REPUBLIC OF INDIA
GOVERNMENT OF TAMILU NADU
TAMIL NADU WATER SUPPLY AND DRAINAGE BOARD (TWAD)

PREPARATORY SURVEY FOR HOGENALLAL WATER SUPPLY PROJECT (PHASE-3)

FINAL REPORT (ADVANCED VERSION)

JANUARY 2026

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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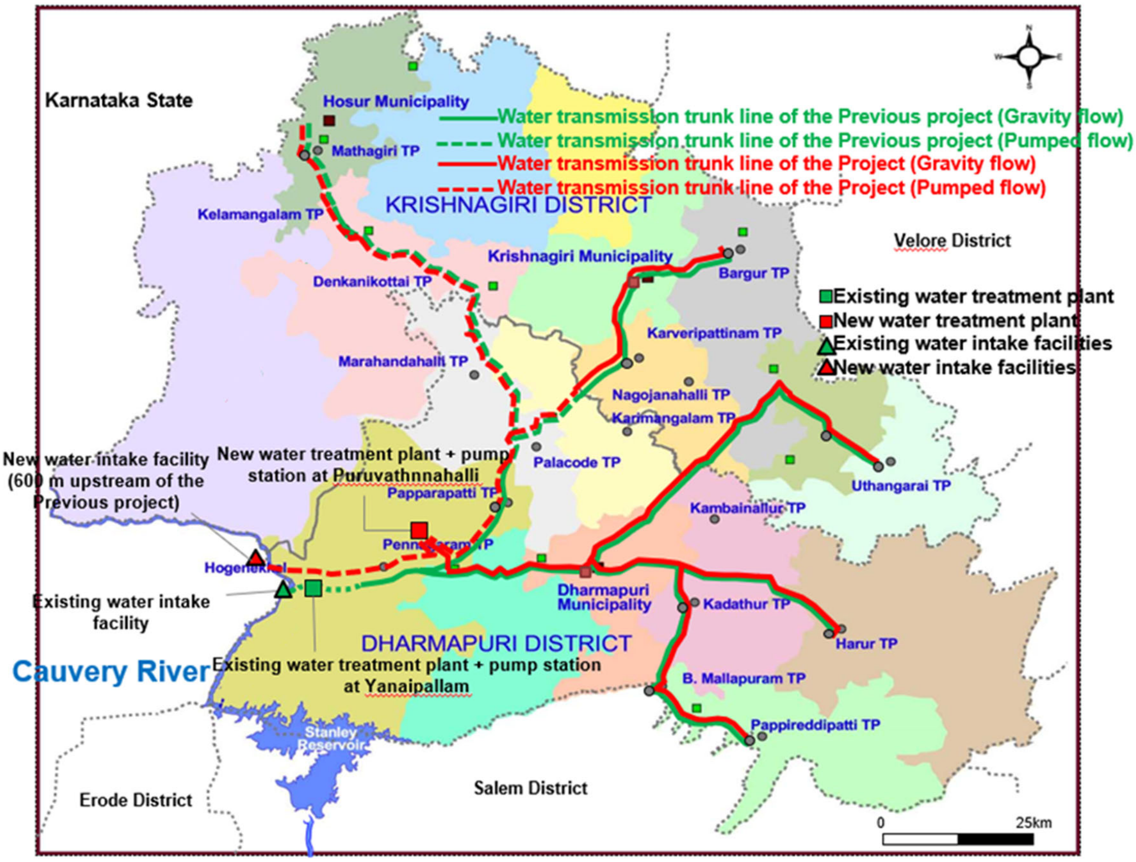

※The map color coding represents village clusters

Source: Prepared by JST, based on materials from previous projects provided by TWAD.

Location Map

Preparatory Survey for
Hogenakkal Water Supply and Fluorosis Mitigation Project (Phase-3)

Final Report

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Abbreviations

A-RAP	Abbreviated Resettlement Action Plan
ADD	Acute Diarrhoeal Disease
AE	Assistant Engineer
AEE	Assistant Executive Engineer
AI	Artificial Intelligence
AIDS	Acquired Immunodeficiency Syndrome
AMR	Automatic Meter Reading
AO	Administrative Officer
ATP	Affordability to Pay
BCM	Billion Cubic Meters
BCR	Benefit-Cost Ratio
BOQ	Bill of Quantity
BPS	Booster Pump Station
BPT	Break Pressure Tank
BSNL	Bharat Sanchar Nigam Limited
CBIC	Chennai-Bangalore Industrial Corridor
CE	Chief Engnineer
CGD	City Gas Distribution
Ch.	Chainage
CMA	Commissionerate of Municipal Administration
CMWA	Cauvery Water Management Authority
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
COVID 19	Coronavirus Disease 2019
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering
CPI	Consumer Price Index
CS	Construction Stage
CWR	Clear Water Reservoir
CWRC	Cauvery Water Regulation Committee
CWSS	Combined Water Supply Scheme
DBO	Design Build Operate
DEDC	The Dharmapuri Electricity Distribution Circle
DFR	Draft Final Report
DI	Ductile Iron
DPR	Detailed Project Report

DTP	Directorate of Town Panchayats
DX	Digital Transformation
EAP	Externally Aided Project
EE	Executive Engineer
EIA	Environmental Impact Assessment
EIRC	Emergency Information Reception Center
EIRR	Economic Internal Rate of Return
ELCOT	Electronics Corporation of Tamil Nadu Limited
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
ESDM	Electronic System Design and Manufacturing
EV	Electric Vehicle
FC	Foreign Currency
FCMA	Flux Compensated Magnetic Amplifier
FHTC	Functional Household Tap Connection
FIDIC	Fédération Internationale Des Ingénieurs-Conseils
FIRR	Financial Internal Rate of Return
FM	Feeder Main
FPO	Farmer Producer Organization
FR	Final Report
FY	Fiscal Year
GDDP	Gross District Domestic Products
GDP	Gross Domestic Products
GI	Galvanized Iron
GIS	Geographic Information System
GL	Ground Level
GOI	Government of India
GOJ	Government of Japan
GoTN	Government of Tamil Nadu
GPRS	General Packet Radio Service
GSDP	Gross State Domestic Products
GST	Goods and Service Tax
GVA	Gross Value Added
HC	House Connection
HDPE	High Density Polyethilen
HGL	Hydraulic Grade Line
HIV	Human Immunodeficiency Virus

HMI	Human Machine Interface
HSC	House Service Connection
IBA	Important Bird and Biodiversity Area
ICB	International Competitive Bidding
ICR	Inception Report
IEC	Information, Education and Communication
IN	Internal Network
INR	Indian Rupee
INW	Internal Network
IoT	Internet of Things
ITM	Internal Transmission Main
ITR	Interim Report
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JCC	Joint Coordination Committee
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
JJM	Jal Jeevan Mission
JSSS	JICA Standard Safety Specification
JST	JICA Study Team
KBA	Key Biodiversity Area
L/A	Loan Agreement
LC	Local Currency
LCB	Local Competitive Bidding
LL	Lakh Litter
LoRaWAN	Long Range Wide Area Network
lpcd	litter per capita day
M-Sand	Manufactured Sand
MA&WS	Municipal Administration and Water Supply Department
MAWS	Municipal Administration and Water Supply Department
MBR	Master Balancing Reservoir
MCC	Motor Control Center
MLD	Million Liter per Day
MoEFCC	Ministry of Environment, Forest and Climate Change
MoHUA	Ministry of Housing and Urban Affairs
MS	Mild Steel
MWL	Maximum Water Level
NDC	Nationally Determined Contributions

NGO	Non-Governmental Organization
NH	National Highway
NHAI	National Highway Authority of India
NOC	No Objection Certificate
NPPCF	National Programme for Prevention and Control of Fluorosis
NRW	Non Revenue Water
NTU	Nephelometric Turbidity Units
NWP	National Water Policy
O&M	Operation and Maintenance
O-PVC	Oriented Unplasticized Polyvinyl Chloride
OFC	Optical Fiber Communication
OHT	Overhead Tank
OPC	Open Platform Communications
OS	Operational Stage
PCCF	Principal Chief Conservator of Forests
PDS	Public Distribution System
PHED	Public Health Engineering Department
PID	Project Implementation Division
PIU	Project Implementation Unit
PLC	Programmable Logic Controller
PMC	Project Management Consultant
PMU	Project Management Unit
PRR	Peripheral Ring Road
PS	Pump Station
PVTG	Particularly Vulnerable Tribal Groups
PWD	Public Works Department
RD&PR	Rural Development and Panchayat Raj Department
RF	Reserved Forest
RFP	Request for Proposal
SBD	Standard Bidding Documents
SCADA	Supervisory Control and Data Acquisition
SDGs	Sustainable Development Goals
SE	Superintending Engineer
SEZ	Special Economic Zone
SGBV	Sexual and gender-based violence
SIPCOT	State Industries Promotion Corporation of Tamil Nadu
SMPS	Switched-Mode Power Supply
SOR	Schedule of Rates

SPCB	Tamil Nadu Pollution Control Board
TANGEDCO	Tamil Nadu Generation and Distribution Corporation
TB	Transmission Branch
TIDCO	Tamil Nadu Industrial Development Corporation Limited
TM	Transmission Main
TNPCB	Tamil Nadu Pollution Control Board
TOR	Terms of Reference
TP	Tapping Point
TP	Town Panchayat
TTRO	Tertiary Treatment Reserve Osmosis
TWAD	Tamil Nadu Water Supply and Drainage Board
UGSS	Underground Sewerage Scheme
ULB	Urban Local Body
UMBR	Union MBR
UN	United Nation
UNESCO	United Nations Educational, Scientific and Cultural Organization
VAP	Village Action Plan
VAT	Value Added Tax
VCB	Vacuum Circuit Breaker
VFD	Variable Frequency Drive
VHN	Village Health Nurse
VP	Village Panchayat
VSAT	Very Small Aperture Terminal
VSD	Variable Speed Drive
VVF	Village Volunteer Force
VWSC	Village Water and Sanitation Committee
WACC	Weighted Average Cost of Capital
WB	World Bank
WG	Working Group
WHO	World Health Organization
WLS	Wildlife Sanctuary
WRD	Water Resources Department
WSS	Water Supply Scheme
WTP	Water Treatment Plant
WTP	Willingness to Pay

SUMMARY

1. Water Supply Plan

The water supply area of the Project is the districts of Dharmapuri and Krishnagiri in Tamil Nadu State (see figure below). The planned development capacity for the target year 2056 is 304.84 MLD (see table below).

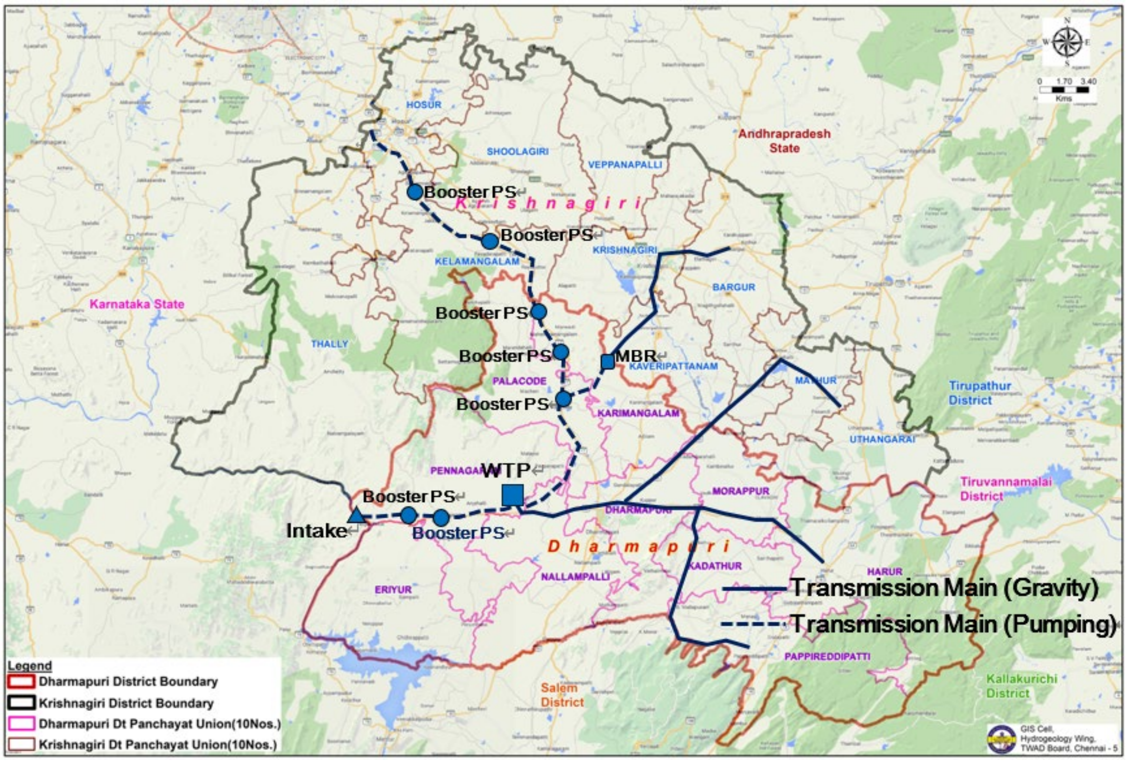
Planned Supply Capacity of the Project

	Projected Populatin			Domestic Demand (MLD)		Supply capactity of existing facility (MLD)			Development Capacity of the Project (MLD)	
	Base 2026	Inter 2041	Ulti 2056	Inter 2041	Ulti 2056	Previous PJT	Other existing	Total	Inter 2041	Ulti 2056
Dharmapuri District										
I. Dharmapuri Mpty	75,200	81,800	88,400	11.04	11.93	8.12	2.01	10.13	2.12	3.21
II. Town Panchayat	172,100	196,600	221,200	13.76	15.48	6.55	5.18	11.74	7.31	9.43
III. Rural	1,463,800	1,639,900	1,819,300	91.71	101.70	47.98	1.58	49.56	57.85	70.19
IV. Industrial						0.58	0.00	0.58	16.75	16.75
Krishnagiri District										
I. Hosur Corp	324,900	434,000	572,900	58.59	77.34	14.12	14.63	28.75	39.05	62.15
I. Krishnagiri Mpty	95,100	122,500	157,900	16.54	21.32	7.06	5.76	12.82	5.79	11.68
II. Town Panchayat	110,300	124,700	139,500	8.73	9.77	4.38	1.89	6.27	6.01	7.29
III. Rural	1,639,800	1,841,900	2,053,800	103.19	115.04	55.33	5.51	60.65	60.35	75.05
IV. Industrial									40.20	40.20
Total Project Area										
I. City corporation/Municipalit	495,200	638,300	819,200	86.17	110.59	29.30	22.41	51.71	46.96	77.05
II. Town Panchayat	282,400	321,300	360,700	22.49	25.25	10.93	7.08	18.00	13.32	16.72
III. Ruala Uniton	3,103,600	3,481,800	3,873,100	194.90	216.74	103.31	7.09	110.20	118.20	145.24
IV. Industrial						0.58	0.00	0.58	56.95	56.95
Total	**3,881,200**	**4,441,400**	**5,053,000**	**303.56**	**352.59**	**144.12**	**36.57**	**180.50**	**235.44**	**295.96**
Treatment loss 3%									7.06	8.88
Development capacity of the Project									**242.50**	**304.84**

Water Supply Area and Planned Supply Capacity (2056)

