of development in the area.

(1) Minimum piping diameter

The size shall be 100 mm (inside diameter) according to the CPHEEO manual. However, if the scope for future expansion is limited, the size may be reduced according to the CPHEEO manual. The minimum diameter of 65 mm takes into account other hydraulic parameters such as flow velocity of 0.6 m/s.

(2) Soil cover

The minimum soil cover shall be 1 m.

(3) Pipe materials

Considering the difficult undulating terrain, few seams to prevent leakage, ease of handling during construction (DCIP is heavy), and the customer's past experience, the pipes shall basically be galvanized iron pipe up to 150 mm (GI pipe) and mild steel pipe over 200 mm (Mild Steel).

(4) Minimum pressure

The Manual on Water Supply and Treatment by CPHEEO recommends the following residual pressures. The water distribution network is designed for a minimum residual pressure of 17 m.

Table 9-2 Residual pressure

Number of floors	Minimum residual pressure (m)
Single-story building	7
Two-storied building	12
Three-storied building	17

Source: DPR

9.2 Review of the Contents of the Water Source Plan

A summary of the results on the review of the water source plans for the 38 priority sites is shown in Table 9-3. In conducting the review, the content of each DPR was examined with a focus on the necessity for new water source development, sustainability and availability of water sources, and climate change impacts.

Table 9-3 A summary of the results on the review of the water source plans for the 38 priority sites

SI. No.	District	Town	Description of Necessity for Water source development	Description of River discharge and GWL	Description on Climate Change
1	Pithoragarh	Berinag	✓	✓	only Climate
2	Pithoragarh	Gangolihat	✓		
3	Bageshwar	Bageshwar	✓		
4	Almora	Almora	✓	✓	
5	Almora	Bhikiyasain	✓	✓	
6	Almora	Ranikhet	✓	✓	only Climate
7	Almora	Dwarahat	✓		
8	Chamoli	Gairsain	✓	✓	Climate, Drought
9	Chamoli	Tharali	✓	✓	only Climate
10	Chamoli	Nandprayag	✓	✓	only Climate
11	Chamoli	Joshimath	✓	✓	Climate, Drought
12	Chamoli	Pipalkoti	✓	✓	Climate, Drought
13	Chamoli	Gopeshwar	✓	✓	
14	Uttarkashi	Barkot	✓		only Climate
15	Uttarkashi	Chiniyali saur	✓		only Climate
16	Uttarkashi	Purola	✓		only Climate
17	Uttarkashi	Naugaon	✓		only Climate
18	Tehri	Chamiyala	✓		only Climate
19	Tehri	Chamba	✓		
20	Tehri	Ghansali	✓		only Climate
21	Tehri	Lambgaon	✓		only Climate
22	Tehri	Kirtinagar	✓		
23	Tehri	New Tehri	✓		only Climate
24	Rudraprayag	Tilwara	✓	✓	Climate, Drought
25	Rudraprayag	Rudraprayag	✓		Climate, Drought
26	Rudraprayag	Ukhimath	✓	✓	Climate, Drought

SI. No.	District	Town	Description of Necessity for Water source development	Description of River discharge and GWL	Description on Climate Change
27	Rudraprayag	Augustmuni	✓	✓	Climate, Drought
28	Champawat	Lohaghat	✓	✓	
29	Nainital	Bhawali	✓		Monthly Temperature, Rainfall
30	Nainital	Bhimtal	✓		Monthly Temperature, Rainfall
31	Nainital	Kaladhungi	✓		
32	Udham Singh Nagar	Jaspur	✓		
33	Haridwar	Piran Kaliyar	✓		
34	Haridwar	Shivalik Nagar	✓		
35	Haridwar	Bhagwanpur	✓		
36	Haridwar	Lakshar	✓		
37	Haridwar	Landhora	✓		
38	Haridwar	Jhabreda	✓		

Source: Prepared by JST

9.2.1 Necessity of New Water Source Development

Descriptions of the necessity for new water source development were found in all DPR. The reason for the necessity is mostly the shortage of water supply due to population growth. At several sites, the shortage of water supply is accelerating due to the increasing tourism. In addition, at sites with older facilities, the necessity for facility replacement is indicated due to aging of the facilities.

9.2.2 Sustainability and Availability of Water Sources

Information on river discharge and groundwater level is essential to examine the sustainability of water sources and to determine their availability. However, there are not many DPRs that contain this information. There are regional differences in the description of river discharge. For example, the DPRs for Pithoragarh, Almora, Chamoli, Rudraprayag, and Champawat include river discharge measurements, while those for other areas do not include specific figures. Regarding the description of groundwater levels, there is absolutely no mention related to groundwater levels in the DPRs for the plain areas and mountain basins where groundwater use is planned.

In addition, there is no mention of analytical results for water quality in all DPRs for both surface water and groundwater.

9.2.3 Acquisition of Water Rights and Permits

In the UK state, for projects implemented by the state government, there is no requirement to acquire water rights. It is sufficient to submit plans and anticipated water intake volumes for the planned intake facilities for Department of Water Resources, without the need for permits or other associated documents.

For river intake, the Department of Water Resources issues a No Objection Certificate (NOC) and reports to the Central Water Commission, while information is shared with the Irrigation Department for lake intake and the hydropower companies for dam intake.

Additionally, all rights to surface water belong to the government, while rights to groundwater belong to the landowners. Therefore, there are no descriptions regarding the acquisition of water rights or permits in the DPR for the 38 target areas.

9.2.4 Impacts of Climate Change on Water Resources Use

Regarding the impacts of climate change on water resources use, floods, river depletion and lowering of groundwater levels are considered. These are important considerations for water source planning. However, there is no specific mention of climate change in the DPRs for the 38 priority areas. Some of the DPRs that use surface water as a water source include drought information, temperature and rainfall data, but not enough to allow for consideration of climate change. DPRs that use groundwater as a water source have no mention of climate change.

9.2.5 Consideration of Sustainable Water Resource Management Methods

In order to ensure sustainable water resources management in the future, more detailed information should be obtained when water supply facility construction is implemented.

For facilities using surface water, it is important to measure seasonal river discharges and confirm monthly river water level fluctuations. For facilities using groundwater, a detailed survey should be conducted before determining the depth of the screen and the planned pumping volume. Ideally, the survey should include test borings at approximately one site out of every three locations, aquifer distribution analysis, pumping tests, and monthly groundwater level measurements. For water quality, both surface water and groundwater should be analysed for the necessary items.

Furthermore, collection of this information should be continued after construction of the water supply facilities. In order to sustainably and adequately manage water resources, it is necessary not only to provide technical assistance to the 38 priority areas for water source planning, but also to strengthen the organizational capacity of the UKPJN from a long-term perspective.

9.2.6 Sustainability of Water Source Use

In conclusion of this section, an evaluation was conducted regarding the sustainability of water source utilization. The evaluation considered factors related to the sustainability of water sources, including the current water source availability and quality, the impact of future climate change in terms of disaster (flood) risk, and the risk of decreased water availability. These factors were analysed based on the information provided in the DPR and existing documentation. Each factor was assessed using a three-tier scoring system based on the criteria shown in Table 9-4. The points with the highest total score are considered to have a high level of water source sustainability.

The aggregated scores for each factor following the evaluation criteria are shown in Table 9-5. Most of the DPR locations that use groundwater as a water source demonstrated high scores, while for surface water sources, DPR locations within the Ganga and Kali river basins tended to have higher scores.

Table 9-4 Evaluation Criteria for Sustainability of Water Source Utilization

Component		Target source	Valuation basis	Score distribution
Present condition	Availability of water sources	River	Average annual flow (m^3/s) Confirmation of river size with reference to Table 4-5, e.g. satellite images.	100,000 or over: 3 100,000～10,000: 2 10,000 or less: 1
		Ground water	Groundwater levels (GL-m) based on CGWB groundwater level observation data	Shallower than 10m: 3 10～20m: 2 More than 20 m deep: 1
	Water quality of water sources	River	Confirmation of PCB measurement results for items of health concern.	Not detected: 3 Detection: 2 Over-the-board: 1
		Ground water	Confirmation of PCB measurement results for items of health concern.	Not detected: 3 Detection: 2 Over-the-board: 1

Component		Target source	Valuation basis	Score distribution
Future projections in the context of climate change	Disaster risk (flooding)	River	Flood risk by river basin is as follows, referring to Table 2-3: The Alaknanda basin is high risk. The Ramganga basin is low risk, and the rest are moderate risk.	Low risk: 3 Medium risk: 2 High risk: 1
		Ground water	No flood risk	All points: 3
	Risk of water quantity reduction	River	Average annual precipitation (mm/year) for the region according to Figure 4-12	1,700 or over: 3 1,200～1,700: 2 1,200 or less: 1
		Ground water	Confirmation of rainwater infiltration capacity due to surrounding development conditions, e.g. via satellite images	Rural: 3 Urban: 2 Industrial: 1

Source: Prepared by JST

Table 9-5 Assessment results on the sustainability of water source use

Sl. No.	District	Town	Basin	Water intake target (rivers, aquifers)	Current situation of water source		Future risks associated with climate change		Total Score
					Availability	Quality	Disaster risk (flooding)	Risk of water quantity reduction	
36	Haridwar	Lakshar	Ganga	3rd Aquifer	3	3	3	3	12
37	Haridwar	Landhora	Ganga	3rd Aquifer	3	3	3	3	12
38	Haridwar	Jhabreda	Ganga	3rd Aquifer	3	3	3	3	12
2	Pithoragarh	Gangolihat	Kali	Ramganga	2	3	2	3	10
3	Bageshwar	Bageshwar	Kali	Saryu	3	2	2	3	10
19	Tehri	Chamba	Ganga	Bhagirathi	3	3	2	2	10
23	Tehri	New Tehri	Ganga	Bhagirathi	3	3	2	2	10
29	Nainital	Bhawali	Ramganga	2nd Aquifer	3	3	2	2	10
30	Nainital	Bhimtal	Ramganga	2nd Aquifer	3	3	2	2	10
31	Nainital	Kaladhungi	Ramganga	2nd Aquifer	2	3	3	2	10
32	Udham Singh Nagar	Jaspur	Ramganga	3rd Aquifer	2	3	3	2	10
33	Haridwar	Piran Kaliyar	Ganga	3rd Aquifer	2	3	3	2	10
35	Haridwar	Bhagwanpur	Ganga	3rd Aquifer	1	3	3	3	10
1	Pithoragarh	Berinag	Kali	Ramganga	2	3	1	3	9
5	Almora	Bhikiyasain	Ramganga	Ramganga	2	3	3	1	9
8	Chamoli	Gairsain	Ramganga	Ramganga	2	3	2	2	9
10	Chamoli	Nandprayag	Alaknanda	Alaknanda	3	3	1	2	9
12	Chamoli	Pipalkoti	Alaknanda	Alaknanda	3	3	1	2	9
13	Chamoli	Gopeshwar	Alaknanda	Alaknanda	3	3	1	2	9
22	Tehri	Kirtinagar	Alaknanda	Alaknanda	3	3	1	2	9
25	Rudraprayag	Rudraprayag	Alaknanda	Alaknanda	3	3	1	2	9
34	Haridwar	Shivalik Nagar	Ganga	3rd Aquifer	2	3	3	1	9
4	Almora	Almora	Ramganga	Kosi	1	3	3	1	8
7	Almora	Dwarahat	Ramganga	Ramganga	2	3	2	1	8
14	Uttarkashi	Barkot	Yamuna	Yamuna	3	1	2	2	8
15	Uttarkashi	Chiniyali saur	Ganga	Bhagirathi	3	1	2	2	8
17	Uttarkashi	Naugaon	Yamuna	Yamuna	3	1	2	2	8
18	Tehri	Chamiyala	Ganga	Bal Ganga	1	3	2	2	8
20	Garhwal	Ghansali	Alaknanda	Bhilangna	2	3	2	1	8
24	Rudraprayag	Tilwara	Alaknanda	Gadhera	2	3	1	2	8
6	Almora	Ranikhet	Ramganga	Kosi	1	2	3	1	7
9	Chamoli	Tharali	Alaknanda	Springs	1	3	1	2	7
11	Chamoli	Joshimath	Alaknanda	Springs	1	3	1	2	7
26	Rudraprayag	Ukhimath	Alaknanda	Springs	1	3	1	2	7
27	Rudraprayag	Augustmuni	Alaknanda	Chena Gad	1	3	1	2	7
16	Uttarkashi	Purola	Yamuna	Kamaal	1	1	2	2	6
21	Tehri	Lambgaon	Ganga	Jalkur	1	1	2	2	6
28	Champawat	Lohaghat	Kali	Lohawati	1	1	2	2	6

Source: Prepared by JST

9.3 Examination of Facility Plan Contents

Regarding the water intake methods for each sub-project, as outlined in the reference document "DPR Content Summary by Package," they are broadly categorized into two types: groundwater extraction (six sub-projects) and surface water extraction from rivers or lakes.

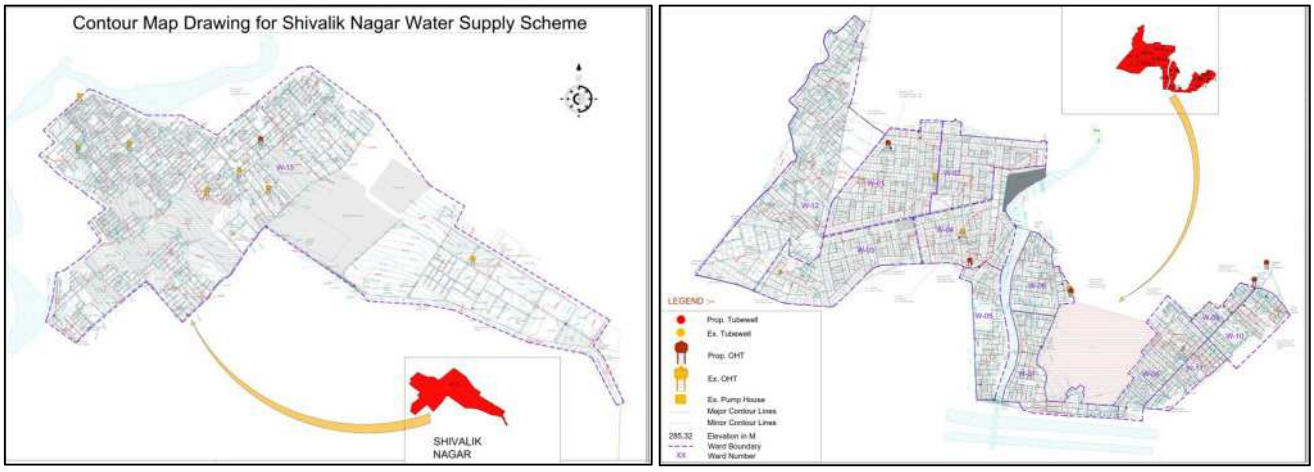
Furthermore, for the surface water extraction method, it is further classified into two sub-types: the Intake Well method, which involves constructing intake towers within rivers to directly extract surface water, and the Infiltration Well method, which involves constructing shallow wells within rivers to extract groundwater.

9.3.1 Shortlist facility plan details

(1) Shivalik Nagar

(a) Town profile

Shivalik Nagar is administered by Nagar Palika and the project area is within the current Municipal boundaries. The town area is 270.00 hectares and is divided into 13 zones.
Shivalik Nagar is located at 78.072 W longitude and 29.934 N latitude in Haridwar District, 10 km away from Haridwar city on Bahadarabad road and 8 km away from Jwalapur railroad station on relatively good ground. The city is located on a plain with a tropical climate and a ground elevation of 3.0 meters.



Source: DPR

Figure 9-1 General view of Shivalik Nagar

(b) Existing water supply facilities

Water supply was first introduced to Shivalik Nagar in 1983-1984. Since then, no major water supply expansion has been implemented, and the current capacity of the existing facilities is 4 intake wells (5,700 lpm), 3 OHTs (1,800 KL), and 11.21 km of distribution pipe network.

The intake well is a typical deep well and draws water from an aquifer at a depth of approximately 120 meters.

In addition, hand-pump wells have been installed throughout the town to compensate for the lack of water supply, totalling 103 wells.



Source: Prepared by JST

Figure 9-2 Existing intake well and OHT (Shivalik Nagar)

(c) Facility plan for the project

In Shivalik Nagar, due to the expansion of the Nagar Palika area and population growth, water shortages continue in large parts of the town. The capacity of water distribution reservoirs is less than actually required, and some are damaged, rendering them unusable. There is an urgent need to restructure the current water supply system in order to satisfy water demand and supply.

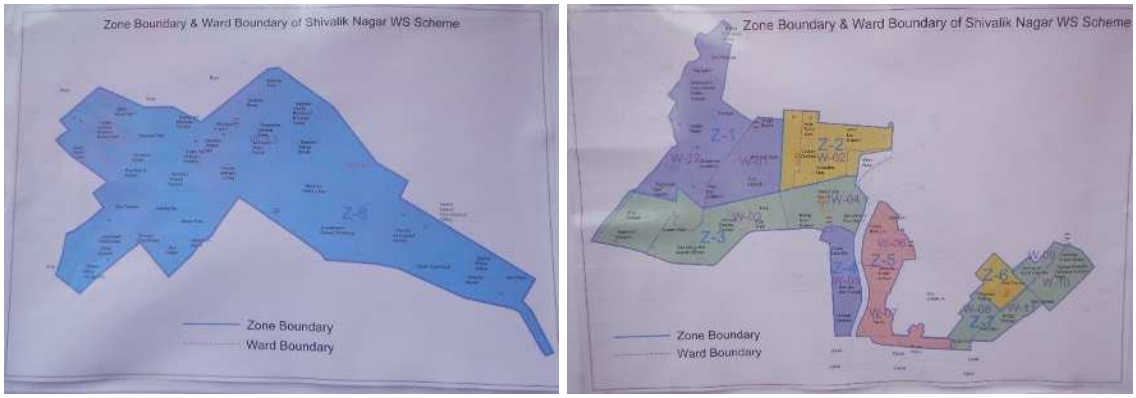
Shivalik Nagar has a population of 33,600 according to the 2011 census, but future population projections predict that the population will be approximately 42,000 in 2021, 54,500 in 2036, and 67,100 in 2051.

Water demand will increase accordingly, and is projected to be 9,000 KL in 2021, 11,600 KL in 2036, and 14,300 KL in 2051.

To meet these increased water demands, the facility plan divides the 13 Wards into 8 zones, each of which will be equipped with intake wells and OHTs.

In addition, the basic concept of the zone split is as follows.

1. Maximize the use of existing water supply facilities.
2. The plan should avoid passing through valley lines whenever possible.
3. Consider limitations such as zone size, existing water supply facility capacity and OHT height.
4. Zone boundaries will be clearly defined and will follow arterial streets and geographic features wherever possible.

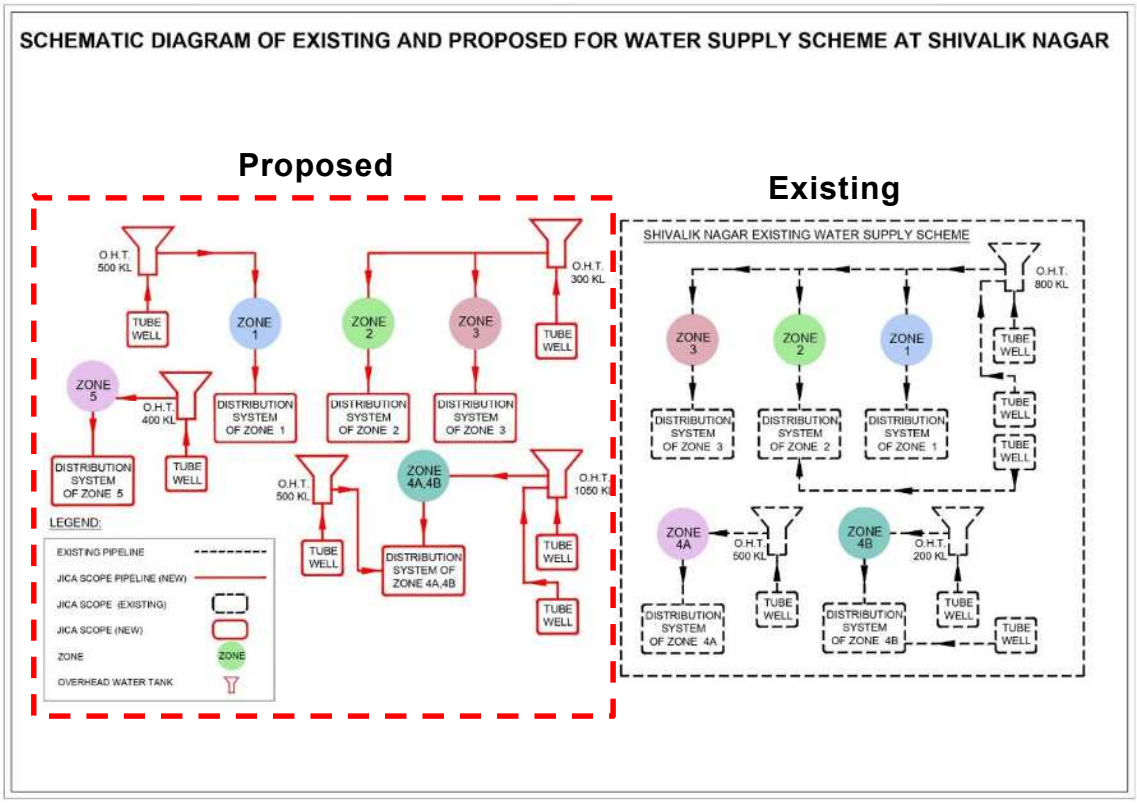


Source: Prepared by JST

Figure 9-3 Town area and water supply zone subdivision plan (Shivalik Nagar)

The new facility plan calls for seven intake wells (10,500 lpm) and five OHTs (3,100 KL) with a capacity for eight hours of maximum daily water supply, with the pumps operating for 16 hours.

The water distribution pipe network has been in operation for more than 30 years and has many leaks, so it was decided to completely reconstruct the network.
According to the DPR, 1,550 m of transmission pipes and 179.6 km of distribution pipes will be installed.



Source: Materials collected by local recommissioning companies

Figure 9-4 Facility plan overview map

(2) Bhagwanpur

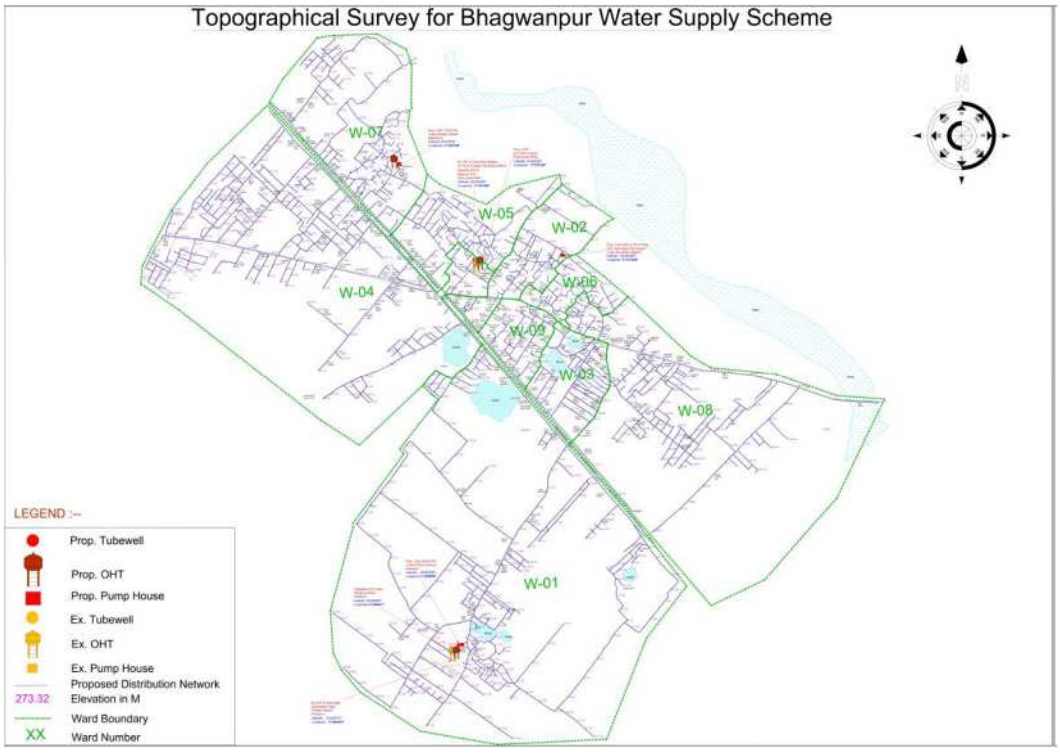
(a) Town Profile

Bhagwanpur is administered by Nagar Panchayat and the project area is within the current Municipal boundaries, with a town area of 577.00 hectares, divided into 9 Wards.

Bhagwanpur is located at 77.484 W longitude and 29.563 N latitude in Haridwar District, 40 km from the district capital of Haridwar and 15 km from Roorkee, the nearest railroad station.

In terms of topography, Old town is relatively elevated, with a ground elevation difference of 3 m, and slopes towards the periphery, resulting in a number of large and small ponds to the east and south of the town.

Bhagwanpur is part of the Tarai Plain Belt and has a tropical climate.



Source: Materials collected by local recommissioning companies

Figure 9-5 Overall view of Bhagwanpur

(b) Existing water supply facilities

Water supply was first introduced in Bhagwanpur in 1983-1984. Since then, no major water supply expansion has been implemented, and the current existing facility capacity is 1 intake well (400 lpm), 2 OHTs (450 KL), and 11.25 km of distribution pipe network.

Water intake wells are typically deep wells, drawing water from the aquifer at a depth of approximately 120 meters. In addition, hand-pump wells have been installed throughout the town to compensate for the lack of water supply, and there are 93 of them.



Source: Prepared by JST

Figure 9-6 Existing intake well and OHT (Bhagwanpur)

(c) Facility plan for the project

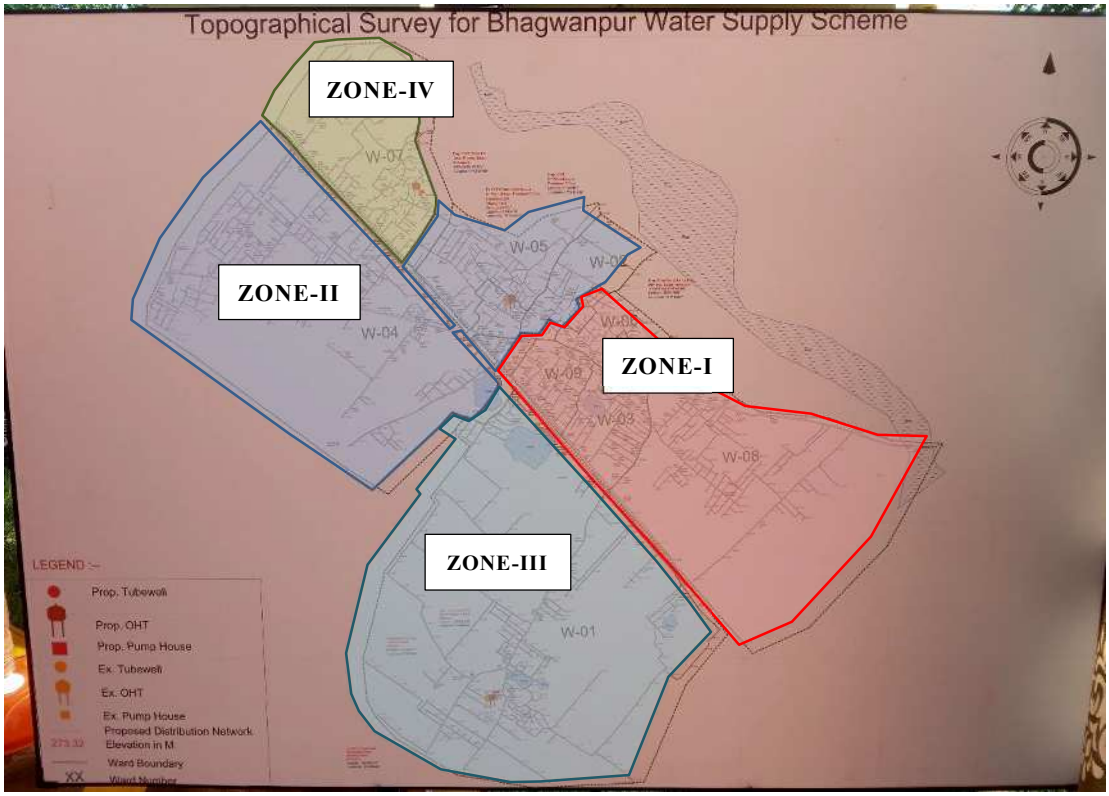
In Bhagwanpur, due to the expansion of the Nagar Panchayat area and population growth, water shortages continue in large parts of the town. The capacity of water distribution reservoirs is less than actually required and some are damaged, rendering them unusable. There is an urgent need to restructure the current water supply system in order to satisfy water demand and supply.

Bhagwanpur's population was 17,179 in the 2011 census, but future population projections predict that the population will be approximately 21,400 in 2021, 29,700 in 2036, and 41,200 in 2051.

Water demand will increase accordingly, and is projected to be 4,400 KL in 2021, 5,800 KL in 2036, and 7,800 KL in 2051.

To meet these increased water demands, the facility plan divides the 9 Wards into 4 zones, with intake wells and OHTs in each zone.
In addition, the basic concept of the zone split is as follows.

1. Maximize the use of existing water supply facilities.
2. The plan should avoid passing through valley lines whenever possible.
3. Consider limitations such as zone size, existing water supply facility capacity and OHT height.
4. Zone boundaries will be clearly defined and will follow arterial streets and geographic features wherever possible.



Source: Prepared by JST

Figure 9-7 Town area and water supply zone subdivision plan (Bhagwanpur)

The new facility plan calls for six intake wells (7,750 lpm) with a pump operating for 16 hours and four OHTs (2,250 KL) with a capacity for eight hours of maximum daily water supply. The water distribution pipe network has been in operation for more than 30 years and has many leaks. It was therefore decided to completely reconstruct the network.
According to the DPR, 1,125 m of transmission pipes and 65.4 km of distribution pipes will be installed.

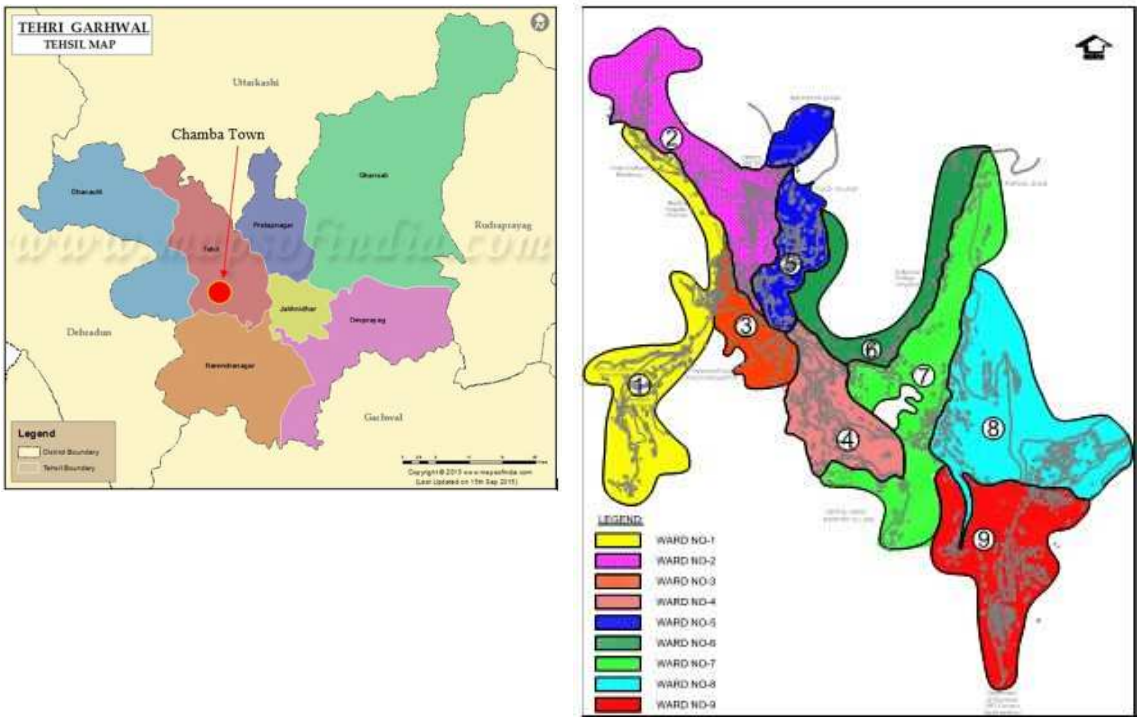
(3) Chamba

(a) Town profile

Chamba is a town in Chamba district at an altitude of 1,006 m. It is famous for its Pahari paintings, handicrafts, textiles, and other arts and crafts from the hill kingdom of North India during the 17th to 19th centuries.

The Char Dham Road project could lead to unprecedented growth through the development of the tourism and hospitality sector.

Chamba consists of 9 Wards and 10 villages.



Source: DPR

Figure 9-8 Chamba location map and area map

(b) Existing water supply facilities

Although the existing water supply system uses surface water as its source, the water supply is only available for one to two hours per day.

In addition, the existing water distribution pipe network is disjointed, the pipe materials are old, and the leakage rate is high, resulting in low water supply coverage and the need for a new distribution pipe network to cover all the developed areas in the project area.

Currently, intake wells, pump stations, valves, and disinfection systems are manually operated and not efficiently maintained in terms of water quantity and energy management.

I. Tap water sources and water treatment facilities

Chamba, as the source river, draws water from Jijli Gadehra and Nagini Gadehra and also feeds the Ranichowri Pumping Water Supply Scheme (RPWSC), which mainly supplies water to the village. Approximately 1.87 MLD of water is being supplied, but as the current demand exceeds approximately 4 MLD, water is currently being supplied on an alternating basis in order to equalize the available water resources.

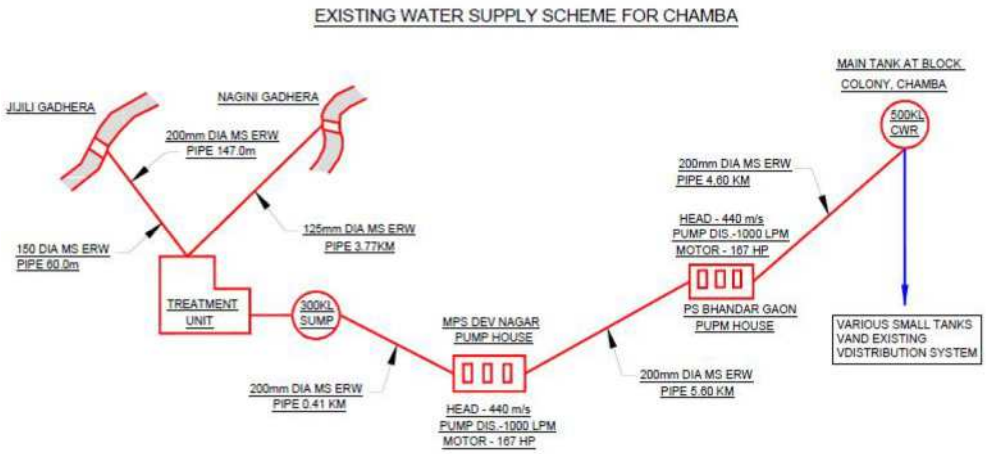
Water taken from Gadehra is treated in a RSF WTP and pumped through the Multi Pumping Scheme (MPS) in DeVnagar to the distribution reservoir.

Currently, Chamba is supplied with 1,200 lpm of clean water, which is quite insufficient for its water needs.

II. Water distribution system

The current water supply is in the range of 40 litres/hour due to the existing Clear Water Reservoirs (CWRs) located throughout the town (10 sites with 3,150 KL) and the associated mutual water distribution system. However, the current status of the water distribution system is mainly as follows:

1. It is developed in fragments and has problems with leakage, scaling, and silt.
2. Water supply to households is intermittent, 3-4 hours per day at most.
3. Water distribution pipes consist mainly of GI pipes, with few Mild Steel pipes.



