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Phase II
Uttarakhand and Uttar Pradesh

India

Indo-German Development Cooperation
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GOPA Infra GmbH
Hindenburgring 18, 61348 Bad Homburg, Germany
Phone +49 6172 6817-0 Fax: +49 6172 25748 Email: info@gopa-infra.de

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1 Background

1.1 National Initiative

The concept of wastewater recycling and reuse and the need to include the same in all water supply and wastewater management programs is recognized by different policy frameworks and institutions in India, which include administration, pollution prevention and abatement, water and sanitation as key elements.

Different policy frameworks and institutions that recognized the concept of waste water recycling and reuse are summarized below:

Ministry, GoI	Policy/Framework	Brief Description
The Ministry of Environment, Forests an Climate Change (MoEF&CC)	The Water (Prevention and Control of Pollution) Act 1974	This act has given discharge norms for sewage and industrial effluents. Industries and local bodies are mandated to treat wastewater to the defined quality level before discharge
	The Water (Prevention and Control of Pollution) Cess Act, 1977	All Industries and Local Authority have to pay Water Cess. Provision of rebate in the case of installation of STP or ETP, as the case may be
	The Environment Protection Act 1986	It is an umbrella act providing for the protection and improvement of the environment including water pollution and for matters connected therewith
	Policy Statement for Abatement of Pollution, 1992	This includes adoption of clean technology, conservation of resources, change of concentration-based standards to mass-based standards, incentives for pollution control, public participation, environmental auditing, and Ecomark on environment friendly products
	The National Environment Policy 2006	The Policy is intended to mainstream environmental concerns in all development activities
The Planning Commission	Water and Waste Management Strategy in the 12th Five Year Plan	Faster, more inclusive and sustainable Growth''. The plan aims to put in place an integrated strategy to counter the water challenge
The Ministry of Urban Development	The National Urban Sanitation Policy, 2008	It endorses reuse of reclaimed water, and recommends a minimum of 20% reuse of wastewater in every city. It also acknowledges the role PPPs could play in this sector in terms of investments, cost recovery through wastewater reuse mechanisms and improving the management of sewerage treatment facilities and networks
	Strategy for Urban Waste Water Management, 2011	MoUD through its activities proposed under the Capacity Building Scheme for Urban Local Bodies (CBULB) established Centres of Excellence (CoE) in reputed institutions in the country to create the necessary knowledge base for improving municipal service delivery and management
	The National Policy on Faecal Sludge and Septage Management (FSSM), 2017	One of the specific milestone of this policy is promoting recycle and reuse of treated sewage for non-potable applications wherever possible

Ministry, GoI	Policy/Framework	Brief Description
	Service Level Benchmarking (SLB) Framework	It envisages a shift in focus from infrastructure creation to delivery of service outcomes. SLB initiative covers water, sanitation, solid waste management and storm water drainage
The Ministry of Water Resources	The National Water Mission under the National Action Plan on Climate Change, 2008	It ensures integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within states. It takes into account the provisions of the NWP and seeks to ensure that a considerable share of the water needs of urban areas are met through recycling of waste water
	The National Water Policy, 2012	It recognises reuse of reclaimed water as an important factor for meeting environmental objectives and suggests preferential tariff to incentivise reclaimed water over freshwater
	Guidelines for improving water use efficiency in Irrigation, Domestic & Industrial Sectors, 2014	It states that achieving high water use efficiency is the first step along the path towards sustainable water development and management
	The Draft National Water Framework Bill, 2016	It contains provisions for an overarching national legal framework with principles for protection, conservation, regulation and management of water as a vital and stressed natural resource
Ministry of Housing and Urban Affairs	Manual on Sewerage and Sewage Treatment Systems, Central Public Health and Environmental Engineering Organization (CPHEEO), 2013	The Manual takes a lead in specifying the water quality guidelines for treated water based on its intended use, along with identifying best practices and examples of other recycling and reuse programs both in India and internationally

The Government of India has emphasised reuse of reclaimed water in many urban development schemes such as Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Swatch Bharat Mission, Smart Cities Mission and the Namami Gange programme.

Under **JNNURM (Jawaharlal Nehru National Urban Renewal Mission),** cities are being provided assistance for 100% sewage treatment facilities and once 100% treatment has been provided, the water bodies will have better quality water and there will be increased availability of water for lower grade water use.

Also, CPCB (Central Pollution Control Board) has specified the standards of various parameters of wastewater which need to be met prior to disposal. CPCB has issued directions to SPCB"s under Section 18(1) (b) of the Water (Prevention and Control of Pollution) Act, 1974 regarding treatment and utilization of sewage.

Other international guiding frameworks for wastewater recycling and reuse include:

- The WHO international guidelines on wastewater recycling in agriculture and aquaculture and recommendations for wastewater treatment and crop restrictions. These guidelines, first published in 1989 and revised in 2006, are also a commonly cited guiding framework for reuse.

- US-EPA (2012) water reuse guidelines and the reuse standards developed by selected states in the USA, such as California, which were among some of the first authorities to develop reuse standards and regulations to guide the application of treated wastewater for different purposes.

Though wastewater reuse is endorsed in many policies and programmes, there is a lack of clear guidelines and frameworks to support the implementation of waste water recycling projects. Such projects, while being undertaken by various states and cities in India, are largely structured individually and developed in isolation at the local level. More detailed policies and stronger enforcement is needed for wastewater reuse projects to be viable.

1.2 NITI Aayog Mandate

Scientific management of water is increasingly recognized as being vital to India's growth and ecosystem sustainability. The Government of India is being proactive about water management and has created the Ministry of Jal Shakti to consolidate interrelated functions pertaining to water management. The newly formed Jal Shakti Ministry under the guidance of Hon'ble Prime Minister strives to over bridge the water challenge by launching the **''Jal Shakti Abhiyan - a campaign for water conservation and water security in 1592 water stressed blocks in 256 districts, to ensure five important water conservation interventions''.** These will be 1) water conservation and rainwater harvesting, 2) renovation of traditional and other water bodies/tanks, 3) **reuse**, 4) bore well recharge structures, 5) watershed development and intensive afforestation. These water conservation efforts are also to be supplemented with special interventions including the development of Block and District Water Conservation Plans, promotion of efficient water use for irrigation and better choice of crops through Krishi Vigyan Kendras.

Inspired by the Hon'ble Prime Minister's impetus on Jal Sanchay, the Jal Shakti Abhiyan is a time-bound, mission-mode water conservation campaign. Government is advocating the adoption of best practices in water sector across India and recognizes that data-based decision making is going to be key to effective water management.

In a first-of-its-kind endeavour towards Jal Sanchay, Jal Sanrakshan, and Jal Sinchan, The National Institution for Transforming India (NITI) Aayog has developed the **''Composite Water Management Index (CWMI)''** to enable effective water management in Indian states. The CWMI is the first comprehensive collection of country-wide water data in India based on in-depth structured questionnaires followed by focus group discussions to generate qualitative information. It represents a major step towards creating a culture of data-based decision-making for water in India, which can encourage "competitive and cooperative federalism" in the country's water governance and management.

CWMI is the first of its kind to monitor key water-related metrics that are relevant for India going forward. The metrics spanned a range of upstream and downstream categories, including groundwater recharge schemes and water treatment capacity. The Index has been developed in close collaboration with multiple national and state stakeholders and involved a robust data validation process. The Index uses water data from both central and

state sources for three years—the base year (FY 15-16), FY 16-17, and the reference year FY 17-18 — thereby enabling not only benchmarking of the current water performance of states, but also the study of the evolution of water performance over time. States were required to fill out the necessary data on a NITI Aayog portal available in public domain. At the backend, this data aggregation involved a massive exercise across 25 states and 2 Union Territories (UTs) in the country, including a complex process of liaising between multiple agencies and departments within states, followed by validation by a third party. Data for several indicators in the Index—including groundwater restoration, irrigation management, on-farm water use, rural and urban drinking water supply, and water policy frameworks - was compiled and then triangulated with contributions across all levels, from union and state water departments to department engineers and local authorities.

The Index is expected to:

- establish a clear baseline and benchmark for state-level performance on key water indicators;
- uncover and explain how states have progressed on water issues over time, including identifying high-performers and under-performers, thereby inculcating a culture of constructive federal competition amongst states; and
- identify areas for deeper engagement and investment on the part of the states. Eventually, NITI Aayog plans to develop the Index into a composite, national-level data management platform for all water resources in India.

There are 2 editions of the CWMI published by NITI Aayog. The first edition was published in 2018 and became a very well-received publication, in and outside the country, as is also reflected by the increase in participation of the number of states and two union territories (Delhi and Puducherry) for the first time. The second edition was published in 2019. Following are the 2 editions of the CWMI;

- Composite Water Management Index, a Tool for Water Management, June 2018
- Composite Water Management Index, a Tool for Water Management, August 2019

1.3 NMCG Initiative/ Directions and Policy

National Mission for Clean Ganga (NMCG) was registered as a society on 12th August 2011 under the Societies Registration Act 1860.It acted as implementation arm of National Ganga River Basin Authority (NGRBA) which was constituted under the provisions of the Environment (Protection) Act (EPA), 1986.

One of the major objectives of NMCG is ‘Aviral Dhara’, that is maintaining uninterrupted flow in Ganga through a number of measures like improved water use efficiency, promotion of reuse of treated wastewater and demand side management.