2. Facility Plan

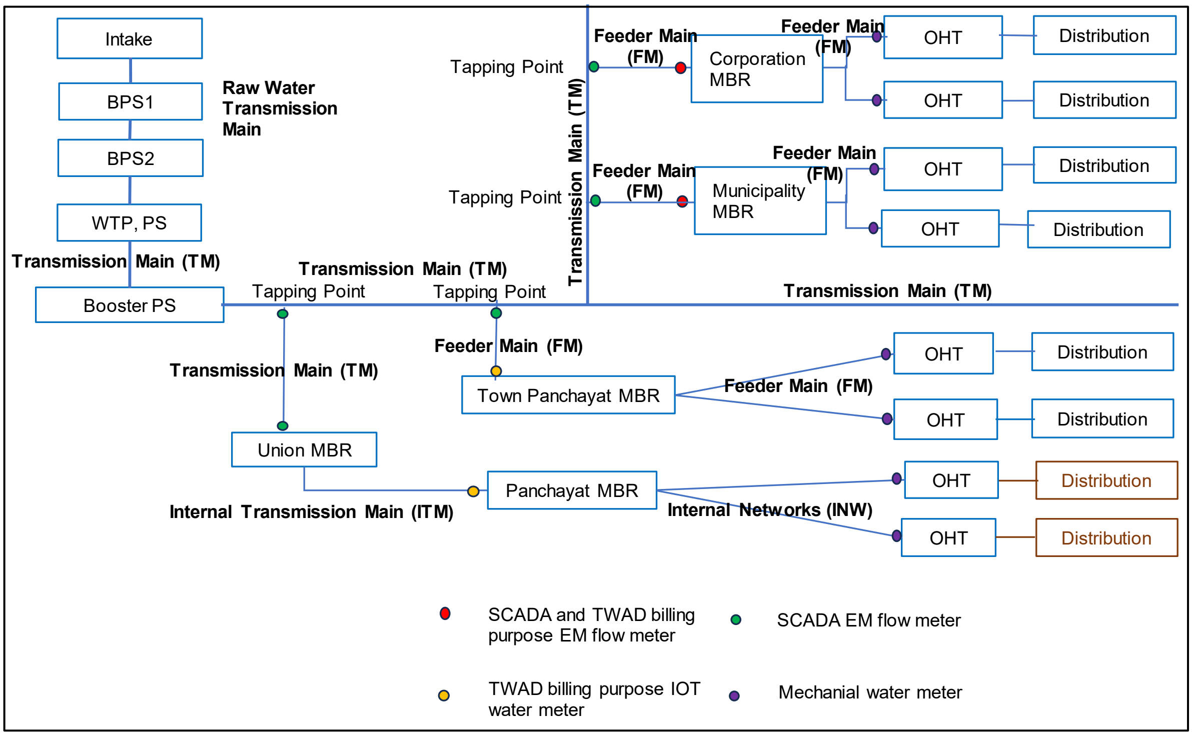
The layout of the major facility is shown below.



Layout of the Major Facility

The treated water transmission system consists of:

- Transmission Main (TM): Transmission pipeline from WTP up to the Union MBRs
- Internal Transmission Main (ITM): Transmission pipeline from the Union MBR to the Rural Panchayat MBRs in each union of rural panchayats
- Internal Network (IWW): Transmission pipeline from the Rural Panchayat MBRs to OHTs in the rural distribution areas
- Feeder Main (FM): Transmission pipeline branched from the TM to the OHTs in the urban distribution areas through the Corporation/Municipality/Town Panchayat MBR



Schematic of Water Supply System of the Project

Salient Features of the Project Facility are shown below.

Salient Features of the Project Facility

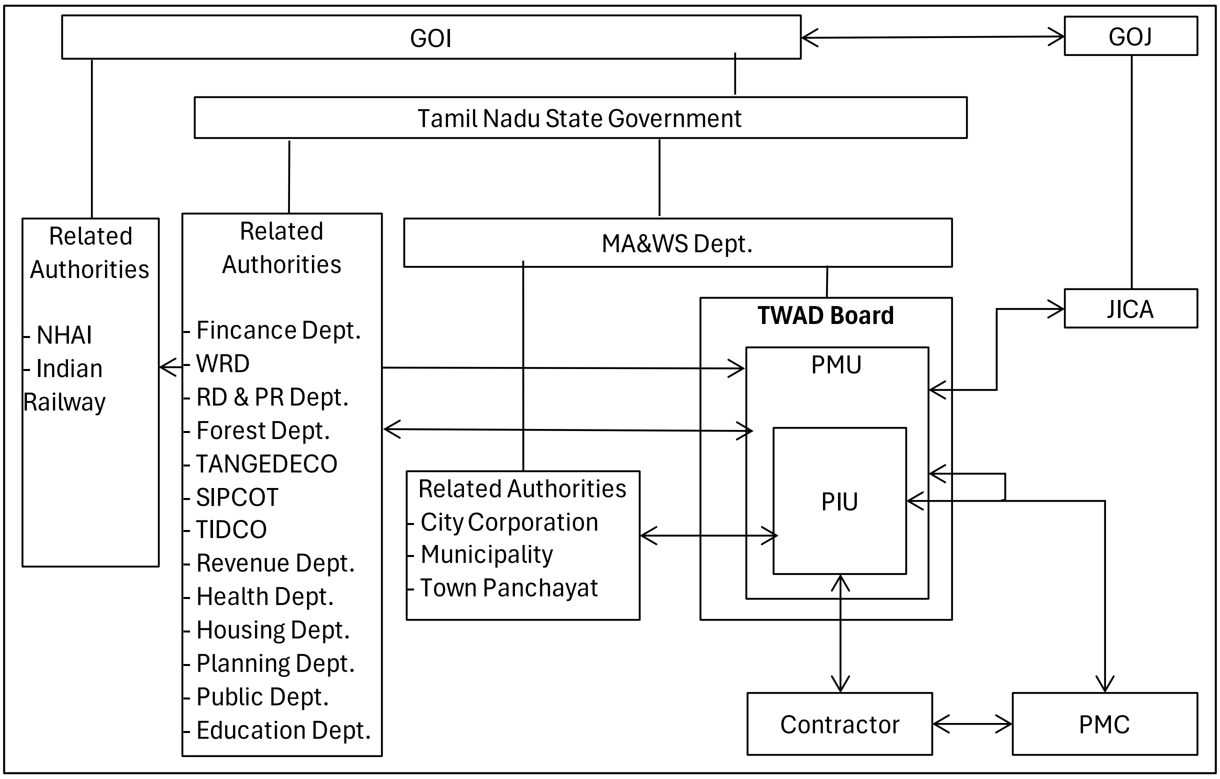
Intake, Raw Water Transmission System, Water Treatment Plant with Treated Water Pump Station, SCADA system	
Intake	Source: Cauvery River, Location: Hogenakkal (GL= 251.0m) Design Capacity: 304.83 MLD Main Structure: Intake Channel, Pump Well, Pump House, Switch Gear Building. Compressor room, Transformer Yard. Intake pump: 27,612 lpm x 78 m Head (7W +3S) (For Intermediate Year)
Transmission Pipeline	From Intake to BPS1 MS Pipe 1,829 mm x 14.20 mm, L=7.20 km
BPS 1	Location: Yanaipallam beside the existing WTP site (GL=310.0 m) Sump: 13,255 m^3 Transmission Pump: 27,612 lpm x 147 m Head (7W +3S) (For Intermediate Year)
Transmission Pipeline	From BPS1 to BPS2 MS pipe 2,032 mm x 20.0 mm, L=0.9 km, MS pipe 2,032 mm x 16.0 mm, L= 1.10 km
BPS 2	Location: Kanavai beside the existing BPS site (GL=446.0m) Sump: 13,255 m^3 Transmission Pump: 27,612 lpm x 105 m Head (7W +3S) (For Intermediate Year)
Transmission Pipeline	From BPS2 to WTP MS Pipe 1,829 mm x 14.20 mm, L=11.0 km
WTP	Location: Paruvathanahalli (GL= 496.0m –526.61m) Design Capacity: 304.83 MLD (250 MLD by the Project for Intermediate Year)

	Major component: Cascade aerator, Parshall Flume, Flash mixer and Mixing Well (2W+1S), Clari-flocculator (7W+2S), Rapid Sand Filter (23W+3S), Backwash Water Recycle Sump (2), Sludge Balancing Tank (2), Sludge Thickener (2), Sludge drying bed, Chemical dosing facilities (Alum, Lime, Chlorination)
Clear Water Main Pipeline	From CWR to MBR MS Pipe 1,118 mm x 8.80 mm, L=0.5 km
Treated Water Pump Station and MBR in WTP	Sump (Clear Water Reservoir): 12,870 m^3, MBR for Dharmapuri Area: 17,730 m^3 Transmission Pump: - to MBR for Dharmapuri Area: 18,467 lpm x 43 m Head (4W+1S) - to Sugar Mill BPS for Krishnagiri Area: 35,149 lpm x 66 m Head (4W+1S)
SCADA	Headworks (Intake), and BPS: Pressure transmitter, Pressure gauge, EM flowmeter, Level transmitter, Motorized valve, RTU based PLC-HMI, UPS WTP: Pressure transmitter, Pressure gauge, EM flowmeter, Level transmitter, Level switch, Motorized valve, Water quality analyzer (Turbidity, pH, Chlorine), RTU based PLC-HMI, UPS Transmission System (Tapping point, Sump, MBR) Pressure transmitter, Pressure gauge, EM flowmeter, Level transmitter, Motorized valve, RTU based PLC-HMI, UPS
Treated Water Transmission System, Distribution System, House Service Connection	
Transmission Pipeline	Transmission Main (TM): D100- D1600, L=402.4 km, Internal Transmission Main (ITM): D63-D500 L=2,832.9 km, Internal Network (INW): D63- D150 L=4,026.4 km Feeder Main (FM): D63-D711, L=214.6 km,
Major BPS MBR Sump with pumps BPT Re-chlorination OHT	Major booster pump Station : 5 nos. Master balancing reservoir (10m^3- 10,250m^3): 324 nos. Sump with pumps: (5 m^3 – 2,080m^3): 598 nos. BPT: (5 m^3 – 1,795 m^3): 32 nos. Re-chlorination: 57 locations Overhead tank (10 m^3 – 1,560 m^3): 1,900 nos.
Distribution pipeline Service connection Water meter	Distribution pipeline: 818.2 km, Installation of house service connection: 89,573 nos. Replacement/Installation of water meter: 71,745 nos.

3. Project Implementation Plan

Project Implementation System

The overall implementation framework of the Project is illustrated below.



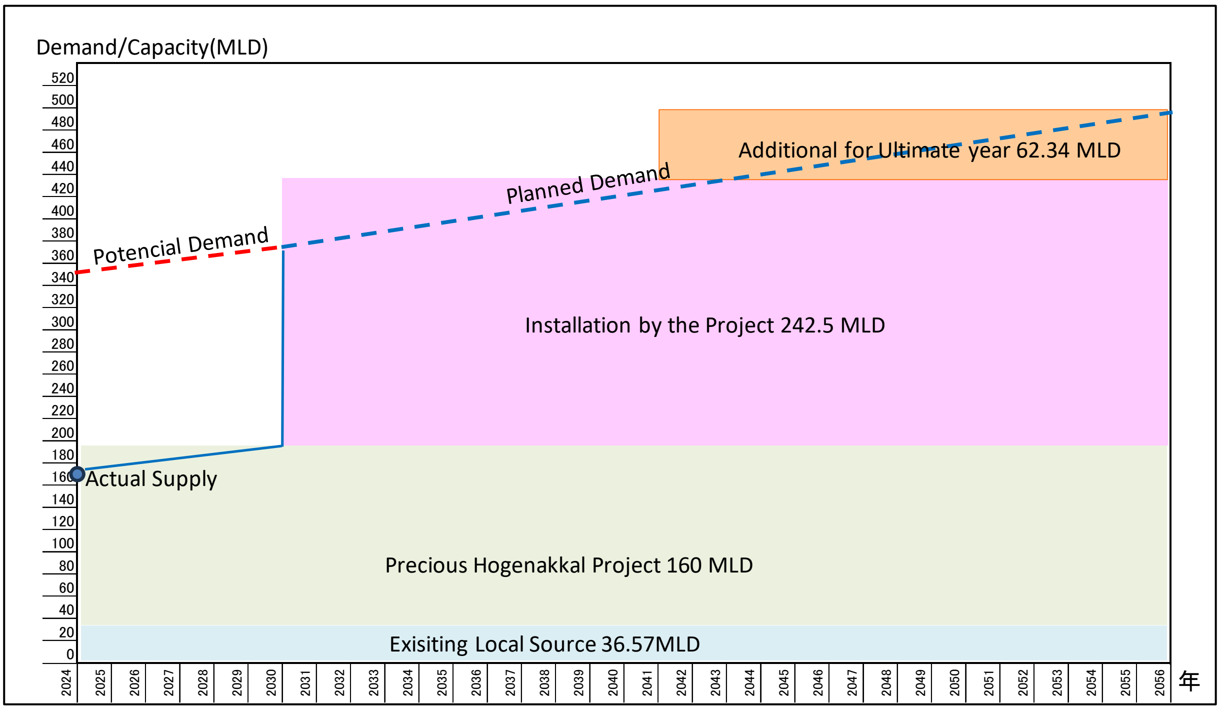
Overall Implementation Framework of the Project

The Executing Agency of the Project is Tamil Nadu Water Supply and Drainage Board (TWAD Board or TWAD). TWAD will set up the (Project Management Unit) PMU at TWAD head office and Project Implementation Unit (PIU) at Dharmapuri.

Procurement Plan

<u>Staged Development</u>

The water demand in Intermediate year is approximately 80 % of the Ultimate year. Therefore, the main equipment of WTP and major BPS will be installed by the Project to meet approximately 242.5 MLD out of the overall planned capacity of 305 MLD. The change in overall water demand and overall supply capacity within the Project area is shown below.



Change in Overall Water Demand and Overall Capacity

4. Project Implementation Schedule

5. Project Cost

6. Operation and Maintenance Plan

Similar to the Previous Hogenakkal Project, the bulk supply—coming from the intake facility through the water treatment plant then to the overhead tanks (OHTs) in each distribution area—will be conducted by the O&M contractor under a contract with the TWAD. O&M of water distribution facilities from OHTs to each house service connection in the water distribution area will be carried out by the respective local body.

The former is expected to be implemented without issues by selecting a qualified and experienced O&M contractor. On the other hand, the implementation system for the latter is considered weak in ensuring the sustainable development of the Project's effects. For this reason, a soft component has been proposed to provide technical support for each local body.

The issues and support needs for urban municipal water supply operation and water supply and sanitation in the entire Project area are shown below.

Issues and Need for Support for Urban Municipal Water Supply Operation

	Issues	Need for support
1. Water Supply Business Management		
(1)	Water supply operations are part of the responsibilities of the Engineering Section, which also handles road and drainage maintenance. As there is no organization solely dedicated to water supply, it is difficult to improve organizational and employee capabilities.	To improve management capabilities in the water supply sector, a department dedicated to water supply should be established within the Engineering Section. Alternatively, a section dedicated to water supply should be set up, and support for this should be provided.
(2)	As water supply is managed by the general accounting of local governments, it is difficult to grasp the financial situation of water supply operations. Furthermore, there is no incentive to improve financial conditions or increase fee collection rates.	Support is needed to establish an accounting system for the clarification of the expenditure status of water-related expenses, as well as for measures to improve fee collection rates. The establishment of a special water supply account should also be considered and recommendations made.
(3)	Since the fee is fixed, residents in areas with good water distribution conditions (water pressure and water volume) do not have awareness on water conservation, thus, the unequal water distribution situation does not improve.	For this project, water meters (AMR meters) are installed at each household connection. However, support will be needed to develop a fee structure to introduce a pay-as-you-go system. Ultimately, permission from the state government is required and assistance in obtaining this is needed.
2. Facility operation and maintenance		
(1)	Facility information, operation and repair procedures, and operation and repair records remain implicit knowledge among staff. This makes it difficult to plan and implement improvement measures, even when there are issues such as inappropriate facility conditions or unequal water distribution conditions. Although an inadequately designed water distribution pipeline network and insufficient water volume are thought to be the causes of the intermittent water supply, developing effective remedial measures is difficult.	There is a need for support in building and operating information management systems that include facility registers, O&M manuals, and operation and repair records to turn these systems into shareable explicit knowledge.