Source: DPR

Figure 9-9 Schematic diagram of existing water distribution system in Chamba



Source: Prepared by JST

Figure 9-10 Jijli Gadehra and existing WTP

(c) Facility plan for the project

Currently, the main source of drinking water in Chamba is Jijli Gadehra, which also feeds the RPWSC. A recent study conducted by UJS concluded that the existing water sources are not sufficient to meet current and future water demands.

Therefore, the plan is to use the existing system with some modifications to supply water to some villages, and to distribute water to Chamba and nearby villages with a new water supply system.

The population of Chamba was 7,771 according to the 2011 census, but with the completion of the Char Dham Road project, the population of Chamba is expected to increase to approximately 15,400 in 2025, 26,200 in 2040, and 44,600 in 2055, based on future population projections, which assume an increase in tourist and permanent residents.

Water demand is expected to increase accordingly, with a projected demand of 4,700 KL in 2025, 6,700 KL in 2040, and 10,050 KL in 2055.

I. Water source planning

The new water source shall be in the vicinity of Koteshwari Lake, 22 km downstream of Tehri Dam (Existing water sources are also available).

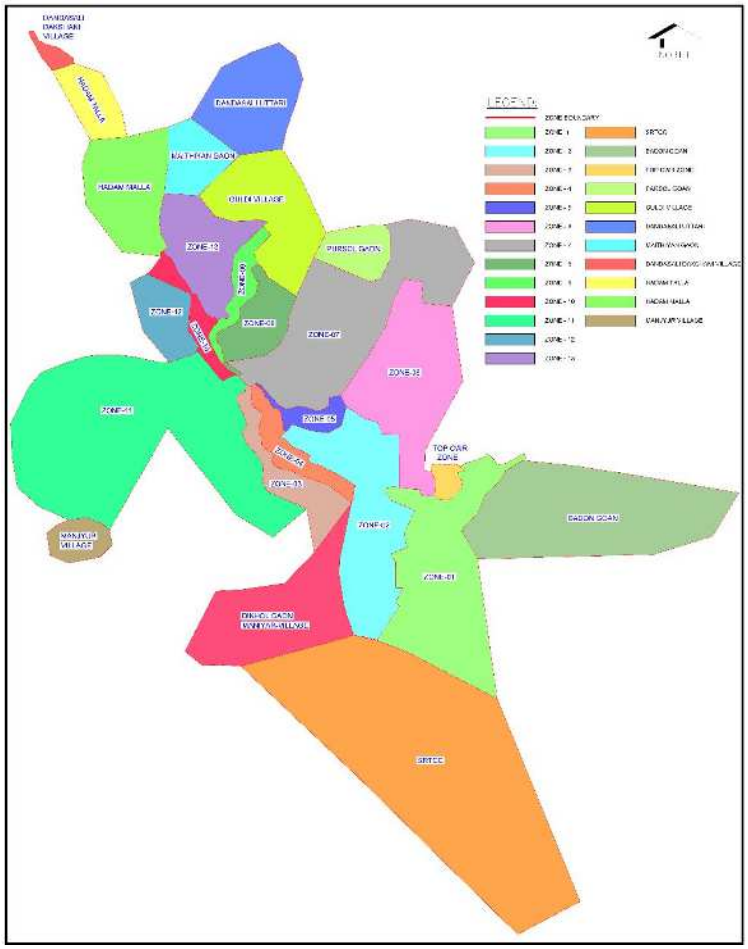


Source: Prepared by JST

Figure 9-11 Existing water source to the village (left) and Tehri dam (right)

II. Water supply area

Chamba's water supply system is divided into 14 zones and 10 neighbourhood villages in Chamba, which are served from primary distribution basins.



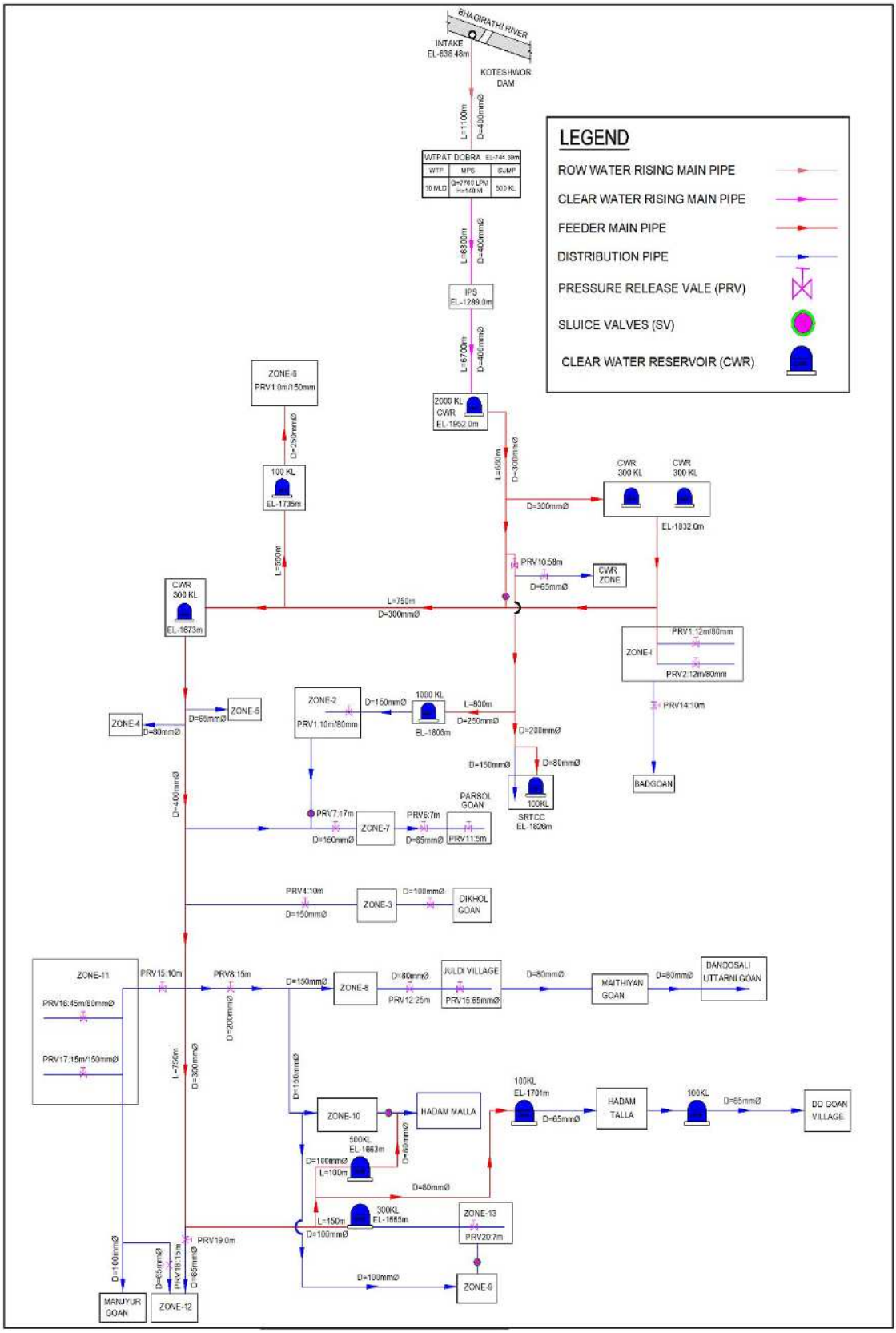
Source: DPR

Figure 9-12 Chamba water supply area plan

III. Facility planning

The proposed facility plan for Chamba is described below.

- New water source (Koteshwar Lake): 7.5 MLD
- New WTP: 10 MLD
- Relay pumping station: 10.05 MLD
- Pumping Pipes: 14.1 km
- New water distribution ponds: 2,000 KL
- Transmission pipes: 7.45 km
- Distribution pipes: 67.6 km



Source: DPR

Figure 9-13 Chamba facility plan map

(4) New Tehri

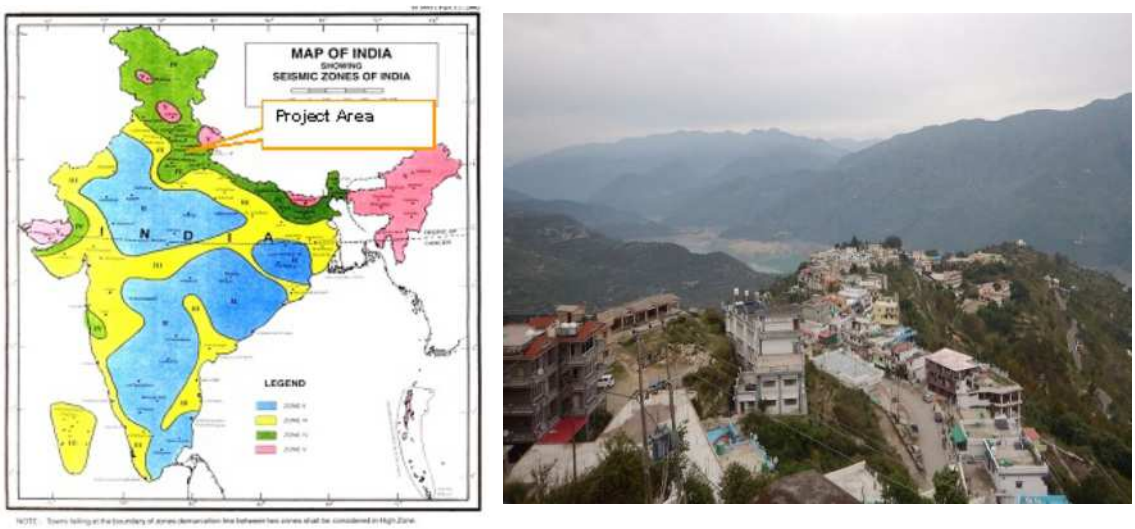
(a) Town profile

New Tehri is a city in Tehri Garhwal district in the UK state and is the administrative capital of Tehri Garhwal district. Consisting of 11 Wards from Vidhi Vihar to Vishwakarma Puram (Koti Colony), New Tehri has a beautiful history.

Originally, the old town of Tehri was located at the confluence of the Bhagirathi and Biranna rivers. However, the construction of the Tehri Dam completely submerged the old town of Tehri, forcing its residents to move to New Tehri at an altitude of 1,750 m. New Tehri is an important stopover on the way to Yamunotri and Gangotri, two of the four char dam pilgrimage sites in the UK state. As such, it attracts tourists interested in temples and pilgrimages, as well as those seeking adventure activities.

New Tehri is approximately 98 km from Dehradun, the capital of the UK state, and 72 km from Rishikesh.

The climate of the region is generally temperate but varies widely from tropical to frigid depending on altitude, and the hilly terrain means that temperatures fluctuate widely.
New Tehri has a cold winter from November to February, with temperatures falling close to freezing; December and January are the coldest months due to winter rains, with snowfall in the neighbouring mountain ranges. Spring, on the other hand, lasts from March to April and is very pleasant, while summer lasts from April to May and July and is not as hot. The monsoon season, especially in July, August and early September, is very humid and the main rainfall occurs during the monsoon season in July and August, up to around 1,700 mm.



Source: Prepared by JST and DPR

Figure 9-14 Location map and view of New Tehri

(b) Existing water supply facilities

The existing water supply system uses surface water as its source, but only supplies 20 LPCD of water per day and only for two to three hours per day.

In addition, the existing water pipeline network is ageing and has a high leakage rate, resulting in low water supply coverage, and a new pipeline network is needed to cover all developed areas in the project area.

The current water supply system consists of a network of several kilometres of distribution pipes, several above-ground distribution reservoirs and a 6.0 MLD WTP (SSF system - current capacity 2.5 MLD), which currently supplies around 2.5 MLD of water. The valves and disinfection system are manually operated and not efficiently maintained in terms of water quantity and energy management.

I. Intake facilities

Currently, New Tehri's water source is Koteshwar Lake from the Tehri reservoir. The water supply system, which comprises an intake facility, a 6 MLD WTP, transmission pipes, intermediate pumping stations, distribution reservoirs and a network of several kilometres of distribution pipes, was constructed in 1996. The current intake capacity is 6 MLD, but due to ageing pumping facilities, less than 3 MLD of water is stored in the distribution reservoirs.

Koteshwar Lake has two intakes, and Intake-1 (6 MLD), which currently supplies water to the Behtogi WTP, is operational, but the water intake is about half of what it should be 3 MLD. On the other hand, Intake-2 at KUND is currently not functioning.



Source: DPR

Figure 9-15 Location of existing water intake facilities



Source: Prepared by JST

Figure 9-16 Intake in operation - 1 (left) and intake (malfunctioned) - 2 (right)

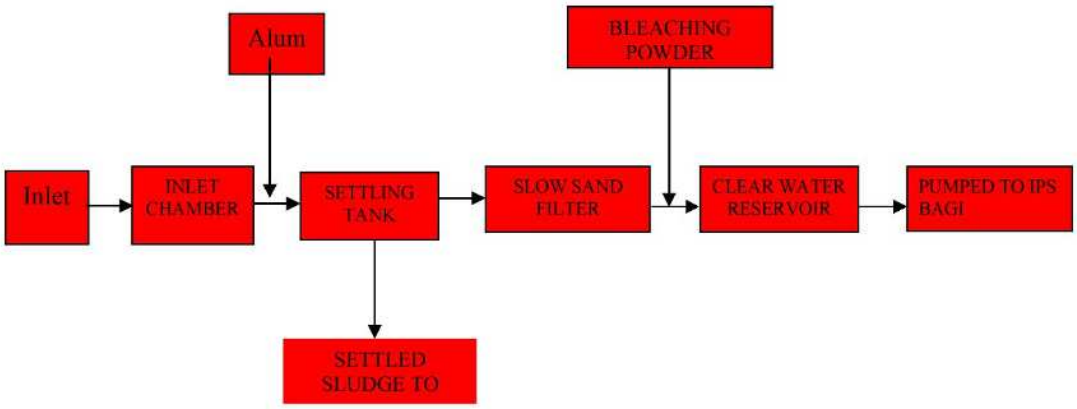
Intake-1 has recently been rehabilitated and a new pump installed. However, Intake-2 requires the following facility plan to ensure sufficient abstraction to meet the water demand.

- ◆ Dismantling of existing pumps at water intakes
- ◆ Modification of existing intake locations
- ◆ Cable re-routing
- ◆ Update existing electrical panels, start-up panels, etc.
- ◆ Re-establishment of conduits between WTP area and water intake area

II. WTP

The WTP in New Tehri is between 20 and 25 years old and needs to be renovated or upgraded as some parts are dilapidated. The water purification capacity was 6.0 MLD at the time of construction, but now the capacity has decreased to 2.78 MLD.

In the water treatment system, raw water is sent to an inlet culvert where it is injected with Alum. The water is then sent through a coagulation sedimentation tank with incline plates to a RSF tank. Bleaching powder is added to the treated water and the treated water is stored in the clear water reservoir and pumped to the intermediate pumping station.



Source: DPR

Figure 9-17 Existing water treatment system flow diagram



Source: Prepared by JST

Figure 9-18 Coagulation sedimentation tank with incline plates (left) and RSF tank (right)

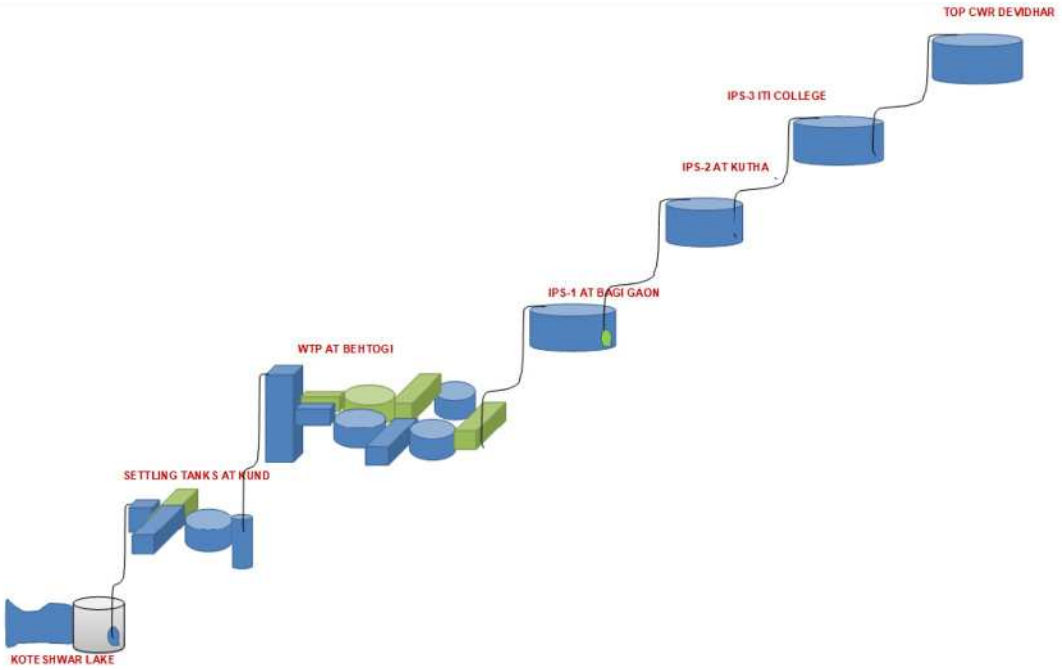
The following are some of the issues facing water treatment facilities, and rehabilitation will be undertaken to address these issues.

- The alum injection system is not suitable
- The filtration sand in slow filtration systems deteriorates and is prone to blockages.
- Chlorination systems not up to standard
- Some valves are not functioning
- No flow meter installed at the treated water outlet

III. Water pumping systems

Currently, approximately 15-16 km of existing pipelines transfer raw and treated water to various distribution reservoirs. These pipelines have problems with leakage and aging, and

the pipe diameters are small in relation to the current water demand. Rehabilitation of these water pipelines is therefore specified in the facility plan.



Source: DPR

Figure 9-19 Existing pump system diagram for New Tehri

IV. Water distribution systems

After passing through the intermediate pumping stations, the treated water is sent to the existing distribution reservoirs in New Tehri and adjacent areas. Currently, there are approximately 28 water distribution reservoirs in New Tehri and adjacent areas with various capacities ranging from 3 KL to 1,000 KL.

The total length of the water distribution pipe network is approximately 50 km, which is regularly reinstalled as necessary. On the other hand, some of them contain many ageing pipelines with problems such as insufficient pipe capacity, leakage and age-related deterioration. Most of the conduits in the existing water distribution pipe network are past their useful life and are mostly GI pipes, with some being Mild Steel pipes.

(c) Facility plan for the project

The existing water supply system in New Tehri and neighbouring villages was first introduced in 1980. Since then, several extensions and improvements have been carried out since 1994, but the system has been developed in an unplanned manner and suffers from the following problems:

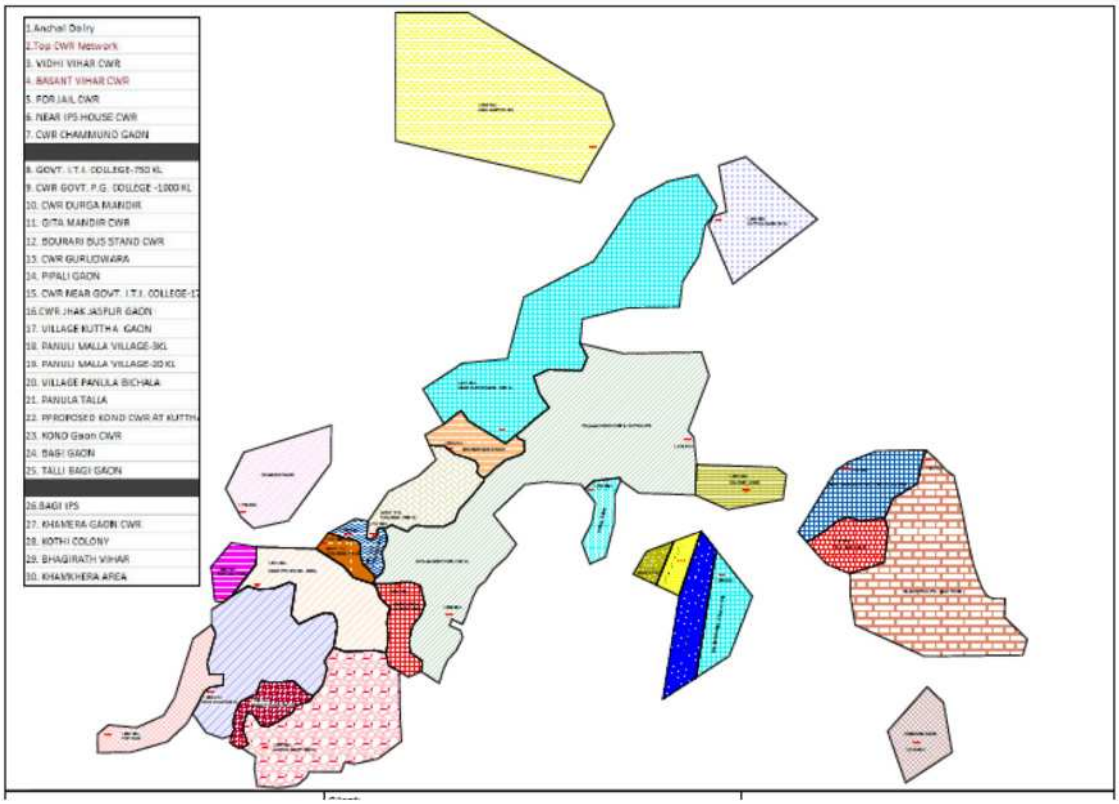
- The ageing existing pumping system (2.78 MLD) makes it difficult for the current water source to supply water to the growing population in the target area.

- The existing pumping system is ageing and has technical problems.
- WTPs are not functioning properly and require refurbishment.
- Water supply is inadequate at 45-50 LPCD, and is only available for 2-3 hours per day.
- The ageing distribution pipe network results in a high amount of non-revenue water due to leakage.

Considering the above challenges and the difficulties faced by local residents to secure the required amount of water for their daily needs, a solid facility plan is necessary and urgent in order to meet the basic needs of the residents to secure water for their daily needs.

The population of New Tehri is 24,014 and 4,334 in the Proximity Village, according to the 2011 census; in 2020, adding the Floating Population and Institutional Population, the population of New Tehri and neighbouring villages are estimated to have a population of 39,241. In future population projections, the population of New Tehri plus the Proximity Villages is projected to be approximately 42,500 in 2025, 53,900 in 2040 and 68,400 in 2055.

Water demand will increase accordingly, and is projected to be 7,820 KL in 2025, 9,920 KL in 2040 and 12,590 KL in 2055.



Source: DPR

Figure 9-20 Water supply area map for New Tehri and neighbouring villages

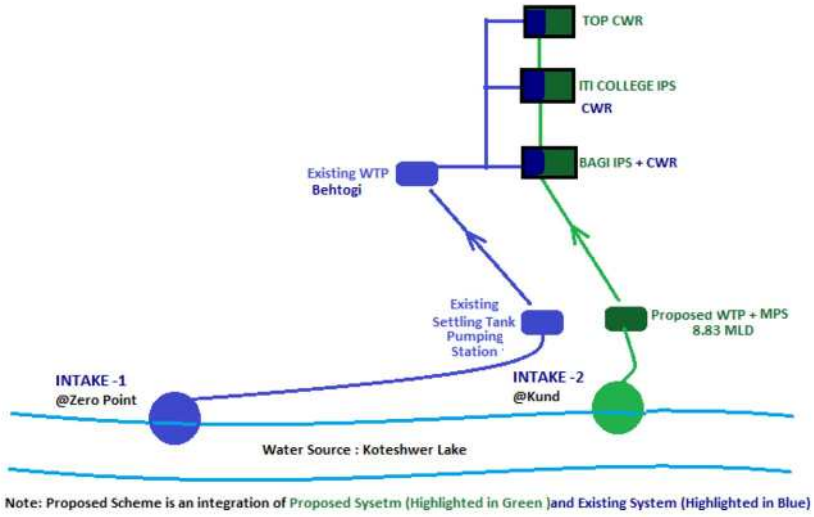
I. Facility planning overview

The proposed facility plan integrates two intake pumping facilities, Intake 1 and Intake 2. The proposed facility plan includes integration of the existing and new systems.

- Identification and development of water sources
- Installation of water treatment facilities
- Installation of water storage facilities
- Maintenance of water distribution pipe network

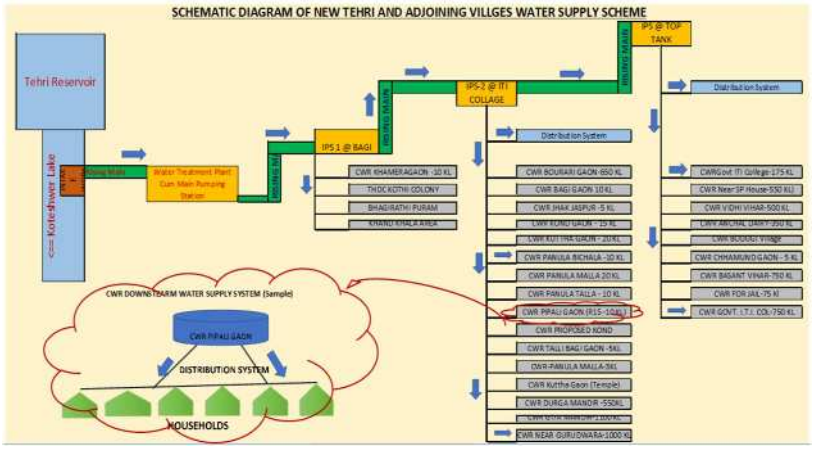
II. Water supply system configuration

The intake is retrofitted to take raw water and convey it to the proposed WTP. The treated water is then pumped to a number of distribution reservoirs cum intermediate pumping stations, and the system distributes the water from the distribution reservoirs to each household in each zone through the network of distribution pipes.



Source: DPR

Figure 9-21 Proposed water supply system configuration diagram



Source: DPR

Figure 9-22 Conceptual diagram of New Tehri and proximity Village water supply systems

III. Facilities planning

The proposed facility plans in New Tehri are described below.

- Water source rehabilitation (Koteshwar Lake): 9.81 MLD
- New WTPs and Multi Pumping Scheme: 8.83 MLD
- Intermediate pumping station: 6.46 MLD (BAGI)
  2.99 MLD (ITI)
- Water pipes: 16.0 km
- New water distribution reservoirs: 3,250 KL
- Transmission pipes: 26.4 km
- Distribution pipes: 102.6 km

(5) Kirtinagar

(a) Town profile

Kirtinagar is a town in Tehri Garhwal in the UK state, located at 30.22°N, 78.76°E and the topography is mountainous with ridges and valleys, with an altitude ranging from 550m to 750 m. Kirtinagar is located 90 km from New Tehri, where the district headquarters is located, and 100 km from Rishikesh, the starting point of the railway, which is currently under construction.



Source: Local recommissioned collection materials

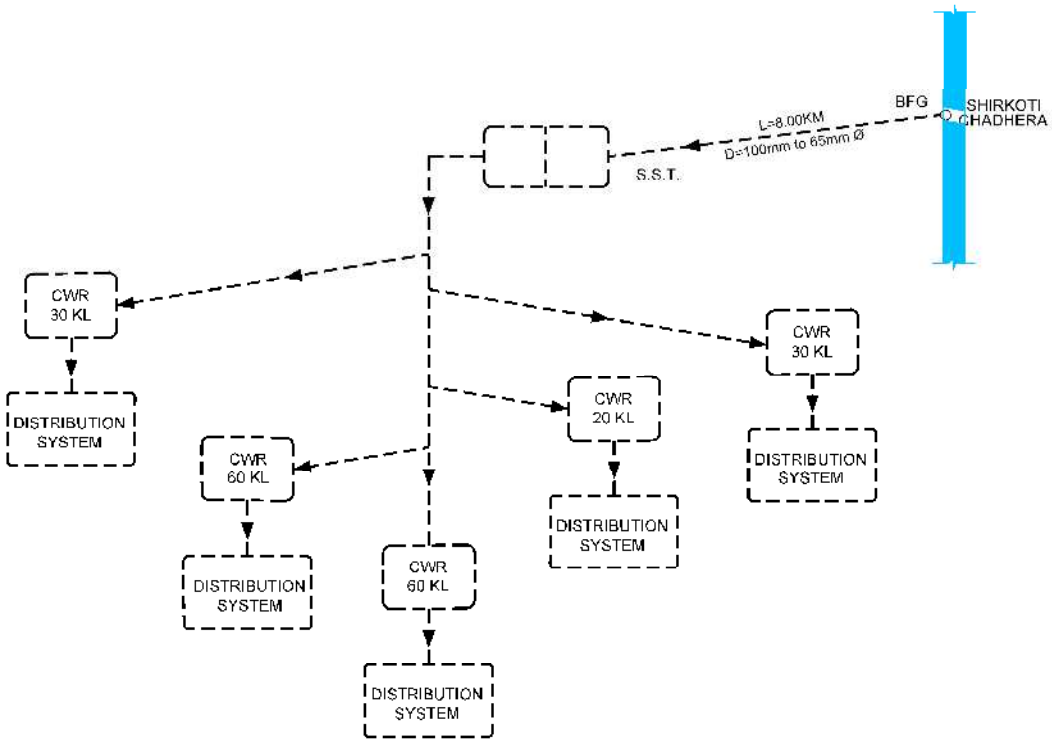
Figure 9-23 View of Kirtinagar

(b) Existing water supply facilities

The water supply system in Kirtinagar, using the Shirkoti Gadhera, which flows near Kirtinagar, as a water source, was built in the 1980s and is about 30-35 years old, thus exceeding its design life in the Indian state.

Kirtinagar is facing water shortages due to the completion of the Chardham National highway, which has led to the construction of many hotels and restaurants along the road, rapid population growth and a decrease in the amount of source water.

The source river is also used for irrigation by farmers, which makes it impossible to ensure sufficient source water supply.



Source: Local recommissioned collection materials

Figure 9-24 Existing water supply system diagram for Kirtinagar

The current existing water supply system is currently being drawn from a temporary pipeline after heavy rains in 2020 caused the mountainside near the source river (Shirkoti Chadhera) to collapse, burying the Boulder Filled Gallery (B.F.G.) located near the source river in the sediment.

Water taken from the gravity flow system goes through a Slow Sand Treatment (S.S.T.) pond and is then sent by gravity flow to a distribution reservoir in the town for distribution to households.



Source: Prepared by JST

Figure 9-25 Collapsed hillside and water source river (left) and temporary intake pipes (right)



Source：Prepared by JST

Figure 9-26 Receiving well (left) and SSF pond (right)

(c) Facility plan for the project

The existing water supply system in Kirtinagar is more than 30 years old and is finding it difficult to meet water demand due to a growing population and a significant decrease in source water quantity. Therefore, there is a need to build a new water supply system with abundant source water quantities.

A potential new water source is the Alaknanda River, which flows near Kirtinagar and has a flow of more than 200,000 litres per minute, which would ensure sufficient source water.

Currently, people living in Kirtinagar are supplied with approximately 30 to 35 LPCD under the existing water supply system, well below the 135 LPCD standard set by the Government of India for urban areas.

With the completion of the Chardham National Highway, the number of hotels and restaurants is increasing rapidly, and new water systems are required.
For the water supply area, the facility plan divides Kirtinagar into seven zones for water distribution.

The population of Kirtinagar was 2,517 according to the 2011 census. In future population projections, taking into account the Floating Population and other factors, the population is expected to be approximately 4,950 in 2023, 6,600 in 2038 and 8,000 in 2053.

Water demand is expected to increase accordingly, with a projected demand of 845 KL in 2023, 1,125 KL in 2038 and 1,370 KL in 2053.

I. Intake facilities

The intake river is the Alaknanda River, located 1.5 km from Kirtinagar town headquarters. The water source is planned to be an intake tower with a diameter of 6.0 m and a height of 24.0 m. The pump room is planned to be located above the intake well, with a footbridge 2.0 m wide and 20.0 m long on the approach.



Source: Prepared by JST

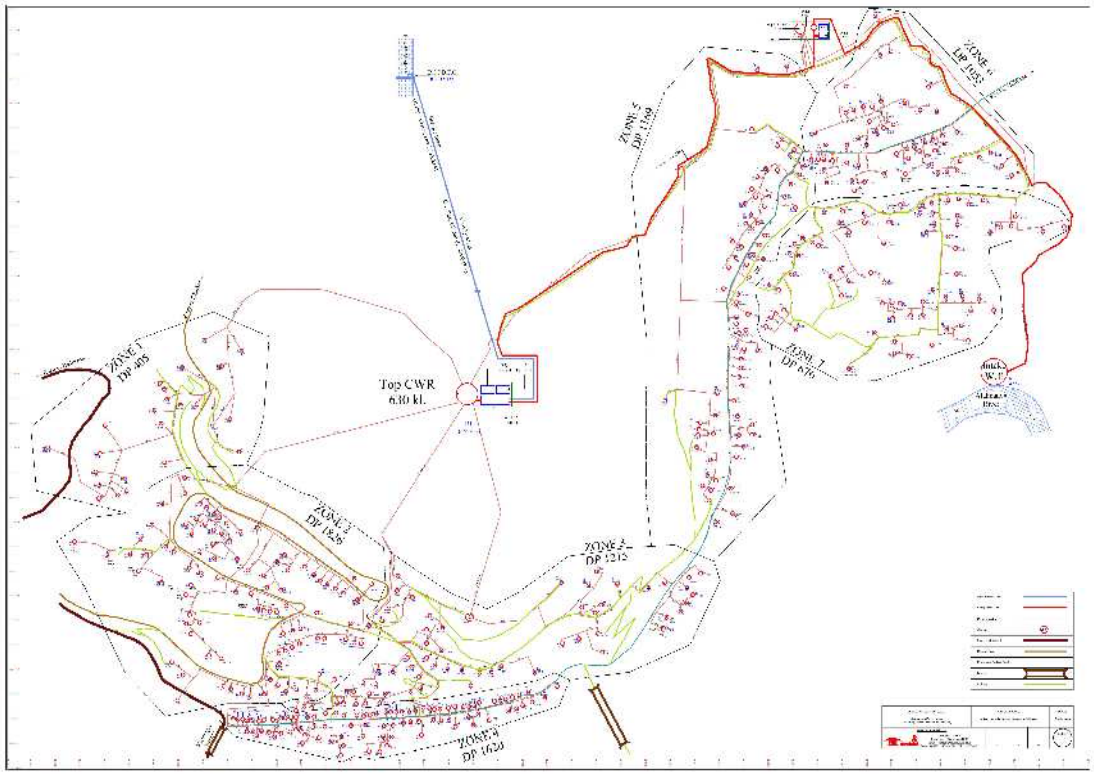
Figure 9-27 Alakanda River as a new water source

II. WTPs

A 2.10 MLD WTP is planned, consisting of a sedimentation pond, a coagulation sedimentation pond and an RSF pond. For effective operation and maintenance, it consists of two 1.05 MLD units.