Major policy/other initiatives under NGRBA that recognized the concept of waste water reuse and recycling are:

- NGRBA Programme Framework
- Ganga River Basin Management Plan, 2015

- Guidelines for preparation of project reports under National River Conservation Plan and National Ganga River Basin Authority
- Guidelines for preparation of DPRs for works of Interception and Diversion of drains and Sewage Treatment Plants
- Septage Management; a Practitioner's Guide
- Request for Qualification (RFQ) for short listing / empanelment of Transaction Advisor(s) for sewerage wastewater treatment and reuse of treated water in various towns on PPP Model under Namami Gange Program
- Action Plan for Municipalities

A roundtable discussion on **''Treated Wastewater Reuse Polices and Approaches in India and the European Union: A Comparative Assessment''** was convened on 23 July 2019 in close cooperation with National Mission for Clean Ganga and National Water Mission. The roundtable was part of the India-EU Water Partnership (IEWP) being implemented by GIZ in cooperation with the Ministry of Jal Shakti, GoI. Various decision makers and officials from Ministry of Jal Shakti, its allied institutions (CWC, CGWB, NMCG, and NWM), Academia and Research, representatives from States, Public & Private Industries, India EU Water Partnership (IEWP)/GIZ PMU participated in the discussion.

The objectives of the discussion were:

- to compare the elements included in treated wastewater reuse policies and approaches;
- to discuss implementation challenges, possible solutions and a strategic way forward towards formulation of a national policy framework on reuse of treated wastewater.

Following were the key points of discussion:

- An immediate need to frame a comprehensive central policy document for river basin management and treated wastewater reuse was highlighted by NMCG.
- GIZ stressed upon the need to deploy holistic river basin management approach and EU practices on treated Waste water reuse.
- Secretary, Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti reiterated the emerging water scarcity issues partially driven by erratic climate events. While he highlighted various successful case studies coming from across the country on reuse of treated wastewater, he emphasised that this is the most appropriate time to frame a national level policy to institutionalise these efforts. He also opined that effective reuse of treated wastewater at micro or local levels could be a promising strategy to mitigate such challenges. He cautioned that quality aspects of treated wastewater should be ensured as per designated end-use.
- The comparative assessment of various elements of wastewater reuse polices from the EU, Spain, and states of Gujarat and Haryana was presented by the consultant from IEWP/GIZ. The study reviews these policies in view of various elements like designated end-use, quality norms, the objectives, associated risks, financial and implementation aspects.

1.4 Initiatives by Other States

Currently India has no national policy or guidance specific to treated wastewater reuse. The Indian States of Gujarat, Haryana and others have related policy and guidance in place, experience of which will contribute to a national policy.

Several states have formulated policies to enable an improvement in their infrastructural capacity to treat wastewater and encourage the reuse of this water. Given differing socio-economic and geographic contexts, states have adopted varying approaches towards institutional arrangements, preferable treatment and reuse options, operation and maintenance of treatment plants, as well as pricing of the treated wastewater.

1.4.1 Policy for Reuse of Treated Waste Water, Government of Gujarat, May 2018

''The policy envisions maximising the collection and treatment of sewage generated; reusing the treated wastewater on a sustainable basis and thereby reducing dependence on freshwater resources; and promoting treated wastewater as an economic resource.''

The policy lays down the following objectives:

- To reach minimum 80% coverage and collection of sewage in all municipal towns.
- To reach a level of 100% treatment of collected sewage as per the prescribed standards.
- To reuse at least 25% of total fresh water consumption from treated waste water within the time limit set under policy by every municipal body.
- To reuse 70% of TWW by 2025.
- To reuse 100% of TWW by 2030.

Detailed policy can be accessed on;
https://gwssb.gujarat.gov.in/downloads/Policy_Reuse_Of_WasteWaterA.pdf

1.4.2 Draft Policy for Reuse of Treated Waste Water, Government of Haryana, October 2018

''The policy envisages maximizing the collection of sewage and its treatment and reusing the treated unused water increasingly for non-potable applications thereby reducing the dependency on the limited ground and surface water resources: and to eventually promote treated unused water as an economic resource to meet with part capital as well as operation and maintenance cost of sewage treatment for enhanced performance."

The policy lays down the following objectives:

- To attain a minimum coverage of 80% of the area with sewerage facilities and collection of sewage in all the 83 towns in the State.
- To attain a level of 100% treatment of collected sewage as per prescribed standards so that treated effluent has BOD and TSS level below 10 mg/l.

- To reuse at least 25% of the treated unused water (TUW) by every Municipality within the time frameset under the policy by every municipal body.
  - To reuse 60% of TUW by 2025.
  - To reuse 100% TUW by 2033.
  - To reuse 50% TUW generated in the rural areas under the Maha Gram scheme by 2033.

Detailed policy can be accessed on;
https://phedharyana.gov.in/WriteReadData/Policy/DRAFT%20POLICY%20FOR%20RE-USE%20OF%20TREATED%20WASTE%20WATER.pdf

1.4.3 Enabling Environment for Urban Wastewater Reuse, Government of Karnataka, December 2017

***Vision**: Accelerated adoption of circular economy across the major towns and cities of Karnataka with respect to wastewater treatment and reuse, with following targets:*

- *By 2020, [10 major cities] have adopted wastewater reuse principles and developed firm plans, to be increased to [100% of all major cities/towns] by 2030.*
- *By 2020,20% of all STW is targeted for reuse across the state, in accordance with regulatory standards; [to be increased to [50%] by 2030, subject to responsible ecological return flow provisions approved under Integrated Urban Water Management plans.*

Policy Goals:
The overall goal of this policy is to establish an enabling environment for the reuse of municipal wastewater to maximize efficient resource use, protect the environment, address water scarcity, and enhance economic output.

Detailed policy can be accessed on;
http://www.uddkar.gov.in/sites/uddkar.gov.in/files/images/ADB/urban_waste_water_re-use_policy_udd_435_prj_2014_dt._27.12.2017.pdf

1.4.4 The State Treated Water Policy, Government of Punjab, 2017

***Goal and Vision of the Policy**:*

- *To protect public health.*
- *To protect the environment and the state's water resources.*
- *Promote recycling & re-use of treated sewage for non-potable applications.*
- *To make sewerage project economical and environmentally sustainable.*

Detailed policy can be accessed on;
https://pwssb.punjab.gov.in/wp-content/uploads/2018/03/notificationtwwp.pdf

1.4.5 Examples of Wastewater Reuse in India

In the last few years, the Government of India has taken many concrete steps to promote reuse of wastewater. It began with regulating industrial water consumption and enforcing mandatory water reuse targets for industries.

Cities have set their own, more stringent targets. For example, Delhi has adopted aspirational reuse targets to treat and reuse 25% of total sewage produced by 2017, and increase the same to 50% by 2022, and to 80% by 2027.

Against this background, municipalities across India have started to pursue reuse projects. Some of these utility-led reuse initiatives in the recent past are as follows:

S. No.	Project	Description
1	Chennai Petroleum Corporation Limited, Chennai	CPCL has 2.5 (Million Gallons Per Day) MGD (475 KL/hr) reclamation of untreated city sewage plant through tertiary treatment and reverse osmosis. CPCL is executing an additional 2.5 MGD (475 KL/ hr) city sewage reclamation plant as well as a 5.8 MGD sea water desalination plant. CPCL is the first company in India to go for a reverse osmosis rejects recovery plant of 80 KL/hr
2	Madras Fertilizers Limited, Chennai	In 1992, the Madras Fertilizer Ltd. constructed a 16 MLD tertiary treatment and reverse osmosis (TTRO) producing 16 MLD of recycled water. Based on these tertiary treatment plants (TTPs), the Chennai Metropolitan Water and Sewerage Board (CMWSB) supplies 12 MLD of secondary treated sewage (with BOD 120 mg/L even after secondary treatment) and 3 MLD of treated freshwater and the MFL provides the required further treatment depending on its end uses. The TTP infrastructure at Madras Fertilizer Ltd. consists of following: • MFL constructed their 16 MLD TTRO plant in 1992 at a cost of Rs. 30 crores. • A 1.6 km Pipeline from STP to TTRO plant. • 5 km pipeline and pumping machinery from TTRO to Fertiliser Plant.
3	Rashtriya Chemicals and Fertilizers, Mumbai	The RCF Plant commissioned a 23 MLD capacity sewage reclamation plant involving reverse osmosis to treat complex wastewater comprising municipal sewage heavily contaminated with various industrial wastes. RCF's STP, which is located in the heart of Mumbai, came on line in 2000. RCF constructed a 5 km pipeline to receive raw sewage from Brihan Mumbai Corporation's (BMC) Ghatkopar pumping station. They also buy 11 MLD of freshwater from BMC. The sewage reclamation plant at the RCF consists of following treatment units: Screening ➔ Grit Removal ➔ Activated Sludge System ➔ Clarifier ➔ Sand Filter ➔ Pressure Filter ➔ Cartridge Filters ➔ Reverse Osmosis ➔ Degasser to remove CO2 ➔ Reuse in Industry.
4	Pragati Power Corporation Limited (PPCL), New Delhi	Gas based Power Plants use over 90% of their water for cooling requiring only slightly higher than secondary or in some cases tertiary and only a fraction of water, 5 percent, is required at the high-end level which requires de-mineralization. The STPs that PPCL was given to operate and use, were two of nine Activated Sludge Process (ASP) plants built along the Yamuna River under JICA funding as a pilot project for the Delhi Jal Board (DJB) in 2002. The STPs used by PPCL treat only 5-10 percent of the sew-