	Issues	Need for support
(2)	The customer ledger is not organized into a database, creating difficulty in managing and updating it.	Support is needed for the creation of a GIS-based customer ledger database, as well as for establishing a system to update the database in response to new service connections or terminations.
(3)	Under this project, AMR meters will be installed for each house connection. However, there is no operational experience in the area. In addition, because the fee is fixed, there is no experience of billing based on meter readings.	Assistance is required for the implementation of software for the AMR meter data management system and billing system. Additionally, in areas with poor communication, meter reading data must be collected using mobile devices, but meter readers need to be trained to do this.
(4)	The amount of water leakage cannot be determined because the amount of water supplied to each customer and the amount of water flowing out from the elevated water reservoir are not measured.	In this Project, AMR meters are installed at each household connection. However, support is needed to utilize the measured values for facility management (leakage management). In addition, to manage leakage, water meters (IOT meters) will be installed at the outlets of elevated water reservoirs (both existing and those to be constructed under this project), and support for managing the measured values will also be required.
3. 24-hour water supply		
(1)	A 24-hour water supply is expected to be provided by the urban municipalities in the Project areas. To start, a pilot area needs to be selected for the trial.	It is necessary to assist in the selection of areas suitable for a 24-hour water supply trial by conducting customer surveys, actual water usage surveys, and inspection of facility conditions.
(2)	To provide a 24-hour water supply, it will be necessary to curb the concentrated opening of water taps, which is based on the assumption of the current intermittent water supply.	There is a need to support the implementation of a 24-hour water supply campaign in pilot areas.
(3)	To implement a 24-hour water supply, it is necessary to prevent excessive water consumption by implementing a pay-per-use system.	Support needs to be provided for the pay-per-use operations. (Same as 1. (3) above)
4. Town Panchayat Project Implementation Structure		
(1)	Each city/municipal corporation has an Engineering Section, but the Town Panchayats do not. Instead, NGOs manage the facilities in each town under the management of the state government's local offices in each district (Town Panchayat Bureau). This makes it difficult to respond to each town individually.	It is necessary to provide the above-mentioned support, from 1. to 3., for the cities/municipalities, and to obtain the understanding of the Tamil Nadu state government regarding the results and lessons learned. After that, it is necessary to provide support for improvements in the town panchayats.

Issues and Need for Water Supply and Sanitation in the Project Area

	Issues	Need for support
1. Operation and maintenance of water distribution facilities		
(1)	The operation and maintenance of water supply facilities in each village is managed by operators employed in each village under the management of the provincial government's local branch office (the Rural Development and Self-Government Bureau), thus, information on facility and operations remains tacitly known to the operators.	Support is needed for officials in each prefecture's rural development and self-governance bureau to build and operate facility information management systems that ensures appropriate and fair water supply, thereby turning them into shareable explicit knowledge. In addition, guidance on the formulation of appropriate water distribution plans is necessary.
(2)	The management skills of operators vary from	It is necessary to prepare an O&M manual for and

	Issues	Need for support
	village to village, in some places water is not being distributed appropriately or fairly.	provide training to the operators in each village.
2. Raising awareness of proper water use and sanitation		
(1)	The number of fluorosis patients has decreased due to fluorosis prevention activities under the Previous Hogenakkal Project. However, these were carried out 13 to 14 years ago.	Training is needed for teachers who have not participated in the school approach under the Previous Hogenakkal Project.
(2)	The most common water-related disease in the target area is acute diarrhea (ADD), many of which are caused by unsanitary water use. All schools that participated in the social conditions survey had handwashing facilities, but 21% did not have soap.	Education on proper water use and handwashing is needed. Additionally, support is needed for the installation of handwashing facilities in each school.
3. Raising awareness of gender sensitivity		
(1)	Gender mainstreaming is underway in Tamil Nadu. This project will increase household water connections, reducing the need to fetch water, which is currently mainly carried out by women. There is a need to encourage women to participate in society through this.	It is necessary to encourage women to participate in supporting the above points, and to raise awareness among men about women's participation.
4. Supporting Japan-India collaborative research in the field of health		
(1)	During the implementation of the Previous Hogenakkal Project, cooperation with a Japanese university was provided for the fluorosis control component. This project also proposes joint research with local medical institutions.	If joint research is to be carried out, the following support will be required to ensure the smooth conduct of the joint research: 1) supporting communication between Indian medical institutions and TWAD; and 2) providing local information to Japanese research and educational institutions.

7. Project Evaluation

Necessity of the Project and Review of the Facility Plan

The facility plan for the Project is based on the DPR prepared by TWAD in 2023. The study team reviewed the water demand projections and facility plans to verify their validity.

Project Scope, Cost and Implementation Plan

The Project covers a series of water supply facilities, from water intake to house service connections. The construction cost of the Project is based on the cost estimate prepared in accordance with the cost estimate standards of the Tamil Nadu State. The JST confirmed the relevance of the construction cost by comparing it with the construction contract amounts of the Previous Hogenakkal Project and the similar Yen Loan Projects in India.

Project Effect and Environmental and Social Consideration

The Economic Internal Rate of Return (EIRR) for the Project was calculated to be 14.7%, confirming its economic feasibility. On the other hand, TWAD requires financial subsidies for its operation due to the low current bulk water tariff. The JST proposed an increase in the bulk tariff based on the projected revenues and expenditures of the Project.

No serious environmental impacts as a result of the Project were identified. The raw water conveyance pipeline will pass through a forest area, but compensation procedures are underway. All the land for the construction of the facility is public land, and no private land acquisition is required.

Operation and Maintenance Plan

The operation and maintenance system for the facilities to be constructed under the Project is as follows:

- O&M of the water intake, raw water conveyance, WTP, and treated water transmission to the OHTs: TWAD will handle this by contracting with an O&M contractor.
- O&M of water distribution from the OHTs in each water distribution area: This will be implemented by each local body.

The former is expected to be implemented without issues by selecting a qualified and experienced O&M contractor. On the other hand, the implementation system for the latter is considered weak in ensuring the sustainable development of the Project's effects. For this reason, a soft component has been proposed to provide technical support for each local body.

8. Expected Project Effect

The proposed operational and effect indicators of the Project are presented below.

Operational and Effect Indicators of the Project

Indicator	Baseline (2024)	Target（2032）[Two years after completion of the construction work]	Means for Obtaining/Calculation of the Value
Operational Indicator			
(1) Average Amount of Water Supply	174,550 m^3/day (Existing: 36,550 m^3/day; Previous Phase: 138,000 m^3/day)	372,150 m^3/day (Existing: 36,550 m^3/day; Previous Phase: 159,900 m^3/day; Project: 175,700 m^3/day)	Operation record of the O&M contractor.
(2) Number of House Service Connections in 11 Target ULBs	71,745	161,318	Customer ledgers of each ULB.
Effect Indicator			
(3) Population Served in the Project Area (1,000 persons)	3,816 (Including Public Tapping)	4,105 (100 % by House Service Connection)	Calculated by multiplying the number of house service connections registered in the customer ledger by the number of persons per household.
(4) Per Capita Water Supply (lpcd)	Corporations and Municipalities: 93 lpcd Town Panchayats: 64 lpcd Rural Panchayats: 35 lpcd	Corporation and Municipalities: 135 lpcd Town Panchayats: 70 lpcd Rural Panchayats: 55 lpcd	Calculated by Indicators (1) and (3).
(5) Average Water Supply Hours per Day (Urban and Rural)	1 to 2 hours on Alternate Days (Urban and Rural)	Urban: 8 hours/day Rural: 4 hours/day	Interview with each local body.

Chapter 1 Background and Objective of the Study

1.1 Background of the Study

In order to solve the sanitation problems caused by groundwater quality and water shortages in the Dharmapuri and Krishnagiri districts of Tamil Nadu State, a construction project of water supply facilities was proposed, sourcing water from the Cauvery River, which flows in the southwestern tip of these districts. Then the Japan International Cooperation Agency (JICA) funded project, the "Hogenakkal Water Supply and Fluorosis Mitigation Project" (Phase-I: L/A in 2008, Phase-II: L/A in 2009) hereinafter the "Previous Hogenakkal Project", was implemented. Under the Previous Hogenakkal Project, the target year for completion was set at 2036, and the water supply facilities with a capacity of 160 MLD (160 million litre per day: 160,000 m^3/day) were constructed in the Project area. As a result, water supply conditions improved to a certain extent, with an average of 93 lpcd of safe water supply in city corporations and urban areas, 64 lpcd in Town Panchayats, and 35 lpcd in rural areas.

Meanwhile, due to population growth beyond the initial expectations, increased demand for commercial and industrial water, and the need to meet the target water supply level in India (135 lpcd in municipalities, 70 lpcd in towns, and 55 lpcd in rural areas), the Tamil Nadu Water Supply and Drainage Board (TWAD) has prepared a Detailed Project Report (DPR) for the construction project to increase the water supply capacity in the districts sourced from Cauvery River, hereinafter "the Project", and requested JICA for funding for the Project.

In light of the above background, JICA has decided to dispatch a study team to conduct the study titled the "Preparatory Survey for Hogenakkal Water Supply Project (Phase 3)", hereinafter referred to as "the Study".

1.2 Objective of the Study

The objective of the Study is to conduct studies and examinations, including a review of the DPR, to ensure the technical, social, environmental, economic, and financial viability of the Project. The findings will be compiled into a report that will contribute to the appraisal process for implementing the Project as an Official Development Assistance (ODA) loan project. The DPR shall be reviewed with particular focus on the following points:

- Necessity of the Project and Rationale of Project Design;
- Project Scope, Cost, and Implementation Plan;
- Project Effect and Environmental and Social Consideration; and
- Operation and Maintenance Plan.

The JICA Study Team (JST) has conducted the Study in close consultation with the executing agency, TWAD, and relevant organizations of the Government of Tamil Nadu, as well as JICA. The outputs of the Study will be utilized for the project appraisal by JICA.

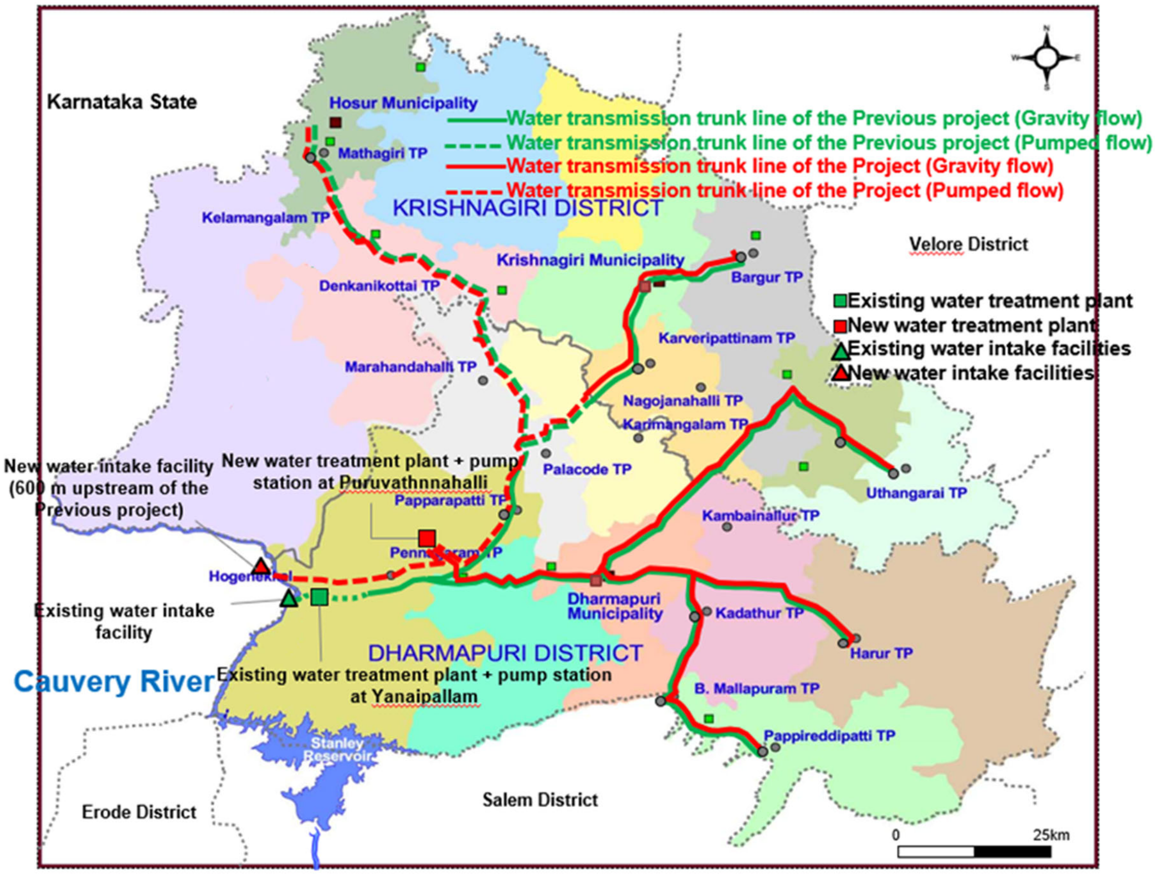
1.3 Basic Concept and Current Status of DPR

1.3.1 Basic Concept

The basic concept of the DPR for the Hogenakkal CWSS Phase II is as follows:

- Water supply area: Same as the Previous Hogenakkal Project, covering three municipalities, 16 Town Panchayats, and 20 rural panchayat unions in Dharmapuri and Krishnagiri districts.
- Target year: 2056
- Facility concept: In the same way as the Previous Hogenakkal Project, the Cauvery River is used as the water source, and the treated water is distributed from the Overhead Tank (OHT) in each distribution area.
- Relation of the Project facility with the existing facilities:
  - Water intake, raw water transmission facilities, the Water Treatment Plant (WTP), and water transmission facilities are constructed in parallel with the facilities of the Previous Hogenakkal Project.
  - The Project facility is planned to meet the water demand in 2056, in combination with the existing facilities, including those of the Previous Hogenakkal Project.

Figure 1.3.1 shows the layout of the water intake facilities, WTPs, and water transmission trunk lines for the Previous Hogenakkal Project and the Project.



Source: JST based on the materials provided by TWAD

Figure 1.3.1 Facility Layout of the Previous Hogenakkal Project and the Project

1.3.2 Current Status of DPR

The DPR has been approved by the Externally Aided Projects (EAP) Committee of the Ministry of Housing and Urban Affairs (MoHUA) on August 11, 2023, following the review process outlined below:

- Regional Technical Committee dated September 5, 2022.
- State Level Technical Committee dated November 10, 2022.
- State Level Scheme Sanctioning Committee dated June 15, 2023.
- Technical Appraisal Report by the Central Public Health and Environmental Engineering (CPHEEO) dated October 20, 2023.