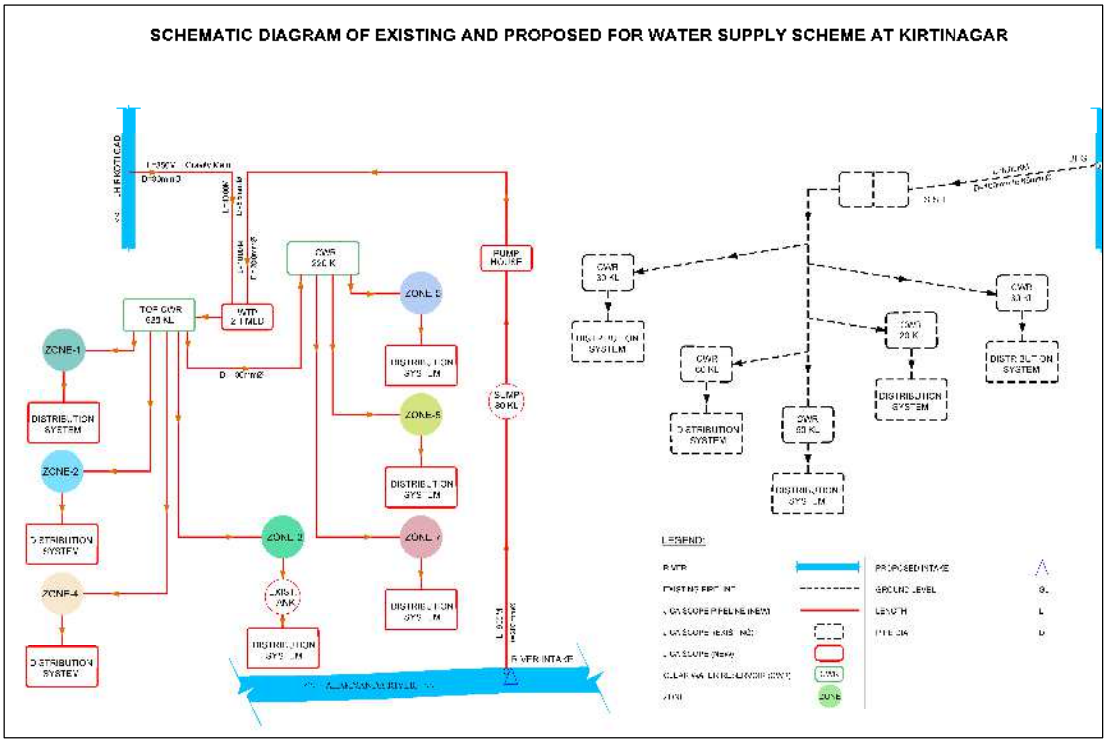
III. Water distribution facilities

For the distribution reservoirs, a 630 KL reservoir is located at the highest ground level as a 12-hour capacity for the maximum daily water distribution, and a 220 KL reservoir is located in part of the Zone.
It is also planned to construct 80 KL as pump wells at the intermediate pumping station.
For water pipes, a total length of 1.9 km is planned.



Source: Local recommissioned collection materials

Figure 9-28 Water supply system planning diagram (Kirtinagar)



Source: Local recommissioned collection materials

Figure 9-29 Comparative diagram of existing and new water supply systems (Kirtinagar)

(6) Tharali

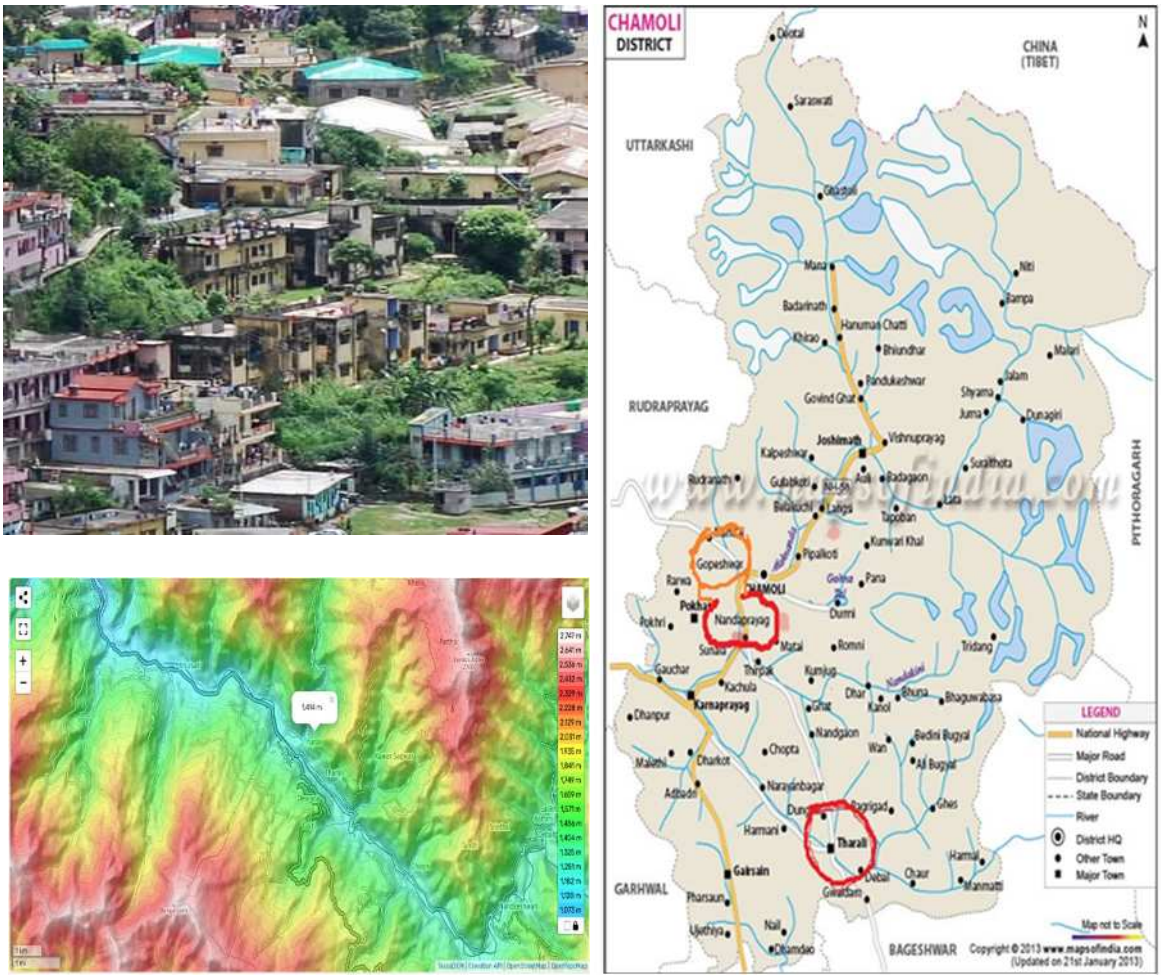
(a) Town profile

Tharali is located at 79°30'24.73" longitude and 30°4' 2.79" latitude and ranges in altitude from about 1,500.00 m to 2,395.00 m. The terrain is undulating and hilly. It is 219 km from Rishikesh, which is currently the base of a railway under construction.

The climate is tropical, with May and June being the driest months, and the rainy season usually running from July to September.

The area is significantly underdeveloped and has only partial facilities for safe drinking water. People's main occupation is agriculture, with a small number serving in the armed forces or other government services.

Lack of social and economic facilities means that even civil servants tend to migrate to larger towns. Farmers depend on rainfall for irrigation, which makes agriculture uneconomic in this area where rainfall is scarce and crop yields low. The economic situation of most of the inhabitants is poor, and women have to travel long distances to fetch drinking water, which requires a lot of labour.



Source: DPR and Local recommissioned collection materials

Figure 9-30 Location map and view of Tharali

(b) Existing water supply facilities

The existing water supply system in Tharali was constructed in 1986 and is approximately 33 years old, exceeding its design life. The existing water system supplies 40 LPCD, well below the standard of 135 LPCD set by the Government of India for urban areas.

The existing water distribution pipe network is damaged or burst in places, affecting water quality. In summer, drinking water is supplied by water trucks by UJS and the local administration, but the water supply is inadequate.

A number of hand-pumped wells have been installed in the town to compensate for the lack of water supply.

In the current water supply system, spring water is collected, piped in for gravity flow, chlorinated in distribution reservoirs and then distributed to households.



Source: Prepared by JST

Figure 9-31 Spring water source (left) and hand-pumps in the town (right)

(c) Facility plan for the project

Tharali is developing rapidly with the construction of new settlements, universities and hotels, and the population continues to grow. The current water supply is 35-40 LPCD and the current water requirement is 2.57 MLD.

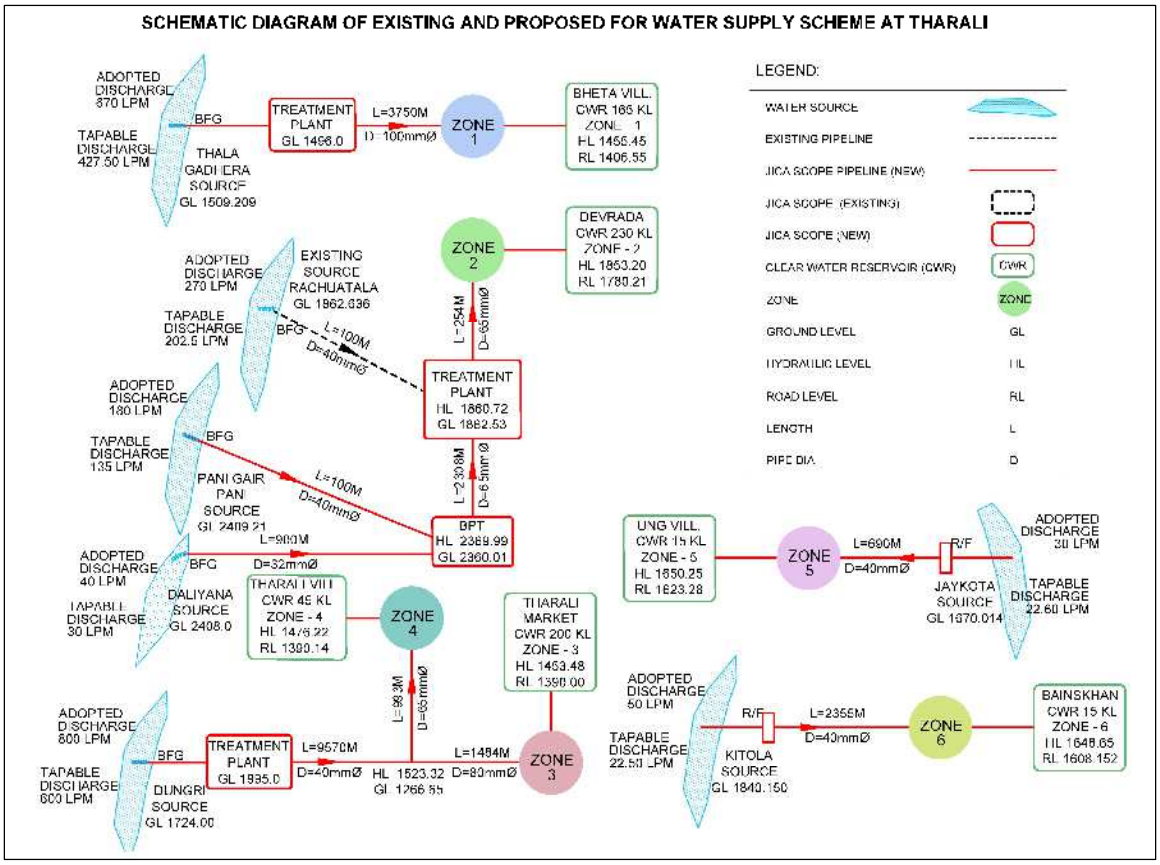
For the water supply area, the facility plan divides Tharali into six zones for water distribution.

The population of Tharali was 4,649 according to the 2011 census. In future population projections, taking into account the Floating Population and other factors, the population is expected to be approximately 6,100 in 2025, 7,400 in 2040 and 8,600 in 2055.

Water demand will increase accordingly, and is projected to be 1,600 KL in 2025, 1,810 KL in 2040 and 2,100 KL in 2055.

The proposed facility plans in Tharali are described below:

- New water sources 2 (B.F.G)
- New WTPs: 3
- Pressure reduction tank: 1
- Water pipes: 21.6km
- New water distribution ponds: 1,660KL
- Water distribution pipes: 47.4km



Source: Local recommissioned collection materials

Figure 9-32 Water supply system planning diagram (Tharali)

9.3.2 Longlist facility plan details

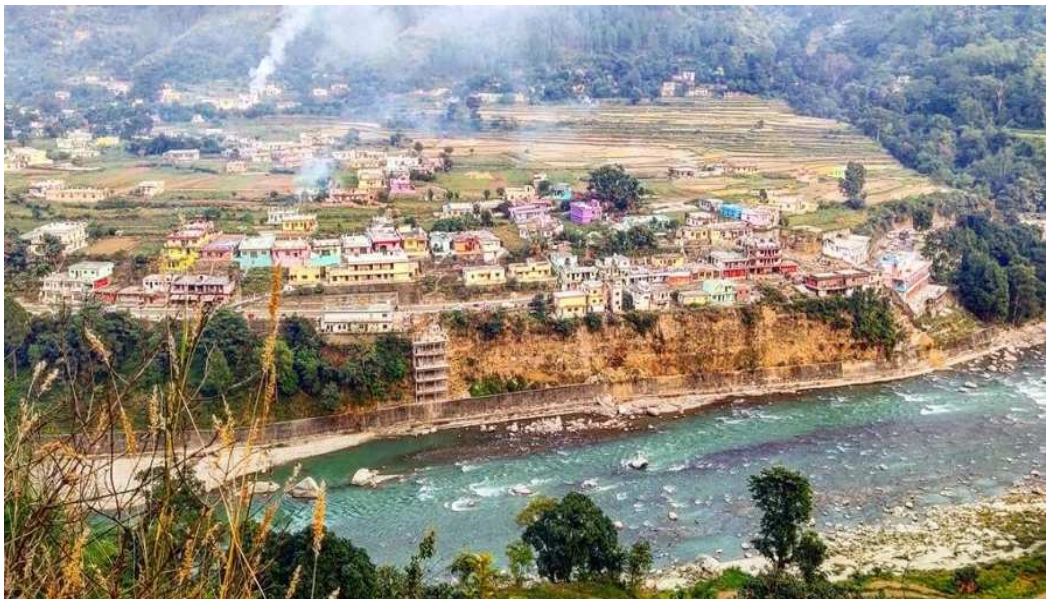
(1) Tilwara

(a) Town Profile

Tilwara is located at latitude 30°25'36"N and longitude 78°55'7"E, with an elevation ranging from 700m to 1,150m. The town center locates at an elevation of 848m and is situated on gentle hills sloping from north to south.

It is located 150km away from the central railway station in Rishikesh and can be accessed by vehicles via the Rishikesh-Rudraprayag-Gaurikund road.

The climate of Tilwara is tropical, with May and June being the dry season, and July to September experiencing the monsoon. While agriculture is the main industry, recent insufficient rainfall during the monsoon has led to decreased crop yields, resulting in economic hardship.



Source: Local recommissioned collection materials

Figure 9-33 View of Tilwara

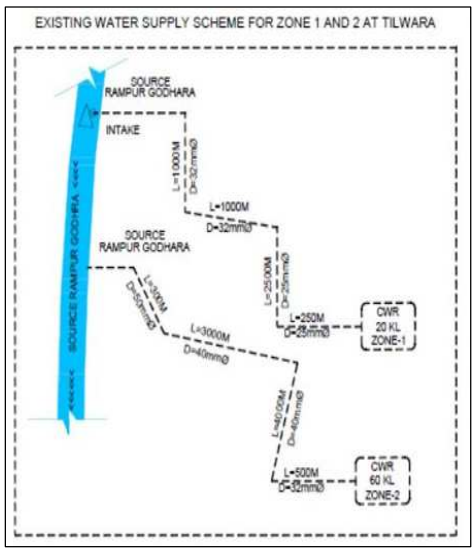
(b) Existing water supply facilities

The existing water supply system in Tilwara was constructed in 1986 and has been in operation for approximately 33 years, exceeding the design service life specified by the Indian government.

Maintenance of the existing water supply system is managed by Uttarakhand Jal Sansthan Rudraprayag. However, due to aging infrastructure, the existing water pipes have experienced damages and leaks, leading to the need for water tankers to supply drinking water during periods of water scarcity, particularly in the summer months.

The capacity of the water supply facility is currently only 0.134MLD (40LPCD) compared to the projected water demand of 2.0MLD by the year 2055.

Presently, the duration of water supply is approximately 2 hours per day, with water supplied to the town on alternate days.



Source : DPR

Figure 9-34 Existing water supply system diagram for Tilwara

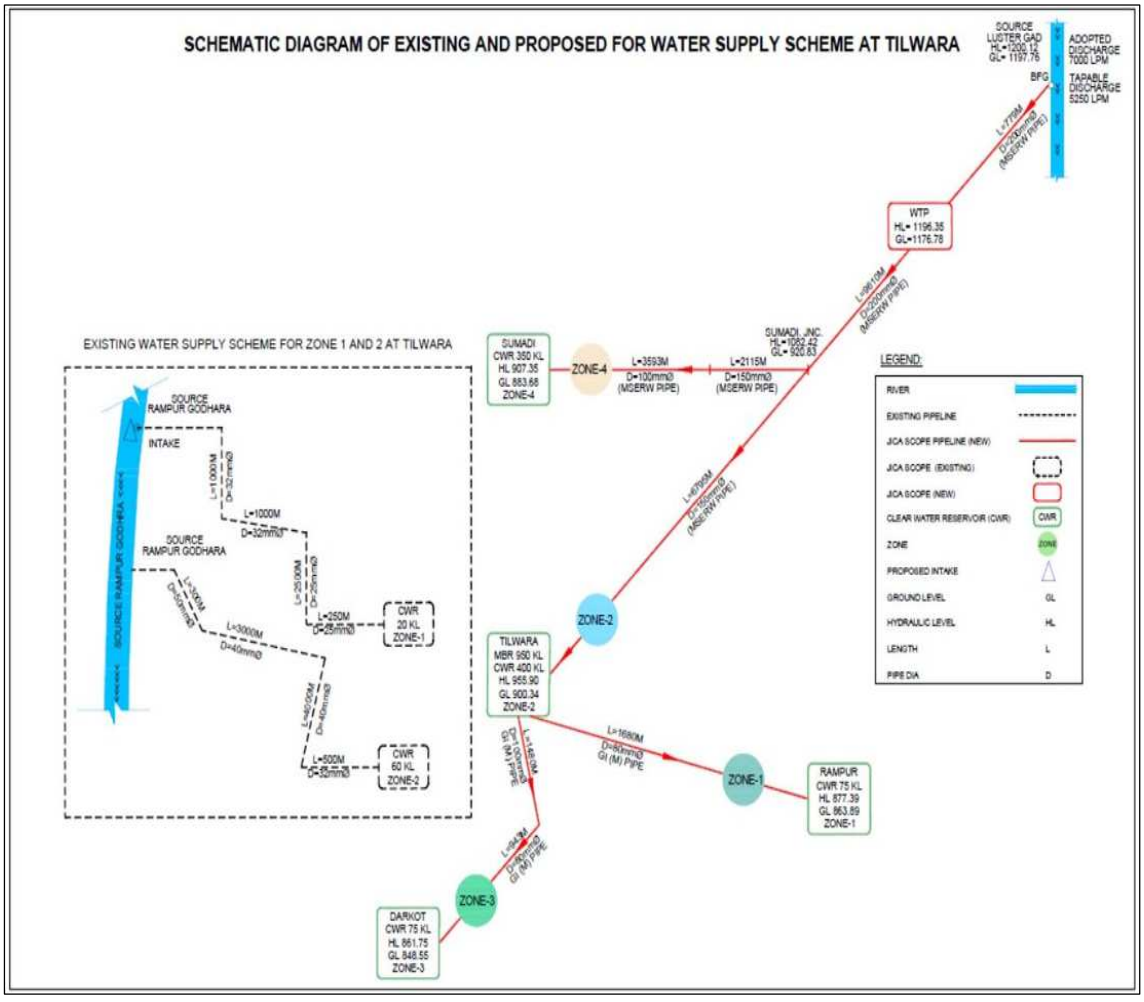
(c) Facility plan for the project

The Nagar Panchayat was established in Tilwara in 2012-2013. Situated on the Chardham Yatra Marg, Tilwara has witnessed the construction of new settlements, universities, and hotels, leading to a surge in population and an increased water demand from 40LPCD to 135LPCD. Consequently, the urban area is expected to have 24-hour water supply.

The proposed project includes the construction of an intake from surface water and a water treatment plant, with Lastar Gadhera identified as the water source. Besides Lastar Gadhera, there are no other suitable water sources available in Tilwara. Local survey results indicate that Lastar Gadhera has sufficient water volume, making it the optimal water source.

Additionally, to utilize this water source effectively, the construction of one B.F.G is proposed.

The proposed water treatment method involves coagulation sedimentation followed by rapid filtration, with a treatment capacity of 2.0MLD.



Source: DPR

Figure 9-35 Proposed water supply system configuration diagram



Source: Prepared by JST

Figure 9-36 New water source river (left) and proposed site for WTP (right)

(2) Rudraprayag

(a) Town Profile

Rudraprayag is located in the Rudraprayag District, at a latitude of 30.28 degrees north and a longitude of 78.98 degrees east, with an average elevation of 895 meters. Situated at the confluence of the Alaknanda River and the Mandakini River, it is one of the five confluences of the Alaknanda River known as Panch Prayag.

The main exports of Rudraprayag include herbs, wooden products, and woollen goods.



Source: Local recommissioned collection materials

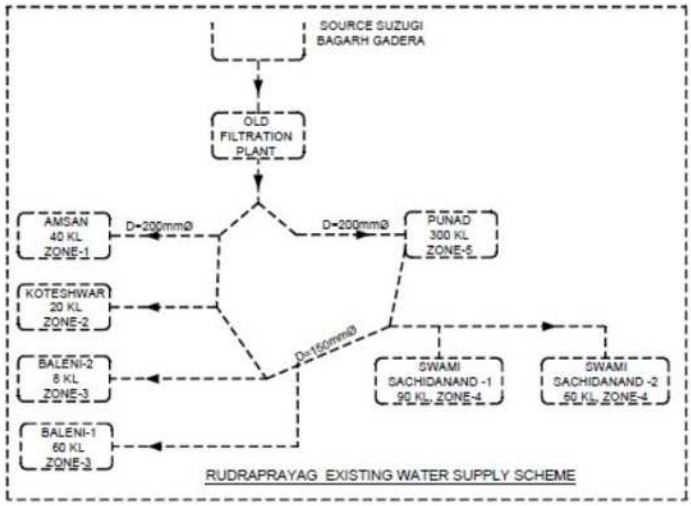
Figure 9-37 View of Rudraprayag

(b) Existing water supply facilities

The existing water supply system in Rudraprayag was constructed in 1975, and it has been approximately 45 years since its establishment, exceeding the designated service life in India.

The current supply volume ranges from 35 to 40 LPCD, with the supply capacity provided by the existing water supply system being 1.73 MLD. However, the current water demand stands at 6.18 MLD, indicating a significant deficit in supply volume.

Presently, the water supply duration is approximately 1 to 2 hours per day, with the state experiencing 3 to 4 days of water supply per week. Particularly during the summer and the Chardham Yatra festival, water scarcity is exacerbated due to decreased water availability from the water sources, necessitating the use of water tankers for drinking water supply. The existing water supply pipes have deteriorated over time, leading to damages and leaks at various points.



Source: Local recommissioned collection materials

Figure 9-38 Existing water supply system diagram for Rudraprayag

(c) Facility plan for the project

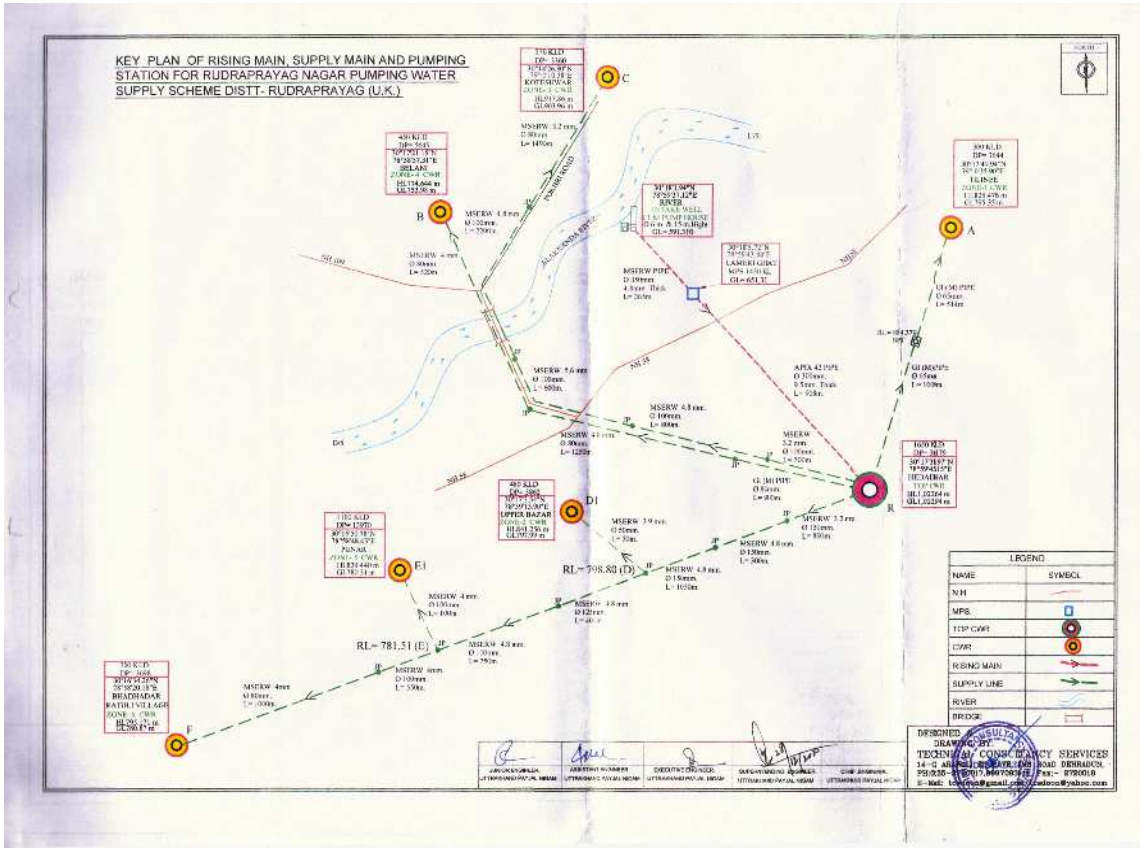
Rudraprayag is located on the Chardham Yatra Marg and has seen rapid development with the establishment of new settlements, universities, hotels, and other facilities, leading to a steady increase in population.

With the water demand increasing from 40 LPCD to 135 LPCD, the urban area is expected to transition to 24-hour water supply.

As part of this project, surface water intake and construction of a water treatment plant are proposed, utilizing the Alaknanda River as the water source.

Key water infrastructure includes an intake structure comprising a 6-meter diameter well and three intake pumps, while the water treatment plant adopts a conventional coagulation-sedimentation plus rapid filtration process, with a treatment capacity of 6.23 MLD.

Apart from the Alaknanda River, there are no other viable water sources available in the vicinity of Rudraprayag, and the water volume from the Alaknanda River is deemed sufficient compared to the water demand.



Source: Local recommissioned collection materials

Figure 9-39 Schematic diagram of the proposed water supply system



Source: Prepared by JST

Figure 9-40 Proposed River for Water Extraction (Left) and Planned Site for Intake Facility Construction (Right)

(3) Gairsain

(a) Town Profile

Gairsain is a town situated in the expansive Dudhatoli mountain range, located on the eastern slope, ranging from an average altitude of 1550m to 2350m, almost in the center of the Kumaon and Garhwal regions of UK state. It lies near the left bank of the Ramganga River, oriented in the north-northeast direction, between latitude 30°5'11" to 30°2'48" north and longitude 79°17'3" to 79°18'12" east.

The annual average temperature is around 15°C, with summer highs reaching around 26°C. The period from April to June marks the dry season, while July to September is the rainy season.

As the summer capital, Gairsain hosts numerous government offices, schools, and accommodations. The primary occupations of its residents include hospitality and government-related work, with many engaged in agriculture, horticulture, and animal husbandry in the surrounding rural areas. Wheat and maize are the main crops cultivated.

Moreover, Gairsain holds significant historical and cultural importance, known for its association with the Chamoli region's historical and mythological narratives. This rich heritage attracts migrants from rural hilly areas seeking better facilities, education, and healthcare, leading to a rapid increase in population.



Source: DPR

Figure 9-41 Gairsain and the state capital in summer (right)

(b) Existing water supply facilities

In Gairsain, there is an existing water supply system utilizing natural gravity-fed sources. However, these sources are significantly affected by climate change, resulting in a substantial decrease in water availability during the dry summer season.

Currently, the water supply volume is around 30 to 40 LPCD, with supply hours limited to approximately 1 to 2 hours per day, usually provided only in the morning and evening.

Additionally, the aging pipeline network of the existing water supply system exacerbates the situation. From February to mid-July, the available drinking water quantity rapidly diminishes, necessitating the use of water tankers for supply, albeit insufficiently meeting the demand.

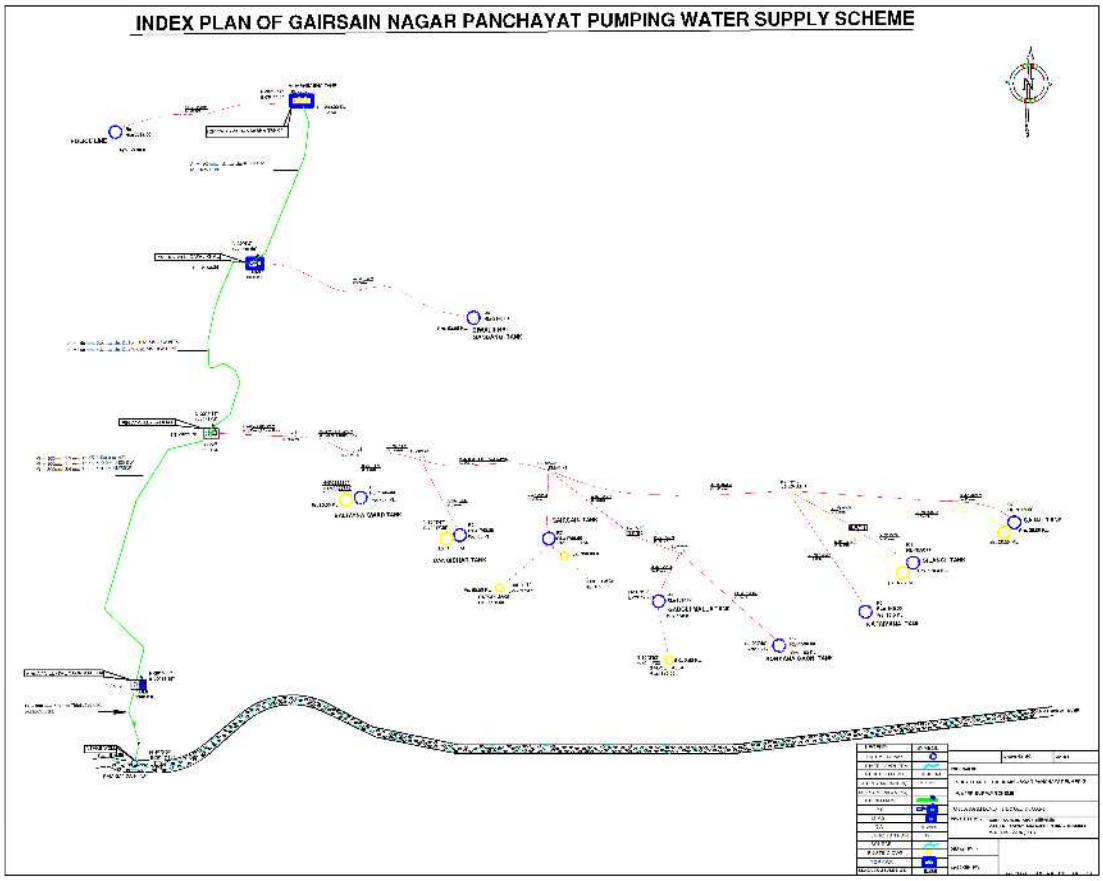
(c) Facility plan for the project

In this project plan, the area is divided into two regions: the right bank and the left bank of the Ramganga River. The Rikholi village (Zone-9) on the right bank of the Ramganga River will utilize the Kumdhoan Gadhera as its water source, while the main areas on the left bank of the Ramganga River (Zone-1 to 8) will rely on the Ramganga Reservoir as their water source.

The Ramganga Reservoir is planned to be constructed by the Irrigation Department with a storage capacity of 7 MLD.

Boulder Filled Gallery (B.F.G) structures, measuring 4 meters in width and 2 meters in height, will be installed at both the Kumdhoan Gadhera and the Ramganga Reservoir. Additionally, the Ramganga Reservoir will have an 8-meter diameter intake well and three pumping units installed to transmit water to the newly constructed water treatment plant.

Regarding water treatment, the Kumdhoan Gadhera, known for its consistently clean water quality throughout the year, will undergo only coarse filtration. On the other hand, due to higher turbidity during the monsoon season, the water from the Ramganga Reservoir will undergo a two-stage sedimentation process along with rapid filtration to ensure water quality after treatment.



Source: DPR

Figure 9-42 Gairsain water supply system diagram

(4) Bageshwar

(a) Town Profile

Bageshwar is located at approximately 29°50'12.89" North latitude and 79°46'20.51" East longitude, with an average elevation of 900 meters.

Situated in the eastern part of the Kumaon region in the UK state, Bageshwar district shares its borders with Chamoli district to the northwest, Pithoragarh district to the northeast, and Almora district to the south.

Bounded by the Baijnath and Nileshwar mountains to the east and west respectively, Bageshwar is surrounded by the Suraj Kund to the north and the Agni Kund to the south. This area holds significant religious, historical, and political importance.



Source: DPR and local recommissioned collection materials

Figure 9-43 Topographic map of Bageshwar and view of the city (right)

(b) Existing water supply facilities

Regarding the existing water supply system in Bageshwar, the sources include deep wells, shallow wells along the Saryu River, and several Gadheras. Water is either naturally flowing or pumped into distribution reservoirs and then supplied to households through a network of distribution pipes.

Additionally, the existing water treatment plants follow a conventional method of coagulation followed by rapid filtration.

However, each water facility and distribution pipeline has deteriorated over time. Currently, water supply is limited to 1-2 hours per day on alternate days, resulting in inadequate water distribution to residents.



Source: Prepared by JST

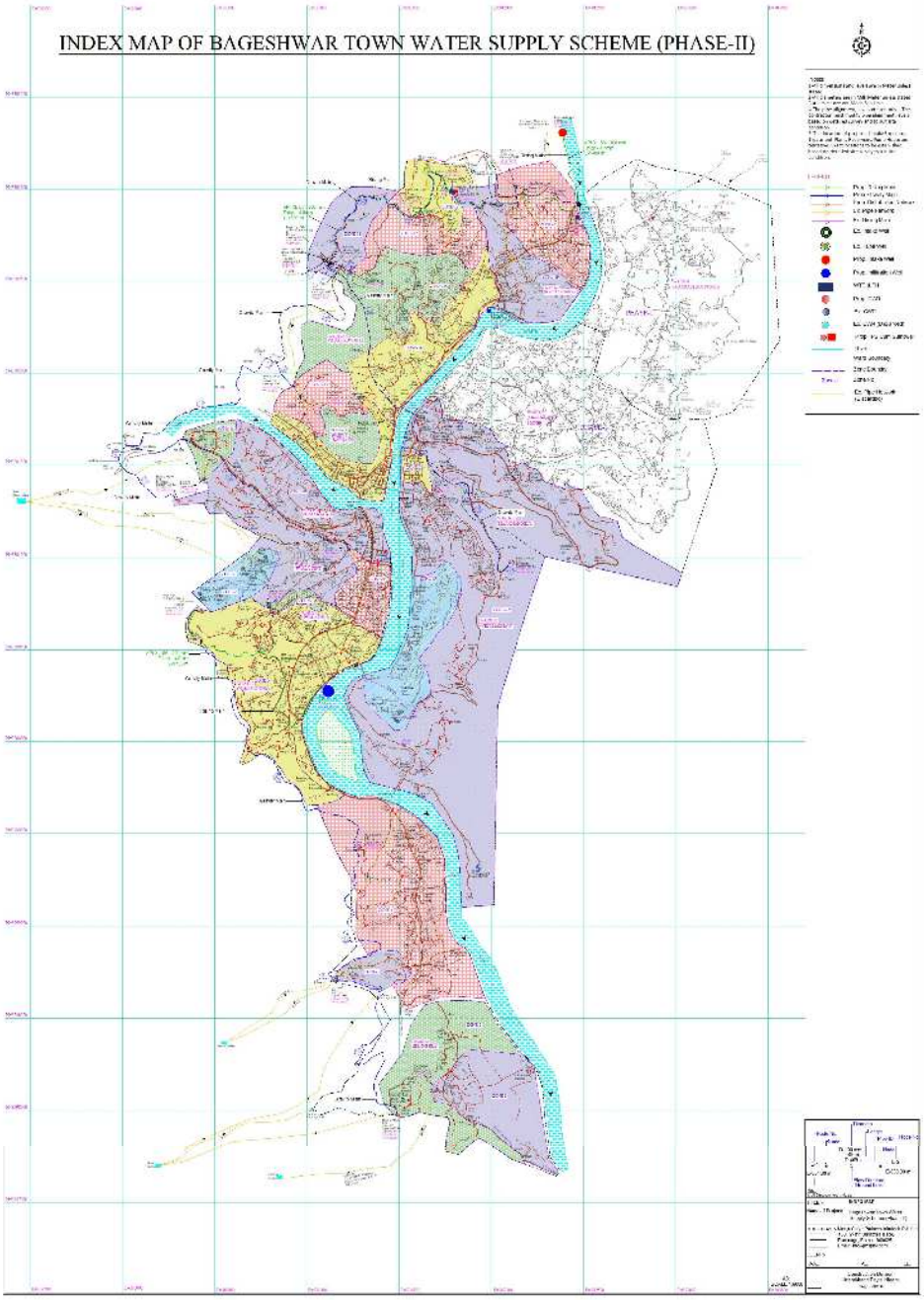
Figure 9-44 Existing water intake tower and the Saryu River (left) and existing WTP (right)

(c) Facility plan for the project

The facility plan for Bageshwar is categorized into Phase I and Phase II, with the "Bageshwar Town Water Supply Scheme (Phase-II)" covering all 11 zones except zones 8 and 9.