		age that flows through the nallahs and the rest is discharged untreated into the Yamuna. The STP treats water to the secondary level with output parameters of BOD < 10, COD < 25-30 and TSS < 15. After that 19 MLD of STW is pumped to the PPCL power plant where it undergoes lime-softening treatment. The bulk of the water is utilized within the PPCL plant at this level of treatment. Only 1-1.5 percent of lime-softened water is sent for DM so it can be used in boilers. While DM is an expensive process that adds to the cost of production, this step is required even if freshwater were used. Lime-softening and DM take place within the power plant and utilize electricity generated by the plant itself. Moreover, both processes are required regardless of water source.
5	JV between Nagpur Municipal Corporation (NMC) and Maharashtra Generation Company (MAHAGENCO)	MAHAGENCO and NMC have jointly invested in a reuse project where treated water from an STP is further treated and used as cooling water. Sewerage network, treatment and disposal, collection of revenue from reuse wastewater. Strong project ownership by MAHAGENCO and NMC. Feasibility undertaken at the beginning. Contracts ring fencing commercial risks. However contracts had loopholes, allowing for significant change in scope post signing. There was no bidding as the operator approached NMC itself. Thus selection was on a nomination (sole source) basis. MAHAGENCO selected an operator through competitive tendering on least project cost basis. Detailed USAID funded feasibility study undertaken on water reuse opportunities. MoU with NMC akin to a concession and a concession agreement between MAHAGENCO and SMS-GSJ Envo Ltd spelled out the PPP structure and project components clearly.
6	Bangalore Water Supply and Sewerage Board (BWSSB)	BWSSB has built a 10 MLD tertiary treatment plant at Yellahanka that supplies reclaimed water to Bengaluru International airport.
7	Surat Municipal Corporation (SMC)	Surat Municipal Corporation (SMC) built a 40 MLD reuse plant in 2014 on PPP basis to supply reclaimed water from the Bamroli STP (100 MLD capacity) to Pandesara Industrial Estate.

Source: 'Urban Waste Water – PPP', FICCI & 2030 Water Resources Group
'Closing the water loop: Reuse of treated wastewater in urban India', September 2016, pwc

Table above reveals that where the end user of the treated wastewater is itself responsible for implementing the PPP project for wastewater reuse (BOT – End user model) such projects have higher degree of success than model where the wastewater is sold by the project SPV to third party users (BOT – Third Party User Charge).

Successful reuse projects, such as the Nagpur Tertiary Treatment Reverse Osmosis (TTRO) plant, and the Bamroli TTRO, needed significant capital subsidies to become viable. The initiation of these projects suggests that businesses are interested in this sector and that reuse projects can be viable if prepared and structured correctly and backed by supportive policies and institutions.

A tripartite agreement was signed between National Mission for Clean Ganga (NMCG), Indian Oil Corporation Ltd (IOCL) and UP Jal Nigam (UPJN) for the reuse of treated wastewater for IOCL's Mathura refinery from the sewage treatment plant being set up by NMCG. The STP is being setup at Lakshmi Nagar, Mathura, using suitable technology such

as membrane-based bio reactors to meet raw water quality requirement of industries. Mathura Refinery[1] of IOC shall buy and reuse 20 million litres per day of treated waste water from this plant. With this initiative the effluent water, which was hitherto being discharged in the river Yamuna will be used by the Mathura Refinery for industrial purposes, completely eliminating the use of fresh water for refinery operations. As per the agreement the capital cost for the rehabilitation of the existing STP and the Tertiary Treatment Reverse Osmosis (TTRO)[2] plant will be borne by NMCG. NMCG will also bear the cost of the O&M of the STP for 15 years. IOCL will bear the cost towards the O&M of TTRO plant and will pay water tariff @Rs 8.70 per kilolitre of treated water used to partially cover the capital cost for the TTRO plant.

2 Water Scenario in Uttarakhand

Uttarakhand is well situated at the foothills of the Himalayan ranges with mountainous topography. The state is endowed with multiple water sources. Water from the Himalayan glaciers and rivers, supply both the State and India as a whole. However, despite the States multiple water reserves, including 17 rivers, several snow-fed glaciers and 31 lakes, water is unevenly distributed and many districts of Uttarakhand face water scarcity. Water resources are routinely diverted for activities in many sectors including agriculture, energy, tourism and urban use. The agriculture sector continues to be the greatest consumer of water in the state, accounting for 75% of total water demand.

2.1 Surface Water

Uttarakhand is an origin place of several Indian rivers including glacial fed rivers, non-glacial fed rivers and Rainfed Rivers. Ganga, Yamuna, Ramganga, Kali, Kosi rivers and their tributaries constitute surface water bodies. The National Commission for Integrated Water Resources Development (NCIWRD, 1999)[3] has estimated the basin-wise average annual flow in Indian River systems as 1953 km^3 and the utilizable annual surface water of the country as 690 km^3. However, an attempt has been made to capture and present the best possible data available. The total catchment area of 12 major river basins of India is more than 20000 km^2. The total catchment area of these rivers is about 25.3 lakh km^2. Uttarakhand possess three main river basins as;

- Bhagirathi (Alaknanda basin and Ganga basin),
- Yamuna (Tons basin) and ,
- Kali system.

[1] https://www.psuconnect.in/news/IndianOil-Signs-Agreement-for-Reuse-of-Treated-water-for-Mathura-Refinery/16313/

[2] http://smcg-up.org/wp-content/uploads/2019/01/34.-AAES-Mathura-Revised-1.pdf

[3] National Commission for Integrated Water Resources Development. 1999. "Integrated Water Resources Development – A Plan for Action." Ministry of Water Resources, Government of India, New Delhi.

In addition of these rivers, glaciers, lakes, numerous streams, springs etc. also contribute as a major part of surface water resources. A total 968 Himalayan glaciers are also important which have 213.74 km^3 total ice volume and cover 31449.3 km^2 basin area and 2883.37 km^2 (i.e. 9.17%) glaciered area including Chorbani, Gangotri, Khatling, Nandadevi glaciers etc.[4]

The Tals such as Bhimtal, Sat Tal, etc. of Nainital district of Kumaun region are important sources for drinking and irrigation purposes. Besides this, Hemkund, Rupkund and Vasukital are some of the glacial lakes whereas Nachiketatal, Nainital, Dodital, Bhimtal and Naukuchiatal are the renowned lakes of middle Himalaya. The total high altitude wetlands area in the state is 103882 ha including 231 ha of high altitudinal lakes i.e. 0.22% of total wetland area for 118 lakes which covers <1% of total wetland area of the state.[5]The lakes and Tals in upper parts and middle Himalaya form an important part of total drainage system.

2.2 Ground Water – Availability, Aquifer Zoning/ Mapping

Uttarakhand State has a distinct geological attribute with wide variety of rock units ranging in age from Archaean to Quaternary. About 85% of the geographical area of the state is mountainous and underlain by hard rocks. Groundwater is the hard rock area is developed through the springs and hand pumps tapping the weathered zone. Discharge of springs in the Lesser Himalaya and Central Himalaya is variable and ranges from 60 to 600 lpm. About 15% of the geographical area is underlain by semi-consolidated and unconsolidated formations known as Tarai and Bhabhar. Ground water in this area is developed by open wells, shallow and deep tube wells.

The ground water resources of Uttarakhand state have been assessed block-wise. The annual replenishable ground water resource of the state has been estimated as 2 bcm and net ground water availability is 1.97 bcm. The annual ground water draft is 0.99 bcm and stage of ground water development is 50%. Out of the18 blocks assessment units, 1 has been categorized as 'Critical', 1 as 'Semi-Critical' and 16 as 'Safe'. As compared to 2011 estimate, there is a marginal decrease in the annual replenishable ground water resource of the state. The ground water draft for irrigation has decreased from 1.10 bcm to 0.84 bcm due to reduction in number of ground water abstraction structures. However, the ground water draft for industrial and domestic water supply has increased from 0.03 bcm to 0.15 bcm. This is attributed to establishment of new industries in the state.

Ground Water Scenario of Uttarakhand

Area (Sq.km)	53,484
Physiography	Ganga Plain, Siwalik Hills, Lesser Himalayas, Central Himalayas
Drainage	The State is drained by major perennial rivers like Ganga, Yamuna, Ramganga, Sarda and Kali and their tributaries.
Rainfall (mm)	1523
Total Districts / Tehsils	13 Districts

[4] Geological Survey of India. Sp. Pub. 34. 2009.
[5] High Altitude Himalayan Lakes. National Wetland Inventory and Assessment. Space Application Centre, ISRO, Ahmedabad. 2011.