Chapter 2 General Conditions of the Project Area

2.1 Geographical Location and Demography

2.1.1 Geographical Location

The Project area, comprising the Dharmapuri and Krishnagiri districts, covers a total area of 9,640 km^2 and is located in the northwestern part of the Tamil Nadu State. The Project area consists of one city corporation (Hosur City Corporation), two municipalities (Dharmapuri Municipality and Krishnagiri Municipality), 16 town panchayats (TPs: ten town panchayats in Dharmapuri District and six town panchayats in Krishnagiri District), and 20 rural panchayat unions (ten rural panchayat unions in Dharmapuri District and ten rural panchayat unions in Krishnagiri District).

The geographical area in India is classified into "urban areas" (city corporations, municipalities, and town panchayats) and "rural areas". According to the official census, "urban area" is defined as the area satisfying the following three conditions:

- Population greater than 5,000 people.
- Population density greater than 400 people per square kilometer.
- At least 75% of male main workers are involved in non-agricultural pursuits.

The 16 Town Panchayats (TPs) satisfy these conditions and are therefore classified as urban area. Figure 2.1.1 shows the geographical map of the Project area, with the location of one city corporation, two municipalities, 16 TPs, and the boundaries of 20 rural panchayat unions.

Source: TWAD

Figure 2.1.1 Geographical Map of the Project Area

2.1.2 Demography

Table 2.1.1 shows the 2011 Census population by local body in the Project area.

Table 2.1.1 Census Population in the Project Area

Local Body	Census Population (2011)	Local Body	Census Population (2011)
Dharmapuri District		**Krishnagiri District**	
I. City Corporation/Municipality		I. City Corporation/Municipality	
1. Dharmapuri Municipality	68,619	1. Hosur City Corporation	244,518
		2. Krishnagiri Municipality	71,323
Total of I.	68,619	Total of I.	315,841
II. Town Panchayat (TP)		II. Town Panchayat (TP)	
1. Pennagaram TP	17,480	1. Uthangarai TP	18,470
2. Kadathur TP	11,382	2. Denkanikottai TP	24,252
3. Kambainallur TP	12,194	3. Kelamangalam TP	13,321
4. B.Mallapuram TP	12,705	4. Kaveripattinam TP	15,006
5. Harur TP	25,469	5. Nagojanahalli TP	9,953
6. Pappireddipatty TP	9,369	6. Bargur TP	16,366
7. Papparapatti TP	12,174		
8. Palacode TP	20,959		
9. Marandahalli TP	12,451		
10. Karimangalam TP	13,511		
Total of II.	147,694	Total of II.	97,368
III. Village Panchayat Union		III. Village Panchayat Union	
1. Dharmapuri Union	137,395	1. Bargur Union	191,483
2. Pennagaram Union	132,040	2. Kaveripattinam Union	169,252
3. Eriyur Union	73,159	3. Krishnagiri Union	127,329
4. Nallampalli Union	190,535	4. Uthangarai Union	144,375
5. Kadathur Union	79,545	5. Mathur Union	107,520
6. Morappur Union	71,950	6. Hosur Union	132,214
7. Harur Union	165,291	7. Thally Union	181,017
8. Pappireddipatty Union	96,448	8. Veppanapalli Union	94,483
9. Palacode Union	156,117	9. Kelamangalam Union	128,884
10. Karimangalam Union	143,451	10. Shollagiri Union	177,900
Total of III.	1,245,931	Total of III.	1,454,457
Total of Dharmapuri District	**1,462,244**	**Total of Krishnagiri District**	**1,867,666**

Source: DPR

2.2 Socio-economic Conditions

2.2.1 Socio-economic Conditions of India and Tamil Nadu State

(1) Socio-economic Conditions of India

India is one of the fastest growing economies and has set a target of becoming a high middle-income status by 2047. In FY 2024, the shares of agriculture, industry, and services sectors in overall gross value added (GVA) at current prices were 17.7%, 27.6%, and 54.7%, respectively. The GVA in the agriculture sector continues to grow at a slower pace. [1]

[1] Government of India (2024) "Economic Survey 2023-2024"

Within the industrial sector, the manufacturing GVA grew by 9.9% in FY 2024, while the services sector remained resilient, compensating for the underperformance in agriculture. Manufacturing activities benefitted from reduced input prices, while catering to stable domestic demand.[2]

Table 2.2.1 shows the real gross domestic product (GDP) growth by sectors (agriculture, industry, and services) in India. The recorded growth of services sector was 10% in FY 2022–2023, the highest percentage among the sectors. That growth rate of the industrial sector was 2.1% in FY 2022–2023, but it is estimated to increase to 9.5% in FY 2023–2024, with a continued high rate of growth expected beyond FY 2024. According to the World Bank, India can accelerate its growth further by leveraging its global trade potential. In addition to IT, business services, and pharmaceuticals, India can diversify its export basket with increased exports in textiles, apparel, footwear, electronics, and green technology products. In the medium term, growth is projected to remain positive, reaching 7% in FY 2024–2025, with continued strong performance through FY 2025–2026 and FY 2026–2027, as shown below.[3]

Table 2.2.1 Real GDP Growth of India and Sectors

Unit: %, at constant factor prices

Item	FY 22–23	FY 23–24	FY 24–25	FY 25–26	FY 26–27
Real GDP Growth in India	6.7	7.2	7.0	6.7	6.7
Agriculture	4.7	1.4	4.1	3.9	3.7
Industry	2.1	9.5	7.6	7.3	7.2
Services	10.0	7.6	7.4	7.1	7.1

Source: The World Bank (2024) "India's Economy to Remain Strong Despite Subdued Global Growth"

Other economic indicators of India are shown in Table 2.2.2. Both GDP and GDP per capita decreased in 2020 due to the impact of the coronavirus 2019 (COVID-19) but recovered in 2021 and continued to increase from 2022 to 2023. Inflation remained between 5% and 6.7% during this period. The volume of imports and exports decreased in 2019 and 2020 but recovered in 2022, with imports decreasing again in 2023. With a narrowing current account deficit and strong foreign portfolio investments, foreign exchange reserves reached USD 670.1 billion in early August 2024.[4]

Table 2.2.2 Economic Indicators of India

Item	2019	2020	2021	2022	2023
Gross domestic product, current prices (in USD billion)	2,836	2,675	3,167	3,353	3,568
Gross domestic product per capita, constant prices*	7,964	7,433	8,088	8,594	9,221
Inflation, average consumer prices (%)	4.769	6.165	5.506	6.653	5.361
Volume of imports of goods and services (%)	-3.735	-13.702	19.371	9.944	-1.201
Volume of exports of goods and services (%)	-2.142	-6.511	19.732	9.679	0.381
Current account balance (% of GDP)	-0.866	0.898	-1.222	-1.997	-0.651

*Purchasing Power Parity; 2021 International Dollar
Source: International Monetary Fund, World Economic Outlook Database, October 2024

Additionally, the "Make in India" was launched by Prime Minister Narendra Modi in 2014. It is a Government of India (GOI) scheme aimed at boosting the domestic manufacturing sector and enhancing

[2] Government of India (2024) "Economic Survey 2023-2024"
[3] The World Bank (2024) "Economic Outlook"
[4] The World Bank (2024) "Economic Outlook"

investment in the country. The “Make in India” website also lists 25 focus sectors, which are shown in Table 2.2.3, along with relevant details about each sector. The campaign also covers 27 main sectors, which are listed in Table 2.2.4.[5]

Table 2.2.3 The 25 Focus Sectors in “Make in India”

Sectors	
1. Aviation	2. Construction
3. Automobile Components	4. Automobiles
5. Biotechnology	6. Chemicals
7. Defense Manufacturing	8. Electrical Machinery
9. Electronic Systems	10. Food Processing
11. IT and BPM	12. Media and Entertainment
13. Leather	14. Oil and Gas
15. Mining	16. Textile and Garments
17. Renewable Energy	18. Pharmaceuticals
19. Ports and Shipping	20. Railways
21. Roads and Highways	22. Space and Astronomy
23. Tourism and Hospitality	24. Thermal Power
25. Wellness	

Source: Balaji D.1, Ridhi Rani and Sripathi K (2017) “Make in India Commented and Make for India Recommended”

Table 2.2.4 The Main Sectors in “Make in India”

Sectors	
Manufacturing Sectors	
1. Aerospace and Defense	2. Textile and Apparels
3. Automotive and Auto Components	4. Chemicals and Petro Chemicals
5. Pharmaceuticals and Medical Devices	6. Electronics System Design and Manufacturing (ESDM)
7. Bio-technology	8. Leather and Footwear
9. Capital Goods	10. Food Processing
11. Gems and Jewellery	12. Shipping
13. Railways	14. Construction
15. New and Renewable Energy	
Service Sectors	
1. Information Technology & Information Technology enabled Services (IT & ITeS)	2. Legal Services
3. Tourism and Hospitality Services	4. Communication Services
5. Medical Value Travel	6. Construction and Related Engineering Services
7. Transport and Logistics Services	8. Environmental Services
9. Accounting and Finance Services	10. Financial Services
11. Audio Visual Services	12. Education Services

Source: Make in India website (https://www.makeinindia.com/ accessed on October 31, 2024)

Furthermore, urban unemployment has improved gradually, especially for female workers, decreasing from 14.3% in FY 2021–2022 to 9% in FY 2024–2025. However, unemployment among urban youth remained elevated at 16.8% in FY 2024–2025.[6] Table 2.2.5 shows the unemployment rate among young

[5] Make in India website (https://www.makeinindia.com/ accessed on October 31, 2024)
[6] The World Bank (2024) “Economic Outlook”

people across India. Although the unemployment rate has been gradually decreasing since 2021, it remains relatively high at 15.8% as of 2023.

Table 2.2.5 Trends in Youth Unemployment in India as a Whole

Unit: %

Item	2019	2020	2021	2022	2023
Youth unemployment rate for India as a whole	22.869	24.595	20.859	17.825	15.788

Source: The World Bank (2024) "World Development Indicators"

According to the World Bank, both employment and worker participation rates increased in 2022–2023. However, high rates of tertiary youth unemployment, low rates of paid employment for women, and poor job quality remain a concern.[7] While extreme and moderate poverty levels remain above pre-pandemic levels, they are expected to decline in FY 2022–2023. During its time, 44% of the population still lives in moderate poverty, earning less than USD 3.65 per person per day.

(2) Socio-economic Conditions of the Tamil Nadu State

Tamil Nadu's rate of economic growth has been higher than India's overall growth rate between 2005–2006 and 2022–2023.The national economy of India grew at an annual rate of 6.7%, while Tamil Nadu's economy grew at 7.8%. Tamil Nadu is the second largest economy in the country, with an INR 23,650 billion in 2022–2023. The state is highly industrialized, contributing 12.3% of India's real manufacturing GDP and 9.1% of the country's total real GDP in 2022–2023.[8]

Income per capita in Tamil Nadu was INR 241,131 in FY 2021–2022, compared to INR 150,007 for India. The state's income per capita was 1.6 times the national average.[9]

As shown in Table 2.2.6, Tamil Nadu's GDP share ranks fourth in India in 2023–2024, with the top three states being Maharashtra, Andhra Pradesh, and Uttar Pradesh.

Table 2.2.6 GDP Share of the Top Ten States in India

Unit: %

No.	State	2023-24
1	Maharashtra	13.3
2	Andhra Pradesh	9.7
3	Uttar Pradesh	9.5
4	Tamil Nadu	8.9
5	Karnataka	8.2
6	Gujarat	8.1
7	Madhya Pradesh	6.1
8	West Bengal	5.6
9	Rajasthan	5.0
10	Bihar	4.3

Source: Economic Advisory Council to the PM (2024) "Relative Economic Performance of Indian States: 1960–61 to 2023–24, EAC-PM Working Paper Series"

[7] The World Bank (2023, 2024) "Macro Poverty Outlook"
[8] Madras School of Economics (2024) "Economic Overview of Tamil Nadu (2023-24)"
[9] India Statistics-2020, Reserve Bank of India (https://www.tn.gov.in/deptst/ecoindiaallstates.htm accessed on November 9th)

Table 2.2.7 shows the gross district domestic product (GDDP) of Tamil Nadu State. After growing by 11.3% from FY 2017–2018 to FY 2018–2019, it increased further by 10.3% from FY 2018–2019 to FY 2019–2020. In terms of GDDP, Thiruvallur District ranks first, followed by Chennai District in second place. The GDDP of Dharmapuri District accounts for 1.8% (ranked 22nd) of Tamil Nadu State, while Krishnagiri District accounts for 3.2% (ranked 13th) of the state's GDDP.

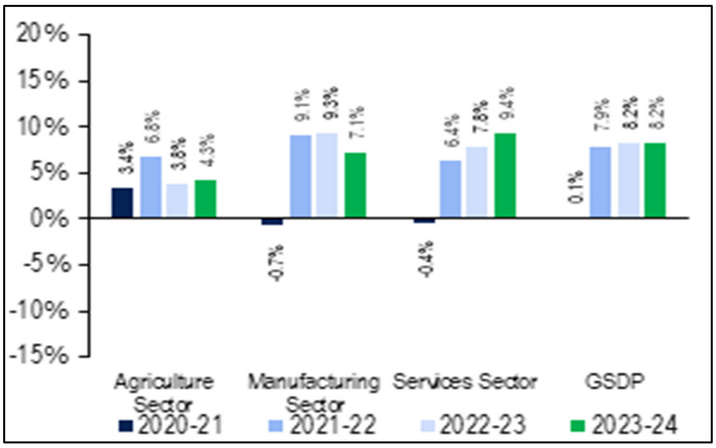
Table 2.2.7 GDDP in Tamil Nadu 2017–2020

Unit: INR in millions

No	District	2017-18	2018-19	2019-20
1	Thiruvallur	132,929	148,056	166,812
2	Chennai	123,348	134,996	147,512
3	Coimbatore	101,245	119,304	136,523
4	Kancheepuram	108,159	115,602	126,745
5	Vellore	76,797	84,542	91,697
6	Erode	64,144	73,814	82,377
7	Tiruchirapalli	64,774	71,756	77,180
8	Madurai	54,393	60,694	68,539
9	Salem	64,815	64,093	68,510
10	Thiruppur	54,250	63,424	68,137
11	Thirunelveli	53,374	58,108	61,466
12	Namakkal	43,115	55,062	59,988
13	Krishnagiri	49,307	53,277	56,613
14	Virudhunagar	42,168	47,704	50,436
15	Cuddalore	41,927	45,806	50,059
16	Kanniyakumari	38,178	44,264	49,778
17	Thanjavur	37,386	42,347	48,981
18	Villupuram	39,214	43,222	47,260
19	Thoothukudi	35,102	40,006	43,939
20	Dindigul	33,464	38,343	41,507
21	Thiruvannamalai	27,401	29,640	34,229
22	Dharmapuri	24,222	26,929	31,511
23	Pudukkotai	20,741	23,268	26,926
24	Nagapatinam	18,989	21,121	23,636
25	Karur	22,710	21,541	23,217
26	Ramanathapuram	17,401	19,305	21,958
27	Theni	16,953	19,157	21,084
28	Sivagangai	15,413	17,631	19,511
29	The Nilgiris	13,606	15,590	17,017
30	Thiruvarur	13,885	14,787	15,590
31	Ariyalur	10,095	11,113	12,240
32	Perambalur	5,547	5,706	6,250
Total	Tamil Nadu	1,465,051	1,630,209	1,797,229

Source: State Planning Commission, Government of Tamil Nadu, Chennai. (2022) "Regional Growth Pattern in Tamil Nadu"

Regarding the gross state domestic product (GSDP), Tamil Nadu's GSDP at constant prices grew at 8.2% in 2022–2024. In 2023–2024, the services sector is estimated to grow by 9.4%, followed by manufacturing (7.1%) and agriculture (4.3%). For the same period, the agriculture, manufacturing, and services sectors are estimated to contribute 13%, 34%, and 53%, respectively, to the state's economy (at current prices).[10]



Source: MoSPI; PRS. (https://prsindia.org/budgets/states/tamil-nadu-budget-analysis-2024-25 accessed on January 7, 2025)

Figure 2.2.1 Growth in the GSDP and Sectors in Tamil Nadu at Constant Prices

Unemployment rate in Tamil Nadu was 4.3% in 2022–2023.[11] The birth rate of the state was 13.8 per 1,000 population in 2020, compared with 19.5 per 1000 for India as a whole. Additionally, the literacy rate in the state was 80.1% (men: 86.8%, women: 73.1%) in 2011, compared with 73.0% (men: 80.9%, women: 65.4%) in India as a whole.[12] The state's birth rate was lower than the national average, while its literacy rate was higher than the national average.