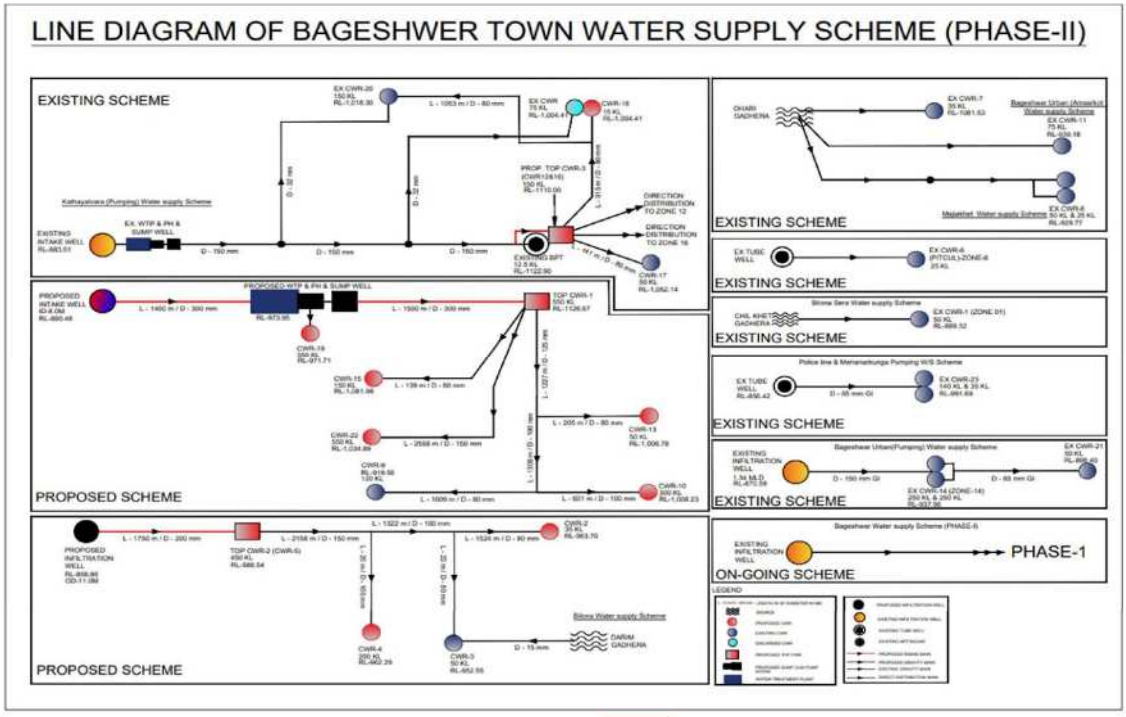
As for the water source, new intake wells will be established in the Saryu River to meet future water demands, while existing intake facilities will be utilized for other water sources.

For the water treatment plant, a conventional sedimentation and rapid filtration system with a treatment capacity of 7MLD is proposed.



Source: DPR

Figure 9-45 Business plan diagram of Bageshwar



Source: DPR

Figure 9-46 Schematic diagram for Project Plan

(5) Berinag

(a) Town Profile

Berinag is located in the district of Pithoragarh, Uttarakhand, at a distance of 124 km from the city of Pithoragarh, which lies at the easternmost tip of the state. Positioned at approximately 29.80 degrees north latitude and 80.07 degrees east longitude, Berinag boasts an average elevation of 1,895 meters.

Situated 460 km northeast of the capital city New Delhi and 443 km southeast of the state capital Dehradun, Berinag is part of the Kumaon division and lies approximately 160 km northeast of Nainital, the headquarters of the Kumaon division.

Nestled amidst the Kumaon hills of the central Himalayas, Berinag has emerged as a hub for tourism and commerce. Over the past decade, the town has witnessed a rapid increase in population, owing to the presence of pilgrimage sites, educational institutions, hospitals, and local markets.



Source: Local recommissioner collection materials

Figure 9-47 View of Berinag

(b) Existing water supply facilities

Berinag's water supply is provided by the Berinag Pumping Water Supply Scheme, with the primary water source being surface water from the Gweer Ghatiya Gadhera in the Ramganga River basin.

This Water Supply Scheme reached the end of its design life in 2009, and the aging of the water supply facilities is progressing.

Currently, water is supplied for approximately 3 hours per day, with households receiving water on alternate days, every three days.

Additionally, the Scheme was initially designed to supply Berinag town at a rate of 49 LPCD. Considering a future water supply rate of 135 LPCD, there is a significant gap in the capacity of the water supply facilities, necessitating improvements to the water supply infrastructure.



Source: Local recommissioner collection materials

Figure 9-48 Intake river (left) and existing WTP (right)

(c) Facility plan for the project

In the Bering facility plan, a shallow well with a diameter of 16.0 meters will be constructed on the right bank of the Ramganga River to serve as the water source.

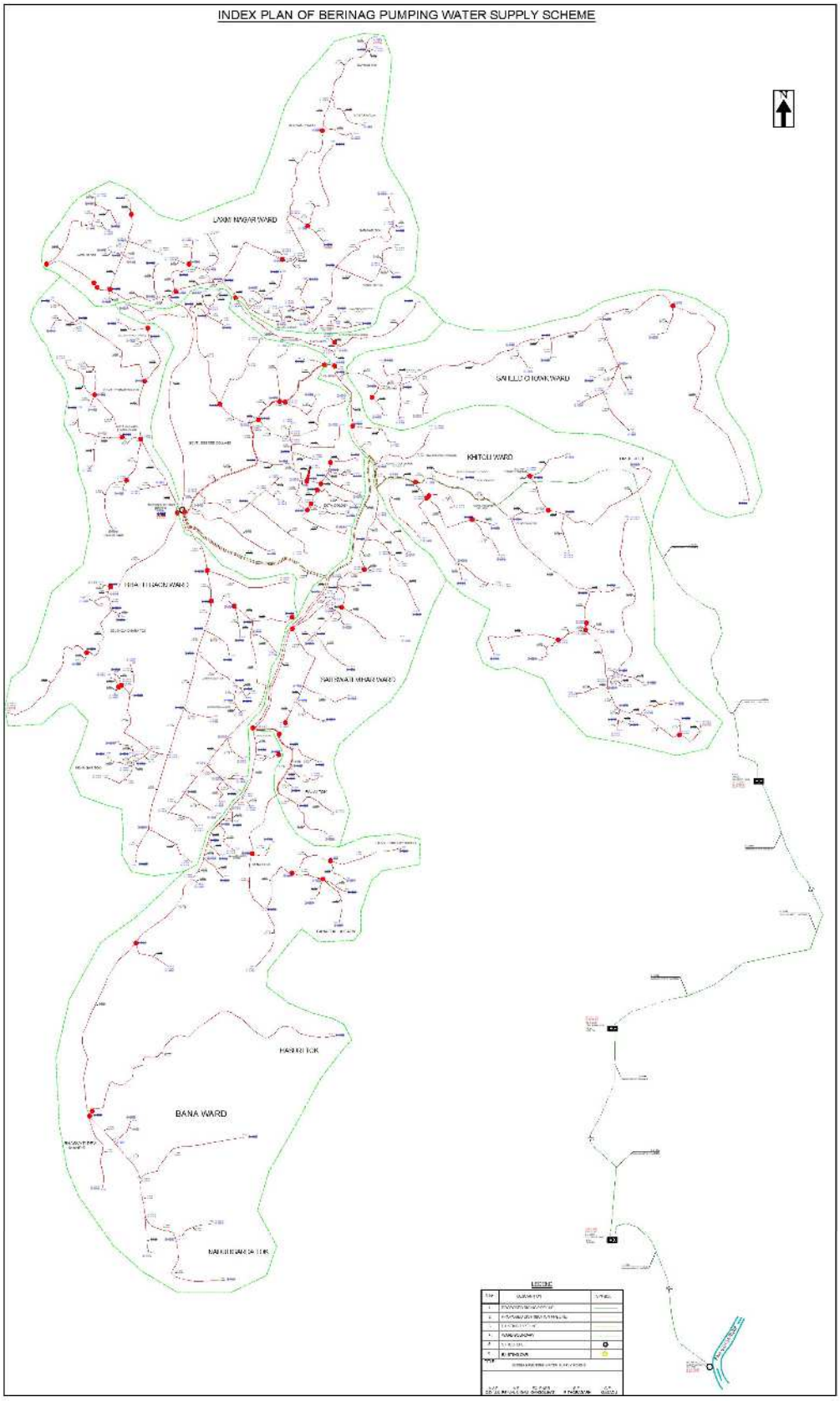
The river water collected from the shallow well will be conveyed to the Top CWR, where chlorine will be added before being distributed to households via natural gravity flow.

In this project, there are no plans to construct a water treatment plant, as the filtration function will be utilized at the shallow well.



Source: Prepared by JST

Figure 9-49 Proposed site for the Top CWR



Source: DPR

Figure 9-50 Proposed water supply system planning diagram

(6) Gangolihat

(a) Town Profile

Gangolihat is located in the Pithoragarh district of the Uttarakhand state, surrounded by the Saryu and Ramganga rivers. These two rivers appear to form a garland around the shoulders of the Himalayas, giving rise to the name "Gangolihat" (derived from the local words for river and garland).

This region, later called Gangori, derives its name from the "hat" or marketplace that was once the central gathering place, hence the name "Gangolihat" for this town.

Nestled in the Himalayas, Gangolihat is a historic and religiously significant town.

Pithoragarh district is a border district that borders China and Nepal, serving as a route to Tibet. Gangolihat is situated at an altitude of approximately 1700 meters, at latitude 29 degrees 39 minutes 25 seconds North and longitude 80 degrees 2 minutes 21 seconds East. Due to the presence of pilgrimage sites, schools, hospitals, and markets in the surrounding areas, the population of Gangolihat has increased rapidly and is on a path of development over the past decade.

The climate in Gangolihat is cold in winter but cool in summer, with an average annual rainfall ranging from 1000 to 2500 millimeters. Agriculture is the main industry, with wheat, vegetables, and fruits being cultivated.



Source: JST

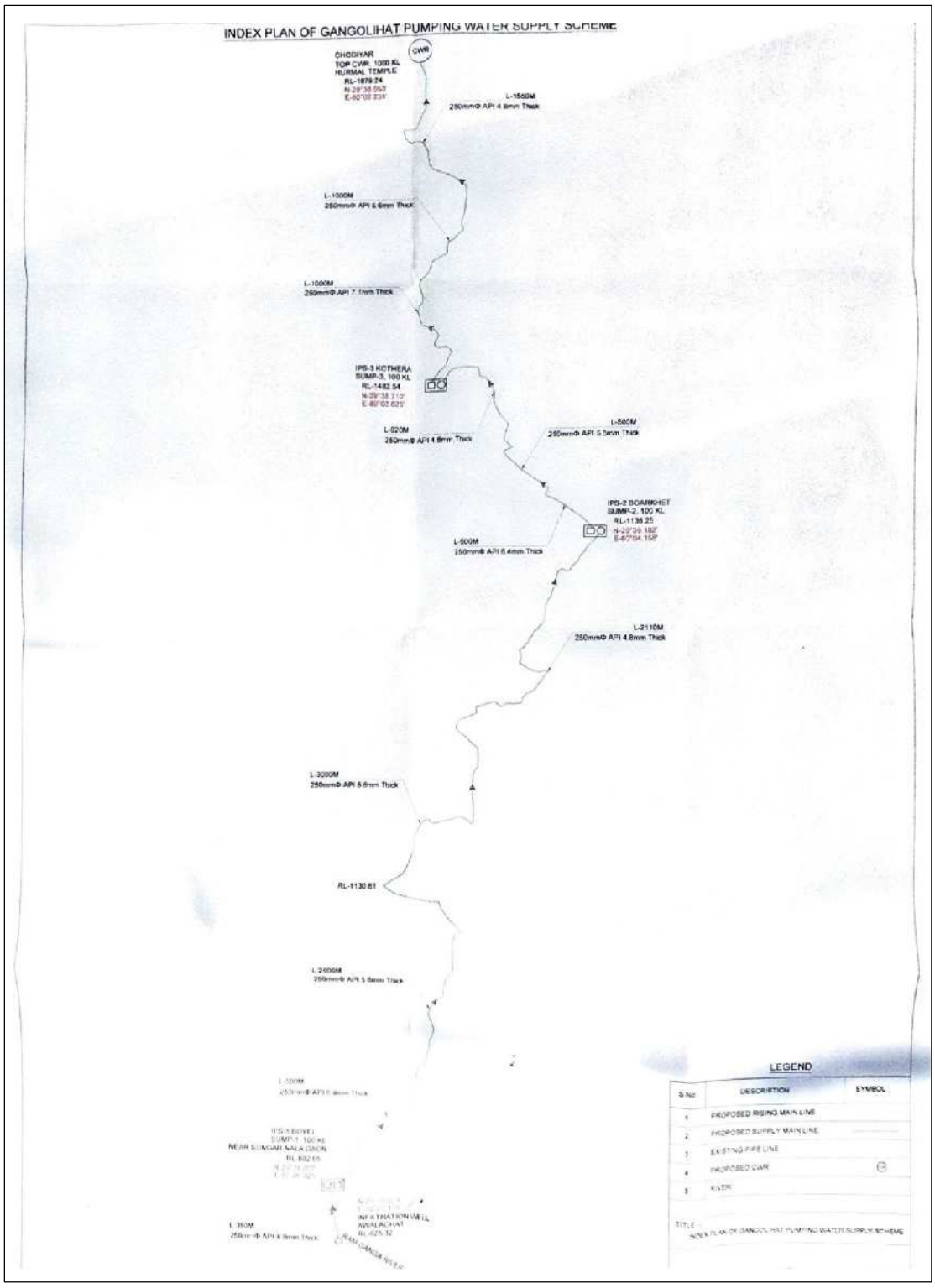
Figure 9-51 View of Gangolihat

(b) Existing water supply facilities

The existing water supply system in Gangolihat was established in 2012, with a designated supply rate of 49 LPCD, utilizing a gravity-fed system sourced from Salikhet Gadhera.
The current distribution network consists of small diameter pipes ranging from 20mm to 40mm, predominantly made of GI material, which have deteriorated over time and are insufficient to distribute the planned supply rate of 135 LPCD.

Presently, the supply duration is around 2 to 3 hours per day, with the distribution area being altered daily through valve operations at the distribution reservoir.

Moreover, Salikhet Gadhera experiences a decline in water levels during the summer months, making it unreliable for ensuring adequate water supply. Therefore, there is a demand for a new water supply system primarily utilizing the Ram Ganga River near Awalaghat as a dependable and sustainable water source.



Source: DPR

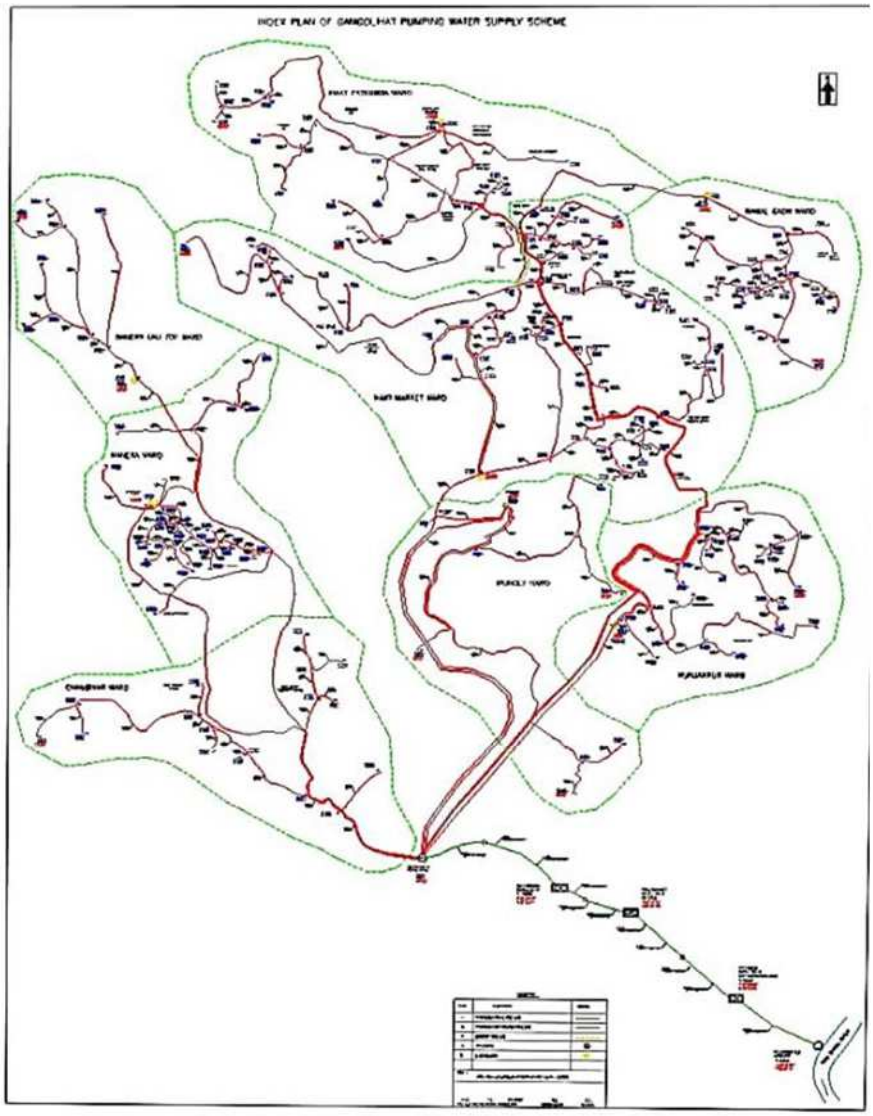
Figure 9-52 Existing water supply system diagram

(c) Facility plan for the project

The Gangolihat Pumping Water Supply Scheme aims to cover all zones, ensuring a minimum water pressure of 7 meters at each household.

For the water source, a 16.0m diameter borewell will be constructed on the right bank of the Ranganga River. Water will be conveyed through a 250mm Rising pipe spanning 14524m to reach an Intermediate Pumping Station (IPS: Intermediate Pumping Station) with a capacity of 100KL, before being directed to the CWR. The CWR is located at coordinates North latitude 29°38.653' and East longitude 80°02.231', with a capacity of 1100KL.

The proposed distribution network comprises GI pipes with diameters ranging from 20mm to 150mm, totaling a length of 44655m.



Source: DPR

Figure 9-53 Proposed water supply system planning diagram

(7) Lohaghat

(a) Town Profile

Lohaghat is located at approximately North latitude 29.40 degrees and East longitude 80.08 degrees, with an average elevation of 1700 meters. It is situated 88 kilometers away from the nearest railway station, Tanakpur, 142km from Nainital city, and 438km from Delhi.

The project implementation area is generally hilly terrain, with average temperatures ranging from 3.0°C to 35.0°C and annual precipitation ranging from 580mm to 1740mm.

Located between the Rohawati River and the town of Champawat, the issue of drinking water supply significantly impacts the social lives of residents in this region. Currently, the only source of water for daily needs comes from small springs with low elevation and minimal discharge rates. It has been observed that the discharge from these sources decreases significantly during the summer months, likely due to factors such as climate change.



Source: Prepared by JST

Figure 9-54 Koli Dhek Lake, a tourist dam

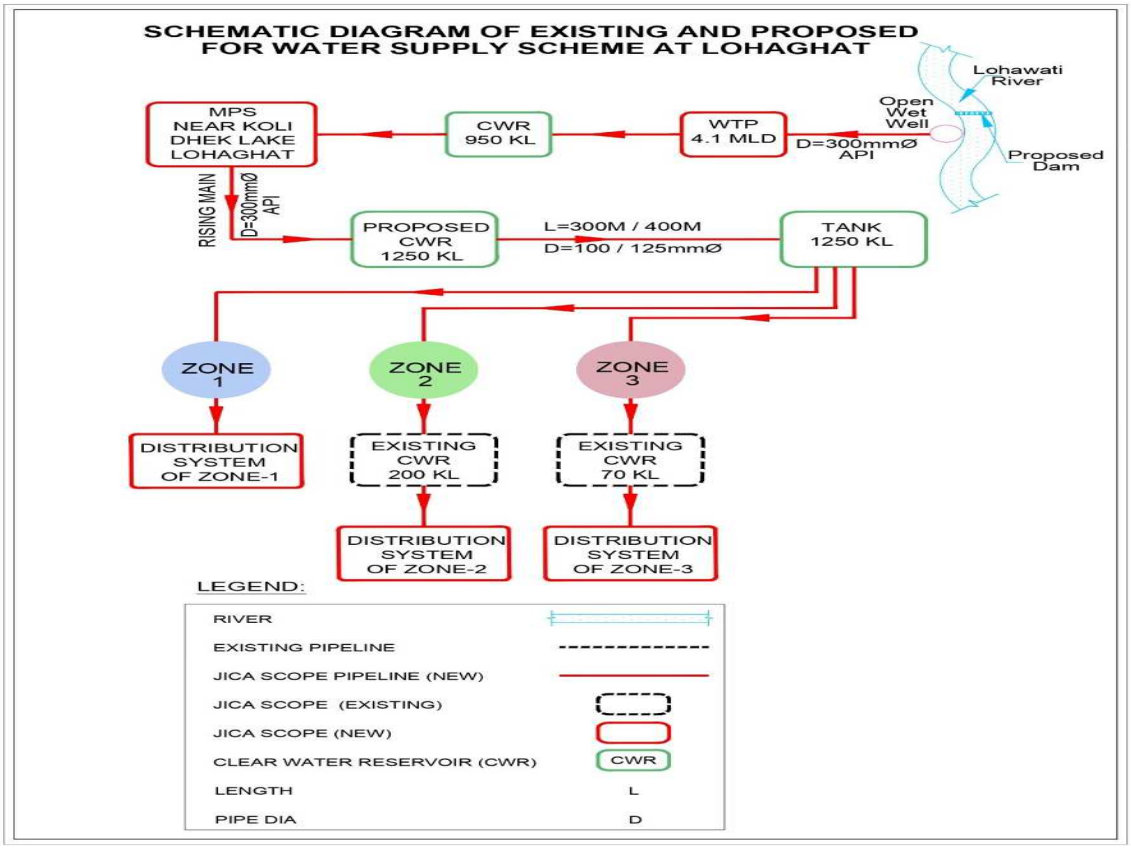
(b) Existing water supply facilities

The existing water supply system in Lohaghat consists of both gravity flow systems from several Gadheras and pump-lift systems from rivers.

Currently, the water supply time is approximately 45 minutes per day, meeting less than half of the population's water needs.

All water sources dry up during the summer months, leading to severe water shortages, necessitating the use of water tankers to supply water to the city from the distribution reservoirs.

The existing water supply system was constructed 20 to 42 years ago and is unable to meet the increased current water demand due to depleted water sources.
Moreover, the aging water pipes frequently leak, highlighting the need for a revamped water supply plan with a new water system.



Source: DPR

Figure 9-55 Schematic diagram of existing and new water supply system configurations

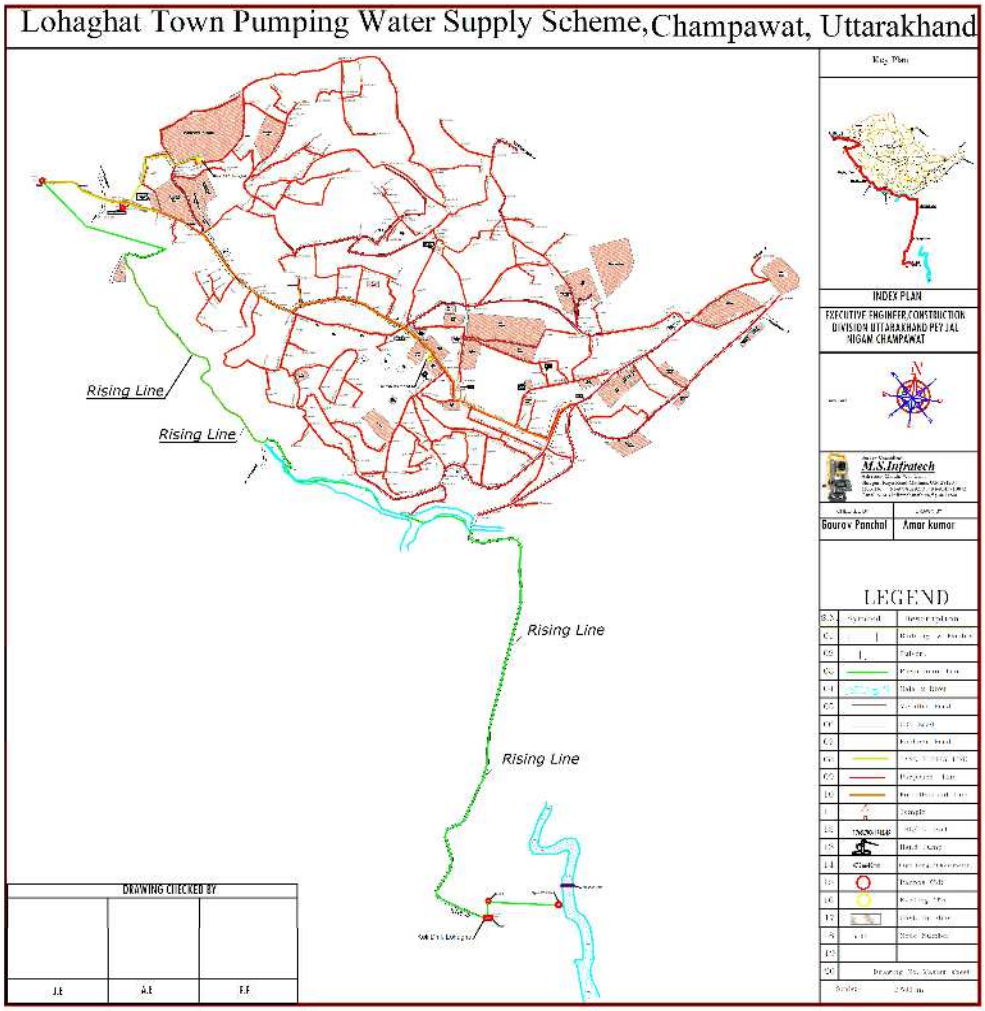


Source: Prepared by JST

Figure 9-56 Existing intake facility (left) and existing WTP (right)

(c) Facility plan for the project

The plan is to construct one intake well measuring 8m x 8m in a square shape with a height of 23.5m on the left bank of Koli Dhek Lake for the water source. Additionally, for the water treatment facility, there is a plan to build a water treatment plant near the water source with a treatment capacity of 4.1MLD using the coagulation-sedimentation and rapid filtration method.



Source: DPR

Figure 9-57 Proposed water supply system planning diagram

In the on-site survey conducted for the Lohaghat Water Supply Scheme, Koli Dhek Lake has been identified as the water source. However, both the quantity and quality of water from this source do not meet the requirements for a satisfactory water source. As an alternative, the option of drawing water from the Ramganga River via long-distance conveyance has been proposed.

Due to insufficient solid data to evaluate the water sources, no definitive opinion has been expressed regarding which water source would be preferable.

In the consultant's view, it is essential for the Lohaghat water project to present a report with attached data demonstrating sufficient water quantity and clean water quality from the selected water source(s) to ensure sustainability. Based on this information, appropriate adjustments to the Detailed Project Report (DPR) may be necessary.

9.3.3 Risk considerations on climate change impacts

(1) Climate risk matrix

In this section, we conduct a comprehensive evaluation of the impact of climate change on the water supply projects in Uttarakhand state, as outlined in Chapter 2, Section 3. We use a regional approach to assess the adaptation measures using a climate risk matrix.

The climate risk matrix, developed as part of this study and categorized based on the utilization of groundwater and surface water in the region, is presented below. Further detailed explanations regarding its contents will be provided on the following pages.

Table 9-6 Climate risk matrix (groundwater use areas)

			Climate Hazard					
			H1	H2	H3			
			Drought	Flood	Sediment Disasters			
		Frequency - ~ + +	+	-	-	Vulnerability	Climate Risk	Adaptation Options
		Future risk	↗	↗	→			
Exposure	E1	Groundwater Source	1 Decrease in water level during drought	0 Low risk in flat areas	0 Low risk in flat areas	・Decreased water supply capacity due to lowering of groundwater level	・Further lowering of groundwater levels during drought periods due to decreased precipitation in recharge areas	・Regular groundwater level monitoring
	E2	Tubewells	1 Decrease in water supply capacity	0 Low risk in flat areas	0 Low risk in flat areas	・Reduction in water supply capacity due to lowering of groundwater level ・Submersion of pump facilities during flooding	・Insufficient water supply capacity due to intermittent lowering of groundwater levels ・Prolonged water supply shutdown periods due to equipment failures during flooding incidents	・Elevation setting considering groundwater level decline ・Identification of flood risks at each facility location ・Facility waterproofing through raising planned ground levels or using watertight barriers ・Development of BCP for flood-related incidents
	E3	Elevated Water Tank	0 Low risk to the facilities	0 Low risk in flat areas	0 Low risk in flat areas	・Submersion of pump facilities during flooding	・Prolonged water supply shutdown periods due to equipment failures during flooding incidents	・Identification of flood risks at each facility location ・Facility waterproofing through raising planned ground levels or using watertight barriers ・Development of BCP for flood-related incidents
	E4	Distribution Network	0 Low risk to the facilities	0 Low risk in flat areas	0 Low risk in flat areas	・No particular issues	・No particular issues	・No specific measures required

Source: Prepared by JST

Table 9-7 Climate risk matrix (surface water use areas)

			Climate Hazard					
			H1	H2	H3			
			Drought	Flood	Sediment Disasters			
		Frequency - ~+++	+	++	++	Vulnerability	Climate Risk	Adaptation Options
		Future risk	↗	↗	↗			
Exposure	E1	Surface Water Sources River, lake, Spring	2 Decrease in water level during drought	1 Deterioration of Water Quality due to Flood	0 Low risk to the facilities	·Water intake obstruction due to a decrease in water level ·Deterioration of water quality due to floodwater flow and sediment runoff	·Further lowering of water levels during drought periods due to decreased precipitation ·changes in flow channels and riverbeds, or deterioration in water quality caused by flood flow and landslides	·Regular monitoring of water quantity, water level, and water quality
	E2	Water intake (gravity systems)	2 Decrease in water intake capacity	2 Submersion of water intake in riverbed	2 Submersion of water intake in riverbed	·Decreased water supply capacity due to reduced water intake ·Direct damage to water intake facilities	·Insufficient water supply capacity due to intermittent droughts ·water supply shutdown periods resulting from facility damage	·Identification of flood risks at each facility location ·Facility waterproofing through robust structures ·Development of BCP for disasters
	E3	Water intake (Pumping systems)	1 Decrease in water intake capacity	1 Flood risk	0 Low risk to the facilities	·Decreased water supply capacity due to reduced water intake ·Decreased water supply capacity due to reduced water intake	·Insufficient water supply capacity due to intermittent droughts ·Facility breakdown and prolonged water supply shutdown periods due to sediment disasters and flooding	·Elevation setting considering water level decline ·Identification of flood risks at each facility location ·Facility waterproofing, and slope protection
	E4	Water treatment plant	2 Limitations in supply due to intake issues	1 Deterioration of Water Quality due to Flood	1 Land slide risk	·Decreased water supply capacity due to reduced water intake ·facility damage due to sediment disasters ·Facility damage due to sediment disasters	·Facility breakdown and prolonged water supply shutdown periods due to sediment disasters and flooding	·Elevation setting considering water level decline ·Facility waterproofing, and slope protection ·Development of BCP for disasters
	E5	Reservoir	0 Low risk to the facilities	0 Low risk to the facilities	0 Low risk to the facilities	·Decreased water supply capacity due to reduced water intake ·Facility damage due to sediment disasters	·Facility breakdown and prolonged water supply shutdown periods due to sediment disasters and flooding	·Identification of flood risks at each facility location ·Raising planned ground levels or using watertight barriers for facility waterproofing ·development of BCP for flood-related incidents
	E6	Distribution Network	0 Low risk to the facilities	0 Low risk to the facilities	0 Low risk to the facilities	·Pipeline damage due to sediment disasters	·Pipeline damage due to sediment disasters, leading to extended water supply shutdown periods	·Setting pipeline routes away from sediment disaster risk areas and slope protection for dangerous cliff areas

Source: Prepared by JST

(2) Impact items associated with climate change

Taking into account past damage incidents, the following impacts of climate change are highlighted as influencing factors in the climate risk matrix presented on the preceding page.

- ✓ Decrease in water levels during dry seasons (groundwater sources, surface water sources)
- ✓ Reduction in pumping capacity due to lowered water levels (groundwater sources) or obstruction of water intake (surface water sources) As described in section 4.2.5 on dry season drought conditions, while significant reductions in river flow or groundwater levels leading to water intake damage have not been observed, there is a possibility of increased risk due to future climate change impacts.
- ✓ Insufficient supply capacity due to pumping and water intake obstructions (groundwater sources, surface water sources) In regions where water supply decreases due to reduced water source capacity, short-term or long-term water shortages may become more severe.
- ✓ Degradation of water quality due to floodwater contamination (surface water sources) Extended periods of high turbidity in raw water caused by floodwaters may lead to difficulties in maintaining water quality in facilities that are not properly managed or exceed their water filtration capacity, potentially resulting in a decline in water service quality.
- ✓ Submergence of water intake facilities within riverbeds (surface water sources) In Kirtinagar, as observed during on-site investigations and as shown in Figure 9-25,

existing river water intake facilities (1m × 1m × 2 bases within the riverbed) have been damaged or submerged due to sediment disasters accompanying floodwaters. Therefore, similar damage to existing water intake facilities installed within riverbeds may increase.

(3) Potentially significant future climate risks

As highlighted in section "2.3.3 (2) Climate Change Impacts in Uttarakhand State" of this report's preceding section, the principal climate change risks in Uttarakhand State include an increased frequency of drought occurrences during the dry season and an increased frequency of flooding events due to intense rainfall during the monsoon season.

(a) Geographical use of groundwater sources

Given its predominantly plains nature, the risk of facility damage due to debris flow is unlikely to increase compared to mountainous regions. However, it is anticipated that risks such as further depletion of groundwater levels during dry periods due to reduced precipitation in recharge areas and inundation of well pump facilities during flooding events will increase across the region as a whole.

(b) Geographical use of surface water sources

Located in steep mountainous terrain with extremely limited flat land, all facilities are susceptible to debris flow risks. Therefore, there are concerns that the risk of facility damage due to debris flow will increase with the future increase in frequency of intense rainfall events. Additionally, the ongoing decrease in precipitation during the dry season is expected to increase the risk of water shortages, leading to water intake disruptions. Furthermore, the occurrence of floods in mountainous areas may pose a particularly high risk of direct damage to water intake facilities, especially those located near rivers.

(4) Consideration of adaptation measures

(a) Soft measures

In the organizational structure of UJS responsible for the operation and maintenance of the water supply and sewerage projects, there is concern about a shortage of staff for emergency response, and comprehensive maintenance management guidelines and disaster BCP manuals have not been developed. In the event of large-scale disasters such as earthquakes or floods, this could potentially disrupt the operation of the projects.