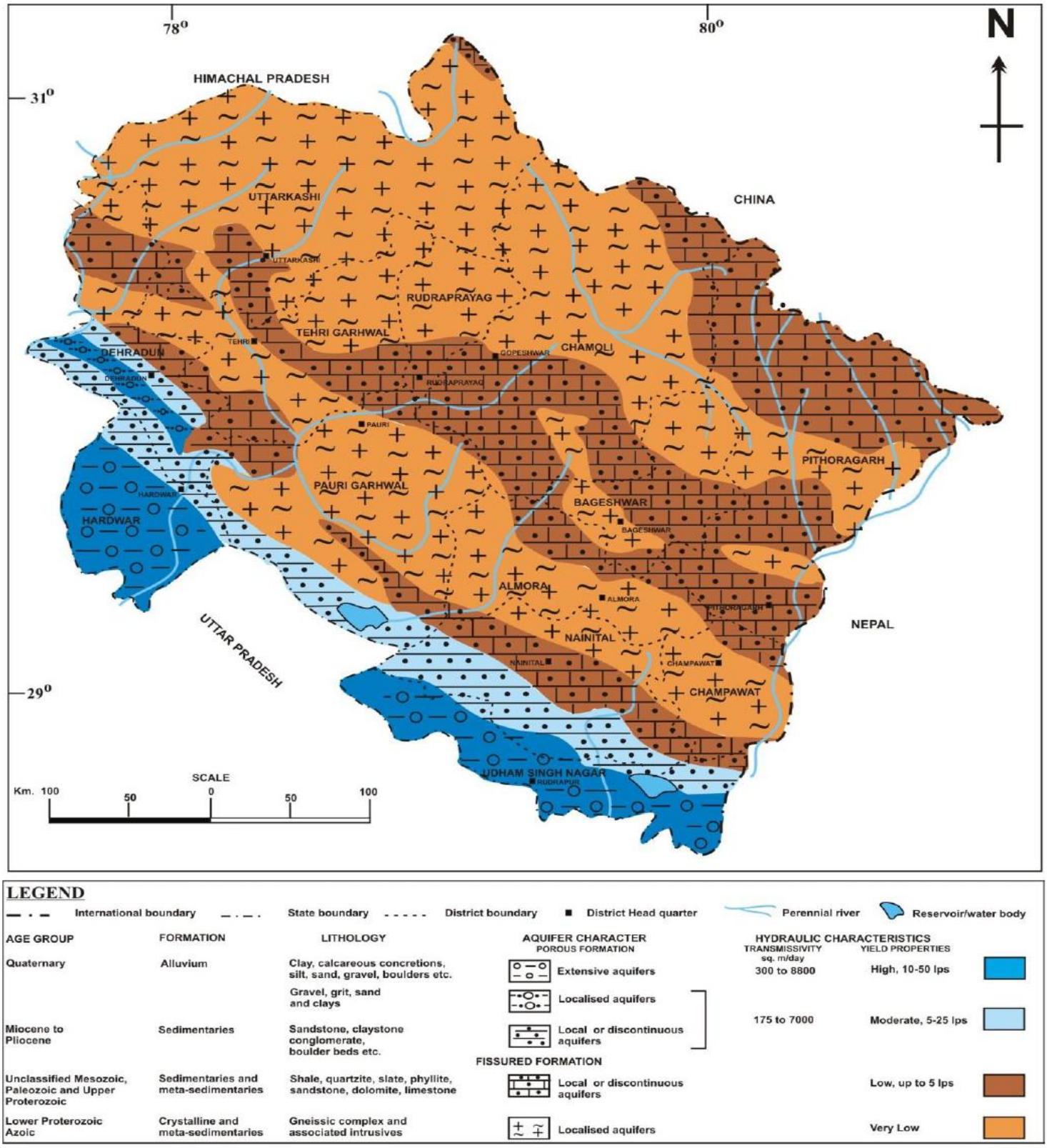
National Aquifer Mapping and Management Programme (NAQUIM)
Central Ground Water Board (CGWB) has been entrusted with the responsibilities of developing & disseminating technologies, monitoring national policies for the scientific and sustainable development and management of India's ground water resources.

CGWB is implementing **NAQUIM** for aquifer mapping in the country including in areas which have recorded a high depletion of ground water, in phases.

In Uttarakhand, aquifer maps and management plans have been prepared by CGWB for an area of nearly 7811 lakh sq. km.

Following Aquifer mapping reports are available;

- Aquifer mapping report, parts of Udham Singh Nagar district, Uttarakhand.
- Report on Aquifer mapping and ground water management plan, Haridwar district, Uttarakhand.



LEGEND

International boundary — State boundary - - - - - District boundary ■ District Head quarter — Perennial river — Reservoir/water body

AGE GROUP	FORMATION	LITHOLOGY	AQUIFER CHARACTER	HYDRAULIC CHARACTERISTICS TRANSMISSIVITY sq. m/day	YIELD PROPERTIES
			POROUS FORMATION		
Quaternary	Alluvium	Clay, calcareous concretions, silt, sand, gravel, boulders etc.	Extensive aquifers	300 to 8800	High, 10-50 lps
		Gravel, grit, sand and clays	Localised aquifers	175 to 7000	Moderate, 5-25 lps
Miocene to Pliocene	Sedimentaries	Sandstone, claystone conglomerate, boulder beds etc.	Local or discontinuous aquifers		
			FISSURED FORMATION		
Unclassified Mesozoic, Paleozoic and Upper Proterozoic	Sedimentaries and meta-sedimentaries	Shale, quartzite, slate, phyllite, sandstone, dolomite, limestone	Local or discontinuous aquifers		Low, up to 5 lps
Lower Proterozoic Azoic	Crystalline and meta-sedimentaries	Gneissic complex and associated intrusives	Localised aquifers		Very Low

Source: Aquifer Information and Management System, CGWB
https://www.aims-cgwb.org/stateWise.php?page=Search&page%20id=Search&type=Searching

2.3 Hydro-geo-morphology of the State

According to the Central Ground Water Board (CGWB) of India, Uttarakhand has two distinct hydrogeological regimes, namely the **Gangetic alluvial plain** and the **Himalayan mountain belt.** The former is covered with a vast expanse of alluvium and unconsolidated sedimentary material of varying size fractions (ranging from boulder to clay) and is a promising zone for ground water development. The latter zone, being predominantly hilly, offers much less potential for large scale development of ground water.

Ground water in the hilly region occurs mostly in fissures/fractures and emerges as springs. The springs are amenable to small scale development of ground water resources in the State. The yield of tube wells in Siwalik formation ranges from 50.4 m3/hr to 79.2 m3/hr, in Bhabar formations yield is up to 332.4 m3/hr. In Tarai belt yield of tubewell ranges 36m3/hr to 144 m3/hr and in Indo-Gangetic plain yield varies from 90 m3/hr to 198 m3/hr.

Much of the groundwater in the plain districts is used for agriculture. According the vulnerability and risk assessment for the state, the percentage of ground water irrigation to net irrigated area has been rising over the years. However, only 2 blocks in the state, according to the CGWB, are overexploited in terms of ground water extraction and 3 blocks are semi-critical.

Enactment of Ground Water Bill to regulate and control the development of ground water: Draft Bill has been prepared on the lines of Model Bill in consultation with Central Ground Water Board. Necessary action for approval of the State Cabinet is being taken before the Bill is introduced in the Assembly. Bill is to be enacted.

Dynamic Ground Water Resources	
Annual Replenishable Ground water Resource	2.27 BCM
Net Annual Ground Water Availability	2.10 BCM
Annual Ground Water Draft	1.39 BCM
Stage of Ground Water Development	66 %
Ground Water Development & Management	
Over Exploited	2 blocks
Critical	NIL
Semi- critical	3 blocks
Ground Water User Maps	5 districts
Artificial Recharge to Ground Water (AR)	• Feasible AR structures: 500 spring development, 500 check dams, 500 sub-surface dykes
	AR schemes completed during IX Plan: 1

Ground Water Quality Problems	
Contaminants	**Districts affected (in part)**
Nitrate (>45 mg/l)	Dehradun, Hardwar, Udhamsinghnagar

Central Ground Water Authority

Areas Notified for Regulation of ground water development	NIL
Mass Awareness Programme (as on 31.03.2010)	12
Water Management Training Programme (as on 31.03.2010)	7

2.4 Water Balance in the River Basin & Sub Basins of the State

Uttarakhand state is divided into 4 sub-basins comprising of major Ganga Basin; Upper Yamuna, Ganga, Ramganga, Sharda. As per the Water Budget of Uttarakhand[6] 2016-17;

Total Availability	MCM	Remarks
A1. Precipitation including Snowfall	48352.00	Only Rainfall data of year 2016. Snow Data not available
A1R. Runoff due to precipitation and snow melt	36294.00	Based on river discharge data available from CWC
A2. Upstream Inflows	-	Rivers originate from Himalayan glaciers within the state
A3. Inflow from Glacial Melts		No data available regarding glacier melt
A4. Inflow from Springs, Nallahs	26.15	On the basis of 1222 no of springs water production as provided by UJS. Also 36 springs monitored by CGWB
A5, A6, A7. Storage in Major, Medium & Minor Reservoirs as on 1st June	4869.00	Based on live storage of reservoirs
A8 & A9. Storage in Ponds, Tanks, Wetlands as on 1st June	0.48	Based on Watershed Management Directorate inventory and Minor Irrigation structures
A10. Water available from Desalination Plants		No coastal line
A11. Inter Basin Transfer		No inflow from other states
A12. Net Annual Ground Water Availability	1910.74	CGWB
TOTAL	91452.37	

Outflows (MCM)	MCM	Remarks
D1. Inter basin transfers (Exports)		
D2. Downstream Outflows (actual) vis-a-vis desirable flow downstream*	25989	Downstream outflow from Bhimgoda barrage
D3. Evapo-Transpiration from Forests, Natural Vegetation		No assessment method provided by Forest Department
D4. Evaporation from all Surface Water Bodies	4.869	Assume 0.1 % of reservoirs live storage
TOTAL	25993.87	