2.2.2 Development Plan in India and Tamil Nadu State

(1) Development Plan and Water Policy in India

1) PM Gati Shakti - National Master Plan for Multi-modal Connectivity[13]

PM Gati Shakti is essentially a digital platform that integrates 16 ministries, including railways and roadways, to enable coordinated planning and implementation of infrastructure connectivity projects. The multi-modal connectivity will provide integrated and seamless connectivity for the movement of people, goods, and services between different modes of transport. It will facilitate last-mile connectivity of infrastructure and contribute in reducing travel time for people.

PM Gati Shakti is based on six pillars:

1. Comprehensiveness: The plan integrates all existing and planned initiatives from various ministries and departments into one centralized portal. This will ensure that each department has visibility into other's activities, comprehensive manner.
2. Prioritization: Through PM Gati Shakti, different departments will be able to prioritize their projects through cross-sectoral coordination and interactions.

[10] Ministry of Statistics and Programme Implementation, Government of India (MoSPI); PRS. (https://prsindia.org/budgets/states/tamil-nadu-budget-analysis-2024-25)
[11] Government of India (719_e.pdf accessed on February 25, 2025)
[12] India Statistics-2020, Reserve Bank of India (https://www.tn.gov.in/deptst/ecoindiaallstates.htm accessed on November 9, 2024)
[13] National Portal of India (https://www.india.gov.in/spotlight/pm-gati-shakti-national-master-plan-multi-modal-connectivity accessed on November 1, 2024)

3. Optimization: The National Master Plan will assist various ministries in planning the projects after identifying critical gaps. For the transportation of goods from one place to another, the plan will help in selecting the most optimal route in terms of time and cost.
4. Synchronization: Individual ministries and departments often operate in silos, leading to a lack of coordination in planning and implementation of the project, which results in delays. PM Gati Shakti will synchronize the activities of each department, as well as of different layers of governance, in a holistic manner by ensuring coordination of work between them.
5. Analytical: The plan will provide the entire data on a single platform, incorporating Geographic Information System (GIS)-based spatial planning and analytical tools with over 200 data layers. This provides better visibility and decision-making support for executing agencies.
6. Dynamic: All ministries and departments will be able to visualize, review, and monitor the progress of cross-sectoral projects through the GIS platform. With periodic satellite imagery and regular updates on project progress reflected on the portal, the system will facilitate in identifying the vital interventions for enhancing and updating the master plan.

2) National Water Policy of 2012[14]

The National Water Policy of 2012 was finalized and adopted by the National Water Resources Council in the same year. The water policy seeks to address issues such as water scarcity, inequities in distribution, and the lack of a unified perspective on planning, management, and utilization of water resources. Some of the key recommendations of the water policy are outlined below:

- Emphasis on the need for a national water framework law and comprehensive legislation to ensure the optimal development of inter-state rivers and river valleys.
- After addressing the pre-emptive needs for safe drinking water and sanitation, achieving food security, supporting those people dependent on agriculture for their livelihood, and allocating high priority to minimum ecosystem needs, water shall be regarded as an economic good to promote conservation and efficient utilization.
- A portion of river flows should be reserved to meet ecological needs, ensuring that both low- and high-flow releases are proportional and correspond closely to the natural flow regime.
- Emphasis on adaptation strategies for climate change in the design and management of water resources structures.
- To ensure efficient water use, develop a system to establish benchmarks for water use for various purposes, such as water footprints and water auditing.
- Establish a Water Regulatory Authority and provide incentives for recycling and reuse of water.
- It is recommended that significant disparities in stipulations for water supply be removed in urban and rural areas.

[14] GOI website (https://jalshakti-dowr.gov.in/ accessed on November 1, 2024)

- Manage water resource projects and services with active community participation and encourage the private sector to become a service provider in a public-private partnership model.
- Provide adequate grants to states to update technology, design practices, improve planning, and management practices.
- Provide grants for preparing annual water balances and accounts for specific sites and basins, hydrologic balances for water systems, and for benchmarking and performance evaluations.

3) Draft of the New National Water Policy (NWP), 2020 [15]

The draft of the new National Water Policy (NWP) has been submitted to the Ministry of Jal Shakti, but it has not yet been finalized. The significant recommendations of the proposed policy are as follows:

- Diversify cropping patterns to include less water-intensive crops, in alignment with regional agroecology.
- Lower the industrial water footprint by reducing freshwater use and shifting to recycled water.
- Mandatorily shift all non-potable uses in cities—such as flushing, fire protection, vehicle washing, landscaping, horticulture, and similar uses—to treated wastewater.
- Address the shift in focus on the supply side, as the country is running out of viable sites for the construction of large dams, while water tables and groundwater quality are declining in many areas.
- Deploy pressurized closed conveyance pipelines, combined with Supervisory Control and Data Acquisition (SCADA) systems and pressurized micro-irrigation, to ensure that water stored in large dams reaches the intended farmers.
- Emphasize the use of nature-based solutions for water storage and supply.
- Supply water through the rejuvenation of catchment areas and incentivize this through compensation for ecosystem services, particularly benefiting vulnerable communities in upstream and mountainous regions.
- Renew thrust on local rainwater harvesting to capture the rain where it falls, when it falls.
- Combine rainwater harvesting with the demarcation, notification, protection, and revival of traditional local water bodies in both rural and urban areas.

[15] India Water Portal (https://www.indiawaterportal.org/faqs/water-policies-india-past-and-present accessed on November 1, 2024)

(2) Development Plan and Water Policy in Tamil Nadu State

1) Development Policy in Tamil Nadu State

The Tamil Nadu State has developed comprehensive state policies and plans that guide growth across various sectors, setting the trajectory for goal attainment. These regulations and guidelines, formulated by the Government, address diverse issues and shape the overall governance direction of the state. Their primary objective is to achieve balanced and inclusive growth while following the Sustainable Development Goals (SDGs).

1. No Poverty 2. Zero Hunger 3. Good Health and Well-being 4. Quality Education 5. Gender Equality, 6. Clean Water and Sanitation 7. Affordable and Clean Energy 8. Decent Work and Economic Growth 9. Industry Innovation and Infrastructure 10. Reduced Inequalities 11. Sustainable Cities and Communities12. Responsible Consumption and Production 13. Climate Action 14. Life Below Water 15. Life on Land 16. Peace, Justice, and Strong Institutions 17. Partnerships for the Goals

Accordingly, the function of preparation and monitoring of plans and expenditure have been reoriented toward achieving the SDGs, based on the outcomes and outputs of the policies and schemes outlined below. Tamil Nadu is actively promoting industrial development through its Industrial Policy, which offers various benefits such as capital subsidies, sales subsidies, and training subsidies. Table 2.2.8 shows a summary of the policies in Tamil Nadu State.

Table 2.2.8 Summary of Policies of Tamil Nadu State

No.	Name of Policy	Summary
1	Tamil Nadu Life Sciences Promotion Policy:	This Policy aims to transform Tamil Nadu into an attractive destination for manufacturers in Life Sciences to invest, innovate, and create Life Sciences products and strives to attract Rs. 20,000 crores of investment in Life Sciences and generate 50,000 jobs by addressing the needs of the industry and creating the infrastructure to support the sector.
2	Tamil Nadu R&D Policy:	This policy aims to transform Tamil Nadu into a knowledge-based economy by 2030 driving manufacturing and service excellence. The following policies are suggested; 1) to give incentives to private companies, 2) to enhance human capital, 3) to offer various funding sources from the government of Tamil Nadu State.
3	Tamil Nadu State Disaster Management Policy	The policy aims to build a safe and disaster resilient Tamil Nadu through inclusive development and mainstreaming disaster risk reduction into the sustainable development ethos of the State. A holistic and integrated approach to disaster management will be developed, with a focus on disaster risk reduction, through constructing collaborative partnerships at various levels, with multiple stakeholders and appropriate technologies.
4	Tamil Nadu Logistics Policy & Integrated Logistics Plan	The vision of Tamil Nadu Logistics Policy 2023 is to promote an integrated, reliable, cost-efficient and sustainable logistics system for enhanced competitiveness and fast-tracked economic development of the State.
5	Tamil Nadu Safe and Ethical Artificial Intelligence Policy	The goal of the Safe and Ethical AI Policy is to allow harnessing the power of Artificial Intelligence for the public good while keeping it safe and ethically compatible with human values. This policy is a road map for the state policy makers for adopting AI-based systems.
6	Tamil Nadu Blockchain Policy	This policy will enable the Government Departments to deliver services to people securely and efficiently. It proposes a top-driven strategy that will ensure that all e-governance blockchain implementations meet established guidelines and standards for design, development, and deployment.
7	Tamil Nadu Policy for Promotion of Farmer Producer Organizations (FPOs)	The policy was formulated with the vision of “establish an equitable agriculture value chain which empowers the farmers of TN to harness their collective strength and extract remuneration proportional to their effort with facilitative support of the Government and in collaboration with academia, research agencies, civil society, and private sector. The Government of TN will support various areas such as in terms of mobilization, capacity building, handholding business facilitation, marketing and access to institutional finance.
8	Tamil Nadu Aerospace &	This Policy aims to make Tamil Nadu a preferred destination to invest, innovate, and create products and services in the Aerospace and Defense sector. The government plans to invest

No.	Name of Policy	Summary
	Defence Industrial Policy	about INR 50,000 million over a period to catalyze the A&D ecosystem through various new initiatives.
9	Tamil Nadu Industrial Policy & Industrialization Policy for a Transitioning Economy	This Policy will serve as a critical instrument to make Tamil Nadu the numerous destination to invest, innovate and create products and associated services. The policy uses the following levers aligned with these pillars: Structured Package • Incentives for Logistics Infrastructure • Incentives for Sunrise Sector • Incentives for Foreign Direct Investment • Incentives for Industrial Parks • Incentives for Sub-Large Projects • Incentives for R&D Projects.
10	Tamil Nadu Data Policy	This policy will support all data initiatives of the Government and create a common framework for Government databases, avoiding duplication of efforts and integrating disparate datasets residing in silos. This policy will also set standards for the classification of sensitive data, integrating the state government departments based on the set of beneficiaries and the various social welfare schemes.
11	State Policy for Children	This policy is grounded in the belief that children deserve protection from violence, exploitation, abuse, neglect, deprivation, and discrimination, empowering them to embrace life's opportunities. The Tamil Nadu State Policy for Children 2021 endeavors to navigate the evolving landscape, addressing emerging issues and ensuring that the well-being and rights of children remain at the forefront of the state's developmental agenda as enshrined in UN Convention on the Rights of the Child 1989 and Sustainable Development Goals 2030.
12	Tamil Nadu Data Centre Policy	This policy will create appropriate institutional measures and build supportive technology. The Government of Tamil Nadu offers a single window facilitation to provide end to-end facilitation support, including information related to clearances at State level.
13	Affordable Urban Housing and Habitat Policy	The Policy aims to make more affordable urban dwelling options available. The main policy tenets and policy emphasis areas are directed by the overarching policy purpose. For everyone to have access to cheap housing, the way that affordable housing is now provided by the public sector needs to be changed.
14	Tamil Nadu Ecotourism Policy	The principal goals of this policy are to recognize, market, and advance natural places as destinations for ecotourism. To manage the influx of visitors within the threshold level to maintain the holiness of the site, and to grow ecotourism on each site depending on the carrying capacity. To encourage environmentally sustainable infrastructure that adheres to the guiding principles.
15	Policy on Invasive Plants & Ecological Restoration:	This policy aims to identify, stop the spread of, appropriately control, and eradicate all invasive alien plant species in the state of Tamil Nadu's wetland and terrestrial ecosystems. It also prevents the incidental or deliberate introduction of invasive alien plant species.
16	State Forest Policy	The State Forest Policy aims to protect natural forests and wildlife, conserve ecosystems and their genetic diversity, stabilize the environment, improve forest productivity, increase the amount of water derived from the forests, increase tree cover, and mitigate the effects of climate change. The following are the primary avenues for attaining the stated goals, Preservation of Wildlife, Biodiversity, and Their Genetic Resources. Restoring and revitalizing degraded forests. Preserving and managing coastal ecosystems.
17	Tamil Nadu Ethanol Blending Policy	The main vision of this policy is to promote Tamil Nadu as a green economy and investment hub for alternate cost-effective green fuel. It seeks to improve farmer income through expansion in opportunities in ethanol blending and also to mitigate climate change risks through the reduction in air pollution that arises from fossil fuels.
18	Tamil Nadu Cybersecurity Policy	This policy aims to provide guidelines for Information Security Management, protecting the Information Assets of Government (Infrastructure, Software, Citizen Services) and maximizing their availability to Government and the Citizens.
19	Tamil Nadu Fintech Policy	The Government of Tamil Nadu has set up a dedicated FinTech Cell in Guidance to support the FinTech sector in the State. The Tamil Nadu Industrial Development Corporation Limited (TIDCO) will develop a FinTech city in Chennai with a built-up space of at least 1 million square feet in a phased manner. The FinTech City will develop as the fulcrum of financial services and related activities, largely driven by next-generation technologies in Tamil Nadu.
20	Tamil Nadu Export Promotion Policy	The goal is to increase exports from Tamil Nadu to USD 100 billion by 2030 through various pathways like making improvements in export-supporting infrastructure to enhance export efficiency, promoting export diversification through knowledge dissemination, investments in technology, and skill upgradation.
21	Tamil Nadu Footwear & Leather Products Policy	The Policy aims to transform Tamil Nadu as the most favored destination for manufacturing of Footwear and Leather products in Asia by creating a conducive ecosystem and a resilient supply chain for footwear manufacturing. Targets set for attracting Rs.20,000 crores investments in Footwear and Leather Products manufacturing and attracting more than 2 lakh jobs in the footwear segment.
22	Tamil Nadu City Gas Distribution Policy	This State Level City Gas Distribution (CGD) policy aims to promote the adoption of natural gas by the State as a green and clean fuel and to increase the coverage of CGD infrastructure across Tamil Nadu.