Therefore, as a first step in addressing soft-side concerns, it is necessary to establish BCP manuals tailored to various disasters predicted by the impact of climate change. These manuals should outline plans for preventive measures, emergency response, and training plans based on limited human resources and equipment. Additionally, after the creation of BCP manuals, efforts are needed to ensure that staff understand and can execute BCPs during emergencies. This may involve conducting training, appointing BCP management specialists, and organizing training sessions at facilities managed by the state government. While these aspects have not been included in the climate risk matrix as they pertain to all project

components, they are effective risk management measures against various impacts of climate change for both the current and existing project components.

(b) Hard measures

Adaptive measures for each component are indicated in the right column of the climate risk matrix as follows.

Regarding groundwater level monitoring, this entails capturing signs of groundwater depletion as early as possible and subsequently implementing measures such as regulating pumping volumes and considering changes in target aquifers. This can be considered a reactive approach. If groundwater development continues on a broad scale in the future, it would be ideal to collect necessary information at the current stage when groundwater depletion is not yet severe, conduct groundwater simulations for future predictions, and develop appropriate groundwater development plans. In this case, information gathering should not target existing documentation but rather involve actual borehole surveys followed by procedures such as electrical logging, pumping tests, creation of hydrogeological models through extensive aquifer correlation, and simultaneous groundwater level measurements.

For the overall water resource management of the state, similar periodic and regionally integrated monitoring (of water quantity, level, and quality) is necessary for surface water, including rivers, lakes, reservoirs, and dams.

Furthermore, as facility measures against various disasters, it is essential to thoroughly assess the risks of natural disasters at each facility location and implement measures such as changing construction sites to low-risk areas, relocating existing facilities, and strengthening facilities against unforeseen forces.

9.4 Land Acquisition Status

The table below shows the status of land acquisition in each area. Acquired sites are marked with a circle, unacquired sites are marked with an X. Blank areas indicate that there are no plans to acquire the site. Many areas have not yet been acquired, but are expected to be by the time the project starts. For areas where land acquisition has been completed, signboards with project details have been installed, as shown on the next page.

Table 9-8 Status of land acquisition in each region

S.l.	Water supply Scheme	Private Land	Revenue Land	Forest Land
1	Berinag	×		×
2	Gangolihat	×	○	×
3	Bhageswar	×	×	×
4	Almora		×	
5	Bhikiyasain	○		
6	Raniket	○ (Partly)	×	×
7	Dwarahat		×	×
8	Gairsain		○	×
9	Tharali		○	×
10	Nand Prayag		○	○
11	Joshimath		○	
12	Pipal Koti		○	×
13	Gopeshwar		○	×
14	Barkot Urban	○		×
15	Chinyalisaur	○	×	×
16	Purola	○		×
17	Naugaon	○	×	
18	Chamiyala	×		×
19	Chamba		○	○
20	Ghansali		×	○
21	Lambgaon	○ (Partly)		
22	Kirti Nagar		×	
23	New Tehri		×	○
24	Tilwara		○	×
25	Rudra Prayag			×
26	Ukhimath		○	○
27	Augustmuni	○		×
28	Lohaghat		×	
29	Bhowali		○	
30	Bhimtal		○	
31	Kaladhungi		×	
32	Jaspur Pumping	×	○	
33	Prian kaliyar		○	
34	Shivalik Nagar		○	
35	Bhagwanpur		○	
36	Lakshar Nagar		×	
37	Landhora		×	
38	Jhabreda		×	

Source: Prepared by JST





Source: Prepared by JST

Figure 9-58 Project signboards at proposed sites

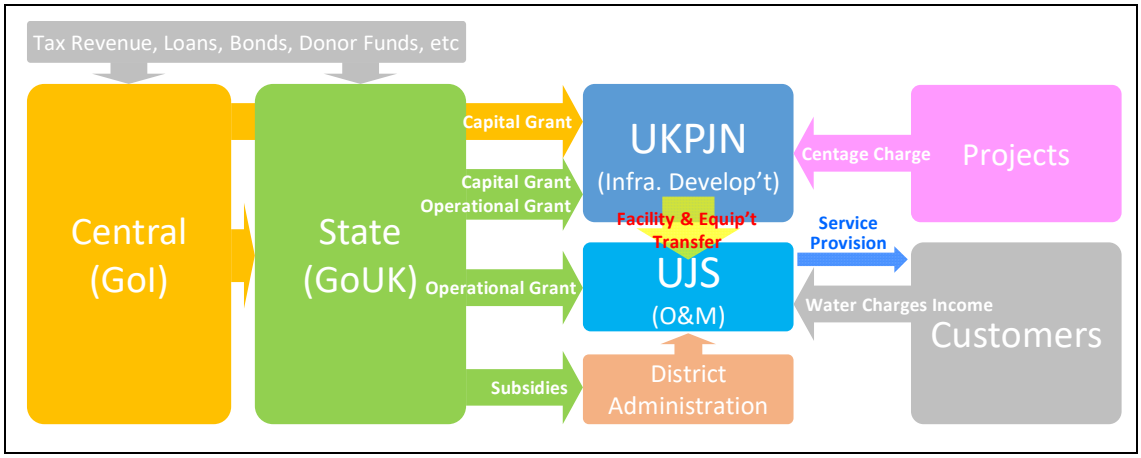
The proposed construction sites for each sub-project are classified into "Private Land," "Revenue Land," and "Forest Land." Upon receiving permission documents for land acquisition, Private Land parcels are obtained from the Sub Divisional Magistrate of the Uttarakhand state, Revenue Land from Municipal Council Officials, and Forest Land from the Uttarakhand Forest Department.

The duration required for land acquisition varies depending on the size of the land to be acquired but generally takes around 2-3 months. Since water supply projects are considered highly public in Uttarakhand, land acquisition is relatively easy to obtain.

9.5 Funding Flow Related to Infrastructure Development and Operation & Maintenance

Schematic funding flow related to infrastructure development and operation and maintenance in the drinking water and sewerage sector in Uttarakhand State is shown in Figure 9-59. UKPJN and UJS receive capital grants and/or operational grants from the central and/or state governments, using tax revenue, loans, bonds, donor funds, etc. as financial resources. For example, capital grants to UKPJN from the central and state governments, revenue grants to UKPJN from state governments when centage charges cannot cover operating expenses, and operational grants to UJS from the state government to cover operating expenses for operation and maintenance, and so forth.

Furthermore, UKPJN's divisional offices responsible for construction and supervision of facilities under the DPR projects, and UJS's divisional offices responsible for operation and maintenance of the constructed facilities receive funding for necessary expenses from each headquarters, and procurement (including outsourcing) is basically made at the discretion of Executive Engineer of each office.



Source: JST

Figure 9-59 Funding Flow Related to Infrastructure Development and Operation & Maintenance

9.6 Financial Sustainability

As described in Chapter 6, both UKPJN and UJS are financially dependent on state government grants, which on a consolidated basis account for 30% to 40% of their total revenue.

Stable state government grants will remain necessary as a major source of funding to maintain and improve the financial sustainability of water supply and sewerage services in Uttarakhand state including cities/towns covered by DPR projects. However, the following efforts are essential in order for UKPJN and UJS to fulfil their original functions as a PSU or an autonomous body.

- Formulation of a medium- to long-term business strategy/plan (including financial plan)
- Water tariff revision based on the financial plan
- Improvement in billing and collection based on metering (*Even if un-metering, more realistic pricing based on water consumption)
- Cost reduction
- Non-revenue water reduction
- Improvement in operational efficiency (including outsourcing)

9.7 Summary of the DPR Review

As a summary of this chapter, the overall review results of the project plan in question have been organized in Table 9-9.

Table 9-9 Summary of scrutiny results for each item

Item	Review results/points raised	Relevant chapter
Plan year	• It is designed for a period of 30 years, with 2026 as the base year. The intermediate and final years are 2041 and 2056 respectively.	9.1.2
Design standard	• The design of the water supply system complies with the standards and parameters specified in the CPHEEO Manual (issued in 1999) and the I.S. codes established by the Bureau of Indian Standards. • With regard to the service life, it is generally accepted that mechanical/electrical facilities have a life span of 15 years, while civil and piping facilities have a life span of 30 years. All DPRs adhere to these standards and are deemed appropriate.	9.1.1 9.1.2
Water supply system	• The non-revenue water rate is stipulated at 15% by CPHEEO regulations for losses occurring in the water supply system, and this is reflected in the water demand forecast.	9.1.3
Projected water quantity	• The current water supply situation falls short of even 100 LPCD in most areas. Through this project, the target water demand has been set to achieve the CPHEEO-specified 135 LPCD for all target areas.	4.1 9.1.3
Existing facilities	1. Water distribution facilities To address the shortage of water supply and intermittent supply conditions, hand-pump wells (shallow wells) have been installed in various locations. Additionally, the existing distribution network has aged over 30 years, with numerous leakage points. Some of the distribution reservoirs have capacities lower than what is actually required, and a few are in a damaged state, rendering them unusable. 2. Water treatment facilities The facilities have aged for over 30 years and are now deteriorating. Each facility is operated manually, and there is a lack of efficient maintenance and management in terms of water quantity and energy control. 3. Intake facilities In the utilization of surface water sources, the planned water extraction primarily involves sourcing water from rivers. It is evident in this project that some regions are considering the utilization of alternative water sources as the existing sources currently in use are deemed insufficient to meet both current and future water demands.	9.3
Water supply project targets	• Continuous water supply, 24 hours a day, 365 days a year. • Water quality testing: Conducted daily by collecting one sample from the water treatment plant. • Residual chlorine levels of 0.2 mg/L or higher. • Customer complaints to be addressed within 24 hours. • Water charges are billed based on usage as measured by water meters.	
Water resources planning	• The availability of water resources and the impact of climate change are crucial pieces of information for assessing the sustainability of water sources, but specific data regarding these aspects are not documented in all DPRs.	9.2.2 9.2.4 9.2.5 9.2.6

Item	Review results/points raised	Relevant chapter
	• The content described in the DPR does not clearly indicate whether sufficient consideration has been given, therefore detailed investigations, such as the determination of the water intake capacity, are necessary during the preliminary design phase. • In order to ensure sustainable water resources management in the future, it will be necessary to acquire more detailed information as the facility construction plans develop in the coming phases. • In facilities utilizing surface water sources, it is crucial to conduct seasonal flow measurements and monthly river water level monitoring. For facilities relying on groundwater sources, it is ideal to perform approximately one test boring at about three locations before determining the extraction depth and planned volume, confirming the distribution of aquifers, conducting pumping tests, and monthly groundwater level measurements. Water quality analysis for required parameters is essential for both surface water and groundwater. • Furthermore, it is essential to continue this data collection even after the facility becomes operational. To sustainably implement proper water resources management, it is imperative not only to provide technical assistance to the prioritized 38 areas for water source planning but also to enhance the organizational capacity of UKPJN with a long-term perspective.	
Facilities planning	Future water supply facility plans are mainly classified into the following three patterns. 1. Well + Elevated Tank System To address the rapidly increasing water demand, the facility plan adopts a similar approach to the existing one, leveraging previous knowledge and experience, including site selection and consideration of the water source's capacity. 2. Water Treatment Plant System The facility plan follows a similar approach to existing water treatment processes when considering the water source capacity, water treatment facilities, and distribution systems. The plan takes into account past performance and experience, including identifying issues and problem areas in the existing water treatment processes. This, in turn, validates the appropriateness of the facility plan. 3. Gravity Flow System Many water treatment facilities in this category are relatively simple due to the good quality of the water source. However, some areas like Kirtinagar are switching to water treatment plant systems during the rainy season due to high turbidity. The gravity flow system, which helps reduce electricity costs, was examined, including similar facilities designed for natural gravity flow. The facility plan in the proposed DPR is considered valid, as it is based on past performance and experience when assessing water source capacity, water treatment facilities, and distribution systems. 【Issue】 • However, many towns in hot regions do not have adequate management of liquid chlorine or ensure proper chlorine injection to maintain residual chlorine levels. Therefore, there is a need to provide guidance on proper maintenance and management methods	9.3

Item	Review results/points raised	Relevant chapter
	after facility construction. • However, in certain areas within this project, there is a need for capacity building related to the proper water treatment methods, as some regions will transition from natural gravity-based processes to water treatment plant systems or from slow sand filtration to rapid filtration processes. • Implementing technical projects focused on operational and maintenance management is also an effective means to sustainably maintain water supply facilities in mountainous regions.	
Pipeline planning	• The standard operating time for conveyance water pumps is 16 hours. • For the reservoir capacity, the standard is set at 8 to 12 hours of maximum daily water supply. • Regarding piping materials, the plan primarily employs steel pipes due to the heavy weight and time-consuming installation of ductile iron pipes, especially in mountainous regions.	9.3
Land acquisition	• While there are many areas yet to be acquired, it is planned to acquire them by the start of the project. However, it is necessary to reconfirm the status of land acquisition at the conceptual design stage.	9.4
Disaster Risks	• In India, various types of natural disasters occur, with earthquakes and floods causing significant human and economic losses. Floods, in particular, are responsible for the majority of economic damage. The state of Uttarakhand is prone to natural disasters such as earthquakes, avalanches, landslides, and floods due to its topographical and geological conditions. • In Uttarakhand, numerous landslide-prone terrains have been identified, and approximately half of the region is assessed to have terrain and geological conditions conducive to landslides. • In Kirtinagal, a major disaster occurred due to landslides, burying the natural gravity-fed water source under debris. • Floods occur almost every year in Uttarakhand, and their impact can extend across a wide area. The primary cause of flooding is often heavy rainfall, but it can also result from glacier outbursts. Floods are predominantly concentrated in the Alaknanda River basin.	2.4
Project cost	• The project costs as outlined in the Phase-1 DPR are based on labour, materials, and transportation costs for piping work, referencing the latest UKPJN rates (Circular No. 320/apprisal anubhag-dar saarni/15/2023.05.06). Other civil construction rates are considered using CPWD DSR 2018（Central Public Works Department Schedule of Rates 2018）, which takes into account the construction conditions specific to each district. The rates for protective works are derived from the latest UK State PWD SOR for 2023. • Additionally, an administration cost of 12.5% of the total project cost is anticipated. • Other factors include anticipated price escalation and VAT. • In the Phase-2 DPR, the project cost has not been revised using the latest rates. Therefore, it is necessary to update the project cost based on the most recent rates.	12.2
Construction planning	• For land excavation and embankment required for site development, proper temporary works are carried out to protect structures and piping. Temporary works are mandatory in areas with slope gradients of 1:6 or greater and in dry geological sections.	

Item	Review results/points raised	Relevant chapter
	• Regarding excavation works for pipe laying, it is assumed that 20% consists of sandy soil and 80% of soft or hard rock. For pipes laid in hard rock sections, a 200mm-thick sand bed is considered. • The excavation width for pipes is set at pipe diameter + 600mm for pipes up to 600mm in diameter and pipe diameter + 900mm for pipes over 600mm in diameter. The standard pipe excavation depth is pipe diameter + 1.0m.	
Procurement planning	• In terms of material transportation, it is anticipated that cement, sand, steel materials, pipes, fittings, etc., will be transported from the nearest Rishikesh railway station, which is an average of 60 kilometres away. • Most of the materials can be sourced domestically in India.	
Project implementation system	• The UKPJN Divisional Office Staff will collaborate with local consultants to oversee construction. • After the completion of facility construction, a trial operation period of six months is anticipated for the handover of water supply facilities to UJS. • Individual household connections for water supply will be the responsibility of the beneficiaries and will not be included in the yen loan project cost.	
Financial conditions	• UKPJN's divisional offices responsible for construction and supervision of facilities under the DPR projects, and UJS's divisional offices responsible for operation and maintenance of the constructed facilities receive funding for necessary expenses from each headquarters. Procurement (including outsourcing) is basically made at the discretion of Executive Engineer of each office.	9.5
Organizational structure	• During the DPR project implementation phase, construction supervision shall be executed by the UKPJN's Divisional Office units. In each Divisional Office, day-to-day management is carried out by an average of 24 staff, including an Executive Engineer, one to four Assistant Engineers, around four Junior Engineers, and administrative staff and field workers. • After construction is completed, the facility is transferred to UJS, and operation and maintenance of the facility shall be carried out by UJS or outsourced contractors.	6.1

In this project, there are sub-projects that involve changing the water source from spring water to surface water or groundwater. According to the DPRs of each sub-project, there are four (Lambgaon, Berinag, Gangolihat, Lohaghat) that use the term "Ghadera" to refer to existing water intake facilities using spring water or streams, and these four are shifting from existing water sources to surface water or groundwater.

The reason for changing the water intake method is that the water volume is gradually decreasing, especially during the spring and summer seasons when there is a significant reduction in water volume, making it unreliable as a stable water source.

Spring water is water that seeps out gradually from layers of rock or soil where rainwater has been stored over time. Under favorable conditions, springs can provide a sustainable water source that doesn't dry up even during the dry season. However, whether spring water can

meet the planned water supply volume depends on the local topography, geology, and hydrological conditions. While in Japan, there are springs that continue to flow steadily even during the summer, providing a stable water source, the springs observed in Uttarakhand do not have sufficient water volume to meet the demand.

On the other hand, surface water flows directly over the land surface after rainfall. Although the annual variation in surface water volume can be significant depending on the region's topography, geology, and hydrological conditions, it generally provides a larger and more stable water source compared to spring water.

Chapter 10 Project Prioritization of Water Supply Development

10.1 Strategies for Project Prioritization of Water Supply Development

10.1.1 Requests from UKPJN

The list of requested towns for Phase-1 and Phase-2 from UKPJN is attached in the appendix at the end of this report. The concept of the request is to designate areas with more critical water supply shortages as Phase-1 projects. In this survey, while taking their requests into account, the following strategies will be used to select priority projects.

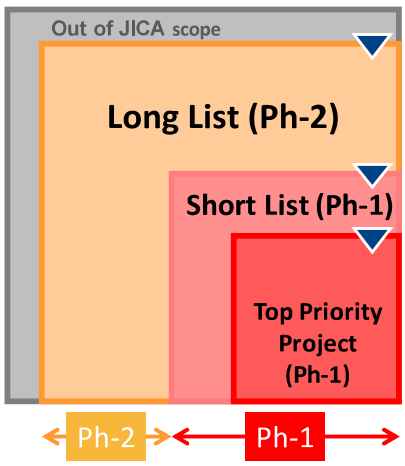
10.1.2 Basic Strategies for Prioritizing Projects

The target areas for this project are scattered across different districts, with many of them situated in mountainous regions, resulting in low accessibility between the project areas. Consequently, if Phase-1 and Phase-2 divisions are made without considering the geographical location of each area, it is anticipated that there may be difficulties in supervising construction in the dispersed project sites. To address this, we propose consolidated construction packages for each region.

In addition, as this marks the first JICA project in the UK state, it is desirable that UKPJN provide overall construction supervision from its headquarters in the state capital, Dehradun, to ensure smooth project implementation and timely response to emergencies. Therefore, while considering the aforementioned construction packages, the selection of Phase-1 areas will also take into account accessibility from Dehradun.

10.1.3 Stepwise Project Selection Policy

The selection of priority projects will be carried out stepwise in three stages, as shown in Figure 10-1. As this project is a sector loan, there is a possibility that UKPJN may independently restructure the project after the Loan Agreement (L/A) has been concluded. In such a case, based on the construction package areas identified in this survey, UKPJN will restructure the project between Phase-1 and Phase-2 based on their priority criteria, focusing on areas with urgent water supply needs in the vicinity. Since UKPJN's specific requirements for priority areas are generally clear, we believe that there will be no obstacles to implementing project restructuring based on their decision.



Source: JST

Figure 10-1 Conceptual diagram of the stepwise project selection in this survey

① Selection of project to be implemented under JICA funding scheme

If any of the following criteria are met, the project will be excluded from the scope of the JICA scheme:

- ✓ The preparation of the DPR is significantly delayed, preventing a review of its contents.
- ✓ The project includes plans for water supply to cantonment area.
- ✓ The project scope falls under Category A of Environmental and Social Considerations, e.g. involving dam construction or national park areas, raising concerns about potential project delays due to future environmental assessments.

② Project selection for Phase-1 and Phase-2

The construction packages will first be selected based on accessibility, administrative division (locality) and project cost range. Subsequently, taking into account their requests, a mutual consultation will be conducted to finalize the classification of Phase-1 and Phase-2 projects.

③ Project commencement criteria

The land acquisition status and the identification of any additional considerations needed in the current DPR will be assessed and organized as final criteria for project commencement. Recommendations will be made to UKPJN to ensure a smooth implementation of the projects.

10.2 Project Selection for Water Supply Development

10.2.1 Target Project under JICA Funding Scheme

Based on the summarized situation below, all 38 target areas will be implemented under the JICA funding scheme.

(1) Preparation status of DPR

All DPRs for the 38 target areas have been completed, although there are variations in the level of detail within the project descriptions.

(2) Water supply plans to cantonment area

Water supply projects for military installations (Cantonment areas) are completely separate from water supply projects handled by the individual ULBs. Therefore, among the 38 target towns, there are no DPRs that include water supply plans for such cantonment areas.

(3) Project with category A of "Environmental and social considerations"

In Lohaghat, a new dam has recently been constructed and completed around January 2023, and it is planned to use this dam as a source for the drinking water scheme. Since this dam is considered an existing facility, it is determined that it does not fall under Category A for environmental and social considerations. Additionally, there are no other dam construction plans in other areas, and there are no construction sites within the premises of the national parks in the water supply planning areas of the 38 target towns.

10.2.2 Project Selection for Phase-1

(1) Accessibility

As stated in the basic strategies of this chapter, the selection of priority project areas will consider accessibility from the state capital, Dehradun. The following factors will be considered in setting the accessibility criteria:

- ✓ There are two airports within the state, in Dehradun and Pantnagar (U.S. Nagar district), and accessibility from Pantnagar Airport will also be taken into account. However, it should be noted that there are no direct flights from Dehradun, and travel may involve a layover in New Delhi.
- ✓ Accessibility will be assessed based not only on distance but also on the travel time by road (one-way). The evaluation criteria will be set as follows, in descending order of desirability: (1) within 3 hours (possible for day trips), (2) 3-5 hours (possible for day trips with some limitations), and (3) over 5 hours (not possible for day trips). This time classification considers the ability to travel from the supervision base, which is the state capital, to the construction site, carry out site inspections, and return to the state capital on the same day.
- ✓ It is important to note that the limited flight schedules mean that it takes about one day to travel by air from Dehradun to Pantnagar. Taking this travel time into account would result in the exclusion of all areas in the eastern region (Garhwal district) from Phase-1. Therefore, the evaluation will be based solely on the vehicle travel time from the two mentioned locations. However, it is important to be aware of this fact during the actual implementation of the project.

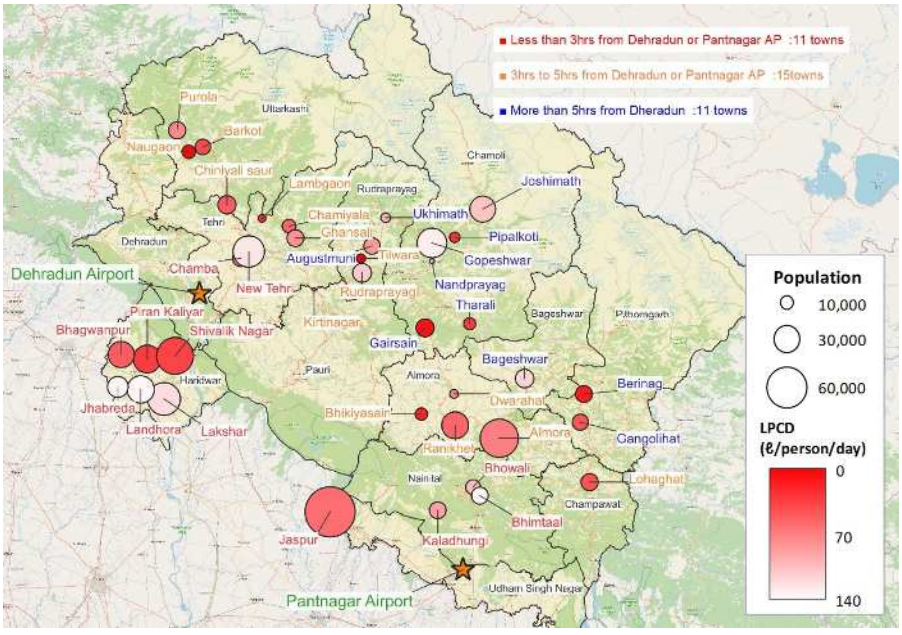


Figure 10-2 Accessibility of each project area

Table 10-1 Accessibility of each project area

Sl. No.	District	Town	Terrain	Dist. from Dehradun (km)	Time from Dehradun (hr)	Dist. from Pantnagar (km)	Time from Pantnagar (hr)
1	Pithoragarh	Berinag	Hilly	374	10.7	211	6.9
2	Pithoragarh	Gangolihat	Hilly	514	11.3	262	6.5
3	Bageshwar	Bageshwar	Hilly	316	8.7	188	6.2
4	Almora	Almora	Hilly	358	8.2	117	3.8
5	Almora	Bhikiyasain	Hilly	306	7.3	155	4.4
6	Almora	Ranikhet	Hilly	319	7.8	110	3.5
7	Almora	Dwarahat	Hilly	303	8.6	143	4.6
8	Chamoli	Gairsain	Hilly	254	7.0	192	6.2
9	Chamoli	Tharali	Hilly	253	6.9	230	7.5
10	Chamoli	Nandprayag	Hilly	227	6.0	259	8.3
11	Chamoli	Joshimath	Hilly	288	7.9	320	10.1
12	Chamoli	Pipalkoti	Hilly	253	6.7	285	8.9
13	Chamoli	Gopeshwar	Hilly	245	6.6	277	8.9
14	Uttarkashi	Barkot	Hilly	138	4.4		
15	Uttarkashi	Chiniyali saur	Hilly	159	4.3		
16	Uttarkashi	Purola	Hilly	144	4.5		
17	Uttarkashi	Naugaon	Hilly	127	4.0		
18	Tehri	Chamiyala	Hilly	163	4.7		
19	Tehri	Chamba	Hilly	88	2.3		
20	Tehri	Ghansali	Hilly	154	4.4		
21	Tehri	Lambgaon	Hilly	133	3.9		
22	Tehri	Kirtinagar	Hilly	137	3.5		
23	Tehri	New Tehri	Hilly	99	2.7		
24	Rudraprayag	Tilwara	Hilly	183	4.8		
25	Rudraprayag	Rudraprayag	Hilly	175	4.6		
26	Rudraprayag	Ukhimath	Hilly	216	5.8	423	9.6
27	Rudraprayag	Augustmuni	Hilly	195	5.1	402	8.9
28	Champawat	Lohaghat	Hilly	435	8.9	182	4.1
29	Nainital	Bhawali	Hilly	302	6.5	63	2.0
30	Nainital	Bhimtal	Hilly	303	6.5	56	1.7
31	Nainital	Kaladhungi	Plain	254	4.8	50	1.2
32	Udham Singh Nagar	Jaspur	Plain	177	3.7	84	1.6
33	Haridwar	Piran Kaliyar	Plain	75	1.7		
34	Haridwar	Shivalik Nagar	Plain	61	1.4		
35	Haridwar	Bhagwanpur	Plain	58	1.4		
36	Haridwar	Lakshar	Plain	82	1.9		
37	Haridwar	Landhora	Plain	86	1.8		
38	Haridwar	Jhabreda	Plain	77	1.9		

Note: Red for within 3hrs, Orange for 3-5hrs, Blue for over 5hrs Source: JST

Diagonal line: Omitted for brevity as it is located far from Pantnagar Airport

(2) Administrative divisions for each DPR

In setting up the construction packages for project implementation, the administrative divisions for each DPR corresponding to the respective projects will be taken into account. To avoid complications in supervision when multiple UKPJN responsible organizations are involved, efforts will be made to consolidate the same administrative divisions within each construction package.

Table 10-2 Administrative divisions for each DPR

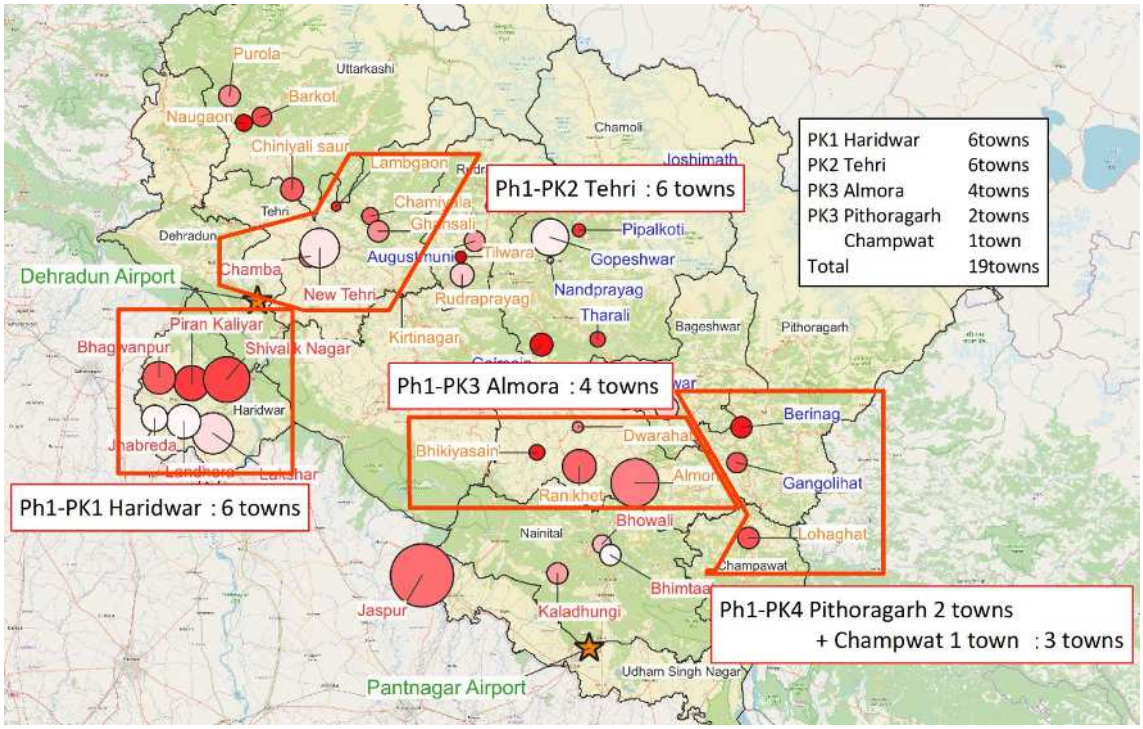
Sl.	District	Name of Division	Town
	Kummaon region		
8	Chamoli	CDKaranprayag	Gairsain
9			Tharali
10		CD Gopeshwar	Nandprayag
11			Joshimath
12			Pipalkoti
13			Gopeshwar
14	Uttarkashi	CD Uttarkashi	Barkot
15			Chiniyali saur
16			Purola
17			Naugaon
18	Tehri	CD Ghansali	Chamiyala
20			Ghansali
21			Lambgaon
19		CD Chamba	Chamba
22		CD Devprayag	Kirtinagar
23		CD New Tehri	New Tehri
24	Rudraprayag	CDRudraprayag	Tilwara
25			Rudraprayag
26			Ukhimath
27			Augustmuni
33	Haridwar	CD Haridwar	Piran Kaliyar
34			Shivalik Nagar
35			Bhagwanpur
36			Lakshar
37			Landhora
38			Jhabreda

Sl.	District	Name of Division	Town
	Garhwal region		
1	Pithoragarh	CD Gangolihat	Berinag
2			Gangolihat
3	Bageshwar	CD Bageshwar	Bageshwar
4	Almora	CD Almora	Almora
5		CD Bhikiyasain	Bhikiyasain
6		CD Ranikhet	Ranikhet
7			Dwarahat
28	Champawat	CDChampawat	Lohaghat
29	Nainital	CD Bhimtaal	Bhawali
30			Bhimtaal
31		CD Ramnagar	Kaladhungi
32	Udham SinghNagar	PIU Kashipur	Jaspur

Source: Prepared by JST based on the data from UKPJN

(3) Selection of Phase-1 projects

The target areas for Phase-1 projects are divided into four construction packages as shown in Figure 10-3, according to UKPJN's request and the strategies mentioned above.



Source: JST

Figure 10-3 Proposed construction packages for Phase-1

(4) Priority evaluation of Phase-1 projects

In preparation for determining the order of implementation of projects within each package, and the need to swap projects between packages, this study attempted to use scoring evaluations to prioritise each project in Phase-1 based on the following criteria:

1. Necessity and urgency (Current per capita water supply status)
2. Beneficial impact (Planned water supply in the implemented project)
3. Accessibility (Travel time from Dehradun and Pantnagar airport)
4. Project efficiency (Cost per capita of the project)
5. Feasibility (Consideration of planned projects in the DPR)

For items 1 to 4, scores were calculated within a range of 5 to 10 points[1] using a proportional function based on the minimum and maximum values of each criterion. Concerning item 5, a qualitative assessment was conducted within a range of 0 to 10 points, considering factors such as the level of planning detail and the status of document preparation, including drawings.

The results of the priority evaluations are presented in Table 10-3 and are sorted by score in descending order, with a maximum score of 50 points. The highest score was observed in Shivalik Nagar in Haridwar District (Package-1), while the lowest score was observed in Dwarahat in Almora District (Package-3). Overall, there is a tendency for higher scores in Haridwar District (Package-1) and Tehri District (Package-2). When comparing the average scores for each construction package, Package-1, followed by Package-2, received higher project priority ratings.

[1] Scoring method: For each evaluation criterion, a scale is set where the maximum value among all ULBs is assigned 10 points, and the minimum value is assigned 5 points. Scores are then calculated based on the values of each evaluation criterion for each ULB, and the evaluation is conducted based on the total scores of the five criteria.

Table 10-3 Priority evaluation of Phase-1 projects

Sl. No.	Priority idea	District	Town	Criteria-1 WS status Score	Criteria-2 WS volume Score	Criteria-3 Accessiblity Score	Criteria-4 per capita cost Score	Criteria-5 DPR Score	Total Score
34	Ph-1, Pack-1	Haridwar	Shivalik Nagar	8.9	10.0	10.0	10.0	10.0	**48.8**
35	Ph-1, Pack-1	Haridwar	Bhagwanpur	8.3	6.5	10.0	9.9	10.0	**44.7**
23	Ph-1, Pack-2	Tehri	New Tehri	9.9	6.5	9.3	8.8	10.0	**44.5**
19	Ph-1, Pack-2	Tehri	Chamba	8.1	6.4	9.5	9.1	10.0	**43.1**
36	Ph-1, Pack-1	Haridwar	Lakshar	6.4	6.3	9.7	9.9	10.0	**42.3**
33	Ph-1, Pack-1	Haridwar	Piran Kaliyar	7.4	6.8	9.8	10.0	8.0	**42.0**
21	Ph-1, Pack-2	Tehri	Lambgaon	9.0	5.2	8.7	9.0	10.0	**42.0**
18	Ph-1, Pack-2	Tehri	Chamiyala	8.2	5.3	8.3	9.0	10.0	**40.8**
37	Ph-1, Pack-1	Haridwar	Landhora	5.0	5.9	9.8	9.9	10.0	**40.5**
38	Ph-1, Pack-1	Haridwar	Jhabreda	5.0	5.5	9.7	9.8	10.0	**40.0**
4	Ph-1, Pack-3	Almora	Almora	8.0	7.1	6.6	9.5	8.0	**39.2**
22	Ph-1, Pack-2	Tehri	Kirtinagar	9.4	5.2	8.9	9.0	6.0	**38.5**
20	Ph-1, Pack-2	Tehri	Ghansali	8.8	5.4	8.5	9.5	6.0	**38.2**
6	Ph-1, Pack-3	Almora	Ranikhet	8.6	5.6	6.8	8.8	8.0	**37.9**
28	Ph-1, Pack-4	Champawat	Lohaghat	8.4	5.4	6.2	9.6	6.0	**35.6**
5	Ph-1, Pack-3	Almora	Bhikiyasain	9.2	5.2	7.0	8.8	5.0	**35.3**
2	Ph-1, Pack-4	Pithoragarh	Gangolihat	8.6	5.4	5.0	7.9	8.0	**35.0**
1	Ph-1, Pack-4	Pithoragarh	Berinag	8.6	5.5	5.3	8.0	6.0	**33.5**
7	Ph-1, Pack-3	Almora	Dwarahat	7.8	5.1	6.3	5.0	8.0	**32.2**
			Sub total for JICA Ph-1						
			Ph-1, Package-1					AVE:	**43**
			Ph-1, Package-2					AVE:	**41**
			Ph-1, Package-3					AVE:	**36**
			Ph-1, Package-4					AVE:	**35**

Source: JST

10.2.3 Operation and Maintenance Capacity of each Divisional-Level Organization

In the implementation phase of the DPR project, each divisional office is the management entity. The table below shows the locations of the UKPJN and UJS branches (Circle Offices) and Divisional Offices that cover the project area, indicated in red if the UKPJN or UJS office is located outside of the District to which the DPR project city belongs.