Utilizable Water	MCM	Remarks
B1. Directly Harvested Rain Water + Useful Soil Moisture	9670	Assumed 20% of total rainfall as base flow
B2. Utilizable portion of Springs, Nallahs	24.82	Based on 1222 number of springs monitored by UJS.
B3, B4, B5. Utilizable portion from Major, Medium and Minor Projects	2434.5	Assumed 50% of total live storage
B6, B7. Utilizable portion from Ponds, Tanks, Wetlands	0.4838	
B8. Water from Desalination Plants/ Sea water		No coastal line
B9. Utilizable portion of Inter-Basin Transfers		
B10. Utilizable Ground Water	1910.74	
B11. Water available from Treated/ Recycled Waste Water		
TOTAL	14040.54	

6 http://nwm.gov.in/sites/default/files/Report_Draft-SSAP_Uttarakhand.pdf

2.5 Water Vulnerability

The index used for estimating vulnerability[7] was 'Water Sustainability Index' (WSI). The range of WSI can vary between 0-1, where a value of 0 indicates highest water scarcity and 1 indicates lowest water scarcity. The five components of WSI were Hydrology (H), Environment (E), Life (L), Rainfall (R) and Vertical Proximity (Pri). The final Water Scarcity Indices for all the districts of Uttarakhand indicates that the low lying districts of Kumaun regions are having much lesser water scarcity than some of the mid Himalayan districts where population load along with unavailability of surface water resulting maximum water scarcity. The Water Scarcity Indices for all the blocks of Uttarakhand further indicated that Ghaat block of Champawat, Ramgarh block of Nainital, Garur block of Bageshwar and Pokhra block of Pauri-Garhwal were amongst the most water scarce blocks. The highest water scarce blocks of each district of Uttarakhand is provided in Table below. Surprisingly, fresh water supply schemes in all these blocks were also noted to be highly dependent on springs.

Once the indices of H, L, E, R and Pri were computed, a cumulative WSI was estimated at block level as: WSI = ((0.4*Pri) + (0.3*Hi) + 0.1*(Ei+Li+Ri)) Finally, Water Scarcity Index was computed as: Water Scarcity Index = (1-WSI)

Table 1: Most water scarce in each block as per WSI in each of the districts

District	Water Scarce Block	Water Scarcity Index
Almora	Takula	0.5
Bageshwar	Garud	0.425
Chamoli	Ghaat	0.52
	Tharali	0.52
Champawat	Barakote	0.35
	Lohaghat	0.35
Dehradun	Doiwala	0.4
Haridwar	Narsan	0.45
Nainital	Ramgarh	0.5
Pauri Garhwal	Pokhara	0.52
Pithoragarh	Pithoragarh	0.425
Rudraprayag	Jakholi	0.4
Tehri Garhwal	Pratapnagar	0.45
Udham Singh Nagar	Kashipur	0.4
Uttarkashi	Bhatwari	0.375

Optimisation of water allocation is needed for its efficient utilisation as water requirement is closely related to population, demand for food, production of non-agricultural and industrial items, production of energy and improvement of the quality of life, and preserving the ecology of the region.

This further justifies the need for Conjunctive Use of Water, particularly with respect to use of Treated Wastewater.

[7] K Kumar, A Tiwari, S Mukherjee, V Agnihotri, RK Verma (2019) Technical report: Water at a glance: Uttarakhand, GBPNIHESD, Almora, Uttarakhand, India.

3 Water Governance Central and UK

3.1 Institutions at Central Level

The Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD & GR) was the apex body for formulation and administration of rules and regulations relating to the development and regulation of the water resources in India.

On 14.06.2019, the Ministry has been renamed as **"(Ministry of Jal Shakti "Jal Shakti Mantralaya)"** with two Departments i.e. **Department of Water Resources, River Development and Ganga Rejuvenation** (Jal Sansadhan, Nadi Vikas Aur Ganga Sanrakshan Vibhag) and **Department of Drinking Water and Sanitation** (Pey Jal Aur Swachhata Vibhag)". The work assigned to Department of Water Resources, River Development and Ganga Rejuvenation are:-

General

- Development, conservation and management of water as a national resource; overall national perspective of water planning and coordination in relation to diverse uses of water and interlinking of rivers;
- National Water Resources Council;
- General Policy, technical assistance, research and development training and all matters relating to irrigation, including multi-purpose, major, medium, minor and emergency irrigation works; hydraulic structures for navigation and hydro-power; tube wells and groundwater exploration and exploitation; protection and preservation of ground water resources; conjunctive use of surface and ground water, irrigation for agricultural purposes, water management, command area development; management of reservoirs and reservoir sedimentation; flood (control) management, drainage, drought proofing, water logging and sea erosion problems; dam safety;
- Regulation and development of Inter - State Rivers and river valleys. Implementation of Awards of Tribunals through Schemes, River Boards;
- Water laws, legislation;
- Water quality assessment; and
- Cadre control and management of the Central Water Engineering Services (Group A).

International Aspects

- International organizations, commissions and conferences relating to water resources development and management, drainage and flood control;
- International Water Law;
- Matters relating to rivers common to India and neighbouring countries; the Joint Rivers Commission with Bangladesh, the Indus Waters Treaty 1960; the Permanent Indus Commission;
- Bilateral and external assistance and cooperation programmes in the field of water resources development.

Presently, the following Attached & Subordinate Offices, Statutory Bodies, Registered Societies and Public Sector Undertakings are working under the control of the Department of Water Resources, RD & GR:-

Attached Offices	Subordinate Offices	Statutory Bodies	Corporate Bodies	Registered Societies/ Autonomous Bodies	Public Sector Undertakings
Central Water Commission (CWC)	Central Ground Water Board (CGWB)	Tungabhadra Board (TB)	Narmada Control Authority (NCA)	National Water Development Agency (NWDA)	National Projects Construction Corporation Limited (NPCC Ltd.)
Central Soil & Materials Research Station (CSMRS)	Central Water & Power Research Station (CWPRS)	Betwa River Board (BRB)	Cauvery Water Management Authority	National Institute of Hydrology (NIH)	Water & Power Consultancy Services Limited (WAPCOS Ltd.)
	Bansagar Control Board (BCB)	Brahmaputra Board (BB)		North Eastern Regional Institute of Water and Land Management (NERIWALM)	
	Sardar Sarovar Construction Advisory Committee (SSCAC)	Godavari River Management Board (GRMB)		National Mission for Clean Ganga (NMCG)	
	Ganga Flood Control Commission (GFCC)	Krishna River Management Board (KRMB)		Polavaram Project Authority (PPA)	
	Farakka Barrage Project (FBP)				
	Upper Yamuna River Board(UYRB)				
	National Water Information Centre (NWIC)				

Source: http://jalshakti-dowr.gov.in/about-us/history

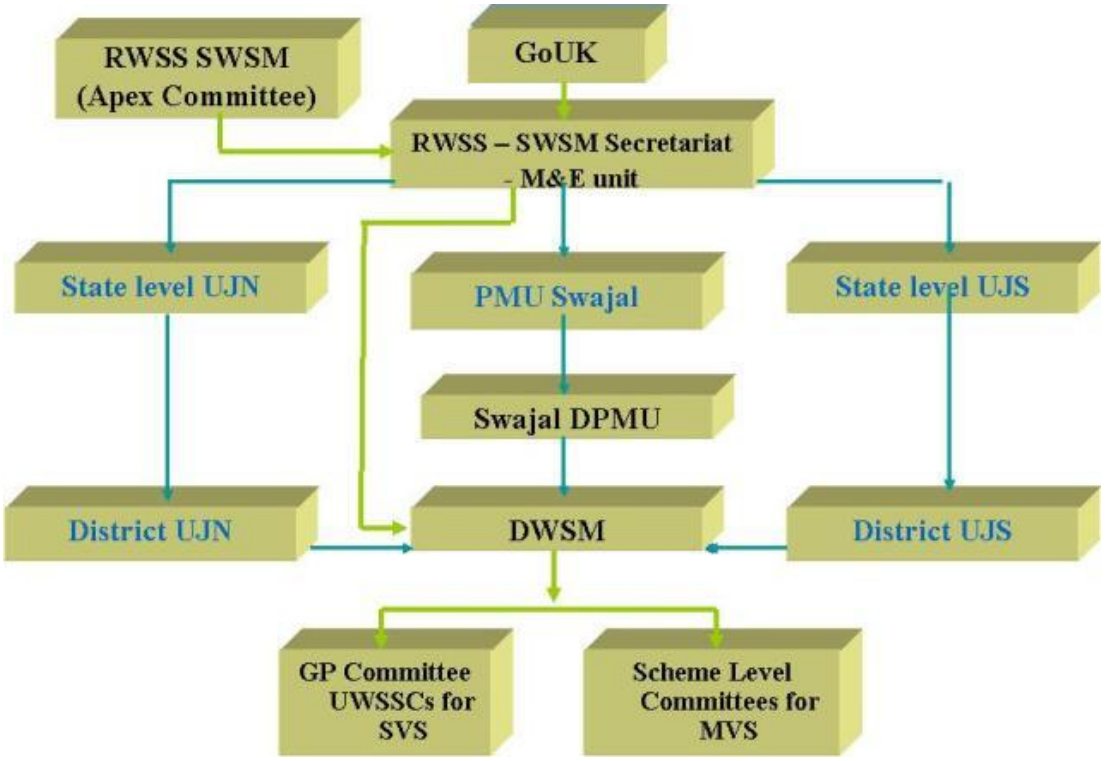
3.2 Institutes at State Level

Uttarakhand state has a single Ministry & Department for rural water supply, urban water supply & sewerage, and sanitation services. The Department of Drinking Water (DDW), Govt. of Uttarakhand has three main institutions;

- **Uttarakhand Peyjal Nigam (UJN)** - autonomous body,
- **Uttarakhand Jal Sansthan (UJS)** - autonomous body,
- **Project Management Unit (PMU), Swajal Project** - society registered under the Societies Registration Act, 1860.