No.	Name of Policy	Summary
23	Community Dog Policy	The policy aims to strike a balance between these two concerns by implementing measures that will help to control the dog population while also promoting responsible dog ownership.
24	Breeding Policy for Cattle and Buffalo:	The policy aims for the conservation of native breeds through the formation of breeders' associations for the native breeds and the conservation of indigenous germplasm by
25	Tamil Nadu Electronics Hardware Manufacturing Policy	The main vision of this policy is to transform Tamil Nadu into an innovative and a globally competitive Electronics System Design and Manufacturing (ESDM) destination, by providing adequate infrastructure and supporting ecosystem to ESDM companies.
26	State Policy for Women	Stemming from a resolution by the Hon'ble Chief Minister, the policy strives to create a safe, equitable environment, aligning with the World Health Organization (WHO) – RESPECT framework to prevent violence against women. With a vision to provide equal opportunities and eliminate discrimination, the policy sets forth ambitious objectives, including improving nutritional outcomes, expanding women's entrepreneurship, bridging the digital gender gap, and enhancing institutional credit access. Over five years, it aims to uplift women across sectors, foster gender equality, and ensure the safety and well-being of all women in Tamil Nadu.
27	State Policy for Senior Citizens	This policy, rooted in the principles of the Indian Constitution and international declarations, aims to improve and empower the lives of senior citizens in the state. The preamble of the policy emphasizes a just and equitable approach, recognizing the social vulnerabilities of senior citizens, including gender, disability, and mental health. The envisioned goals include timely access to healthcare, nutrition, safety, social security, housing, and legal assistance. The government intends to collaborate with various stakeholders, including officials, experts, civil society organizations, and senior citizens, to ensure the successful implementation of the policy.
28	Draft Policy on Waste Management*	This draft policy is aimed at improving waste management practices and promoting the reuse of recycled waste to minimize the impact of waste on the environment.
29	Organic Farming Policy*	The Tamil Nadu Government released the Tamil Nadu Organic Farming Policy 2023 to ensure, upscale, and support chemical-free organic agriculture in Tamil Nadu and to provide safe food for the people.
30	Draft Tamil Nadu Employment Policy	This policy focuses on expanding job opportunities and accessibility to uplift income levels and reduce poverty. It strategically addresses the state's job market, prioritizing social justice through meaningful job creation and inclusive growth. Additionally, it targets inter-district employment gaps and aligns the education system with future skill requirements, demonstrating a comprehensive strategy for immediate and long-term challenges, dedicated to fostering equitable economic growth and societal advancement.
31	Draft Sustainable Land Use Policy:	This policy aims to provide a strategic framework to conserve land resources and accommodate development patterns that are inclusive and offer integration of environmental, economic, and social development initiatives at all levels of governance leading to growth and development that promotes a higher quality of life and happiness with social and economic well-being, sustainable growth, equitable access to resources and conflict-free land use management.
32	Draft Policy for Art, Culture & Language	Central to this policy is the revitalization of the arts, encompassing modernization and economic upliftment for artists. Additionally, the policy emphasizes collaborative initiatives, cultural research, and a focus on the use of language to articulate the social impact of art, thereby elevating the cultural sophistication of the broader population.
33	Tamil Nadu Manufactured Sand (M sand) Policy	M-Sand / Crushed Sand is an alternate to river sand for construction activities and infrastructural development. The main objectives of this M-Sand Policy are to ensure zero waste mining/ quarrying in the State, prevent damage to the river ecosystem by rationalizing the use of river sand in a conserved manner and to promote the usage of quality M-Sand /Crushed Sand having greater compressive strength.
34	State Water Policy	Water is a vital resource for all forms of life, and access to clean water is essential for basic human needs. This policy is to prepare a roadmap for equitable access to water for all basic human needs and to make a commendable effort towards ensuring that every individual has access to safe drinking water and water for irrigation. This policy emphasizes balancing environmental sustainability while catering to human needs, which is a crucial aspect of sustainable development. Furthermore, the policy's objective to enhance water governance in the state is a significant step towards improving water management practices. By focusing on ensuring sufficient water for all, the policy aims to address the issue of water scarcity, which has been a persistent concern in many regions.

Note: *"Draft Policy on Waste Management" and "Organic Farming Policy" are not available in the following website.
Source: Government of Tamil Nadu (https://spc.tn.gov.in/policies-and-plans-v3/ accessed on January 7, 2025)

State priority indicators related to water are shown in Table 2.2.9. The target is to ensure that 100% of the population has access to safe and adequate drinking water within their premises by 2030. During the period 2019–2021, the performance of the urban Commissionerate of Municipal Administration (CMA) and the Directorate of Town Panchayats (DTP) was relatively lower than the achievement of the Urban-Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) from 2019–2021.

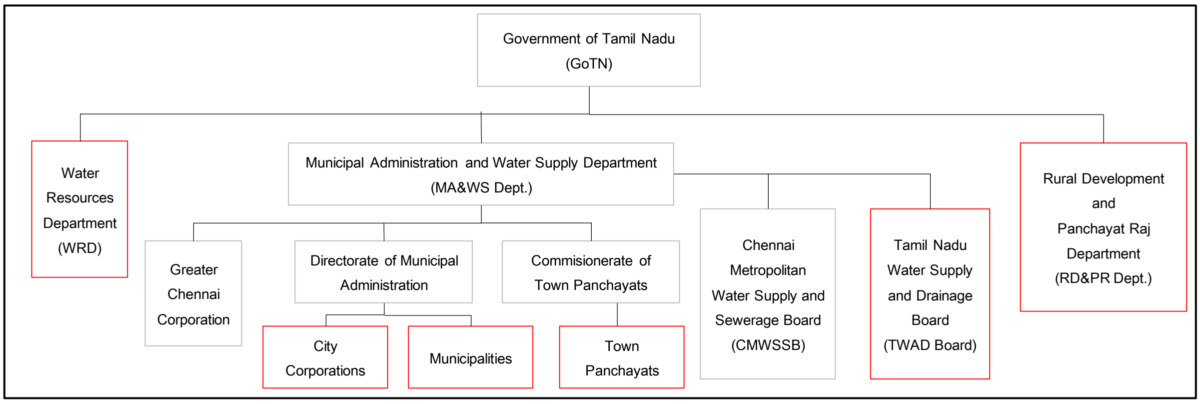
Table 2.2.9 Priority Water Indicators for Tamil Nadu State

No.	Indicator	Sub-category	2019	2020	2021	Target Year (2030)
1	Percentage of population having safe and adequate drinking water within their premises	Urban - CMA	50	51	52	100
2		Urban - CMWSSB	59	67.6	83.6	100
3		Urban - DTP	35	39	45	100

Source: Tamil Nadu State (https://tnsdg.tn.gov.in/reports/priority-indicators/state-level/ accessed on January 7, 2025

2) Organizations and Jurisdictions for Water and Sanitation Sector of Tamil Nadu State

Tamil Nadu utilizes a combination of surface water, groundwater, and rainwater to supply its drinking water needs. In the Greater Chennai Corporation area, the plants help in augmenting the supply of drinking water to cater to the needs of the urban population. The following agencies under Municipal Administration and Water Supply Department, Rural Development and Panchayat Raj Department, and Water Resources Department of the Government of Tamil Nadu (GoTN) are involved in water supply projects. The government organizations involved in these projects are shown in Figure 2.2.2.



Note: Red-highlighted organizations are related to the Project.
Source: TWAD (2024)

Figure 2.2.2 Government Organizations Involved in Water Supply Projects

The jurisdictions of organizations responsible for water supply and drainage are shown in Table 2.2.10.

Table 2.2.10 Jurisdictions of Organizations for Water Supply and Drainage

Name	Design and construction of water supply facilities	Water supply services up to OHT**	O&M of the water distribution facilities to the residents/ customers	Water Tariff Setting from ULBs to TWAD	Tariff collection	Drainage services	Customer service	Conservation of surface water, and monitoring and assessment of quality and quantity of ground water
TWAD Board	☑	☑		☑	☑		☑	

Name	Design and construction of water supply facilities	Water supply services up to OHT**	O&M of the water distribution facilities to the residents/ customers	Water Tariff Setting from ULBs to TWAD	Tariff collection	Drainage services	Customer service	Conservation of surface water, and monitoring and assessment of quality and quantity of ground water
				Bulk water tariff setting	Bulk water tariff collection from ULBs			
Urban Local Bodies (ULBs)*			☑	☑ Water tariff from customers	☑ Water tariff collection from customers	☑	☑	
Rural Development and Panchayat Raj Department			☑	☑ Water tariff from customers	☑ Water tariff collection from customers	☑	☑	
Water Resource Department (WRD)								☑

Note: *Urban Local Bodies (ULBs) means City Corporations, Municipalities, and Town Panchayats, **OHT: Overhead Tank
Source: TWAD (2025)

(3) Japanese Companies in Tamil Nadu State

According to the Japan External Trade Organization (JETRO), there are more than 579 Japanese companies in Tamil Nadu State.[16] Most of them are located in Chennai, Coimbatore, Hosur, Kancheepuram, and Madurai. These companies operate across diverse sectors, such as manufacturing, finance and insurance industry, wholesale and retail trade, information and communications, and other service businesses.

2.2.3 Socio-economic Conditions in the Project Area

(1) Social and Economic Conditions in Krishnagiri and Dharmapuri Districts

Krishnagiri District was separated from Dharmapuri District in 2004, becoming the 30th district of Tamil Nadu State. It is bounded by Vellore and Thiruvannamalai districts to the east, Karnataka State to the west, Andhra Pradesh State to the north, and Dharmapuri District to the south. Three languages, namely: Tamil, Telugu, and Kannada are predominantly spoken in the district. Major religions in Krishnagiri District are Hinduism, Islam, and Christianity. The district stands as an ideal exhibit of national integration and religious harmony, with its society reflecting the confluence of diverse languages and religions.[17]

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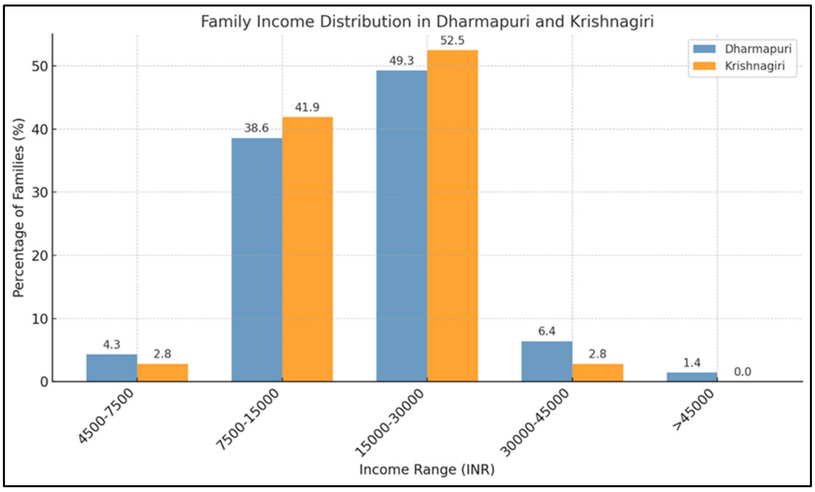
16 JETRO (2023) "Japanese Business Establishments in India"
17 Krishnagiri District Administration (https://krishnagiri.nic.in/about-district/district-at-a-glance/ accessed on November 8th, 2024)

According to the 2011 Census, the population of Krishnagiri District in 2011 was 1,879,809, reflecting an increase of approximately 20% from 2001. The district comprises around 448,000 households, with an average household size roughly estimated at 4.2 members.[18]

As per data from TWAD, the average monthly household income is estimated at INR 27,917. Based on the social condition survey, the average monthly income per household in Krishnagiri is INR 17,744. The family income distribution in Krishnagiri and Dharmapuri districts is shown in Figure 2.2.3.



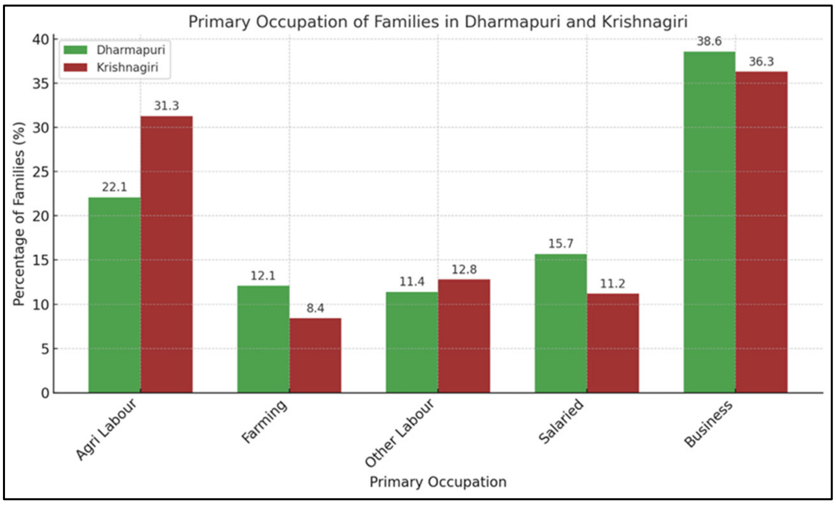
Source: JST

Figure 2.2.3 Family Income Distribution in Krishnagiri and Dharmapuri Districts

The economy of the district primarily relies on agriculture and industry. It has a predominantly agrarian base, with significant cultivation of crops including paddy, maize, ragi, banana, sugarcane, cotton, tamarind, coconut, mango, groundnut, vegetables, and flowers. The district also has a notable industrial presence, particularly in granite processing and floriculture. The per capita income of the district was INR 180,444 in FY 2016–2017.[19] The agricultural population in Krishnagiri District is shown in Table 2.2.11. However, data for other industries, excluding employment in Hosur Municipal Corporation, are unavailable.

According to the social condition survey, business leads with 36.3% of households are engaged in business activities, followed by 31.3% in agricultural labor, indicating a higher reliance on agriculture compared to Dharmapuri. Other work (12.8%) is the next most common, followed by wage labour (11.2%) in fourth place, with more than 20% of the workforce engaged in non-agricultural activities. Agricultural management, such as farming, engages 8.4% of households.[20] Figure 2.2.4 shows the results of primary occupations in Krishnagiri and Dharmapuri districts.

[18] Tamil Nadu Water Supply and Drainage Board (TWAD)
[19] Indiastat districts (https://www.indiastatdistricts.com/ accessed on November 8, 2024)
[20] Agricultural management involves owning or managing farmland and making decisions regarding to crop production and management.



Source: JST

Figure 2.2.4 Primary Occupation in Krishnagiri and Dharmapuri Districts

Dharmapuri District was bifurcated from the erstwhile Salem District in1965, comprising Hosur, Krishnagiri, Dharmapuri, Harur, and Taluks. Subsequently, in 2004, Dharmapuri District was further bifurcated into two districts—Dharmapuri and Krishnagiri—for administrative reasons.[21] Tamil, Telugu, Kannada, and Urdu are spoken in this district, with Hinduism as the major religion.

Based on the 2011 Census, the population of Dharmapuri District was 1,506,843, reflecting an increase of about 21% from 2001. The district comprises approximately 412,000 households, with an average household size of around 4.1 members.[22] According to TWAD, the average monthly income per household is estimated at INR 19,083, while the average monthly income per household is INR 18,811 in Dharmapuri, which is about 6% higher than in Krishnagiri based on the social condition survey.

Agriculture remains the mainstay of the economy in Dharmapuri District, with crops including paddy, groundnut, and vegetables being prominent. The district also has growing industries in granite, quartz, and molybdenum. More than half of the district's population is engaged in agriculture. The per capita income was INR 121,647 in FY 2016–2017.[23] The agricultural population in Dharmapuri District is detailed in Table 2.2.11. However, data on employment in other industries, excluding employment in Hosur City Municipal Corporation, are currently unknown.