According to the results of interviews with UKPJN and UJS, there are cases where the Circle Offices and project cities belong to different Districts, but the Divisional Offices are located in the same District. Therefore, there are no obstacles in terms of construction supervision and facility operation and maintenance.

Table 10-4 UKPJN and UJS Circle Offices and Divisional Offices in the cities targeted by the DPR Project

Sl. No.	Phase Package	Town	District	Division	UKPJN Circle Office	UKPJN Divisional Office	UJS Circle Office	UJS Divisional Office
1	Ph-1, Pack-4	Berinag	Pithoragarh	Kumaon	Pithoragarh	Gangolihat	Pithoragarh	Pithoragarh
2	Ph-1, Pack-4	Gangolihat	Pithoragarh	Kumaon	Pithoragarh	Gangolihat	Pithoragarh	Pithoragarh
3	Ph-1, Pack-1	Bageshwar	Bageshwar	Kumaon	Almora	Bageshwar	Bageshwar	Bageshwar
4	Ph-1, Pack-3	Almora	Almora	Kumaon	Almora	Almora	Almora	Almora
5	Ph-1, Pack-3	Bhikiyasain	Almora	Kumaon	Almora	Bhikiyasain	Almora	Almora
6	Ph-1, Pack-3	Ranikhet	Almora	Kumaon	Almora	Ranikhet	Almora	Ranikhet
7	Ph-1, Pack-3	Dwarahat	Almora	Kumaon	Almora	Ranikhet	Almora	Ranikhet
8		Gairsain	Chamoli	Garhwal	Gopeshwar (Chamoli District)	Karnparavag	Gopeshwar (Chamoli District)	Karnparavag
9		Tharali	Chamoli	Garhwal	Gopeshwar (Chamoli District)	Karnparavag	Gopeshwar (Chamoli District)	Karnparavag
10		Nandprayag	Chamoli	Garhwal	Gopeshwar (Chamoli District)	Gopeshwar	Gopeshwar (Chamoli District)	Gopeshwar
11		Joshimath	Chamoli	Garhwal	Gopeshwar (Chamoli District)	Gopeshwar	Gopeshwar (Chamoli District)	Gopeshwar
12		Pipalkoti	Chamoli	Garhwal	Gopeshwar (Chamoli District)	Gopeshwar	Gopeshwar (Chamoli District)	Gopeshwar
13		Gopeshwar	Chamoli	Garhwal	Gopeshwar (Chamoli District)	Gopeshwar	Gopeshwar (Chamoli District)	Gopeshwar
14		Barkot	Uttarkashi	Garhwal	Tehri	Uttarkashi	Tehri	Purola
15		Chiniyali saur	Uttarkashi	Garhwal	Tehri	Uttarkashi	Tehri	Uttarkashi
16		Purola	Uttarkashi	Garhwal	Tehri	Uttarkashi	Tehri	Purola
17		Naugaon	Uttarkashi	Garhwal	Tehri	Uttarkashi	Tehri	Purola
18	Ph-1, Pack-2	Chamiyala	Tehri	Garhwal	Tehri	Ghansali	Tehri	Ghansali
19	Ph-1, Pack-2	Chamba	Tehri	Garhwal	Tehri	Chamba	Tehri	Tehri
20	Ph-1, Pack-2	Ghansali	Tehri	Garhwal	Tehri	Ghansali	Tehri	Ghansali
21	Ph-1, Pack-2	Lambgaon	Tehri	Garhwal	Tehri	New Tehri	Tehri	Tehri
22	Ph-1, Pack-2	Kirtinagar	Tehri	Garhwal	Tehri	Devprayag	Tehri	Devprayag
23	Ph-1, Pack-2	New Tehri	Tehri	Garhwal	Tehri	New Tehri	Tehri	Tehri
24		Tilwara	Rudraprayag	Garhwal	Gopeshwar (Chamoli District)	Rudraprayag	Gopeshwar (Chamoli District)	Rudraprayag
25		Rudraprayag	Rudraprayag	Garhwal	Gopeshwar (Chamoli District)	Rudraprayag	Gopeshwar (Chamoli District)	Rudraprayag
26		Ukhimath	Rudraprayag	Garhwal	Gopeshwar (Chamoli District)	Rudraprayag	Gopeshwar (Chamoli District)	Rudraprayag
27		Augustmuni	Rudraprayag	Garhwal	Gopeshwar (Chamoli District)	Rudraprayag	Gopeshwar (Chamoli District)	Rudraprayag
28	Ph-1, Pack-4	Lohaghat	Champawat	Kumaon	Pithoragarh	Champawat	Pithoragarh	Champawat
29		Bhawali	Nainital	Kumaon	Haldwani (Nainital District)	Bhimtal	Haldwani (Nainital District)	Nainital
30		Bhimtal	Nainital	Kumaon	Haldwani (Nainital District)	Bhimtal	Haldwani (Nainital District)	Nainital
31		Kaladhungi	Nainital	Kumaon	Haldwani (Nainital District)	Ramnagar	Haldwani (Nainital District)	Haldwani
32		Jaspur	Udham Singh Nagar	Kumaon	Udham Singh Nagar	PIU Kashipur	Haldwani (Nainital District)	Ramnagar
33	Ph-1, Pack-1	Piran Kaliyar	Haridwar	Garhwal	Haridwar	Haridwar	Haridwar	Haridwar
34	Ph-1, Pack-1	Shivalik Nagar	Haridwar	Garhwal	Haridwar	Haridwar	Haridwar	Haridwar
35		Bhagwanpur	Haridwar	Garhwal	Haridwar	Haridwar	Haridwar	Haridwar
36	Ph-1, Pack-1	Lakshar	Haridwar	Garhwal	Haridwar	Haridwar	Haridwar	Haridwar
37	Ph-1, Pack-1	Landhora	Haridwar	Garhwal	Haridwar	Haridwar	Haridwar	Haridwar
38	Ph-1, Pack-1	Jhabreda	Haridwar	Garhwal	Haridwar	Haridwar	Haridwar	Haridwar

Source: The JST

At each UKPJN Divisional Office, day-to-day construction supervision is carried out by an average of 24 staff members, including one Executive Engineer, one to four Assistant Engineers, about four Junior Engineers, administrative staff, and field staff.

Upon completion of construction, the facility is transferred to UJS, and operation and maintenance of the facility will be carried out by UJS or outsourced contractors. At each UJS Divisional Office, day-to-day operation and maintenance management is carried out by an average of 64 staff members, including one Executive Engineer, about three Assistant Engineers, about five Junior Engineers, and administrative staff and field staff (i.e., in charge of meter readers, pump operators, leakage repairs, etc.).

Chapter 11 Project Prioritization of Sewerage Development

11.1 Strategies for Project Prioritization of Sewerage Development

11.1.1 Requests from UKPJN

There have been no specific requests from UKPJN regarding sewerage development in the state. Therefore, we will conduct an information gathering process on the status of the sewerage development across the state and assess the development needs. Based on this assessment, JST will explore possibilities for initiating new projects for its sewerage sector.

11.1.2 Basic Strategies for Prioritizing Projects

(1) Basic strategies

Given the project funding constraints, it is common for only water supply development to be prioritized as a primary project. However, given that sewage generation increases along with water supply development, it can be argued that integrating sewerage development with water supply development leads to higher project efficiency in terms of reducing the risk of water source contamination.

On the other hand, if proper on-site sewage treatment and management, such as septic tanks, are in place and the impact of pollution on water bodies is minimal, urgent sewage system development may not be necessary. Therefore, it is essential to consider social and regional conditions and to carefully evaluate the need for sewerage development.

(2) Suitable area for sewerage development

There are two types of sewage treatment methods: on-site treatment, such as septic tanks and cesspools, and off-site treatment through public sewers and sewage treatment plants.

Regarding off-site treatment, urban areas with large populations and high population densities are more cost-effective in terms of efficient collection of sewage within the targeted treatment area through sewer pipes. Thus, off-site treatment system development approach is suitable. On the other hand, in rural areas with low population densities and scattered houses, it is preferable to continue with the on-site treatment system, which currently involves the widespread use of septic tanks, after ensuring proper maintenance and management.

Therefore, the focus will be on the urban area (ULBs) within the state, and this study attempted to identify priority areas for sewerage development based on the following perspectives:

- ✓ Areas of high population density where sewerage facilities are not yet developed and currently rely on on-site treatment
- ✓ Areas with large populations and high potential for project benefits through this development assistance
- ✓ Areas with high risk of contamination of drinking water sources
- ✓ Areas with high risk of waterborne diseases
- ✓ Areas where previous plans have been suspended due to financial constraints

(3) Study methods for selection of priority areas on sewerage development

The basic information of each ULB compiled by the MoHUA is attached on the following pages. The orange-colored shaded cells in the table indicate the ULBs that currently have sewerage treatment plants within their respective towns. The table also includes population projections until 2050 and the current status of sewerage facilities. In addition, the areas targeted for the UUWSP under JICA funding scheme are marked with a ✔ for reference. The selection of priority areas for sewerage development will be considered following the outlined procedure:

① Taking into account the current plans for sewerage development of each ULB, the sewage treatment capacity, after completion of the development based on the current plans, has been organized.

② The amount of sewage generated as of 2050 was calculated based on population projections, and the shortfall in sewage treatment capacity was determined. This shortfall can be used as a reference for the level of pollution risk in the region due to insufficient treated water from on-site treatment[1] and untreated grey water.

[1] On-site processing, specifically septic tanks, raises concerns about pollution load due to inadequate management, as highlighted in Section 5.3.2. Additionally, even in areas with on-site processing, grey water is released without undergoing treatment in septic tanks. Therefore, it is suggested here that the discharged water from such on-site treatment area should be considered alongside untreated sewage in terms of its potential environmental impact.

Table 11-1 Basic information of ULBs and sewerage development status in the state (1 of 2)

S.I.	Location			Population				House Hold 2021 (Nos)	Population density (Nos/km2)	Existing Used Water Infrastructure (2021)							Used Water-Gap Identification (2025)			
	ULB	UUWSP	District	2021	2025	2030	2050			No. of households having sewer connections	No. of households having septic tanks	No. of households having no sewer connections or septic tanks	Total Sewage Generation (MLD)	Design capacity of Existing STPs (MLD)	Operational capacity of Existing STPs (MLD)	Untreated Sewage (MLD)	Required No. of sewer connections	No. of households for FSSM	Total Sewage Generation (MLD)	Estimated Gap (MLD)
1	Bhikiyasain	✔	Almora	3,841	4,150	4,536	6,080	948	948	0	930	18	0.22	0.00	0.00	0.22	1,025	0	0.47	0.47
2	Ranikhet	✔	Almora	5,100	5,581	6,183	8,590	1,259	7,385	0	1,259	0	0.29	0.00	0.00	0.29	1,378	0	0.62	0.62
3	Dwarahat	✔	Almora	2,955	3,051	3,170	3,649	730	1,030	0	730	0	0.17	0.00	0.00	0.17	753	0	0.38	0.38
4	Choukhutiya		Almora	5,112	5,409	5,780	7,265	1,262	1,133	0	1,262	0	0.29	0.00	0.00	0.29	1,336	0	0.61	0.61
5	Almora	✔	Almora	39,627	41,688	44,263	54,566	9,784	5,256	1,036	8,748	0	2.27	2.00	2.00	0.27	10,411	1,036	4.77	2.77
6	KAPKOT		Bageshwar	7,379	8,309	9,471	14,120	1,822	1,344	0	1,822	0	0.42	0.00	0.00	0.42	2,052	0	0.93	0.93
7	Bageshwar	✔	Bageshwar	31,302	35,453	40,641	61,394	7,729	3,683	0	7,729	0	1.80	0.00	0.00	1.80	8,852	0	4.04	4.04
8	Joshimath	✔	Chamoli	22,320	24,463	27,141	37,855	5,511	1,943	5,200	311	0	1.28	1.08	0.00	1.28	6,040	0	2.77	1.69
9	Gairsain	✔	Chamoli	12,998	15,598	18,847	31,845	3,209	1,726	0	3,209	0	0.75	0.00	0.00	0.75	3,851	0	1.77	1.77
10	Tharali	✔	Chamoli	6,044	6,769	7,676	11,302	1,492	1,317	0	1,492	0	0.35	0.00	0.00	0.35	1,671	0	0.75	0.75
11	Pipalkothi	✔	Chamoli	8,039	8,682	9,486	12,702	1,985	1,148	0	1,985	0	0.46	0.00	0.00	0.46	2,144	0	1.74	1.74
12	Karanparyag		Chamoli	12,313	13,544	15,083	21,240	3,040	1,612	0	3,040	0	0.71	0.35	0.17	0.54	3,344	0	1.52	1.17
13	Pokhri		Chamoli	6,119	6,413	6,780	8,248	1,511	1,020	0	1,511	0	0.35	0.00	0.00	0.35	1,583	0	0.89	0.89
14	Nandparyag	✔	Chamoli	6,216	6,838	7,615	10,723	1,535	2,878	0	1,535	0	0.36	0.15	0.13	0.23	1,688	0	0.76	0.61
15	Badrinathpuri		Chamoli	2,520	2,792	3,132	4,493	622	1,254	177	445	0	0.14	1.27	0.03	0.11	689	177	0.90	(0.37)
16	Gochar		Chamoli	14,664	17,040	20,009	31,887	3,621	2,721	0	3,621	0	0.84	0.00	0.00	0.84	4,207	0	2.31	2.31
17	Gopeshwar	✔	Chamoli	22,168	24,207	26,757	36,954	5,474	1,574	4,101	1,373	0	1.27	4.32	1.31	(0.04)	5,977	4,101	4.03	(0.29)
18	Tanakpur		Champawat	22,265	23,657	25,397	32,357	5,498	11,843	0	5,498	0	1.28	0.00	0.00	1.28	5,841	0	2.68	2.68
19	Champawat	✔	Champawat	14,847	15,775	16,936	21,577	3,666	2,969	0	3,666	0	0.85	0.00	0.00	0.85	3,895	0	1.79	1.79
20	Lohaghat	✔	Champawat	10,484	11,139	11,959	15,236	2,589	2,330	0	2,589	0	0.60	0.00	0.00	0.60	2,750	0	1.26	1.26
21	Banbasa		Champawat	7,737	8,221	8,825	11,244	1,910	3,306	0	1,910	0	0.44	0.00	0.00	0.44	2,030	0	0.92	0.92
22	Mussoorie		Dehradun	91,903	110,247	133,177	224,896	22,692	1,419	1,600	21,082	10	5.27	7.32	7.32	(2.05)	27,221	1,321	20.11	12.79
23	Dehradun		Dehradun	1,200,540	1,360,452	1,560,342	2,359,901	296,430	5,823	177,858	83,000	35,572	68.91	118.13	44.38	24.53	388,616	177,858	216.78	98.65
24	Vikas Nagar		Dehradun	36,009	40,805	46,801	70,783	8,891	5,903	2,501	2,894	3,496	2.07	0.00	0.00	2.07	10,075	0	5.67	5.67
25	Doiwala		Dehradun	83,642	94,783	108,710	164,415	20,652	2,637	0	11,655	1,295	3.01	0.00	0.00	3.01	23,403	0	13.16	13.16
26	Rishiksh		Dehradun	123,096	135,406	150,793	212,341	30,394	10,667	0	27,349	3,045	7.07	26.00	16.00	(8.93)	33,763	0	15.34	(10.66)
27	Selaqui		Dehradun	23,680	27,497	32,269	51,355	5,847	1,870	0	3,634	2,213	1.36	0.00	0.00	1.36	6,789	0	3.85	3.85
28	Herbetpur		Dehradun	13,209	14,530	16,181	22,786	3,261	3,476	0	2,618	643	0.76	0.00	0.00	0.76	3,588	0	1.91	1.91
29	Roorkee		Haridwar	154,893	169,571	187,918	261,306	38,245	19,029	3,000	1,000	34,245	8.89	33.00	5.00	3.89	56,717	3,000	31.39	(1.61)
30	Manglaur		Haridwar	70,720	74,403	79,007	97,422	17,462	3,886	0	16,875	587	4.06	0.00	0.00	4.06	18,371	0	8.57	8.57
31	Shivalik Nagar	✔	Haridwar	42,007	46,261	51,580	72,852	10,372	1,226	0	9,680	692	2.41	0.00	0.00	2.41	11,422	0	5.31	5.31
32	Laksar	✔	Haridwar	32,522	35,816	39,933	56,402	8,030	3,395	0	7,250	780	1.87	0.00	0.00	1.87	8,843	0	4.69	4.69
33	Bhagwanpur	✔	Haridwar	21,370	22,483	23,874	29,439	5,277	3,084	0	5,277	0	1.23	0.00	0.00	1.23	5,551	0	2.53	2.53
34	Jhabrera		Haridwar	13,097	13,779	14,632	18,042	3,234	4,280	0	3,200	34	0.75	0.00	0.00	0.75	3,402	0	1.54	1.54
35	Piran Kaliyar	✔	Haridwar	19,439	20,451	21,717	26,779	4,800	1,112	0	4,600	200	1.12	0.00	0.00	1.12	5,050	0	2.32	2.32
36	Landhaura	✔	Haridwar	21,801	22,936	24,356	30,033	5,383	7,195	0	5,383	0	1.25	0.00	0.00	1.25	5,663	0	2.61	2.61
37	Haridwar		Haridwar	332,517	365,795	407,393	573,785	82,103	4,250	100,283	0	0	23.31	145.00	128.13	(104.82)	90,320	0	73.34	(71.66)
38	Padli Gujjar		Haridwar	9,523	10,019	10,639	13,119	2,351	4,623	0	2,351	0	0.55	0.00	0.00	0.55	2,474	0	1.11	1.11
39	Ramnagar		Nainital	75,065	83,176	93,315	133,871	18,535	29,990	0	15,000	3,535	4.31	0.00	0.00	4.31	24,727	0	13.77	13.77
40	Bhimtal	✔	Nainital	15,759	17,020	18,596	24,899	3,891	856	302	3,589	0	0.90	1.25	0.80	0.10	4,202	302	3.76	2.51
41	Bhowali	✔	Nainital	12,113	13,179	14,511	19,841	2,991	1,787	0	2,525	466	0.72	0.00	0.00	0.72	3,254	0	2.28	2.28
42	Kaladhungi	✔	Nainital	9,632	10,595	11,798	16,612	2,378	4,816	0	2,378	0	0.55	0.00	0.00	0.55	2,616	0	1.19	1.19
43	Lalkuan		Nainital	10,618	12,242	14,272	22,393	2,622	2,498	0	6,220	900	1.66	0.00	0.00	1.66	4,063	0	4.06	4.06
44	Haldwani		Nainital	355,342	392,752	439,515	626,567	87,739	9,669	6,123	20,000	61,616	20.39	28.00	0.00	20.39	110,715	6,123	61.79	33.79
45	Nainital		Nainital	55,487	56,293	59,894	74,298	13,700	3,827	11,501	0	0	8.86	19.20	12.50	(3.64)	13,362	100	16.97	(2.23)
46	Swargashram Jonk		Pauri	5,603	6,051	6,612	8,853	1,383	3,148	344	1,039	0	0.32	3.00	0.08	0.24	1,494	0	1.82	(1.18)
47	Dugaada		Pauri	2,906	3,138	3,429	4,591	718	1,937	0	685	33	0.17	0.00	0.00	0.17	775	0	0.44	0.44
48	Satpuli		Pauri	9,500	10,830	12,493	19,143	2,346	4,148	0	679	0	0.16	0.00	0.00	0.16	2,674	0	1.27	1.27
49	Kotdwara		Pauri	189,730	220,072	257,999	409,707	46,847	4,152	0	28,108	18,739	10.89	0.00	0.00	10.89	54,339	0	30.57	30.57

Source: Prepared by JST

Table 11-2 Basic information of ULBs and sewerage development status in the state (2 of 2)

S.I.	Location			Population				House Hold 2021 (Nos)	Population density (Nos/km2)	Existing Used Water Infrastructure (2021)							Used Water-Gap Identification (2025)			
	ULB	UUWSP	District	2021	2025	2030	2050			No. of households having sewer connections	No. of households having septic tanks	No. of households having no sewer connections or septic tanks	Total Sewage Generation (MLD)	Design capacity of Existing STPs (MLD)	Operational capacity of Existing STPs (MLD)	Untreated Sewage (MLD)	Required No. of sewer connections	No. of households for FSSM	Total Sewage Generation (MLD)	Estimated Gap (MLD)
50	Srinagar		Pauri	105,350	122,206	143,276	227,556	26,012	12,394	726	6,274	726	1.80	4.50	2.90	(1.10)	30,174	726	14.36	9.86
51	Pauri		Pauri	25,440	28,188	31,622	45,360	6,281	606	0	0	0	0.00	0.00	0.00	0.00	6,960	0	3.24	3.24
52	Berinag	✔	Pitthoragarh	11,951	12,094	12,274	12,991	2,951	1,707	0	2,061	890	0.69	0.00	0.00	0.69	2,986	0	1.65	1.65
53	Gangoliahat	✔	Pitthoragarh	11,037	11,147	11,285	11,837	2,725	1,657	0	1,918	807	0.63	0.00	0.00	0.63	2,752	0	1.25	1.25
54	Didihat		Pitthoragarh	8,852	10,116	11,697	18,019	2,186	2,059	0	2,186	0	0.51	0.00	0.00	0.51	2,498	0	1.19	1.19
55	Dharchula		Pitthoragarh	7,835	8,189	8,633	10,405	1,935	2,239	499	1,436	0	0.45	0.00	0.00	0.45	2,022	499	0.92	0.92
56	Pitthoragarh		Pitthoragarh	82,313	90,238	100,144	139,770	20,324	7,396	1,026	2,086	17,212	4.73	6.25	0.28	4.45	24,746	1,026	13.84	7.59
57	Agastmuni	✔	Rudraparyag	15,475	16,837	18,539	25,348	3,821	2,959	0	3,439	382	0.89	0.75	0.00	0.89	4,157	0	2.04	1.29
58	Tilwara	✔	Rudraparyag	8,181	8,901	9,801	13,400	2,020	3,041	0	1,818	202	0.47	0.10	0.00	0.47	2,198	0	1.71	1.61
59	Rudraparyag	✔	Rudraparyag	24,209	26,339	29,002	39,654	5,978	2,421	0	5,380	598	1.39	0.00	0.00	1.39	6,503	0	5.13	5.13
60	Ukhimath	✔	Rudraparyag	6,879	7,484	8,241	11,268	1,699	1,694	0	1,529	170	0.40	0.00	0.00	0.40	1,848	0	0.93	0.93
61	Kedarnath		Rudraparyag	8,012	8,717	9,598	13,124	1,978	11,446	0	1,780	198	0.46	1.03	0.00	0.46	2,152	0	0.97	(0.06)
62	Chamba	✔	Tehri Garhwal	15,457	16,817	18,517	25,319	3,817	3,864	0	3,435	436	0.90	0.00	0.00	0.90	4,152	0	1.91	1.91
63	Tehri (New Tehri)	✔	Tehri Garhwal	35,401	38,799	43,048	60,040	8,741	885	4,000	4,741	0	2.03	6.00	2.50	(0.47)	9,580	4,000	4.45	(1.55)
64	Narendra Nagar		Tehri Garhwal	11,211	12,422	13,935	19,989	2,768	1,082	0	2,768	0	0.64	0.00	0.00	0.64	3,067	0	1.41	1.41
65	Lambgaon	✔	Tehri Garhwal	2,460	2,588	2,748	3,387	607	743	0	487	120	0.14	0.00	0.00	0.14	639	0	0.29	0.29
66	Muni Ki Reti-Dhalwala		Tehri Garhwal	18,544	20,398	22,716	31,988	4,579	5,360	0	4,579	0	1.06	0.00	0.00	1.06	5,037	0	2.31	2.31
67	Gaja		Tehri Garhwal	2,645	2,899	3,216	4,486	653	2,449	0	653	0	0.15	0.00	0.00	0.15	716	0	0.32	0.32
68	Ghansali	✔	Tehri Garhwal	8,864	9,360	9,981	12,463	2,189	5,540	0	792	0	0.18	0.00	0.00	0.18	2,311	0	1.05	1.05
69	Kritinagar	✔	Tehri Garhwal	4,877	5,156	5,505	6,899	1,204	5,028	0	628	576	0.28	0.00	0.00	0.28	1,273	0	0.58	0.58
70	Chamiyala	✔	Tehri Garhwal	5,719	6,039	6,440	8,041	1,412	3,574	0	839	573	0.33	0.00	0.00	0.33	1,491	0	0.68	0.68
71	Devprayag		Tehri Garhwal	3,100	3,435	3,853	5,527	765	1,649	418	133	214	0.18	1.62	0.49	(0.31)	848	418	0.80	(0.82)
72	Gadarpur		U.S. Nagar	35,027	40,071	46,376	71,595	8,649	5,473	0	8,649	0	2.01	0.00	0.00	2.01	9,894	0	4.67	4.67
73	Khatima		U.S. Nagar	71,643	79,094	88,407	125,662	17,690	4,935	0	17,650	40	4.11	0.00	0.00	4.11	19,529	0	8.77	8.77
74	Kela Khera		U.S. Nagar	13,752	15,182	16,970	24,121	3,396	2,761	0	3,396	0	0.79	0.00	0.00	0.79	3,749	0	1.79	1.79
75	Nanakmatta		U.S. Nagar	10,384	11,318	12,485	17,154	2,564	1,766	0	2,420	144	0.60	0.00	0.00	0.60	2,795	0	1.29	1.29
76	Shaktigarh		U.S. Nagar	7,784	8,625	9,676	13,879	1,922	2,982	0	1,900	22	0.45	0.00	0.00	0.45	2,130	0	0.96	0.96
77	Gularbhoj		U.S. Nagar	7,177	8,216	9,515	14,709	1,772	3,385	0	1,722	50	0.41	0.00	0.00	0.41	2,029	0	0.97	0.97
78	Dineshpur		U.S. Nagar	15,438	17,667	20,454	31,600	3,812	3,765	0	3,812	0	0.89	0.00	0.00	0.89	4,362	0	2.08	2.08
79	Sultanpur		U.S. Nagar	14,745	16,178	17,970	25,136	3,641	3,650	0	3,641	0	0.85	0.00	0.00	0.85	3,995	0	1.89	1.89
80	Mahua Kheraganj		U.S. Nagar	16,479	18,519	21,069	31,270	4,069	2,022	0	4,069	0	0.95	0.00	0.00	0.95	4,573	0	3.37	3.37
81	Mahua Dabra Haripura		U.S. Nagar	8,784	9,483	10,357	13,853	2,169	2,142	0	2,169	0	0.50	0.00	0.00	0.50	2,341	0	1.07	1.07
82	Rudrapur		U.S. Nagar	203,347	245,969	299,245	512,353	50,209	3,682	0	50,209	0	11.67	0.00	0.00	11.67	60,733	0	28.90	28.90
83	Kichha		U.S. Nagar	113,318	137,074	166,769	285,549	27,980	3,913	0	27,980	0	6.51	0.00	0.00	6.51	33,845	0	16.10	16.10
84	Sitarganj		U.S. Nagar	38,840	42,879	47,929	68,125	9,590	15,536	0	8,044	1,546	2.23	0.00	0.00	2.23	10,587	0	4.92	4.92
85	Bazpur		U.S. Nagar	31,713	34,796	38,649	54,061	7,830	4,479	0	7,830	0	1.82	0.00	0.00	1.82	8,592	0	3.99	3.99
86	Jaspur	✔	U.S. Nagar	77,500	89,466	104,424	164,254	19,136	9,885	0	19,136	0	4.45	0.00	0.00	4.45	22,090	0	10.27	10.27
87	Kashipur		U.S. Nagar	246,498	277,014	315,160	467,742	60,864	6,192	1,162	59,702	1,162	14.42	0.00	0.00	14.42	68,399	1,162	32.55	32.55
88	Purola	✔	Uttarkashi	9,173	10,070	11,192	15,677	2,265	1,744	0	1,750	515	0.53	0.00	0.00	0.53	2,486	0	2.94	2.94
89	Barkot	✔	Uttarkashi	26,799	28,756	31,203	40,990	6,617	3,828	0	6,600	17	1.54	0.00	0.00	1.54	7,100	0	6.13	6.13
90	Naugaon	✔	Uttarkashi	5,928	6,361	6,902	9,067	1,464	847	0	1,144	320	0.34	0.00	0.00	0.34	1,571	0	2.20	2.20
91	Chinyalisaur	✔	Uttarkashi	11,929	12,930	14,181	19,187	2,945	1,930	0	2,147	798	0.69	0.00	0.00	0.69	3,193	0	3.17	3.17
92	Uttarkashi		Uttarkashi	33,224	36,226	39,979	54,989	8,203	2,233	3,850	3,806	547	1.91	2.00	2.00	(0.09)	8,945	547	7.36	5.36
93	Gangotri		Uttarkashi	1,110	1,210	1,336	1,837	274	139	170	104	0	0.06	1.00	0.03	0.03	299	124	1.74	0.74
Total				**4,720,177**	**5,294,834**	**6,015,762**	**8,899,439**	**1,165,476**	**376,207**	**325,877**	**629,578**	**196,384**	**273.98**	**413.32**	**226.05**	**47.93**	**1,396,353**	**202,520**	**792.22**	**378.90**

Source: Prepared by JST

11.1.3 Selection of Priority Areas on Sewerage Development

(1) Examination of untreated wastewater volume in the future

According to the UKPJN, the following table on the next page provides additional information on the capacity of sewage treatment plants that are currently in progress or planned for implementation. Since we could not obtain information regarding the projected sewage volume in 2050, we calculated it proportionally based on the population and sewage generation for the year 2025 and the estimated population for 2050.

In the same table, each ULB is arranged in descending order of the amount of untreated wastewater volume expected in the year 2050. This means that the regions at the top of the list are areas of concern where future increases in environmental pressure and deterioration in sanitation conditions are anticipated. It is worth noting that among the areas covered by the current project (UUWSP), Jaspur in U.S. Nagar district is estimated to be the region where the highest volume of untreated wastewater is expected in the future.