Apart from this there is an umbrella body called **State Water & Sanitation Mission (SWSM).** UJN is primarily engaged in construction of drinking water schemes in rural and urban areas and sewerage schemes in urban areas, whereas UJS is primarily carrying out functions of O&M of these schemes handed to them by the UJN. Both these organizations are also implementing World Bank assisted **Uttarakhand Rural Water Supply & Sanitation Project (URWSSP)** since 2006. The Swajal Project implements World Bank assisted **Uttarakhand Rural Water Supply & Sanitation Project (URWSSP)** & GoI-funded **Nirmal Bharat Abhiyan (NBA)** & Capacity Building Component of **National Rural Drinking Water Programme (NRDWP).**

As part of its decentralization commitment, the state government has decided to devolve the water and sanitation sector funds, functions, and functionaries and strengthen the three-tier Panchayati Raj Institutions (PRIs) system.



Department of Drinking Water: DDW is the nodal agency for the RWSS by coordinating with the sector stakeholders, including UJN, UJS, PMU, and other sector ministries.

State Water and Sanitation Mission: At the State level, the SWSM, with the support of the SWSM Secretariat, implements the URWSSP, NRDWP and NBA following demand-responsive approaches. It ensures adequate financial provisions and oversee the implementation of the sector program. SWSM is the highest policy-making body in the sector. Functions include:- (i) oversee, disseminate, and monitor the implementation of policy decisions undertaken by SWSM; (ii) compile, review, and approve the annual plan and budget allocation for the sector for monitoring (iii) appraise and approve high-cost Multi Village Schemes (MVSs) that are beyond the prescribed limit of DWSM.

Project Management Unit: The PMU / Swajal Directorate, assisted by the District Project Management Units (DPMUs), Functions of the PMU include: (i) coordinate and implement the new capital investments for Single Village Schemes (SVSs); and (ii) undertake Information Education & Communication (IEC) campaigns and the capacity-building activities.

Uttarakhand Peyjal Nigam and Uttarakhand Jal Sansthan: The functions of UJN and UJS, along with their district agencies include: (i) plan, construct, (other than for intra-village investments) operate, and maintain the MVS according to the Memorandum of Understanding (MoU) and (ii) provide technical support to the PRIs and the User Water & Sanitation Sub Committee (UWSSC) for SVS, if desired by the latter.

3.3 Water Allocation Policy

3.3.1 Federal Regulatory Framework

The National Water Policy of the Government of India was first enunciated in 1987. The policy laid down an allocation prioritization principle for water as follows:

- Drinking Water
- Irrigation
- Hydro-power
- Navigation
- Industrial and other uses

The National Water Policy (NWP 2002) was subsequently introduced in relation to the rapidly changing scenario in the domain of water to address the emerging issues and provide critical policy inputs. NWP 2002 gave emphasis for the first time to ecological and environmental aspects of water allocation.

The National Water Policy (NWP 2012) calls for a common integrated perspective to govern the planning and management of water resources. Such a perspective would consider local, regional, and national contexts and be environmentally sound. The Policy clearly states that water needs to be managed as a common pool community resource that is held by the State under the public trust doctrine to ensure equitable and sustainable development for all.

NWP 2012 has done away with water allocation prioritization mentioned in NWP 1987 and 2002, but has emphasized on treating water, over and above the pre-emptive need for safe drinking water and sanitation, as an economic good. NWP 2012 also emphasizes the fact that the service provider role of the State has to be gradually shifted to that of a regulator of services and facilitator for strengthening the relevant institutions.

Some of the basic guiding principles stated in the NWP 2012 include:

- The principle of equity and social justice must inform the use and allocation of water resources.
- Planning, development, and management of water resources need to be governed by common integrated perspectives considering local, regional, and national context, having an environmentally sound basis, keeping in view the human, social, and economic needs.
- Safe drinking water and water for sanitation should be considered as pre-emptive needs, followed by high priority allocation for other basic domestic needs, supporting agriculture for food security and minimum ecosystem needs. After meeting the previously mentioned needs, water should be allocated in a manner to promote its conservation and efficient use.
- Given the limits on enhancing utilizable water resources coupled with climate change impacts, meeting the future needs of water will depend more on demand management. There is an urgent need for evolving an agricultural system which can economize water use and maximize the value from water and also enhance water use efficiency by curbing wastages.
- Water-using activities need to be regulated keeping in mind the local geo-climatic and hydrological situations.

The NWP makes recommendations on several major issues including:

- Adapting to climate change
- Enhancing water availability
- Water demand management through efficient water use practices
- Water pricing
- Conservation of river corridors, water bodies, and infrastructure
- Project planning and implementation
- Management of floods and droughts
- Water supply and sanitation
- Institutional arrangements
- Trans-boundary rivers
- Database and information system
- Research and training needs
- Preparation of a plan of action by the National Water Board based on the National Water Policy

3.3.2 State Level Regulatory Framework for Water Allocation

Kumaon Water Rules, 1917 and 1930: These rules substituted the customary rights of the local communities over their water resources with a more formalized and 'rational' state system of water allocation for various purposes - drinking, water irrigation, and other uses. The rules marked a shift from the customary handling of water resources based on the principle of 'prior use'. Therefore, in case of conflicts between individuals, communities, and so on, and where the rights of the state are not in contention, the concept of prior use rights prevail. However, these rules also state that both the beds and water of all rivers and natural streams, lakes, natural ponds, and other collections of still water within the hill tracts of the Kumaon division are the property and subject to the control of the state. The rules also shift from the customary rights to a state allocation of water resources.

Uttarakhand Water Management and Regulatory Act, 2013: This act ensures sustainable, equitable, and judicious management and optimal allocation of the state's water resources through the establishment of a state water management and regulatory authority. The authority will determine and allocate water resources among various user categories based on availability at the project/utility level and establish a system to monitor and measure the actual use among different user categories; fix, regulate, and monitor a water tariff system; monitor water conservation and management practices; support the enhancement and preservation of the water quality; and determine standards for performance of water supply services and efficient water use by consumers. A water management and regulatory authority is still to be constituted by the state to oversee the implementation of this act.

According to this regulation, the State Water Authority will determine allocation and distribution of water resources based on the State Water Policy. It will also review and clear new water resource projects to ensure their integration with the Integrated State Water Plan and Basin-level Plans. Monitoring and enforcing entitlements is also under the jurisdiction of this authority. In all areas where such plans are made, the actual use of water resources would need to follow identified entitlement. Presently, there is the Ganga Basin Management Plan, and supporting legislation.

4 Major Water Users and Usage Pattern in UK

Drinking Water Production in Uttarakhand is approx. 1735 MLD of which 47% is for Rural Water Supply and the rest 63% is for Urban Drinking Water Supply. It's noted that Tube wells / Bore holes are the single largest source for water supply in the state at about 77%; with it being 65% of the water sources in Rural and about 86% in Urban Water Supply. Agriculture plays a major role in the Uttarakhand economy with almost half the workforce (49 per cent) engaged in it, but contributed only 11 per cent to the state income. The prominent sub-sectors have been construction and manufacturing in the secondary sector, while trade, hotel & restaurants catering mainly the tourism and hospitality industry in the

tertiary sector during the time periods 2005-2012 and 2012-18. In recent times, the primary sector has grown somewhat sluggishly during 2011-12 to 2017-18 (1.07 percent AGCR), the secondary sector posted a growth rate of 6.1 per cent, while the tertiary sector recorded growth of 7.2 per cent.

Sl #	Operational Holdings	Nos.	Ha
1	Marginal Holdings (<1.0 Ha.)	672000	296000
2	Small Holdings (1.0 - 2.0 Ha.)	157000	225000
3	Semi Medium and Medium Holdings (2-10 Ha.)	82000	270000
4	Large Holdings (>10 Ha.)	1000	25000
	Total	912,000	816,000

Uttarakhand industrial sector: – As per MSME Development Institute[8] about 22249 MSMEs of 62 categories exist in Uttarakhand (Feb 2018) There are about 272 large industries working till Jan, 2017 in the state.

4.1 Current Water Demand

As per the Water Budget[9] 2016-17, prepared by National Water Mission (NWM), Govt. of India for the State of Uttarakhand, the current Water Demand for the different sectors is as follows:

Consumptive Use	MCM	Remarks
C1. Farm Sector Consumptive Use	9516.00	Gross irrigated area of the state is 540999 ha.
C2. Industry	46.25	As per PCB, WC details
C3. Establishments & Institutions Use		Not Assessed yet
C4. Domestic Use (Rural)	295.54	UJS
C5. Domestic Use (Urban)	337.74	UJS
C6. Forestry & Wildlife Consumptive Use		
Livestock	119.00	
TOTAL	10314.53	

4.2 Water Demand Projections

Water Demand-Supply and Consumption: Drinking Water Consumption in Uttarakhand is approx. 1735 MLD of which 47% is for Rural Water Supply and the rest 63% is for Urban Drinking Water Supply. It's noted that Tube wells / Bore holes are the single largest source for water supply in the state at about 77%; with it being 65% of the water sources in Rural and about 86% in Urban Water Supply.

Demand maybe calculated at the established norm of 135 lpcd for urban areas and 55 lpcd in the rural areas.