Regarding occupation, the largest occupational group is business, representing 38.6% of households and indicating a significant entrepreneurial presence in the district. Agricultural labor is the second most common occupation, involving 22.1% of households and reflecting the district's rural economy. Salaried jobs account for 15.7%, indicating a moderate level of formal employment. Other labor types and agricultural management constitute 11.4% and 12.1% respectively, highlighting diverse income sources.

[21] Dharmapuri District (https://dharmapuri.nic.in/ accessed on November 15, 2024)
[22] TWAD
[23] Indiastat districts (https://www.indiastatdistricts.com/ accessed on November 8, 2024)

Overall, more than 30% of households are engaged in agriculture, which includes agricultural labor and management.

Regarding power outages, in both districts, the Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) schedules planned shutdowns at all substations from 09:00 to 14:00 once every month, except between February and April due to school examinations. Unscheduled power outages may also occur for one or two hours during the time of breakdowns or natural calamities. Press notifications regarding total shutdown will be published in the daily newspaper for prior notice to the consumers.[24]

Both districts are rich in natural beauty and agricultural production. Krishnagiri has a slightly more industrialized profile, while Dharmapuri remains predominantly focused on agriculture and natural resources. The natural conditions of both districts are described in detail in Section 2.3. Specific features and issues of Krishnagiri and Dharmapuri districts in comparison with other districts are as follows:

- ✓ Krishnagiri focuses on horticulture, especially the cultivation of fruits such as mangoes, while Dharmapuri has a more diverse crop profile emphasizing groundnuts, bananas, and pineapples.
- ✓ Krishnagiri has a notable industrial presence, particularly in granite industries, whereas Dharmapuri is more reliant on agricultural and forest-based activities.

Table 2.2.11 presents key social and economic indicators for Krishnagiri and Dharmapuri districts. Both districts have birth rates and literacy rates lower than the national averages. The birth rate of Dharmapuri reports higher than that of Krishnagiri, while the literacy rate of Krishnagiri was higher than that of Dharmapuri. Both districts per capita income were higher than the national average. In terms of GDDP, Dharmapuri District's GDDP is lower than the Tamil Nadu State average (INR 56,163 million), whereas Krishnagiri District's GDDP is above the state average.

Table 2.2.11 Social and Economic Indicators in Krishnagiri and Dharmapuri Districts

Description	Krishnagiri	Dharmapuri	Average in India
Birth Rate (infants per 1,000 person) (2011)	15.6	17.0	21.8
Literacy rate (2011)	72.41%	68.50%	74.04%
Literacy rate Men (2011)	79.65%	76.90%	82.14%
Literacy rate Women (2011)	64.86%	59.80%	65.46%
Income per capita FY 2016-17 (INR at current price)	180,444	121,647	103,870
GDDP (million INR) (2019-20)	56,613	31,511	-
Population in Agriculture (2024)	281,733	210,300	-
Incidence rates of water-related diseases[25] (2021)	0.2%	0.1%	2.7%
Unemployment Rate (2021)	5%	6%	6.4%

[24] TWAD
[25] Census 2025 and BMC Public Health (2022) (Krishnagiri District Population Census 2011 - 2021 - 2025, Tamil Nadu literacy sex ratio and density, Dharmapuri District Population Census 2011 - 2021 - 2025, Tamil Nadu literacy sex ratio and density, Prevalence and predictors of water-borne diseases among elderly people in India: evidence from Longitudinal Ageing Study in India, 2017–18 | BMC Public Health | Full Text, India - total population 2019-2029 | Statista accessed on February 25, 2025)

Source: 1. India Census 2011 excluding income per capita 2. Indiastat districts (https://www.indiastatdistricts.com/ accessed on November 8th, 2024) for Income per capita for Krishnagiri and Dharmapuri 3. Ministry of Statistics and Programme Implementation, Government of India (2018) "National Accounts Statistics" 2018 for Income per capita for India 4. Planning Commission, Government of Tamil Nadu, Chennai. (2022) "Regional Growth Pattern in Tamil Nadu" for GDDP 5. Krishnagiri District (Agriculture | Krishnagiri District, Government of Tamil Nadu | India accessed on January 13, 2025) 6. Dharmapuri District (Agriculture | Dharmapuri District, Government of Tamil Nadu | India accessed on January 13 2025) for agricultural population 7. TWAD (2021) for water-related diseases and unemployment rate in target areas 8. The World Bank (2024) (https://data.worldbank.org/indicator/SL.UEM.TOTL.NE.ZS?locations=IN accessed on March 7 for unemployment rate in India.

Dharmapuri State Industries Promotion Corporation of Tamil Nadu Limited (SIPCOT) is an upcoming industrial park that will expand 1,733 acres, strategically located along the National Highway (NH)-44, ensuring excellent connectivity to Chennai and Bangalore. This industrial park is expected to play a vital role in supporting electric vehicle (EV) industries and enhancing regional industrial development in Dharmapuri District. Currently, the Dharmapuri SIPCOT is undertaking development works to enhance infrastructure, including the construction of roads, stormwater drains, streetlights, and water supply systems. These improvements aim to establish a well-equipped industrial environment. Industry allotments are expected to commence soon, offering opportunities for businesses to set operations and contribute to the region's industrial growth.

A significant development within this initiative is the reservation of 700 acres of land for M/s. Ola Electric Technologies Pvt. Ltd., allocated under Tamil Nadu Government Order No. 08, issued by the Investment Promotion and Commerce Department, dated January 23, 2023. This land has been earmarked for establishing facilities for their suppliers. This initiative positions the Dharmapuri SIPCOT as a major hub for the EV manufacturing ecosystem and other allied industries, thereby contributing significantly to regional economic growth and employment generation.[26]

(2) Use of Agricultural and Industrial Water in India

Regarding water use in agriculture, the annual groundwater extraction for all uses amounts to 239.16 billion cubic meters (BCM), of which 208.49 BCM (87%) is utilized for agricultural activities in India. The availability and extraction of groundwater resource depend upon several factors, including intensity and duration of rainfall, geological strata of the area, number of existing recharge structures, volume extraction by consumers for various purposes such as industrial applications, drinking and domestic purposes, and irrigation practices including cropping pattern and crop intensity.

Additionally, industrial water is used for fabricating, processing, washing, diluting, cooling, or transporting products.[27] In the mining sector in India, clarifiers and disposable filtration equipment are mainly used for the treatment of suspended solids.[28] Forestry relies on rainfall and also contributes to groundwater through recharging water sources.

(3) Industrial Profile in Hosur City Municipal Corporation

[26] SIPCOT (2025)
[27] Aquaetech (Industrial Uses of Water | Essential Guide accessed on January 7, 2025)
[28] Modor Intelligence (https://www.mordorintelligence.com/ja/industry-reports/india-water-and-wastewater-treatment-wwt-technology-market accessed on January 7, 2025)

SIPCOT was established in 1971 as part of a state-led initiative to promote industrial development. It initially started operations across 16 locations within the state. Among these regions, Hosur was selected as the site for industrial complexes. The planned area in Hosur was subsequently expanded, thus, become an industrial city with more than 2,000 comprehensive engineering companies.

The establishment of SIPCOT was not merely an administrative move; it embodied a comprehensive strategy, deliberately designed to not only foster industrial growth but also to spearhead economic transformation across Tamil Nadu. This landmark initiative encapsulated the Government's forward-thinking vision, laying the groundwork of a specialized corporation geared towards pioneering industrial development and elevating the state's economic stature. SIPCOT develops and maintains strategically planned industrial parks, Special Economic Zones (SEZs), and technology parks equipped with essential infrastructure, thereby reducing the time and cost required for businesses to set up operations.[29]

The GoTN has undertaken initiatives to decongest Chennai and its neighboring districts by promoting the establishment of diverse industries in Tier I and Tier II cities.[30] As a result, Hosur has emerged as a major beneficiary, which is set to have significant number of industries in Krishnagiri District. A comparative analysis of Hosur City Municipal Corporation and other SEZs is shown in Table 2.2.12. At the present time, the GDP of Hosur City Municipal Corporation is lower than that of the Visakhapatnam SEZ in Andhra Pradesh State and Surat Special Economic Region in Gujarat State. However, it could increase with future development. According to an interview with SIPCOT, life science industries and aerospace industries are expected to be the upcoming industries in Hosur.

Table 2.2.12 Comparison of Hosur City Municipal Corporation and Other Special Economic Zones in India

Name of Cities	Main Industries		Population	GDP (mil. INR)
Hosur City Municipal Corporation, Tamil Nadu State	Automobile Industries	Biotechnology Industries	621,000 (2024)	234,450 (2021)
	General Engineering Industries	Heavy Engineering Industries		
	Chemical Industries	Electric Vehicle (EV) Industries		
	Electronics Hardware Industries	EV Battery Industries		
	Pharmaceutical Industries	Food Industries		
	Petro-Chemical Industries	Textile Industries		
	Footwear Industries	Iron & Steel Industries		
	Glass Industries	Plastic Industries		
Visakhapatnam Special Economic Zone, Andra Pradesh State	Oil Refinery Industries	Zinc Industries	610,186 (2023)	1,100,940 (2023)
	Fertilizers Industries	Steel Industries		
	Dredging Industries	Heavy Engineering Industries		

29 SIPCOT (SIPCOT - State Industries Promotion Corporation of Tamil Nadu accessed on January 7, 2025)
30 Tier I and Tier II means phases which the suppliers joined. Tier I is the first phase.

Name of Cities	**Main Industries**		**Population**	**GDP (mil. INR)**
Surat Special Economic Region, Gujarat State	Pharmaceuticals & Chemical Industries	Gem & Jewellery Industries	15,700,000 (2023)	6,227,280 (2023)
	Engineering Industries	Medical Equipment Industries		
	Plastics Industries	Textile Industries		
	Tobacco Industries	Software & Hardware Industries		

Source: 1. SIPCOT (2025) 2. United Nations (World Population Prospects accessed on January 13, 2025) 3. The Hindu (2024) 4. Government of India (ABOUT VIZAG – VSEZ accessed on January 13, 2025) 5. Surat SEZ (--:: SURAT SPECIAL ECONOMIC ZONE ::-- accessed on January 13, 2025) 6. NITI Aayog (2024) "Economic Mater Plan for Surat Economic Region"

The SIPCOT Industrial Area in Krishnagiri District spans 4,650.11 acres and currently employs more than 54,200 individuals directly. Furthermore, SIPCOT is projected to generate more than 30,000 additional direct jobs in Krishnagiri District in the coming years. Table 2.2.13 presents the current number of employees in the SIPCOT Industrial Park.

Table 2.2.13 Current Number of Employees at the SIPCOT Industrial Park in Krishnagiri District

No	**Name of Area**	**Extent in acres**	**No. of Allotments**	**Current Employees**
1	Hosur – Phase I	1,236	242	36,000
2	Hosur – Phase II	857	126	
3	Shoolagiri	1,022	84	N.A.
4	Kurubarapalli	156	2	3,200
5	Bargur	1,380	149	15,000
	Total	4,650	603	54,200

Source: SIPCOT (2025)

Considering the strong growth in industrial development and floriculture, the GoTN approved the Master Plan Vision 2046 in year 2022. This aims to develop the Hosur New Town Development Area into a leading industrial and floricultural hub on a sustainable basis. Goals that will be pursued over the planned period are as follows:

- Goal 1: Development of agricultural and mineral resources.
- Goal 2: Enhancement of human resources and promotion of public participation.
- Goal 3: Promotion of industrial development across four sectors namely micro, small, medium, and large enterprises.
- Goal 4: Conservation of ecosystem and biodiversity.

The existing infrastructure facilities have been analyzed and gaps were identified. Accordingly, strategies have been formulated to address the physical infrastructure requirements of the Industrial Area proposed in the master plan.

The policy of Tamil Nadu State Government is to promote production for export to every part of the globe. Tata Electronics and Delta Electronics are building massive manufacturing facilities in and around Hosur. The presence of these two major companies is expected to foster another major player in the sector to choose the industrial town.

Tata Electronics will comprise industries primarily related to high-technology electronics manufacturing. The core industries include:

- ➢ Consumer Electronics and Mobile Device Components
- ➢ Precision Engineering and Machining
- ➢ Semiconductor and Chip Packaging (Future Expansion)
- ➢ Green and Sustainable Manufacturing
- ➢ Automotive Electronics (Possible Diversification)

Delta Electronics in Kurubarapalli manufactures components such as switched-mode power supply (SMPS), variable frequency drives (VFDs), industrial controllers, and automation solutions. The key industries will include:

- ➢ Industrial Automation
- ➢ Power Electronics
- ➢ Renewable Energy Solutions
- ➢ Electric Vehicle (EV) Infrastructure
- ➢ Data Center Solutions
- ➢ Transportation Solutions

Additionally, Hosur is designated as one of the nodes in the Defense Corridor, as announced by the Government.[31]

- Under SIPCOT Phase 1: Industrial estate was established at Zuzuvadi abutting NH-44, covering an extent area of 1235.86 acres. Large industries like Ashok Leyland, Titan, Tanishq, Lakshmi Automatic Looms, Hindustan Unilever Limited, GRB Dairy Foods, TTK Prestige Limited, GE India Ltd., Carborundum Universal Ltd., WENDT India Ltd., and other various establishments were set up in this phase. About 239 industrial units were allotted space within the industrial complex.
- Under SIPCOT Phase 2: Industrial estate was set up at Moranapalli and Thorapalli Agraharam, covering an extent area of 456.88 acres. Subsequently, approximately 399.76 acres of land was added to provide additional industrial units in the Phase II Expansion. About 124 industrial units were allotted space within the complex. Few of large industries built in this phase include Ashok Leyland, Gabriel India Ltd., Terex India Pvt. Ltd., Marudhar Rocks Intl. Ltd., Mylan Laboratories Ltd., First Steps Baby Wear Pvt. Ltd., Weg India Pvt. Ltd., and VeeBee Medicare Pvt. Ltd.
- In Adagurukki and Doripalli, industrial complexes were established under SIPCOT Phases 3 and 4 with 121.07 ha and 389.585 ha, to accommodate the growing demand for industrial space in Hosur area.

[31] Indian aerospace and defence bulletin (https://www.iadb.in/2021/12/02/tamil-nadu-defence-industrial-corridor-an-overview/ accessed on 27th December 2024)

- The industrial development by SIPCOT is expected to increase employment generation and stimulate vibrant economic activity in the region.
- The Electronics Corporation of Tamil Nadu (ELCOT) IT Park is situated on NH-207 at Viswanathapuram village, opposite the Hosur City Municipal Corporation Office, with an extent area of 106.28 acres. It features 16 IT park plots, and the ELCOT office building has been constructed. This provides an opportunity to develop Hosur also as an IT Hub.
- Seamless Transportation: The city claims excellent road connectivity, with the NH-44 (formerly NH-7) and the NH-844 passing through the area, providing efficient access to major cities such as Bengaluru and Chennai. Additionally, the upcoming Peripheral Ring Road (PRR) will span a 73.5 km-stretch with a 100 m-wide carriageway. The PRR project aims to connect Hosur and Bengaluru. However, the Bangalore Metro extension to Hosur is not scheduled to be extended in the near future.