Table 11-3 Estimated sewage treatment status in the future (1/3)

S.I.	Location			Used Water-Gap Identification (2025)				Gap Analysis (2025)			STP capacity after completion of new projects				Used Water-Gap (2050)		Gap Analysis (2050)	
	ULB	Region	District	Required No. of sewer connections	No. of households for FSSM	Total Sewage Generation (MLD)	Estimated Gap (MLD)	Operational capacity / Sewage Generation	Design gap / Sewage Generation	Untreated / Sewage Generation	Exsting STP capacity (MLD)	On-going STP capacity (MLD)	Proposed STP capacity (MLD)	Total Capacity after completion (MLD)	Estimated Total Sewage Generation in 2050 (MLD)	Estimated Gap (MLD) ●Desc. Order	Treated / Sewage Generation	Untreated / Sewage Generation
23	Dehradun	Garhwal	Dehradun	388,616	177,858	216.78	98.65	20%	34%	46%	118.13	18.00	35.50	171.63	376.04	204.41	46%	54%
82	Rudrapur	Kumaon	U.S. Nagar	60,733	0	28.90	28.90	0%	0%	100%	0.00	0.00	0.00	0.00	60.20	60.20	0%	100%
49	Kotdwara	Garhwal	Pauri	54,339	0	30.57	30.57	0%	0%	100%	0.00	0.00	0.00	0.00	56.91	56.91	0%	100%
44	Haldwani	Kumaon	Nainital	110,715	6,123	61.79	33.79	0%	45%	55%	28.00	0.00	17.50	45.50	98.58	53.08	46%	54%
83	Kichha	Kumaon	U.S. Nagar	33,845	0	16.10	16.10	0%	0%	100%	0.00	3.00	0.00	3.00	33.54	30.54	9%	91%
22	Mussoorie	Garhwal	Dehradun	27,221	1,321	20.11	12.79	36%	0%	64%	7.32	3.50	0.00	10.82	41.02	30.20	26%	74%
87	Kashipur	Kumaon	U.S. Nagar	68,399	1,162	32.55	32.55	0%	0%	100%	0.00	31.80	0.00	31.80	54.96	23.16	58%	42%
25	Doiwala	Garhwal	Dehradun	23,403	0	13.16	13.16	0%	0%	100%	0.00	0.00	0.00	0.00	22.83	22.83	0%	100%
50	Srinagar	Garhwal	Pauri	30,174	726	14.36	9.86	20%	11%	69%	4.50	0.00	0.00	4.50	26.74	22.24	17%	83%
39	Ramnagar	Kumaon	Nainital	24,727	0	13.77	13.77	0%	0%	100%	0.00	0.00	0.00	0.00	22.16	22.16	0%	100%
86	Jaspur	Kumaon	U.S. Nagar	22,090	0	10.27	10.27	0%	0%	100%	0.00	0.00	0.00	0.00	18.86	18.86	0%	100%
29	Roorkee	Garhwal	Haridwar	56,717	3,000	31.39	(1.61)	16%	84%	0%	33.00	0.00	0.00	33.00	48.37	15.37	68%	32%
56	Pitthoragarh	Kumaon	Pitthoragarh	24,746	1,026	13.84	7.59	2%	43%	55%	6.25	0.00	0.00	6.25	21.44	15.19	29%	71%
73	Khatima	Kumaon	U.S. Nagar	19,529	0	8.77	8.77	0%	0%	100%	0.00	0.00	0.00	0.00	13.93	13.93	0%	100%
30	Manglaur	Garhwal	Haridwar	18,371	0	8.57	8.57	0%	0%	100%	0.00	0.00	0.00	0.00	11.22	11.22	0%	100%
24	Vikas Nagar	Garhwal	Dehradun	10,075	0	5.67	5.67	0%	0%	100%	0.00	0.00	0.00	0.00	9.84	9.84	0%	100%
92	Uttarkashi	Garhwal	Uttarkashi	8,945	547	7.36	5.36	27%	0%	73%	2.00	0.00	0.00	2.00	11.17	9.17	18%	82%
89	Barkot	Garhwal	Uttarkashi	7,100	0	6.13	6.13	0%	0%	100%	0.00	0.00	0.00	0.00	8.74	8.74	0%	100%
31	Shivalik Nagar	Garhwal	Haridwar	11,422	0	5.31	5.31	0%	0%	100%	0.00	0.00	0.00	0.00	8.36	8.36	0%	100%
72	Gadarpur	Kumaon	U.S. Nagar	9,894	0	4.67	4.67	0%	0%	100%	0.00	0.00	0.00	0.00	8.34	8.34	0%	100%
59	Rudraparyag	Garhwal	Rudraparyag	6,503	0	5.13	5.13	0%	0%	100%	0.00	0.00	0.00	0.00	7.72	7.72	0%	100%
43	Lalkuan	Kumaon	Nainital	4,063	0	4.06	4.06	0%	0%	100%	0.00	0.00	0.00	0.00	7.43	7.43	0%	100%
32	Laksar	Garhwal	Haridwar	8,843	0	4.69	4.69	0%	0%	100%	0.00	0.00	0.00	0.00	7.39	7.39	0%	100%
27	Selaqui	Garhwal	Dehradun	6,789	0	3.85	3.85	0%	0%	100%	0.00	0.00	0.00	0.00	7.19	7.19	0%	100%
7	Bageshwar	Garhwal	Bageshwar	8,852	0	4.04	4.04	0%	0%	100%	0.00	0.00	0.00	0.00	7.00	7.00	0%	100%
80	Mahua Kheraganj	Kumaon	U.S. Nagar	4,573	0	3.37	3.37	0%	0%	100%	0.00	0.00	0.00	0.00	5.69	5.69	0%	100%
51	Pauri	Garhwal	Pauri	6,960	0	3.24	3.24	0%	0%	100%	0.00	0.00	0.00	0.00	5.21	5.21	0%	100%
84	Sitarganj	Kumaon	U.S. Nagar	10,587	0	4.92	4.92	0%	0%	100%	0.00	3.00	0.00	3.00	7.82	4.82	38%	62%
91	Chinyalisaur	Garhwal	Uttarkashi	3,193	0	3.17	3.17	0%	0%	100%	0.00	0.00	0.00	0.00	4.70	4.70	0%	100%
88	Purola	Garhwal	Uttarkashi	2,486	0	2.94	2.94	0%	0%	100%	0.00	0.00	0.00	0.00	4.58	4.58	0%	100%
16	Gochar	Garhwal	Chamoli	4,207	0	2.31	2.31	0%	0%	100%	0.00	0.00	0.00	0.00	4.32	4.32	0%	100%
40	Bhimtal	Kumaon	Nainital	4,202	302	3.76	2.51	21%	12%	67%	1.25	0.00	0.00	1.25	5.50	4.25	23%	77%
78	Dineshpur	Kumaon	U.S. Nagar	4,362	0	2.08	2.08	0%	0%	100%	0.00	0.00	0.00	0.00	3.72	3.72	0%	100%
18	Tanakpur	Kumaon	Champawat	5,841	0	2.68	2.68	0%	0%	100%	0.00	0.00	0.00	0.00	3.67	3.67	0%	100%
9	Gairsain	Garhwal	Chamoli	3,851	0	1.77	1.77	0%	0%	100%	0.00	0.00	0.00	0.00	3.61	3.61	0%	100%
41	Bhowali	Kumaon	Nainital	3,254	0	2.28	2.28	0%	0%	100%	0.00	0.00	0.00	0.00	3.43	3.43	0%	100%
36	Landhaura	Garhwal	Haridwar	5,663	0	2.61	2.61	0%	0%	100%	0.00	0.00	0.00	0.00	3.42	3.42	0%	100%
33	Bhagwanpur	Garhwal	Haridwar	5,551	0	2.53	2.53	0%	0%	100%	0.00	0.00	0.00	0.00	3.31	3.31	0%	100%
8	Joshimath	Garhwal	Chamoli	6,040	0	2.77	1.69	0%	39%	61%	1.08	0.00	0.00	1.08	4.29	3.21	25%	75%

Source: Prepared by JST

Table 11-4 Estimated sewage treatment status in the future (2/3)

S.I.	Location			Used Water-Gap Identification (2025)				Gap Analysis (2025)			STP capacity after completion of new projects				Used Water-Gap (2050)		Gap Analysis (2050)	
	ULB	Region	District	Required No. of sewer connections	No. of households for FSSM	Total Sewage Generation (MLD)	Estimated Gap (MLD)	Operational capacity / Sewage Generation	Design gap / Sewage Generation	Untreated / Sewage Generation	Exsting STP capacity (MLD)	On-going STP capacity (MLD)	Proposed STP capacity (MLD)	Total Capacity after completion (MLD)	Estimated Total Sewage Generation in 2050 (MLD)	Estimated Gap (MLD) ●Desc. Order	Treated / Sewage Generation	Untreated / Sewage Generation
45	Nainital	Kumaon	Nainital	13,362	100	16.97	(2.23)	74%	26%	0%	19.20	0.00	0.00	19.20	22.40	3.20	86%	14%
90	Naugaon	Garhwal	Uttarkashi	1,571	0	2.20	2.20	0%	0%	100%	0.00	0.00	0.00	0.00	3.14	3.14	0%	100%
35	Piran Kaliyar	Garhwal	Haridwar	5,050	0	2.32	2.32	0%	0%	100%	0.00	0.00	0.00	0.00	3.04	3.04	0%	100%
28	Herbetpur	Garhwal	Dehradun	3,588	0	1.91	1.91	0%	0%	100%	0.00	0.00	0.00	0.00	3.00	3.00	0%	100%
62	Chamba	Garhwal	Tehri Garhwal	4,152	0	1.91	1.91	0%	0%	100%	0.00	0.00	0.00	0.00	2.88	2.88	0%	100%
74	Kela Khera	Kumaon	U.S. Nagar	3,749	0	1.79	1.79	0%	0%	100%	0.00	0.00	0.00	0.00	2.84	2.84	0%	100%
5	Almora	Kumaon	Almora	10,411	1,036	4.77	2.77	42%	0%	58%	2.00	1.50	0.00	3.50	6.24	2.74	56%	44%
11	Pipalkothi	Garhwal	Chamoli	2,144	0	1.74	1.74	0%	0%	100%	0.00	0.00	0.00	0.00	2.55	2.55	0%	100%
19	Champawat	Kumaon	Champawat	3,895	0	1.79	1.79	0%	0%	100%	0.00	0.00	0.00	0.00	2.45	2.45	0%	100%
79	Sultanpur	Kumaon	U.S. Nagar	3,995	0	1.89	1.89	0%	0%	100%	0.00	0.50	0.00	0.50	2.94	2.44	17%	83%
57	Agastmuni	Garhwal	Rudraparyag	4,157	0	2.04	1.29	0%	37%	63%	0.75	0.00	0.00	0.75	3.07	2.32	24%	76%
64	Narendra Nagar	Garhwal	Tehri Garhwal	3,067	0	1.41	1.41	0%	0%	100%	0.00	0.00	0.00	0.00	2.27	2.27	0%	100%
48	Satpuli	Garhwal	Pauri	2,674	0	1.27	1.27	0%	0%	100%	0.00	0.00	0.00	0.00	2.24	2.24	0%	100%
58	Tilwara	Garhwal	Rudraparyag	2,198	0	1.71	1.61	0%	6%	94%	0.10	0.32	0.00	0.42	2.57	2.15	16%	84%
54	Didihat	Kumaon	Pitthoragarh	2,498	0	1.19	1.19	0%	0%	100%	0.00	0.00	0.00	0.00	2.12	2.12	0%	100%
12	Karanparyag	Garhwal	Chamoli	3,344	0	1.52	1.17	11%	12%	77%	0.35	0.00	0.00	0.35	2.38	2.03	15%	85%
34	Jhabrera	Garhwal	Haridwar	3,402	0	1.54	1.54	0%	0%	100%	0.00	0.00	0.00	0.00	2.02	2.02	0%	100%
75	Nanakmatta	Kumaon	U.S. Nagar	2,795	0	1.29	1.29	0%	0%	100%	0.00	0.00	0.00	0.00	1.96	1.96	0%	100%
42	Kaladhungi	Kumaon	Nainital	2,616	0	1.19	1.19	0%	0%	100%	0.00	0.00	0.00	0.00	1.87	1.87	0%	100%
17	Gopeshwar	Garhwal	Chamoli	5,977	4,101	4.03	(0.29)	33%	67%	0%	4.32	0.00	0.00	4.32	6.15	1.83	70%	30%
52	Berinag	Kumaon	Pitthoragarh	2,986	0	1.65	1.65	0%	0%	100%	0.00	0.00	0.00	0.00	1.77	1.77	0%	100%
77	Gularbhoj	Kumaon	U.S. Nagar	2,029	0	0.97	0.97	0%	0%	100%	0.00	0.00	0.00	0.00	1.74	1.74	0%	100%
20	Lohaghat	Kumaon	Champawat	2,750	0	1.26	1.26	0%	0%	100%	0.00	0.00	0.00	0.00	1.72	1.72	0%	100%
93	Gangotri	Garhwal	Uttarkashi	299	124	1.74	0.74	2%	56%	43%	1.00	0.00	0.00	1.00	2.64	1.64	38%	62%
6	KAPKOT	Garhwal	Bageshwar	2,052	0	0.93	0.93	0%	0%	100%	0.00	0.00	0.00	0.00	1.58	1.58	0%	100%
81	Mahua Dabra Haripura	Kumaon	U.S. Nagar	2,341	0	1.07	1.07	0%	0%	100%	0.00	0.00	0.00	0.00	1.56	1.56	0%	100%
76	Shaktigarh	Kumaon	U.S. Nagar	2,130	0	0.96	0.96	0%	0%	100%	0.00	0.00	0.00	0.00	1.54	1.54	0%	100%
38	Padli Gujjar	Garhwal	Haridwar	2,474	0	1.11	1.11	0%	0%	100%	0.00	0.00	0.00	0.00	1.45	1.45	0%	100%
60	Ukhimath	Garhwal	Rudraparyag	1,848	0	0.93	0.93	0%	0%	100%	0.00	0.00	0.00	0.00	1.40	1.40	0%	100%
68	Ghansali	Garhwal	Tehri Garhwal	2,311	0	1.05	1.05	0%	0%	100%	0.00	0.00	0.00	0.00	1.40	1.40	0%	100%
53	Gangoliahat	Kumaon	Pitthoragarh	2,752	0	1.25	1.25	0%	0%	100%	0.00	0.00	0.00	0.00	1.33	1.33	0%	100%
21	Banbasa	Kumaon	Champawat	2,030	0	0.92	0.92	0%	0%	100%	0.00	0.00	0.00	0.00	1.26	1.26	0%	100%
10	Tharali	Garhwal	Chamoli	1,671	0	0.75	0.75	0%	0%	100%	0.00	0.00	0.00	0.00	1.25	1.25	0%	100%
55	Dharchula	Kumaon	Pitthoragarh	2,022	499	0.92	0.92	0%	0%	100%	0.00	0.00	0.00	0.00	1.17	1.17	0%	100%
13	Pokhri	Garhwal	Chamoli	1,583	0	0.89	0.89	0%	0%	100%	0.00	0.00	0.00	0.00	1.14	1.14	0%	100%
14	Nandparyag	Garhwal	Chamoli	1,688	0	0.76	0.61	17%	3%	80%	0.15	0.00	0.00	0.15	1.19	1.04	13%	87%
2	Ranikhet	Kumaon	Almora	1,378	0	0.62	0.62	0%	0%	100%	0.00	0.00	0.00	0.00	0.95	0.95	0%	100%
70	Chamiyala	Garhwal	Tehri Garhwal	1,491	0	0.68	0.68	0%	0%	100%	0.00	0.00	0.00	0.00	0.91	0.91	0%	100%
63	Tehri (New Tehri)	Garhwal	Tehri Garhwal	9,580	4,000	4.45	(1.55)	56%	44%	0%	6.00	0.00	0.00	6.00	6.89	0.89	87%	13%

Source: Prepared by JST

Table 11-5 Estimated sewage treatment status in the future (2/3)

S.I.	Location			Used Water-Gap Identification (2025)				Gap Analysis (2025)			STP capacity after completion of new projects				Used Water-Gap (2050)		Gap Analysis (2050)	
	ULB	Region	District	Required No. of sewer connections	No. of households for FSSM	Total Sewage Generation (MLD)	Estimated Gap (MLD)	Operational capacity / Sewage Generation	Design gap / Sewage Generation	Untreated / Sewage Generation	Exsting STP capacity (MLD)	On-going STP capacity (MLD)	Proposed STP capacity (MLD)	Total Capacity after completion (MLD)	Estimated Total Sewage Generation in 2050 (MLD)	Estimated Gap (MLD) ●Desc. Order	Treated / Sewage Generation	Untreated / Sewage Generation
4	Choukhutiya	Kumaon	Almora	1,336	0	0.61	0.61	0%	0%	100%	0.00	0.00	0.00	0.00	0.82	0.82	0%	100%
69	Kritinagar	Garhwal	Tehri Garhwal	1,273	0	0.58	0.58	0%	0%	100%	0.00	0.00	0.00	0.00	0.78	0.78	0%	100%
1	Bhikiyasain	Kumaon	Almora	1,025	0	0.47	0.47	0%	0%	100%	0.00	0.00	0.00	0.00	0.69	0.69	0%	100%
47	Dugaada	Garhwal	Pauri	775	0	0.44	0.44	0%	0%	100%	0.00	0.00	0.00	0.00	0.64	0.64	0%	100%
67	Gaja	Garhwal	Tehri Garhwal	716	0	0.32	0.32	0%	0%	100%	0.00	0.00	0.00	0.00	0.50	0.50	0%	100%
3	Dwarahat	Kumaon	Almora	753	0	0.38	0.38	0%	0%	100%	0.00	0.00	0.00	0.00	0.45	0.45	0%	100%
61	Kedarnath	Garhwal	Rudraparyag	2,152	0	0.97	(0.06)	0%	100%	0%	1.03	0.00	0.00	1.03	1.46	0.43	71%	29%
65	Lambgaon	Garhwal	Tehri Garhwal	639	0	0.29	0.29	0%	0%	100%	0.00	0.00	0.00	0.00	0.38	0.38	0%	100%
15	Badrinathpuri	Garhwal	Chamoli	689	177	0.90	(0.37)	3%	97%	0%	1.27	0.00	0.00	1.27	1.45	0.18	88%	12%
85	Bazpur	Kumaon	U.S. Nagar	8,592	0	3.99	3.99	0%	0%	100%	0.00	10.00	0.00	10.00	6.20	0.00	100%	0%
66	Muni Ki Reti-Dhalwala	Garhwal	Tehri Garhwal	5,037	0	2.31	2.31	0%	0%	100%	0.00	8.30	0.00	8.30	3.62	0.00	100%	0%
71	Devprayag	Garhwal	Tehri Garhwal	848	418	0.80	(0.82)	61%	39%	0%	1.62	0.00	0.00	1.62	1.29	0.00	100%	0%
46	Swargashram Jonk	Garhwal	Pauri	1,494	0	1.82	(1.18)	4%	96%	0%	3.00	4.50	0.00	7.50	2.66	0.00	100%	0%
26	Rishiksh	Garhwal	Dehradun	33,763	0	15.34	(10.66)	100%	0%	0%	26.00	5.00	0.00	31.00	24.06	0.00	100%	0%
37	Haridwar	Garhwal	Haridwar	90,320	0	73.34	(71.66)	100%	0%	0%	145.00	0.00	8.00	153.00	115.04	0.00	100%	0%
Total				**1,396,353**	**202,520**	**792.22**	**378.90**				**413.32**	**89.42**	**61.00**	**563.74**	**1,324.29**	**819.10**		

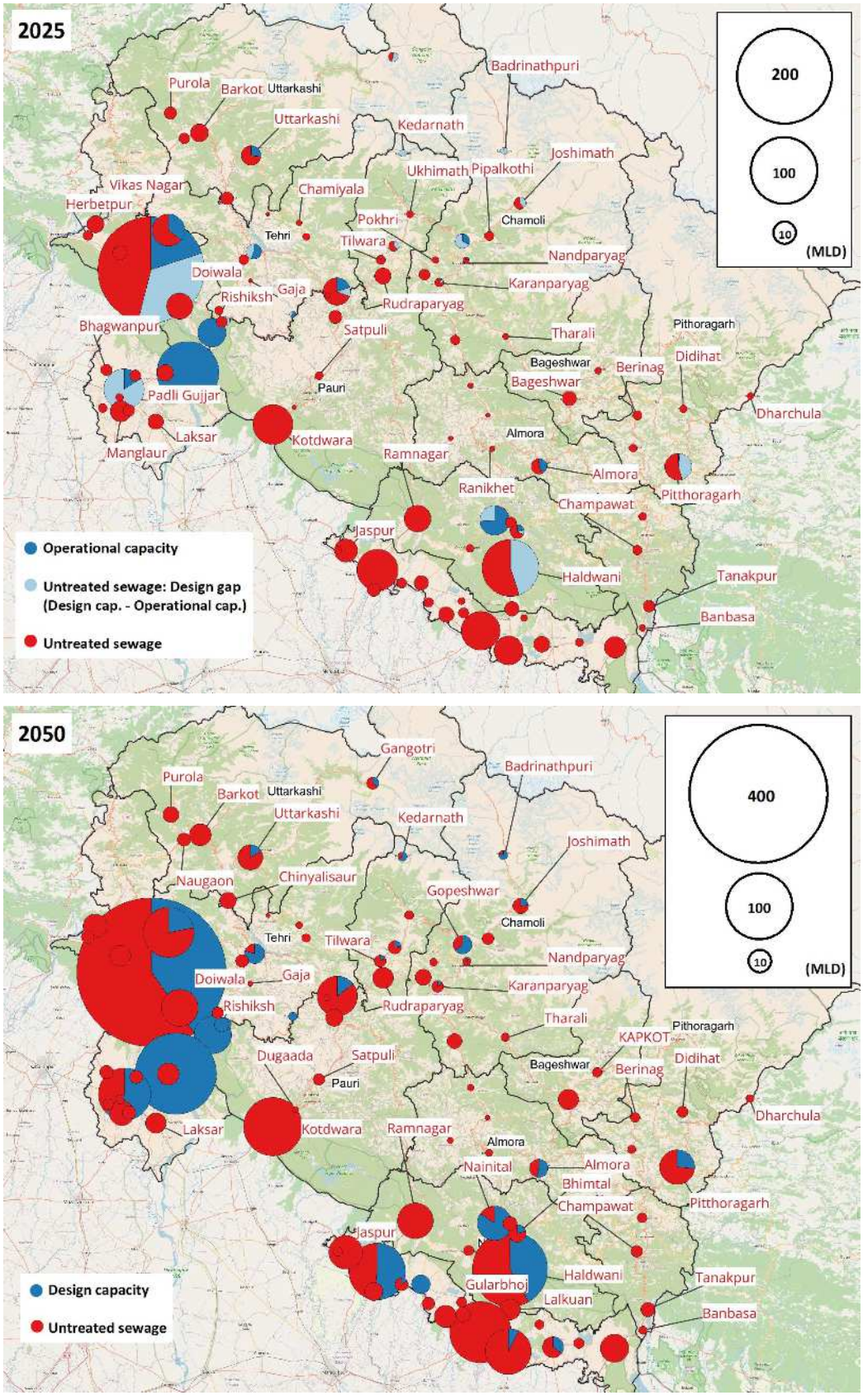
Source: Prepared by JST

(2) Estimated sewage treatment status in the future

Based on the table on the previous pages, Figure 11-1 visualises the status of the sewage system development for each ULB in terms of the projected sewage volume for the years 2025 and 2050. In this figure, the size of each circle at each ULB location represents the size of the generated sewage volume, and the pie charts within these circles represent the distribution of this volume.

In order to take into account situations where sewage pipelines and house connections are not yet in place, the upper part of Figure 11-1 for the year 2025 distinguishes between the amount of sewage that is currently treated by existing sewage treatment plants and the expected increase in treated sewage volume (currently counted as untreated sewage volume) due to future development of sewage pipelines.

The lower part of the figure for the year 2050 is based on the assumption that ongoing and planned development projects are established, and therefore does not make the same distinction as in the 2025 section. From this figure, it is evident that without additional development planning to accommodate the expected increase in sewage volume in the future, there is a concern about the increase in untreated wastewater.

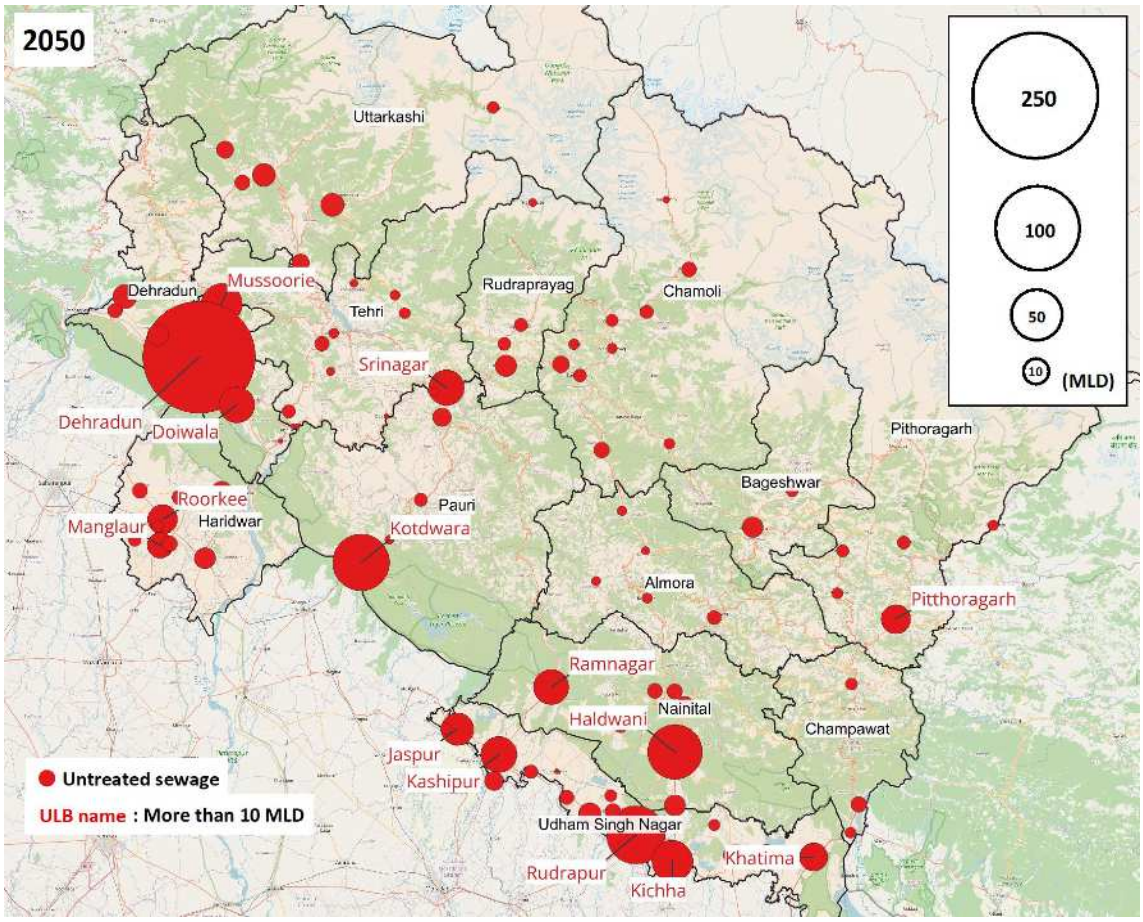


Source: Prepared by JST

Figure 11-1 Estimated sewage treatment status in the future (the years 2025 and 2050)

(3) Identification of the Water Pollution Risk in the future

Figure 11-2 shows the estimated level of untreated sewage in 2050 if no additional sewage system development plans are implemented in the future. In contrast to Figure 11-1, where the circular area represents the volume of sewage generated, only the scale of untreated sewage volume (in MLD) is shown here to illustrate the extent of the risk of water pollution. The regions highlighted in red indicate areas where the volume of untreated sewage exceeds 10 MLD.



Source: Prepared by JST

Figure 11-2 Estimated untreated sewage volume in the future (the year 2050)

As shown in Figure 11-2, Dehradun stands out as the area with the highest volume of untreated sewage and, as shown earlier in Figure 5-5, it also has a significantly elevated current risk of waterborne disease. Therefore, prioritizing sewage system development to improve sanitation conditions is deemed necessary in this region.

In addition, in the southern regions of the state, particularly in U.S. Nagar and Nainital districts, areas with substantial untreated sewage volume can be observed, primarily due to the high population density. As mentioned in Chapter 5, groundwater contamination in U.S.

Nagar and Haridwar districts has been reported. Continuous groundwater monitoring is therefore essential, as is the promotion of sewage system development projects.

In areas dependent on surface water sources (mountainous regions), the population is relatively small, and there is currently no confirmed contamination of river water quality. As a result, the urgency for sewerage system development is low in these areas. However, it is worth noting that some regions, such as Uttarkashi, Srinagar, and Pithoragarh, still have relatively large volumes of untreated sewage that require close attention.

(4) Priority of sewerage project implementation

Regarding the priority of sewerage project implementation, a scoring[2] is conducted for each ULB based on the following criteria, and the priority is set based on the total points of each criterion as listed in the table on the next page.

Criterion-1 Current water supply volume:

It is noted that in regions where extensive water supply is provided, assuming the implementation of sewage treatment facilities, a stable sewage generation is expected based on the water supply volume. Therefore, the current water supply volume is considered one of the indicators.

Criterion-2 Current number of households having no sewer and septic tank:

Despite the obligation to install septic tanks, as indicated in Table 11.1, there are regions with households where septic tanks have not been installed. In such areas, environmental pollution due to untreated sewage, including urine, is a concern. Therefore, the number of such households is considered one of the indicators.

Criterion-3 Untreated Sewage Volume in 2050:

As stated in Table 11.3, scoring is calculated based on the anticipated scale of untreated sewage in 2050.

[2] Scoring method: For each evaluation criterion, a scale is set where the maximum value among all ULBs is assigned 10 points, and the minimum value is assigned 5 points. Scores are then calculated based on the values of each evaluation criterion for each ULB, and the evaluation is conducted based on the total scores of the three criteria. However, Haridwar, Rishikesh, and similar areas with a untreated sewage volume of 0 in 2050 are excluded from this analysis.

Table 11-6 Sewerage project implementation priority proposal (1/2)

S.I.	Location			Criteria-1		Criteria-2		Criteria-3		Total Score
	ULB	UUWSP	District	Current Water Supply (MLD)	Score-1:	No. of households having no sewer connections or septic tanks	Score-2:	Estimated Used Water Gap Volume (2050)	Score-3:	●Desc. Order
23	Dehradun		Dehradun	312.1	**10.0**	35,572	**7.9**	204.4	**10.0**	**27.9**
44	Haldwani		Nainital	72.0	**6.2**	61,616	**10.0**	53.1	**6.3**	**22.5**
29	Roorkee		Haridwar	20.0	**5.3**	34,245	**7.8**	15.4	**5.4**	**18.5**
49	Kotdwara		Pauri	33.2	**5.5**	18,739	**6.5**	56.9	**6.4**	**18.4**
56	Pitthoragarh		Pitthoragarh	15.7	**5.3**	17,212	**6.4**	15.2	**5.4**	**17.0**
82	Rudrapur		U.S. Nagar	19.0	**5.3**	0	**5.0**	60.2	**6.5**	**16.8**
39	Ramnagar		Nainital	10.0	**5.2**	3,535	**5.3**	22.2	**5.5**	**16.0**
25	Doiwala		Dehradun	14.1	**5.2**	1,295	**5.1**	22.8	**5.6**	**15.9**
22	Mussoorie		Dehradun	7.7	**5.1**	10	**5.0**	30.2	**5.7**	**15.9**
87	Kashipur		U.S. Nagar	11.9	**5.2**	1,162	**5.1**	23.2	**5.6**	**15.9**
83	Kichha		U.S. Nagar	6.4	**5.1**	0	**5.0**	30.5	**5.7**	**15.9**
50	Srinagar		Pauri	9.7	**5.2**	726	**5.1**	22.2	**5.5**	**15.8**
24	Vikas Nagar		Dehradun	2.9	**5.0**	3,496	**5.3**	9.8	**5.2**	**15.6**
86	Jaspur	✔	U.S. Nagar	4.5	**5.1**	0	**5.0**	18.9	**5.5**	**15.5**
30	Manglaur		Haridwar	10.5	**5.2**	587	**5.0**	11.2	**5.3**	**15.5**
73	Khatima		U.S. Nagar	3.9	**5.1**	40	**5.0**	13.9	**5.3**	**15.4**
27	Selaqui		Dehradun	1.4	**5.0**	2,213	**5.2**	7.2	**5.2**	**15.4**
92	Uttarkashi		Uttarkashi	4.0	**5.1**	547	**5.0**	9.2	**5.2**	**15.3**
5	Almora	✔	Almora	16.0	**5.3**	0	**5.0**	2.7	**5.1**	**15.3**
31	Shivalik Nagar	✔	Haridwar	2.3	**5.0**	692	**5.1**	8.4	**5.2**	**15.3**
84	Sitarganj		U.S. Nagar	3.3	**5.1**	1,546	**5.1**	4.8	**5.1**	**15.3**
43	Lalkuan		Nainital	2.3	**5.0**	900	**5.1**	7.4	**5.2**	**15.3**
32	Laksar	✔	Haridwar	1.8	**5.0**	780	**5.1**	7.4	**5.2**	**15.3**
59	Rudraparyag	✔	Rudraparyag	1.7	**5.0**	598	**5.0**	7.7	**5.2**	**15.3**
72	Gadarpur		U.S. Nagar	2.6	**5.0**	0	**5.0**	8.3	**5.2**	**15.2**
45	Nainital		Nainital	10.0	**5.2**	0	**5.0**	3.2	**5.1**	**15.2**
89	Barkot	✔	Uttarkashi	0.5	**5.0**	17	**5.0**	8.7	**5.2**	**15.2**
7	Bageshwar	✔	Bageshwar	3.2	**5.1**	0	**5.0**	7.0	**5.2**	**15.2**
51	Pauri		Pauri	5.0	**5.1**	0	**5.0**	5.2	**5.1**	**15.2**
91	Chinyalisaur	✔	Uttarkashi	0.7	**5.0**	798	**5.1**	4.7	**5.1**	**15.2**
88	Purola	✔	Uttarkashi	0.5	**5.0**	515	**5.0**	4.6	**5.1**	**15.2**
28	Herbetpur		Dehradun	1.3	**5.0**	643	**5.1**	3.0	**5.1**	**15.1**
80	Mahua Kheraganj		U.S. Nagar	0.0	**5.0**	0	**5.0**	5.7	**5.1**	**15.1**
41	Bhowali	✔	Nainital	1.0	**5.0**	466	**5.0**	3.4	**5.1**	**15.1**
40	Bhimtal	✔	Nainital	1.8	**5.0**	0	**5.0**	4.3	**5.1**	**15.1**
16	Gochar		Chamoli	1.6	**5.0**	0	**5.0**	4.3	**5.1**	**15.1**
52	Berinag	✔	Pitthoragarh	0.7	**5.0**	890	**5.1**	1.8	**5.0**	**15.1**
18	Tanakpur		Champawat	1.9	**5.0**	0	**5.0**	3.7	**5.1**	**15.1**
78	Dineshpur		U.S. Nagar	1.5	**5.0**	0	**5.0**	3.7	**5.1**	**15.1**
36	Landhaura	✔	Haridwar	1.9	**5.0**	0	**5.0**	3.4	**5.1**	**15.1**
62	Chamba	✔	Tehri Garhwal	0.4	**5.0**	436	**5.0**	2.9	**5.1**	**15.1**
8	Joshimath	✔	Chamoli	2.1	**5.0**	0	**5.0**	3.2	**5.1**	**15.1**
35	Piran Kaliyar	✔	Haridwar	1.3	**5.0**	200	**5.0**	3.0	**5.1**	**15.1**
54	Didihat		Pitthoragarh	3.6	**5.1**	0	**5.0**	2.1	**5.1**	**15.1**

Source: Prepared by JST

Table 11-7 Sewerage project implementation priority proposal (2/2)

S.I.	Location			Criteria-1		Criteria-2		Criteria-3		Total Score
	ULB	UUWSP	District	Current Water Supply (MLD)	Score-1:	No. of households having no sewer connections or septic tanks	Score-2:	Estimated Used Water Gap Volume (2050)	Score-3:	●Desc. Order
64	Narendra Nagar		Tehri Garhwal	3.2	5.1	0	5.0	2.3	5.1	15.1
53	Gangoliahat	✔	Pitthoragarh	0.5	5.0	807	5.1	1.3	5.0	15.1
90	Naugaon	✔	Uttarkashi	0.2	5.0	320	5.0	3.1	5.1	15.1
57	Agastmuni	✔	Rudraparyag	0.9	5.0	382	5.0	2.3	5.1	15.1
17	Gopeshwar	✔	Chamoli	3.5	5.1	0	5.0	1.8	5.0	15.1
9	Gairsain	✔	Chamoli	0.4	5.0	0	5.0	3.6	5.1	15.1
33	Bhagwanpur	✔	Haridwar	0.8	5.0	0	5.0	3.3	5.1	15.1
63	Tehri (New Tehri)	✔	Tehri Garhwal	4.0	5.1	0	5.0	0.9	5.0	15.1
74	Kela Khera		U.S. Nagar	0.9	5.0	0	5.0	2.8	5.1	15.1
79	Sultanpur		U.S. Nagar	1.4	5.0	0	5.0	2.4	5.1	15.1
12	Karanparyag		Chamoli	1.9	5.0	0	5.0	2.0	5.0	15.1
58	Tilwara	✔	Rudraparyag	0.6	5.0	202	5.0	2.2	5.1	15.1
70	Chamiyala	✔	Tehri Garhwal	0.3	5.0	573	5.0	0.9	5.0	15.1
76	Shaktigarh		U.S. Nagar	2.1	5.0	22	5.0	1.5	5.0	15.1
19	Champawat	✔	Champawat	0.7	5.0	0	5.0	2.4	5.1	15.1
75	Nanakmatta		U.S. Nagar	0.7	5.0	144	5.0	2.0	5.0	15.1
34	Jhabrera		Haridwar	1.1	5.0	34	5.0	2.0	5.0	15.1
69	Kritinagar	✔	Tehri Garhwal	0.1	5.0	576	5.0	0.8	5.0	15.1
11	Pipalkothi	✔	Chamoli	0.3	5.0	0	5.0	2.5	5.1	15.1
48	Satpuli		Pauri	0.5	5.0	0	5.0	2.2	5.1	15.1
6	KAPKOT		Bageshwar	1.3	5.0	0	5.0	1.6	5.0	15.1
42	Kaladhungi	✔	Nainital	0.8	5.0	0	5.0	1.9	5.0	15.1
55	Dharchula		Pitthoragarh	1.8	5.0	0	5.0	1.2	5.0	15.1
60	Ukhimath	✔	Rudraparyag	0.4	5.0	170	5.0	1.4	5.0	15.1
77	Gularbhoj		U.S. Nagar	0.5	5.0	50	5.0	1.7	5.0	15.1
81	Mahua Dabra Haripura		U.S. Nagar	0.6	5.0	0	5.0	1.6	5.0	15.0
20	Lohaghat	✔	Champawat	0.3	5.0	0	5.0	1.7	5.0	15.0
93	Gangotri		Uttarkashi	0.2	5.0	0	5.0	1.6	5.0	15.0
68	Ghansali	✔	Tehri Garhwal	0.5	5.0	0	5.0	1.4	5.0	15.0
13	Pokhri		Chamoli	0.9	5.0	0	5.0	1.1	5.0	15.0
21	Banbasa		Champawat	0.7	5.0	0	5.0	1.3	5.0	15.0
38	Padli Gujjar		Haridwar	0.1	5.0	0	5.0	1.5	5.0	15.0
10	Tharali	✔	Chamoli	0.2	5.0	0	5.0	1.3	5.0	15.0
61	Kedarnath		Rudraparyag	0.3	5.0	198	5.0	0.4	5.0	15.0
14	Nandparyag	✔	Chamoli	0.2	5.0	0	5.0	1.0	5.0	15.0
2	Ranikhet	✔	Almora	0.2	5.0	0	5.0	1.0	5.0	15.0
4	Choukhutiya		Almora	0.4	5.0	0	5.0	0.8	5.0	15.0
15	Badrinathpuri		Chamoli	1.3	5.0	0	5.0	0.2	5.0	15.0
1	Bhikiyasain	✔	Almora	0.3	5.0	18	5.0	0.7	5.0	15.0
47	Dugaada		Pauri	0.2	5.0	33	5.0	0.6	5.0	15.0
65	Lambgaon	✔	Tehri Garhwal	0.1	5.0	120	5.0	0.4	5.0	15.0
3	Dwarahat	✔	Almora	0.2	5.0	0	5.0	0.5	5.0	15.0
67	Gaja		Tehri Garhwal	0.0	5.0	0	5.0	0.5	5.0	15.0

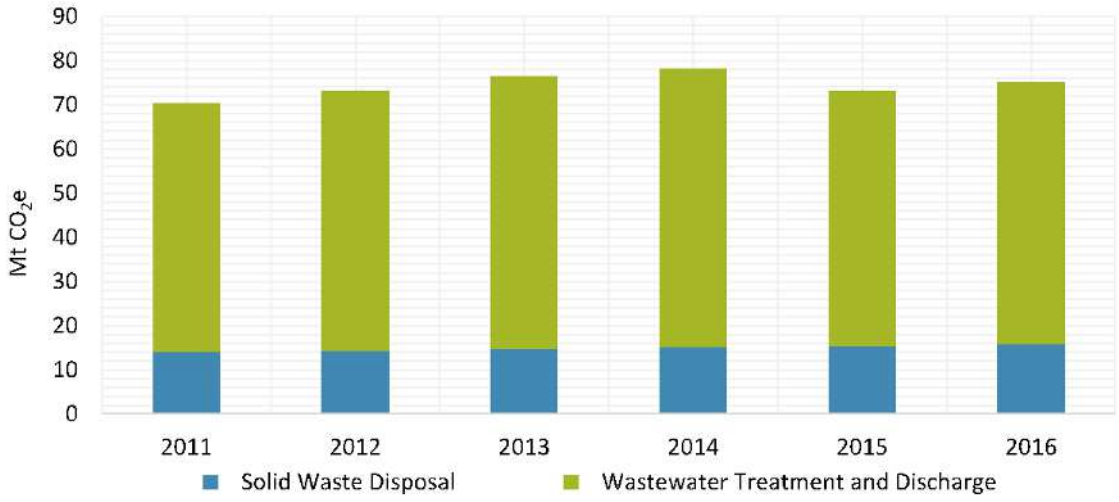
Source: Prepared by JST

11.2 Contribution of Sewerage Development to Climate Change Mitigation

11.2.1 Current Status of Greenhouse Gas Emissions in the Sewerage Sector

The trend in greenhouse gas emissions in the sewerage sector of India is illustrated in the following figure. Within the figure, attention is directed to the green segment, focusing specifically on the sewerage sector, as the waste management sector is also included.