[8] **Brief Industrial Profile of State, Uttarakhand (**http://msmedihaldwani.gov.in/)

9 http://nwm.gov.in/sites/default/files/Report_Draft-SSAP_Uttarakhand.pdf

Irrigation: As per Irrigation Department statistics, total land usable for agriculture is 1.55 million ha, which is 35.61% of total geographical area of Uttarakhand state. Total irrigation potential developed by Irrigation Department is 0.4458 million ha against total irrigation potential of 5.42 lac ha of the state. By year 2016-17, the actual irrigated area in the state is 0.3142 million ha and CCA is 0.3815 million ha.

Industry Water Demand: @ 20 kL/acre/day[10] in heterogeneous industrial estate. The industrial estates in Haridwar, Sitarganj and Kashipur area itself extends to about 7400 acres which would have a fresh water demand of about 148 MLD.

Livestock water demand for drinking, washing and shed cleaning: 324 MLD[11]

5 Waste Water Generation Pattern in Uttarakhand

5.1 Sources, Quantity, Type and Diurnal / Seasonal Frequency

Municipal: Waste Water generation is assumed to be 80% of water supplied, considering actual consumption and other losses during conveyance. Considering the population census data as of 2011 and assuming water supply of 135 lpcd in urban areas and 70 lpcd in rural, the water demand for domestic supply is estimated as 411.66 MLD for urban areas and 329.33 MLD as the sewage generation; whereas for the rural areas it is estimated as 492.59 MLD and 394.1 MLD respectively.

The sewage generation projected for 2021 given a decadal growth of 20% for urban areas is 329.33 MLD.

The Waste Water/ effluent generated from the industries may be estimated at about 65% of the industrial water consumption, which would be approx. 30.0625 MCM

5.2 Current Management Practices

As regards industries, the water polluting industries are to obtain Consent to Operate from the State Pollution Control Board and treat the waste water to prescribe standards before discharging. The point of discharge and standards are prescribed by SPCB as per the site sensitivity. In case of clusters or industrial estates the industries may come together or the industrial estate developer may establish a Common Effluent Treatment Plant to treat the effluent; in which case the member industry need to establish Primary Effluent Treatment Plant (PETP).

[10] Project Information Memorandum, CETP at SIIDCUL, IIE Haridwar
[11] http://nwm.gov.in/sites/default/files/Report_Draft-SSAP_Uttarakhand.pdf

As regards Municipal Sewage, the sewage from households are transferred vide sewerage networks to centralized Sewage Treatment Plants in the towns. These are established by the Government of Uttarakhand and maintained by the line departments like UJS and or UKPJN which is primarily tasked with establishing these facilities.

Effluents post treatment are discharged from the STPs to be the rivers or water bodies close to it. CETPs are also currently discharging the treated effluent to the nearest water bodies.

Discussions are on with the irrigation department to divert the treated waste water for irrigation application in Haridwar. As regards, the treated water reuse from CETPs[12], there has been series of discussions between SIIDCUL and industries.

5.3 Points of Discharge and Discharge Standards

The discharge standards for STPs and CETPs are prescribed and notified by the Ministry of Environment, Forests & Climate Change, Govt. of India. The State Pollution Control Board is to be specify the inlet norms to the CETP as well make the discharge norms stringent as per the local requirements.

There has been a series of requirements specified by the regulators to adopt Zero Liquid Discharge in industries as well as for the STPs to promote reduce of treated water. However, these orders met with low compliance level as a clear road map on achieving it, over a phased manner is yet to be developed. Further, the market factors, incentive schemes and the linked policies are to be also set in place to bring in acceptability for the norms.

[12] https://nmcg.nic.in/writereaddata/fileupload/ngtmatters/4thMeetingofprincipalCommittee.pdf http://seip.urban-industrial.in/live/hrdpmp/hrdpmaster/igep/content/e62771/e63552/e67433/e67434/e67496/20171102_MoMwithJalNigam.pdf

5.4 Existing Infrastructure (STP/ CETP/ ETP)

As regards the existing Municipal Sewage treatment infrastructure is concerned, there are 61 operational STPs in Uttarakhand as given in table below:

Town	Existing STPs (nos)
Almora	1
Badrinath	3
Bhimtal	1
Dehradun	7
Devprayag	3
Gopeshwar	5
Haridwar	5
Joshimath	1
Karnparayag	5
Kirtinagar	2
Muni-ki Reti	2
Mussoorie	5
Nandprayag	2
Nanital	3
Pithoragarh	2
Rishikesh	1
Rudraprayag	6
Srinagar	2
Swargashram	1
Tapovan	1
Tehri	1
Uttarkashi	2
Grand Total	61

The higher capacity plants are in the plains, i.e. in cities/ towns like Haridwar, Dehradun. The table below details the town-wise sewage treatment capacity available, current in-flows and the % utilization of the facility as on date. The actual inflow is the actual water available for treatment and supply as treated waste water.

Town	STP Capacity (MLD)	Capacity Being Utilized (MLD)	Utilization (%)
Almora	2.00	1.65	82.5
Badrinath	1.27	0.19	15.0
Bhimtal	1.25	1.00	80.0
Dehradun	115.13	43.31	37.6
Devprayag	1.63	0.17	10.6
Gopeshwar	4.37	0.32	7.3
Haridwar	145.00	120.06	82.8
Joshimath	1.08	0.42	39.0
Karnparayag	0.35	0.13	35.7
Kirtinagar	0.06	0.03	56.7
Muni-ki Reti	12.50	6.70	53.6
Mussoorie	7.32	1.60	21.9
Nandprayag	0.15	0.02	14.7
Nanital	11.25	7.45	66.2
Pithoragarh	6.25	1.80	28.8
Rishikesh	26.00	10.80	41.5
Rudraprayag	0.53	0.32	60.0
Srinagar	4.50	0.25	5.6
Swargashram	3.00	2.12	70.7
Tapovan	3.50	1.10	31.4

Town	STP Capacity (MLD)	Capacity Being Utilized (MLD)	Utilization (%)
Tehri	5.00	2.50	50.0
Uttarkashi	3.00	1.98	66.1
Grand Total	355.13	203.92	57.4

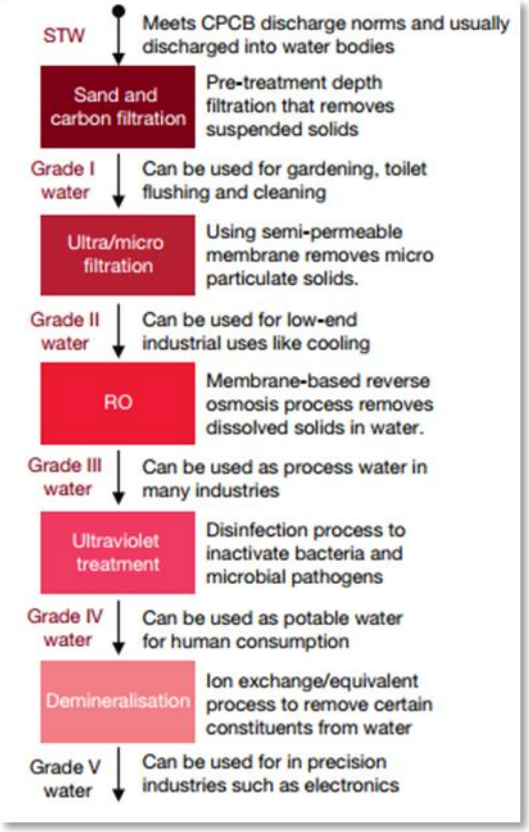
CETPs – 3 nos at Haridwar (4.5 MLD), Pantnagar (4 MLD) and Sitarganj (4 MLD)

As the wastewater generators as well as the potential users are higher in Haridwar, Dehradun and US Nagar districts. Hence, these districts maybe focused for piloting reuse of treated waste water.

5.5 Defining Service Levels of Treated Waste Water Supply

Traditionally[13], treatment focused on removing contaminants and pathogens to recover water and safely discharge it into the environment. Today, treatment plants should be viewed as water resource recovery facilities that recover elements of the wastewater for beneficial purposes: water (for agriculture, the environment, industry, and even human consumption), nutrients (nitrogen and phosphorus), and energy.

14Wastewater can be treated to various qualities/ grades as per the demand of the buyers/ stakeholders, ranging from industry to agriculture. It may also be used to maintain the environmental flow and can even be reused as drinking water. Wastewater treatment for reuse is one solution to the world's water scarcity problem, freeing scarce freshwater resources for other uses, or for preservation. Further, by-products of wastewater treatment can become valuable for agriculture and energy generation, making wastewater treatment plants more environmentally and financially sustainable. Hence, advanced wastewater management can become a value proposition in terms of financial returns that can cover operation and maintenance costs partially or fully, apart from the environmental and health benefits of wastewater treatment. Resource recovery from wastewater facilities in the form of energy, reusable water, bio solids,



13 "Rodriguez, Diego J.; Serrano, Hector A.; Delgado, Anna; Nolasco, Daniel; Saltiel, Gustavo. 2020. From Waste to Resource: Shifting paradigms for smarter wastewater interventions in Latin America and the Caribbean." World Bank, Washington, DC.
14 Image Source: https://www.pwc.in/assets/pdfs/publications/2016/pwc-closing-the-water-loop-reuse-of-treated-wastewater-in-urban-india.pdf

and other resources, such as nutrients, represents an economic and financial benefit that contributes to the sustainability of water supply and sanitation systems and the water utilities operating them.

Currently no service levels are defined for Treated Waste water supply in the state. The negotiation is currently to only use the irrigation canals to transport the treated water for irrigation of farmlands. However, as irrigation water is required only during specific seasons and crop requirements, need to also think of alternate applications during the times of low demand.

With the paradigm shift towards upgrading the Sewage Treatment Plant to a Water Recovery unit essentially requires a shift in the approach from that of a service industry to that a product manufacturing unit.

Defining Service levels would depend on the specific requirements of the end clients/ buyers of the treated water, - i.e. quality requirements, quantity requirements, frequency or supply timing, etc.; particularly in case of dedicated buyers.

5.6 Monitoring & Enforcement Mechanisms in Uttarakhand & Nationally

There are a host of Central and State agencies to monitor groundwater levels, quality and regulate water abstraction as well at its discharge or reuse;

- Central Ground Water Authority: is to monitor, control and manage ground water abstraction and recharge.
- Uttarakhand Environment Protection & Pollution Control Board: State enforcement agency to monitor and regulate the impact of pollution from various sources.
- Central Pollution Control Board: Monitor and inform the concerned agencies and gathers data to review policies and strategies.
- National Mission for Clean Ganga: Has enforcement powers under sec 5 of E(P) Act to prevent/ arrest polluting of the river Ganga
- State Ganga Committee, Uttarakhand: Has enforcement powers under sec 5 of E(P) Act to prevent/ arrest polluting of the river Ganga in Uttarakhand
- State Programme Management Group – Namami Gange: Executive arm of the State Ganga Committee of Uttarakhand
- Consumer Courts, Dept. of Consumer Affairs, Govt. of India

The courts can take action suo moto or in cognizance of any public interest litigations;

- Hon'ble High Court of Uttarakhand
- Hon'ble Supreme Court of India
- National Green Tribunal: Quasi-judicial body, instituted as a Special Tribunal on Environment powers.

6 Identification of Potential Users of Treated Waste Water

Potential users of Treated waste water could be from different sectors

- **Irrigation:** For use as irrigation water, particularly the treated waste water from STPs. As regards CETPs, the treated waste water quality needs to be assured to be in conformance with the irrigation water quality requirements.
- **Construction Water:** Maybe mandated to use only treated waste water for construction/ real estate development activities.
- **Municipal Use:** Maybe utilized by ULBs for irrigation of public parks, schoolyards, highway medians, and residential landscapes, road wetting, construction activities, as well as for toilet flushing and fire protection
- **Commercial / Institutions:** Maybe supplied as raw water for gardening, toilet flushing, cooling towers and other non-body contact applications
- **Railway Depots/ Bus Stations:** For washing of coaches, buses.
- **About 12,000 litres to 14,000 litres** of water is being used for cleaning one rake consisting of 22-24 coaches15. For bus washing, it requires about 100-120 liters16 of water per bus.
- **Solar PV Plants (> 10 MW):** Maybe used for washing of solar panels: Required would be approximately 7 – 20 kL per MW17 per week. Currently the high capacity Solar PV18 plants are in Haridwar (82MWp) and US Nagar (80 MWp) districts of Uttarakhand with a potential combined demand of up to 3.2 Million liters per week.
- **Industries:** Mostly as raw water. Haridwar's SIIDCUL Integrated Industrial Estate alone requires about 20 MLD19 of water. Needs to investigate of this, how much can be replaced with the treated waste water.
- **Environmental Reuses:** It is nothing but the use of reclaimed water to sustain, enhance, create or augment water bodies including aquatic habitats, or streamflow. For example, constructed wetlands fed by wastewater provide both habitats for flora & fauna and wastewater treatment.

[15] http://www.railnews.in/railways-installs-automatic-train-washing-system-at-hazrat-nizamuddin-station-it-takes-8-minutes-to-wash-a-24-coach-rake/
[16] https://www.bitimec.com/en/faq-questions-inline
[17] https://www.saurenergy.com/solar-energy-blog/solar-pv-modules-cleaning-operations-and-maintenance
[18] http://ureda.uk.gov.in/pages/display/179-grid-connected-solar-power-plant
[19] Project Information Memorandum, CETP at SIIDCUL, IIE Haridwar

7 Way Ahead

The Way Ahead towards an era of Water Stewardship and Circular Economy would need proper planning to ensure successful implementation.

Following are few points to consider;

- Conduct Market & Social Surveys to understand the psychological concerns, current demand, quality requirements, availability, current costs
- Awareness Creation (IEC activities) to eradicate misconceptions
- Market Mechanisms / Interventions including restrictions on indiscriminate use of groundwater
- Rationalization of Water Tariffs for Commercial/ Industrial sectors
- Identifying the potential customers and their needs
- Concerns regarding acceptability of treated waste water if any
- Technical feasibility – Conveyance mechanisms
- Quality, Quantity, Frequency of supply and associated infrastructure requirements
- Innovative pricing mechanisms
- Innovative financing mechanisms – explore PPP mode for the Recovery Unit
- Legal Instrument on 'Minimum quality requirements for water reuse' for two specific uses, agricultural irrigation and aquifer recharge

The above activities may be taken up on a time bound manner with clear targets / milestones to be achieved over given time frames.

References

https://cpcb.nic.in/upload/home/water-pollution/WaterAct-1974.pdf
https://cpcb.nic.in/upload/home/water-pollution/A1977-36.pdf
https://cpcb.nic.in/displaypdf.php?id=aG9tZS9lcGEvZXByb3RlY3RfYWN0XzE5ODYucGRm
http://moef.gov.in/division/environment-divisions/control-of-pollution-cp/introduction/
http://moef.gov.in/wp-content/uploads/2018/04/nep2006e.pdf
https://niti.gov.in/planningcommission.gov.in/docs/plans/plan-rel/12thplan/pdf/12fyp_vol2.pdf
http://mohua.gov.in/upload/uploadfiles/files/NUSP_0.pdf
http://cedindia.org/wp-content/uploads/2013/08/Strategy-for-Urban-Waste-Water-Management-.pdf
http://amrut.gov.in/upload/newsrelease/5a5dc55188eb0FSSM_Policy_Report_23Feb.pdf
http://mohua.gov.in/upload/uploadfiles/files/Flyer.pdf
http://mowr.gov.in/sites/default/files/Mission_Doc_Vol22880755143_0.pdf
http://mowr.gov.in/sites/default/files/NWP2012Eng6495132651_1.pdf
http://mowr.gov.in/sites/default/files/Guidelines_for_improving_water_use_efficiency_1.pdf
http://jalshakti-dowr.gov.in/sites/default/files/Water_Framework_18July_2016%281%29.pdf
http://cpheeo.gov.in/cms/manual-on-sewerage-and-sewage-treatment.php
https://apps.who.int/iris/bitstream/handle/10665/78265/9241546824_eng.pdf?sequence=1
https://www.epa.gov/sites/production/files/2019-08/documents/2012-guidelines-water-reuse.pdf
http://social.niti.gov.in/uploads/sample/water_index_report.pdf
https://niti.gov.in/sites/default/files/2019-08/CWMI-2.0-latest.pdf
https://nmcg.nic.in/writereaddata/fileupload/18_NGRBA_Framework_2.pdf
https://nmcg.nic.in/writereaddata/fileupload/13_GRBMP%20-%20MPD.pdf
https://nmcg.nic.in/writereaddata/fileupload/40_Guidelines%20for%20Report%20Preparation%20under%20NRCP%20NGRBA%20Dec%202010.pdf
https://nmcg.nic.in/pdf/13_Guide%20Lines%20IAndD%20and%20STP%20-%20Final.pdf
https://nmcg.nic.in/writereaddata/fileupload/5_Septage%20Practitioner's%20Guide-EnglishVersion.pdf
https://nmcg.nic.in/writereaddata/fileupload/59_ExtendedDateForRFQofTransaction%20Advisor(s)AndOtherDetails.pdf
https://nmcg.nic.in/writereaddata/fileupload/16_templetforactionplanforMunicipalities.pdf\
(https://www.iewp.eu/img/Event/1564399736_Comparative%20Assessment.pdf)
http://cgwb.gov.in/AQM/NAQUIM_REPORT/Uttarakhand/Udham%20Singh%20.pdf
http://cgwb.gov.in/AQM/NAQUIM_REPORT/Uttarakhand/Haridwar.pdf
http://publications.iwmi.org/pdf/H017585.pdf
https://www.iitr.ac.in/wfw/pdf/Water_managment_and_regulatory_act-2013_uttarakhand.pdf
http://swsm.uk.gov.in/pages/display/12-about-us

SGR - GOPA Infra GmbH Team

Laura Sustersic
Team Leader
GIZ-Support to Ganga Rejuvenation Project – UK & UP (2018-20)

John Thomas
Technical Advisor & Sr. Long Term Expert
GIZ-Support to Ganga Rejuvenation Project – UK & UP (2016-20)

Trushit Desai
National Short-term Expert, Waste Water
GIZ-Support to Ganga Rejuvenation Project – UK & UP (2016-20)

Ruchi Yadav
Project Support Manager
GIZ-Support to Ganga Rejuvenation Project – UK & UP (2016-20)

We can be contacted at;

State Programme Management Group (SPMG)
117, Indira Nagar
Dehradun, Uttarakhand, India

State Mission for Clean Ganga (SMCG)
Plot no 18, Sector 7
Gomti Nagar Extension
Lucknow, Uttar Pradesh, India

Laura Sustersic
Team Leader
M - +91 93686 13625
E – Laura.Sustersic@gopa-infra.de