In recent years, the combined emissions from the waste and sewerage sectors have shown a stable trend. As of 2016, the total emissions stood at 75.2 Mt-CO_2/year, with the sewerage sector contributing 59.4 Mt-CO_2/year (78.9%). The breakdown of greenhouse gas emissions from the sewerage sector reveals that 65.4% originates from households, while 34.6% comes from industrial sources. This includes emissions from on-site and off-site treatment, as well as untreated discharges. Considering that the overall greenhouse gas emissions for India in the same year were 2,839 Mt-CO_2/year, the sewerage sector represents approximately 2% of the total emissions across all sectors.[1]



Source: India Third Biennial Update Report, 2021

Figure 11-3 The trend in greenhouse gas emissions in the sewerage sector of India

11.2.2 Contribution of Sewerage System Development to Mitigation Measures

As shown in the Table 11-5, it is estimated that the untreated sewage volume in the entire UK state to be 819.1 MLD as of the year 2050 in this study. Concerns arise regarding the generation of greenhouse gases such as methane and nitrous oxide when such a volume of untreated sewage is discharged into the natural environment.

Table 11.8 calculates the greenhouse gas emissions from untreated sewage discharge if sewerage system development is not pursued, as well as the reduction in greenhouse gas emissions when the entire volume is treated. In this analysis, following the emission

calculation methods of the Japanese Ministry of the Environment, it is assumed that methane is generated from organic matter in untreated sewage, and nitrous oxide is produced from nitrogen in the natural environment.

In the scenario where sewerage system development is not pursued, i.e., no mitigation measures are implemented, the estimated total emissions in terms of CO_2 equivalent amount to approximately 156,000 tons per year (as shown in the Table item ①). On the other hand, if sewerage system development is carried out, and the entire sewage volume is treated at sewage treatment plants, the emissions reduce to approximately 7,000 tons per year (as shown in the Table item ②). Therefore, the implementation of sewerage system development is expected to result in a reduction of approximately 149,000 tons per year (0.15 Mt-CO_2/year) in greenhouse gas emissions.

Table 11-8 The estimation of GHG reduction effect by sewerage development in the UK

Symbol	Items	Unit	Imput, Output	References
U	Untreated sewage volume (Statewide, 2050)	MLD	819.10	Table11-5
	〃	MLY	298,972	
	〃	m^3/year	298,971,500	
c1	Untreated sewage: BOD conc.	mg-BOD/L	250	Ref: CPHEEO std
	〃	kg-BOD/m^3	0.25	
c2	Untreated sewage: BOD load	kg-BOD/year	74,742,875	=U×c1
c3	Methane generation per BOD load	tCH_4/kg-BOD	0.00006	Ref: Japanese MoE std
c4	Global warming potential of Methane	tCO_2/tCH_4	28	
C	**Greenhouse Gas Emission from Sewage BOD**	**tCO_2/year**	**125,568**	=c2×c3×c4
n1	Untreated sewage: Nitrogen conc.	mg-N/L	50	Ref: CPHEEO std
	〃	kg-N/m^3	0.05	
n2	Untreated sewage: Nitrogen load	kg-N/year	14,948,575	=U×n1
n3	Nitrous oxide per Nitrogen load	tN_2O/kg-N	0.0000079	Ref: Japanese MoE std
n4	Global warming potential of Nitrous oxide	tCO_2/tN_2O	265	
N	**Greenhouse Gas Emission from Sewage Nitrogen**	**tCO_2/year**	**31,295**	=n2×n3×n4
①	**Greenhouse Gas Emissions w/o sewerage development**	**tCO_2/year**	**156,863**	**=C+N**
T	Treated sewage volume through STPs	m^3/year	298,971,500	=U
c5	Methane generation per sewage treatment volume	tCH_4/m^3	0.00000088	Ref: Japanese MoE std
c4	Global warming potential of Methane	tCO_2/tCH_4	28	
②	**Greenhouse Gas Emissions w/ sewerage development**	**tCO_2/year**	**7,367**	=T×c5×c4
	Greenhouse Gas Emission Reduction by sewerage development	**tCO_2/year**	**149,496**	**=①−②**

Source: Prepared by JST

11.3 Contribution to Gender Mainstreaming through Water Supply and Sewerage Development

11.3.1 Contribution to Gender Issues through Water Supply Development

As indicated in section "2.9.3 Actual Conditions of Water Pumping Labour" of this report, in rural areas, particularly in mountainous regions, women still face the burden of fetching water for long hours in distant and hazardous cliff locations. Additionally, even in urban areas, the deployment of water supply trucks during drought periods supply suggests that labor is incurred in transporting water from these trucks to households. It is presumed that such activities impose a labor burden due to water transportation, impacting women and girls who spend considerable time fetching water. This leads to opportunity costs, restricting girls' access to education and limiting women's engagement in income-generating productive activities.

Through the widespread adoption of water facilities and improvement in water supply conditions facilitated by the current project, labor associated with water fetching is expected to be reduced. This reduction not only diminishes the risks of accidents and SGBV related to remote water fetching labor but also increases opportunities for women's social participation by cutting down the time dedicated to such labor. It is anticipated that this will contribute to the revitalization of the local economy.

11.3.2 Contribution to Gender Issues through Sewerage Development

Toilets are essential facilities from a public health perspective, and the absence of toilet facilities, even communal ones, in areas without proper infrastructure leads to the continued practice of open defecation, posing risks such as SGBV and difficulties in maintaining hygienic menstrual practices.

In the UK state, as described in sections "2.10 Access to Sanitation Facilities" and "5.2 Sanitation Facility Status" of this report, the Swachh Bharat Mission has led to the widespread adoption of sanitation facilities, eradicating open defecation in the state, with the establishment of gender-segregated communal toilets. Therefore, in the UK state, gender-related challenges regarding open defecation are generally moving towards resolution.

However, despite the installation of communal toilets, the percentage of households with individual toilet installations in the state remained around 80% as of 2016. Moreover, even in cases where toilets are installed, improper septic tank cleaning and inadequate sanitation management are prevalent. From a gender perspective, the installation of flush toilets within one's home, available for use as per one's convenience, and in a hygienic environment is desirable. Furthermore, it can contribute to reducing the risk of infectious diseases like COVID-19 compared to communal toilets.

At the current stage of the government-led Swachh Bharat Mission Phase 2 project promoting sanitation facilities, an emphasis on sewerage development and thorough management of fecal sludge is expected to contribute to improving public health environments and, consequently, contribute to addressing gender-related challenges.

11.3.3 Initiatives from an Organizational Structure Perspective

Upon reviewing the organizational roster of UKPJN, it was confirmed that out of the total staff of 1,196 across the entire state of UK, female employees constitute 217, accounting for 18.1% of the total (Table 11.9). Therefore, approximately 80% of the staff are male, indicating a low proportion of female employees within UKPJN. Additionally, the majority of Executive Engineers in each office are male, and many female employees are employed in non-specialized roles such as Peon or Chowkidar.

Consequently, it is desirable to actively promote initiatives to improve the proportion of female employees within the organization in each district. Furthermore, advancing the appointment of women in managerial positions with decision-making authority will increase opportunities for gender-inclusive planning. Therefore, efforts should be made to enhance the representation of women in leadership roles, fostering a gender-inclusive perspective in the planning and decision-making processes.

Table 11-9 Gender-wise Distribution of Staff in UKPJN Organization

SL	Division	Male	Female	Total
1	PM Construction and Maintenance Unit Ganga Gopeshwar	8	3	11
2	Executive Engineer 2nd Construction Division Kotdwar	13	1	14
3	Superintending Engineer Construction Circle Nainital	7	1	8
4	Executive Engineer Central Store Division Dehradun	15	5	20
5	Superintending Engineer Construction Circle Pithoragarh	4	4	8
6	Executive Engineer Construction Division Almora	25	8	33
7	Executive Engineer Construction Division Bageshwar	19	7	26
8	Executive Engineer Construction Division Bhikiyasen	15	1	16
9	Executive Engineer Construction Division Chamba	25	3	28
10	Executive Engineer Construction Division Dehradun	16	7	23
11	Executive Engineer Construction Division Deoprayag	26	8	34
12	Executive Engineer Construction Division Didihat	19	7	26
13	Executive Engineer Construction Division Gangolihat	15	1	16
14	Executive Engineer Construction Division Ghansali	24	2	26
15	Executive Engineer Construction Division Gopeshwar	27	4	31
16	Executive Engineer Construction Division Haridwar	25	3	28
17	Executive Engineer Construction Division Karnprayag	19	1	20
18	Executive Engineer Construction Division Khatima	11	4	15
19	Executive Engineer Construction Division Muni Ki Reti	22	3	25
20	Executive Engineer Construction Division Musoorie	13	4	17
21	Executive Engineer Construction Division New Tehri	13	6	19
22	Executive Engineer Construction Division Pauri	22	6	28
23	Executive Engineer Construction Division Purodi	25	3	28
24	Executive Engineer Construction Division Ramnagar	14	6	20
25	Executive Engineer Construction Division Ranikhet	28	3	31
26	Executive Engineer Construction Division Rudraprayag	24	3	27
27	Executive Engineer Construction Division Srinagar	18	7	25
28	Executive Engineer Construction Division Udhamsingh Nagar	17	4	21
29	Executive Engineer Construction Division Uttarkashi	19	3	22
30	Executive Engineer Construction Division Champawat	22	3	25
31	Executive Engineer Doon Division Dehradun	26	7	33
32	Executive Engineer Construction Division Kotdwar	20	4	24
33	Executive Engineer Mechanical Division Almora	22	3	25
34	Executive Engineer Mechanical Division Dehradun	35	5	40
35	Executive Engineer Mechanical Division Haldwani	16	10	26
36	Executive Engineer Mechanical Division Haridwar	14	1	15
37	Executive Engineer Mechanical Division Kotdwar	23	3	26
38	Executive Engineer Mechanical Division New Tehri	1	1	2
39	PM Construction and Maintenance Unit Elect.Mechanical Ganga Haridwar	13	3	16
40	PM Construction and Maintenance Unit Ganga Haridwar	19	5	24
41	PM Construction and Maintenance Unit Ganga Rishikesh	16	0	16
42	PM Construction and Maintenance Unit Ganga Srinagar	8	3	11
43	Project Implementation Unit AMRUT Haldwani	29	11	40
44	Project Implementation Unit AMRUT Kashipur	18	6	24
45	Project Implementation Unit AMRUT Roorkee	9	5	14
46	Project Manager Construction Unit Chakrata	9	1	10
47	Project Manager Construction Unit Chamba	9	3	12
48	Project Manager Construction Unit Dehradun	11	1	12
49	Project Manager Construction Unit Lohaghat	8	4	12
50	Project Manager Construction Unit Pithoragarh	7	1	8
51	Project Manager Construction Unit Ranikhet	12	2	14
52	Project Manager Construction Unit Rishikesh	10	1	11
53	Project Manager Construction Unit Srinagar	9	2	11
54	Project Manager Construction Unit Udham Singh Nagar	9	3	12
55	Project Manager Mechanical Unit Dehradun	11	2	13
56	Temparary const. unit Pauri	6	0	6
57	Project Manager Temporary Construction Unit Sports Dehradun	9	0	9
58	Project Manager Construction Unit Ramnagar	16	1	17
59	World Bank Project Unit Dehradun	11	3	14
60	World Bank Project Unit Haldwani	9	0	9
61	World Bank Project Unit Haridwar	14	5	19
	TOTAL	979	217	1,196

Source: Prepared by JST

References for Chapter 11

[1] India Third Biennial Update Report to The United Nations Framework Convention on Climate Change, Ministry of Environment, Forest and Climate Change Government of India, 2021

Chapter 12 Consultants' recommendation

The consultants conducted a thorough review and confirmation of the DPRs for each sub-project before their departure to the site. The first on-site survey took place from May to June 2023, followed by the second on-site survey in January 2024.

Through these surveys, the consultants gathered their impressions and insights. They will consolidate these observations into advice and recommendations in this chapter to ensure the proper implementation of each sub-project.

12.1 Impact of natural disasters

(1) Landslides and debris flows

In mountainous regions, landslides and debris flows occur frequently, but the risk of their occurrence varies depending on the topography, geology and weather conditions. Places visited during the second on-site survey, such as Gairsain, Berinag, Gangolihat, and Lohaghat, are towns developed on gentle slopes with landslide terrain (Figure 12-1). According to the UK state slope angle distribution map, the south-eastern part of the mountainous region, which includes these towns, is dominated by areas with slope angles of less than 20 degree (Figure 12-2)[1]. The distribution of these loose slopes suggests that landslides have occurred repeatedly in the past.

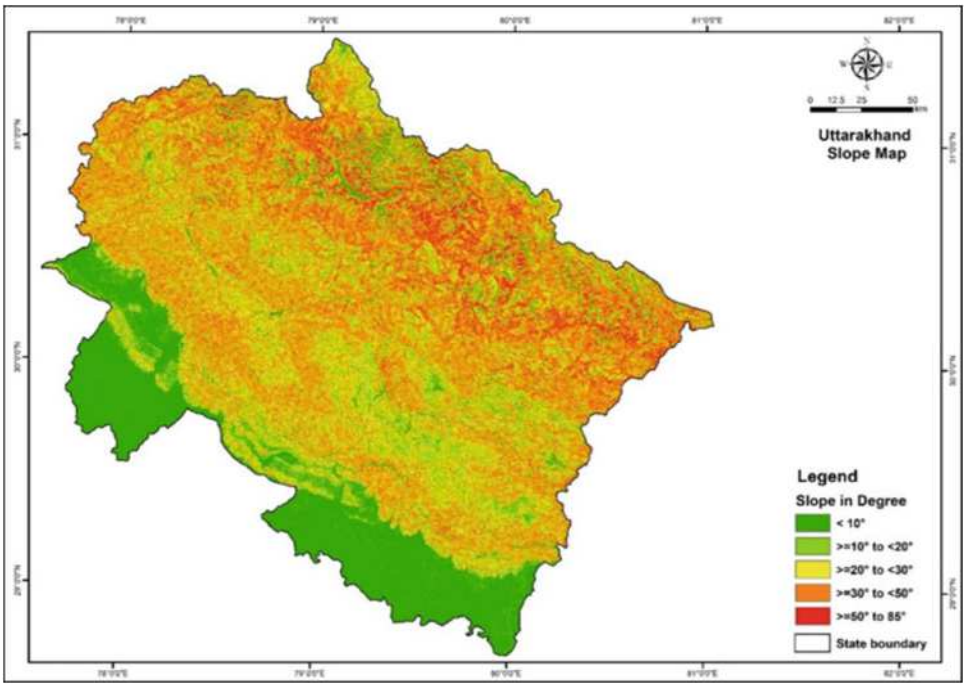
It is believed that these landslides occurred in ancient times, and the reactivation potential of the landslides themselves is considered low. However, it is important to consider the possibility of small-scale debris flows occurring at the boundaries of landslide blocks, requiring careful planning for facilities such as water purification plants and pipelines. In Lohaghat, it is reported that the water supply has to be stopped for two to three days at the small stream water intake points due to turbid water caused by the increased river water volume during the rainy season every year.

Furthermore, debris flows can cause destructive damage to various structures. Debris flows and slope failures were observed in many locations during the first on-site survey (Figure 12-3). During the second on-site survey, debris flows and slope failures were also observed in locations with similar topographical and geological conditions. It is crucial to carefully examine the geological conditions and consider construction plans for water supply facilities, including construction points and access roads accordingly.



Source : Prepared by JST

Figure 12-1 Towns and farmland on landslide terrain (left: Gangolihat, right: near Gairsain).



Source: Mani et al (2023)

Figure 12-2 Slope map in the UK state



Source : Prepared by JST

Figure 12-3 Debris flows (Left: near WTP, New Tehri) and slope failure (Right: Kirtinagar)

(2) Identification of high water levels during floods

In the UK state, floods frequently occur, primarily around major rivers, leading to both human and material damage. In recent years, the impacts of climate change have heightened the risk of irregular rainfall and glacial lake outbursts in the state, necessitating adequate caution even in surface water usage. As described in Chapter 2, flood damage is common in the upper reaches of rivers such as Uttarkashi, Rudraprayag, Chamoli and Pithoragarh. Among them, Pithoragarh district, in addition to having an average annual rainfall of more than 2,000 mm, is included in the zone with the highest risk of earthquake damage and is at very high risk of flooding[2]. Heavy rainfall in July 2020 caused landslides and debris flows in many villages upstream of the DPR target sites, killing 28 people[3]. The area contains the main boundary of the Himalayan geological tectonic zone, with many faults and fracture zones.

Flood patterns vary depending on location and season, emphasizing the importance of continuous monitoring in each region. However, even in DPRs with limited mention of river water levels, attention is often focused only on the minimum water levels during the dry season for assessing whether the required water volume can be met. Moving forward, as the construction of water supply facilities progresses, it is essential to establish a system to monitor also high water levels during floods from the perspective of the safety of intake points.

12.2 Region-wide water resources management plans

According to interviews conducted during the on-site surveys, frequent floods occur during the rainy season in some rivers in the mountainous regions. On the other hand, there are areas where a decreasing trend in flow rates is observed in the currently used springs and small rivers. Additionally, in the plains, problems related to groundwater use are not currently identified, but there are regions where a decrease in groundwater levels and contamination in the shallow aquifer are confirmed.

Both surface water and groundwater require accurate assessment of the current quantity and quality to achieve sustainable water resource management in the future. However, the information regarding water quantity and quality in the DPRs is very limited. Even when river flow data is provided, it is often based on surveys conducted by other agencies rather than independent measurements at the planned intake points. There were no DPRs that included information on groundwater levels, and no DPRs provided information on water quality for surface water and groundwater.

In order to develop appropriate water supply projects in the State, it is crucial to create a water resource management plan for the entire state, rather than just considering the 38 target areas. Strengthening monitoring systems for surface water and groundwater is necessary to accurately understand the current situation of water quantity and quality. Instead of relying on data from other agencies, independent monitoring at the intake points of water supply facilities is required. Monitoring results should be analyzed from the perspective of integrated water resource management to develop sustainable water resource utilization plans. Training of engineers capable of managing these plans is also required.

Moreover, while surface water utilization is primarily considered in the planning process for mountainous regions, the potential for groundwater use should also be explored, especially in areas with developed gentle slopes prone to landslides. Depending on the conditions, groundwater utilization may be more cost-effective and easier to maintain than using river water. In places like Lohaghat visited during the on-site surveys, wells for water supply and small household wells are actually utilized. The potential for groundwater use requires detailed surveys of topography and geology, and there is a need to train engineers within the UKPJN organization who can manage these aspects.

12.3 Sustainable maintenance

In the maintenance and management of water supply facilities in the UK state, it is inferred that the rich and continuous past experiences and technical expertise have been passed down through generations, and the high level of technical prowess is also astounding.

On the other hand, with the implementation of this project, it is anticipated that in many areas, there will be a need to change the maintenance and management systems as well as operational methods, compared to the past, to ensure stable water supply quantity and duration, and to secure safe water quality.

With the implementation of this project, it is believed that technical guidance will be necessary for increased water supply quantity and duration, changes in water treatment methods, ensuring water quality based on Indian standards, efficient operation of water intake, transmission, distribution, and pumping systems, as well as the introduction of IoT systems and automatic water meter reading systems.

After the completion of this project, the contractor is expected to provide operational management guidance for 6 months to 1 year. However, to implement sustainable operation and maintenance management, continuous management of water source water quantity, operation and maintenance management, and water quality management of water supply facilities are necessary.

Therefore, to ensure the sustainability of the sector loan's achievements and to utilize the experience for future appropriate water supply and sanitation services, the implementation of technical cooperation projects is proposed from the perspective of utilizing the experience gained.

Table 12-1 Expected Scope of Work covered by technical cooperation projects.

Scope of work	Purpose of the work
1 Technical guidance on source water quantity management	1) Understanding of water quantity management for intake wells. 2) Understanding of water quantity management for River Bank Filtration. 3) Understanding of water quantity management for Infiltration Wells. 4) Understanding of water quantity management for Uttaranchal Koop. 5) Understanding of water quantity management for surface water sources. 6) Understanding of water quantity management for spring water sources.

2 Technical guidance on operation and maintenance	1) Understanding of water treatment methods in the target area. 2) Understanding of the components and purposes of water treatment methods. 3) Understanding of pump systems for water transmission and distribution. 4) Understanding of IoT systems. 5) Training on appropriate operation and maintenance methods for water facilities. 6) Training on response methods to special situations such as accidents. 7) Understanding of chemical handling and management for coagulants, disinfectants, etc.
3 Technical guidance on water quality management	1) Understanding of water quality standards in India. 2) Understanding of water quality management parameters. 3) Understanding of the frequency of water quality parameter measurements. 4) Understanding of the usage of water quality analysis equipment. 5) Understanding of operational management methods for water treatment plants to respond to changes in source water quality.

References for Chapter 12

[1] Land Use Land Cover Changes and Climate Change Impact on the Water Resources: A Study of Uttarakhand State. River Conservation and Water Resource Management, Chapter 1, 1-16, Mani et al, 2023.

[2] Study of Drastic Disaster Events between 2010-2020 in District Pithoragarh by Using Remote Sensing and GIS Applications. International Journal of Research in Engineering and Science, 10-7, 146-157, Parihar and Pandey, 2022.

[3] Rain-Induced Slope Instability: Case Study of Monsoon 2020 Affected Villages in Pithoragarh District of Uttarakhand, India. International Journal of Earth Sciences Knowledge and Applications, 4 (1), 1-18, Khanduri, 2022.

Appendix

Appendix-1　　Member List of JICA Survey Team

(1) 1st Field Survey

Work Assignment	Name	Organizations
Team leader / Water supply, piping plan (Mountainous / remote areas)	YASHIRO Daisuke	NJS Co., Ltd.
Water source / Intake facility plan (Surface water / Ground water)	SUENAGA Kazuyuki	Earth System Science Co., Ltd.
Treatment process / Mechanical equipment	NUMAJIRI Yuusaku	NJS Co., Ltd.
Electrical equipment / Digital technology / DX	NATSUI Akio	NJS Co., Ltd.
Sewerage / Sanitation Plan (Mountainous / remote areas)	NATORI Teppei	NJS Co., Ltd.
Operation and maintenance / Cost estimate	FUJIWARA Hiroki	NJS Co., Ltd.
Management / Financial analysis	MIYOSHI Satonori	Yachiyo Engineering Co., Ltd.
Organization / HR development	TANAKA Mai	Yachiyo Engineering Co., Ltd.
Assistant for water supply and piping plan / Coordination of survey work 1	ISHIDA Akihisa	NJS Co., Ltd.
Assistant for water supply and piping plan / Coordination of survey work 2	EGUCHI Eiko	NJS Co., Ltd.

(2) 2nd Field Survey

Work Assignment	Name	Organizations
Team leader / Water supply, piping plan (Mountainous / remote areas)	YASHIRO Daisuke	NJS Co., Ltd.
Water source / Intake facility plan (Surface water / Ground water)	SUENAGA Kazuyuki	Earth System Science Co., Ltd.

Appendix-2 Survey Schedule

(1) 1st Field Survey (First Half)

MTG: Meeting
SS: Site survey
Traveling

	5/28	5/29	5/30	5/31	6/1	6/2	6/3	
	Sun	Mon	Tue	Wed	Thu	Fri	Sat	
7:00	TG323 07:35 (BKK) to 10:35 (DEL)							7:00
8:00				to Haridwar, Jagjeetpur STP, 2 hrs.				8:00
9:00			SS@ Mehuwla cluster Water Supply World Bank Project.		Dehradun to Chamba, 3 hr.	SS@New Tehri		9:00
10:00		MTG w/ UKPJN Officials	OHT, Collection Center, Tubwell & Smart Metering System under Mehuwala cluster.	SS@Jagjeetpur 68MLD STP, SCADA room for Jagjeetpur,		Intake*2 for New tehri, *2 for Chamba		10:00
11:00			to Bhagwanpur 1.5 hrs			WTP*1, STP*1		11:00
12:00		Lunch	Lunch	Lunch	Lunch	Lunch	OFF	12:00
13:00	UK617 13:50 (DEL) to 14:45 (DED)		SS@ Bhagwanpur tubwell & OHT	Haridwar to Shivalik Nagar, 0.5hr	SS@Chamba Town	OHT/CWR*2		13:00
14:00				SS@Shivalik Nagar TW*2, OHT*2	WTP*1	Proposed sites		14:00
15:00	to Dhr., 1.0hr	MTG w/ Central Ground Water Board, Uttaranchal Region (Discussion & Data Collection)			OHT/CWR*2	PAC test		15:00
16:00		MTG w/ Geological Survey of India, Uttarakhand (Discussion & Data Collection)	Back to Dehradun, 1.5hr	Back to Dehradun, 1.5hr	Proposed sites	Back to Dehradun, 3 hr.		16:00
17:00					PAC test			17:00
18:00					to New Tehri, 0.5hr			18:00
19:00					Stay at Hotel Bhagirathi Darshan.			19:00
20:00								20:00
	6/4	6/5	6/6	6/7	6/8	6/9	6/10	
	Sun	Mon	Tue	Wed	Thu	Fri	Sat	
7:00								7:00
8:00								8:00
9:00		Dehradun to Rishikesh, 1.5hr		Dehradun to Purkal Gaun 0.5hr.	Dehradun to Kirtinagar, 3.0hr	MTG w/ UKPJN	to Airport., 1.0hr	9:00
10:00			MTG w/ UKPJN, Secretary	SS@Purkal Gaun 15 MLD Water Treatment Plant Under Maintainance Jal Sansthan North Div.				10:00
11:00		SS@Rishikesh 26MLD STP (SBR)					TG324 11:40 (DEL) to 17:35 (BKK)	11:00
12:00	OFF	Lunch	Lunch	Lunch	Lunch	Lunch		12:00
13:00		OCMS control room			SS@Kirtinagar			13:00
14:00		to Rishkesh, 0.5hr	MTG w/ UKPJN	SS@Dilaram Chowk 27 MLD Water Treatment Plant Under Maintainance Jal Sansthan South Div.				14:00
15:00		SS@Rishikesh 7.5MLD STP (MBBR)						15:00
16:00			MTG w/ ADB		Back to Dehradun 3.0hr.			16:00
17:00		Back to Dehradun 1.5hr.		Back to Dehradun 0.5hr.				17:00
18:00								18:00
19:00								19:00
20:00								20:00

1st Field Survey (Second Half)

MTG: Meeting
SS: Site survey
SI: Site Interview
Traveling

	6/11 Sun			6/12 Mon			6/13 Tue			
7:00	Team-1	Team-2	Team-3	Team-1	Team-2	Team-3	Team-1	Team-2	Team-3	7:00
8:00	(Yashiro, Ishida)	(Miyoshi, Tanaka)	(Suenaga)	(Yashiro, Ishida)	(Miyoshi, Tanaka)	(Suenaga)	(Yashiro, Ishida)	(Miyoshi, Tanaka)	(Suenaga)	8:00
9:00							Work in the Hotel		to Bhimtal, 7.5hr	9:00
10:00				MTG w/ UKPJN	MTG w/ UKPJN	MTG w/ UKPJN		Interview w/UKPJN		10:00
11:00								(Finance)		11:00
12:00	Off		Off	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	12:00
13:00		UK 617 13:50 (DEL) to 14:45 (DED)		Work in the Hotel	MTG w/ UJS	Work in the Hotel	Work in the Hotel	Interview w/UKPJN		13:00
14:00								(Admin & HR)		14:00
15:00					Interview w/ UKPJN or UJS					15:00
16:00		to Dhr., 1.0hr			(General Information)			Interview w/UKPJN		16:00
17:00								(PIC)		17:00
18:00										18:00
19:00										19:00
20:00										20:00

	6/14 Wed			6/15 Thur			6/16 Fri		6/17 Sat	
7:00	Team-1	Team-2	Team-3	Team-1	Team-2	Team-3	Team-1	Team-2		7:00
8:00	(Yashiro, Ishida)	(Miyoshi, Tanaka)	(Suenaga)	(Yashiro, Ishida)	(Miyoshi, Tanaka)	(Suenaga)	(Yashiro, Ishida)	(Miyoshi, Tanaka)		8:00
9:00	Work in the Hotel		SS @Bhimtal	Work in the Hotel	Dhr. To Shivalik Nagar, 1.5hr	SS @ Jaspur				9:00
10:00		Interview w/UJS	TW, OHT			TW, OHT				10:00
11:00		(Finance)					MTG w/ UKPJN Site Survey Results	MTG w/ UKPJN, Site Survey Results		11:00
12:00	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch		12:00
13:00	Work in the Hotel	Interview w/UJS		Work in the Hotel	SI @Shivalik Nagar (Haridwar)	to Airport, 4.5hr	Work in the Hotel	Work in the Hotel		13:00
14:00		(Admin & HR)	to Jaspur, 3.5hr							14:00
15:00										15:00
16:00		Interview w/UJS			Back to Dhr., 1.5hr					16:00
17:00		(PIC)				TG316 23:30 (DEL) to 05:25 (BKK)				17:00
18:00										18:00
19:00										19:00
20:00										20:00

	6/18 Sun		6/19 Mon		6/20 Tue		6/21 Wed		
7:00	Team-1	Team-2	Team-1	Team-2	Team-1	Team-2	Team-1	Team-2	7:00
8:00	(Yashiro, Ishida)	(Miyoshi, Tanaka)	(Yashiro, Ishida)	(Miyoshi, Tanaka)	(Yashiro, Ishida)	(Miyoshi, Tanaka)	(Yashiro, Ishida)	(Miyoshi, Tanaka)	8:00
9:00	to Almora, 8.0hr		SS @Almora	to Tehri, 1.5hr	to Tharali, 4.0hr		Back to Dhr, 8.0hr		9:00
10:00						MTG w/ UJS (District Office)		MTG w/ UJS	10:00
11:00		Off							11:00
12:00	Lunch		Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	12:00
13:00			to Raniket, 1.5hr	UKPJN/UJS District Office	SS @Thalari	MTG w/ UKPJN			13:00
14:00									14:00
15:00			SS @Raniket						15:00
16:00				Back to Dhr, 1.5 h	Back to Almora, 4.0hr				16:00
17:00			Back to Almora, 1.5hr						17:00
18:00									18:00
19:00									19:00
20:00									20:00

	6/22 Thur		6/23 Fri		6/24 Sat	
7:00	Team-1	Team-2	Team-1	Team-2		7:00
8:00	(Yashiro, Ishida)	(Miyoshi, Tanaka)	(Yashiro, Ishida)	(Miyoshi, Tanaka)		8:00
9:00						9:00
10:00	SS@ Haridwar	MTG UKPJN	MTG w/ UKPJN	MTG w/ UKPJN		10:00
11:00	(Accompany with JICA Director)					11:00
12:00	Lunch	Lunch	to Airport, 1.0hr	Follow-up UKPJN or UJS		12:00
13:00		MTG UKPJN Secretary	6E 15:30 (DED) to 16:30 (DEL)			13:00
14:00			MTG w/ NJSEI	to Airport, 1.0hr		14:00
15:00		Follow-up UKPJN or UJS				15:00
16:00				UK618 15:20 (DED) to 16:15 (DEL)		16:00
17:00	Back to Dhr 3.0hr					17:00
18:00						18:00
19:00				24day		19:00
20:00			TG316 23:30 (DEL) to 05:25 (BKK)	JL030 19:05 (DEL) to 06:45 (HND)		20:00

(2) 2nd Field Survey

MTG: Meeting
SS: Site survey
SI: Site Interview
Traveling

	1/9 Tue		1/10 Wed		1/11 Thu		1/12 Fri		
7:00	Yashiro	Suenaga	Yashiro	Suenaga	Yashiro	Suenaga	Yashiro	Suenaga	7:00
8:00		NH849 00:15 (HND) to 9:55 (DEL)	6E2018 8:30 (DEL) to 9:20 (DED)		to Rudrapurayag., 0.5hr		to Bageshwar., 4.0hr		8:00
9:00					MTG w/ UKPJN, Rudraprayag				9:00
10:00	NH837 10:35 (HND) to 17:25 (DEL)		to Tilwara., 4.5hr						10:00
11:00					to Gairsain., 3.0hr				11:00
12:00							SS @ Bageshwar		12:00
13:00									13:00
14:00			Lunch		Lunch				14:00
15:00			SS @ Tilwara		SS @ Gairsain		Lunch		15:00
16:00							to Berinag., 2.0hr		16:00
17:00					MTG w/ UKPJN, Gairsain				17:00
18:00			Stay at Tilwara		Stay at Lohaghat		Stay at Berinag		18:00
19:00									19:00
20:00									20:00

	1/13 Sat		1/14 Sun		1/15 Mon		1/16 Tue		
7:00	Yashiro	Suenaga	Yashiro	Suenaga	Yashiro	Suenaga	Yashiro	Suenaga	7:00
8:00	SS @ Berinag								8:00
9:00			SS @ Berinag		to Dehli, 7.0hr				9:00
10:00	SS @ Gangolihat								10:00
11:00									11:00
12:00	MTG w/ UKPJN, Gangolihat		Lunch		Lunch				12:00
13:00			to Pantnagar, 6.0hr						13:00
14:00	Lunch								14:00
15:00	to Lohaghat, 3.0hr								15:00
16:00									16:00
17:00									17:00
18:00	Stay at Lohaghat		Stay at Pantnagar		NH838 18:55（DEL） to 06:00（HND）				18:00
19:00									19:00
20:00									20:00

Appendix-3 List of parties related to the project

(1) Uttarakhand Peyjal Nigam (UKPJN)

Uday Ray Singh	Add. Secretary
Namita Tripathi	Executive Engineer
G P Singh	General Manager
Rajesh Kumar Gupta	Executive Engineer Construction Division (Haridwar)
Jeetmani	Executive Engineer Construction Division (New Tehri)
Keshwanand Semwal	Executive Engineer Construction Division (Chamba)
Naval Kumar	Executive Engineer Construction Division (Rudharprayag)
Ranjeet Singh Dharmshaktu	Executive Engineer Construction Division (Pithoragarh)
Ashutosh Upadhyay	Executive Engineer Construction Division (Gangolihat)
Vijay Kumar Pal	Executive Engineer Construction Division (Champawat)
Sanjeev Verma	Executive Engineer Construction Division (Almora)
Sameer Pratap Singh	Executive Engineer Construction Division (Ranikhet)
Vipin Kumar Ravi	Executive Engineer Construction Division (Bhageshwar)
Aryn Pratap Singh	Executive Engineer Construction Division (Chamoli)

(2) Asian Development Bank (ADB)

Na Won Kim	Principal Urban Development Specialist
Vivek Vishal	Project Analyst

(3) Kreditanstalt für Wiederaufbau (kfw)

Rahul Mankotia	Sector Specialist

(4) JICA

Tatsuhiko Sunouchi	Senior Director, South Asia Division 1, South Asia Departmrnt