➢ Japanese companies inside and outside SIPCOT

- Inside SIPCOT, there are two Japanese companies—Kansai Nerolac Paints Ltd. and Japan Metal Building System Pvt. Ltd.—which are currently operating. Kansai Nerolac Paints Ltd. has applied for Environmental Clearance to support its further expansion.
- Outside SIPCOT, in the vicinity of Hosur area, Japanese companies such as Essae-Teraoaka, IFFCO Tokio General Insurance, Indian Nippon Electricals, Asahidenso Multilink Pvt. Ltd., Transystem Logistics International Pvt. Ltd., Toyota Boshoku Pvt. Ltd., and Yazaki India Ltd. are operating and are expected to expand.

Hosur, a rapidly growing industrial hub, plays a strategic role in the supply chain network connecting Chennai and Bangalore. The relationship between these cities is characterized by the flow of goods and components across various industries, supported by well-developed transportation infrastructure. Key supply chain links are as follows:

- Electronics and Technology Products

Hosur produces components for smartphones and electronic devices, with companies like Tata Electronics manufacturing parts for Apple iPhones. These components are transported to Chennai for further assembly and export, leveraging Chennai's port facilities. Bangalore, being a technology hub, provides software development and design services that complement hardware manufacturing in Hosur.

- Automotive Components and Electric Vehicles (EVs)

Hosur is home to several manufacturing factories producing automotive components and electric vehicles. Major companies, like TVS Motor Company and Ashok Leyland, operate major plants in the region. Ola Electric Technologies Pvt. Ltd. is one of the leading manufacturers of the two-wheeled EVs. Finished vehicles and components are transported to Chennai for export via its port facilities or distributed to Bangalore and other cities for domestic markets. EV-related components, such as charging equipment and batteries produced in Hosur are integrated into supply chains connecting with Bangalore's technology ecosystem.

- Renewable Energy Solutions

Companies like Delta Electronics, which manufacture SMPS, VFDs, industrial controllers, and automation solutions, and power management systems, are in Hosur. These products are distributed to Bangalore—one of the main market for renewable energy projects—and are transported to Chennai for export.

- Logistics and Infrastructure

The proximity of Hosur to Bangalore (40 km) positions it as an integral part of the Bangalore metropolitan area's supply chain. Chennai's ports serve as a gateway for exporting goods manufactured in Hosur, including electronics, vehicles, and machinery. The Chennai-Bangalore Industrial Corridor (CBIC) enhances connectivity, facilitating the efficient transport of raw materials and finished goods. This creates a strong supply chain ecosystem, with Hosur specializing in manufacturing, while Bangalore and Chennai provide technology services, assembly, and export facilities.[32]

(4) Water Supply System and Issues at the Hosur Industrial Estate

The current water usage at the Hosur Industrial Estate (total area of 1,200 ha) is estimated to be around 108 MLD (90 m^3/day/ha). Of this, the amount of freshwater supplied is thought to be approximately 32 MLD, which is about 30% of the total water usage. In India, the industrial water reuse rate is estimated to be around 80%, whereas in Hosur it is estimated to be 70%. Out of the 32 MLD of freshwater, 3.75 MLD is supplied by SIPCOT, while the remaining 28.25 MLD is from each factory's own water source (underground water) or purchased from private water tankers.

According to the Japanese companies in the SIPCOT Industrial Area, they face the following challenges regarding water supply:

- The groundwater and the water supplied by SIPCOT have problems with high total dissolved solids (TDS) and discoloration. As a result, this water is utilized mainly for gardening and toilets. For manufacturing and products washing, the water purchased from private vendors are used; however, the unit cost of water purchased from private water suppliers is high, at INR 160/m^3.
- The groundwater table is deep (over 300 m), requiring a great amount of energy to pump the water upwards.

In the future, the following improvements to the water supply for the industrial estate are planned:

a) Sewerage reclamation plant which is under construction by SIPCOT: 20 MLD.

   This plant is a Tertiary Treatment Reverse Osmosis (TTRO), currently under construction by SIPCOT. The construction of the plant is nearly complete, and operations are scheduled to

[32] SIPCOT (2025)

commence in the second half of 2025. The treated water from this plant will be supplied to both Hosur SIPCOT and Shoolagiri SIPCOT. A contract has also been signed for the construction of the water supply facilities.

b) Water supply to SIPCOT through the Project: An initial supply of 3 MLD is planned, with a future expansion to 16.25 MLD.

(5) Sewerage Development Status

The sewerage systems shown in Table 2.2.14 have been developed in the cities and municipal corporations within the Project's target area.

Table 2.2.14 Sewerage Development Status of Municipalities and Municipal Corporation

Municipalities/ Municipal Corporation	Sewerage Treatment Coverage Rate (%)	Sewerage Collection System	Number of Treatment Plants	Total Treatment Capacity (MLD)
Hosur City Corporation	70.8%	Separated sewer system	2	32.64
Krishnagiri Municipality	40%	Separated sewer system	1	9.00
Dharmapuri Municipality	47%	Separated sewer system	1	4.86

Source: TWAD

There are no sewage treatment plants in the towns and villages.

2.3 Natural Conditions in the Project Area

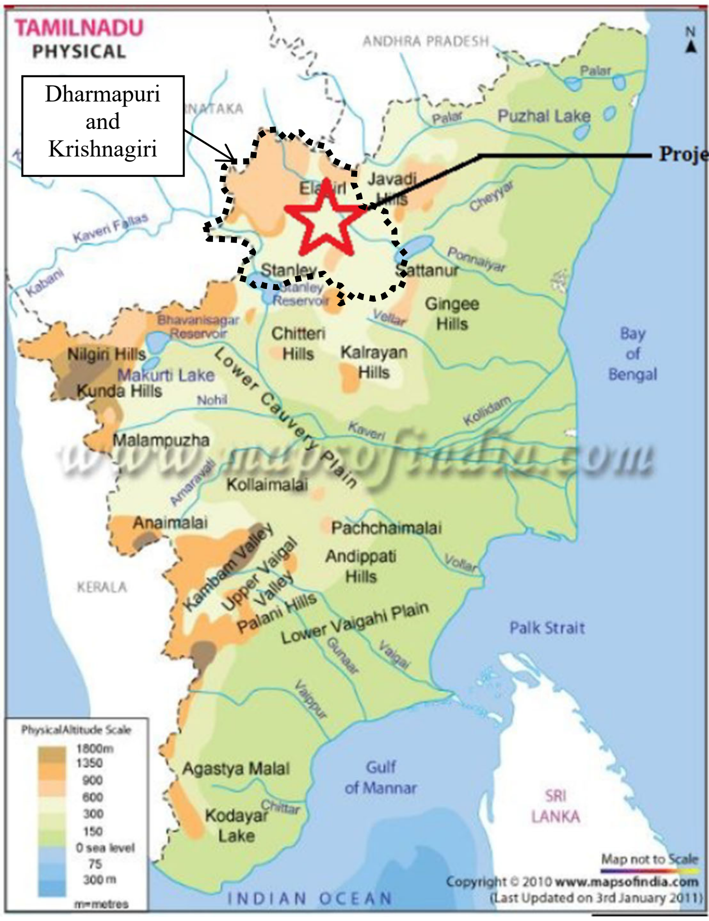
2.3.1 Geographical and Geological Features

(1) Geographical Features

Dharmapuri District, established on October 2, 1965, is located in the northwestern part of Tamil Nadu State, between latitudes 11°47' N and 12°33' N and longitudes 77°02' E and 78°40' E. It shares borders with Tiruvannamalai, Villupuram, Salem, Krishnagiri, and the Kaveri River, covering an area of 4497.77 km^2, representing 3.46% of the total area of Tamil Nadu State. In terms of topography, the western and southern regions feature mountainous terrain, while the northern and eastern regions are flat.

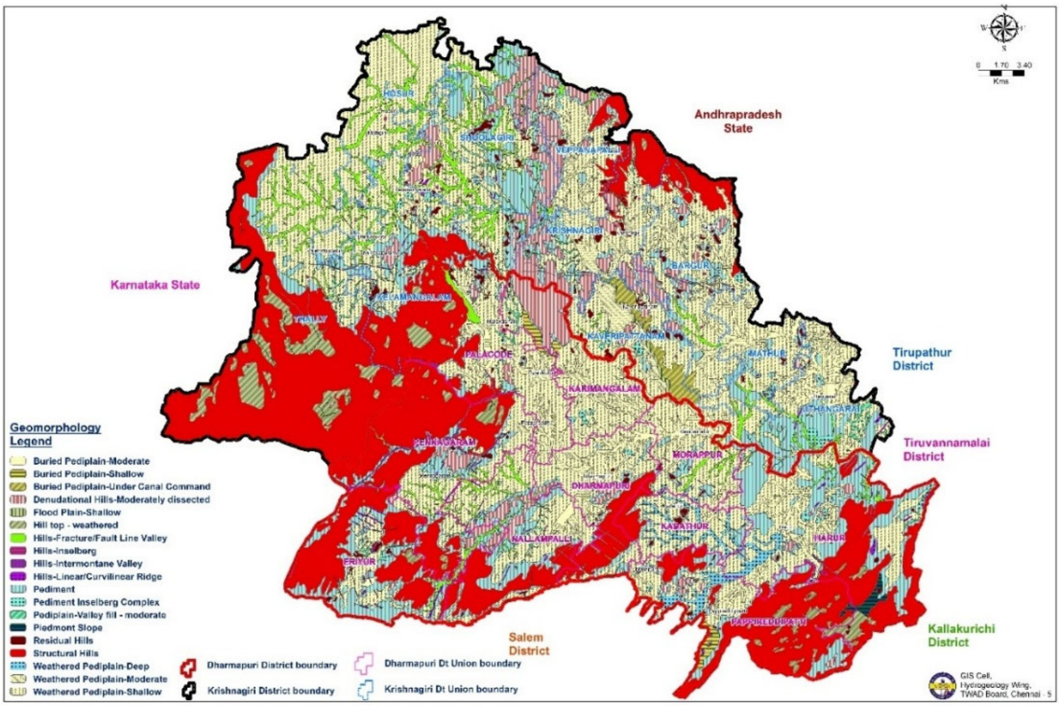
Krishnagiri District, formed on February 9, 2004, after being carved out of Dharmapuri District, covers an area of 5,143 km^2 in Tamil Nadu. It is located between latitudes 11°12' N to 12°49' N and longitudes 77°27' E to 78°38' E. The district is bordered by Vellore, states of Karnataka, Andhra Pradesh, and Dharmapuri, with elevations from 300 m to 1400 m. Topographically, there are mountainous areas to the western and parts of the eastern regions, while the rest of the region features a mix of flat terrain, hills, and valleys.

Figure 2.3.1 shows the geological map of Tamil Nadu, while Figure 2.3.2 illustrates the geomorphological features of the target districts.



Source: EIA Report from DPR

Figure 2.3.1 Geological Map of the Tamil Nadu State

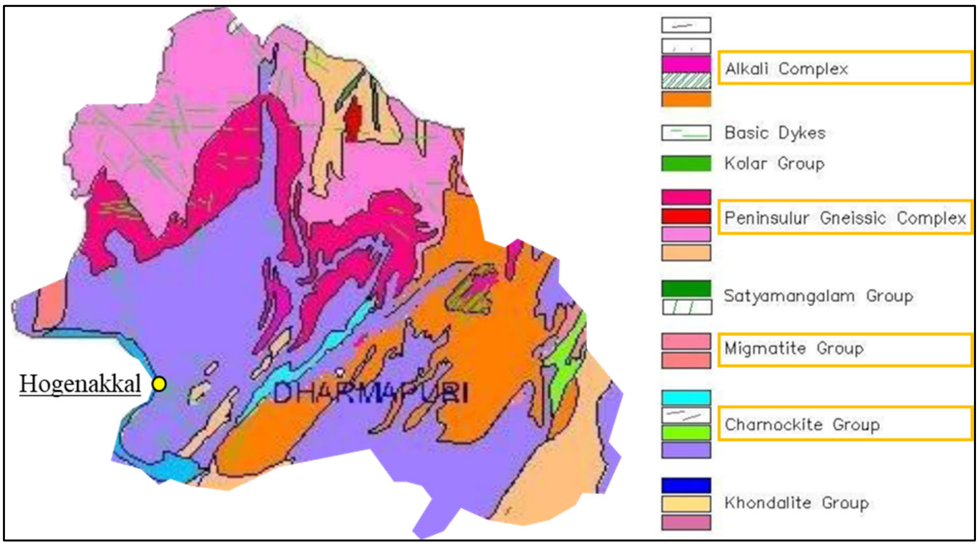


Source: TWAD

Figure 2.3.2 Geomorphological Map of the Project Area

(2) Geological Features

Figure 2.3.3 shows the geological map of Krishnagiri and Dharmapuri districts. Over 80% of Tamil Nadu State is underlain by crystalline rocks dating from the Archaean to late Proterozoic eras. The remaining area consists of phanerozoic sedimentary rocks, primarily distributed along the coastal belt and within certain inland river valleys. The hard rock terrain predominantly consists of Charnockite and Khondalite groups, along with their migmatitic derivatives, supracrustal sequences from the Sathyamangalam and Kolar groups, and the Peninsular Gneissic Complex (Bhavani Group). Consequently, in the Project area, hard rock formations are anticipated to be present in many regions, except in specific geological areas in the eastern part (Alkali complex).

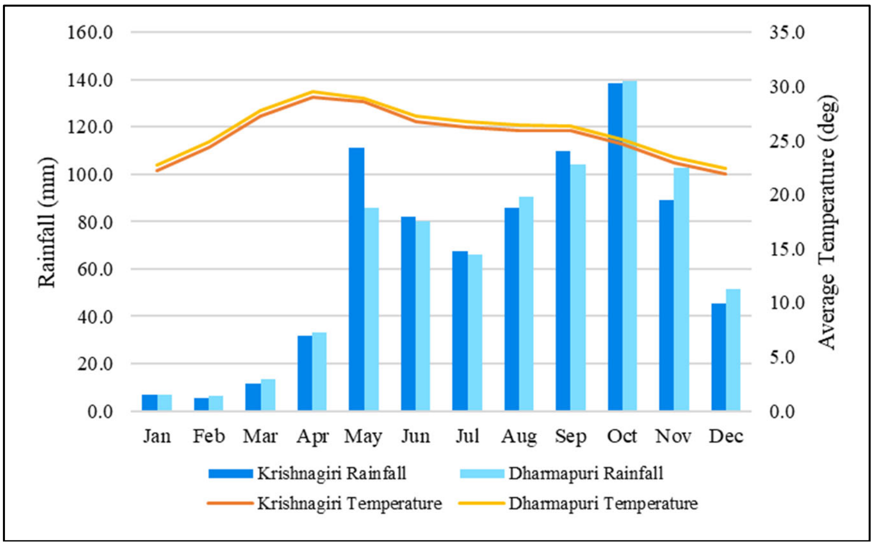


Source: Prepared by JST based on District Survey Report, Department of Geology and Mining, Government of Tamil Nadu (https://tnmines.tn.gov.in/district-survey-reports.php)

Figure 2.3.3 Geological Map of the Project Area

2.3.2 Climate Conditions

Figure 2.3.4 shows the annual rainfall and average temperature patterns in the Project area, covering Krishnagiri and Dharmapuri districts.



Source: JST based on data provided by TWAD and Climate-data.org

Figure 2.3.4 Annual Rainfall and Average Temperature Around the Project Area (1991–2024)

Climatically, the year in Tamir Nadu state is divided into three major seasons such as:

- Dry season: December to April
- Rainy season: May to November
- Monsoon season: Late September to Late November

The mean annual rainfall is 786 mm in Krishnagiri and 780 mm in Dharmapuri, both of which is lower than the national average of 1,180 mm and the Tamil Nadu State average of 960 mm.[33]

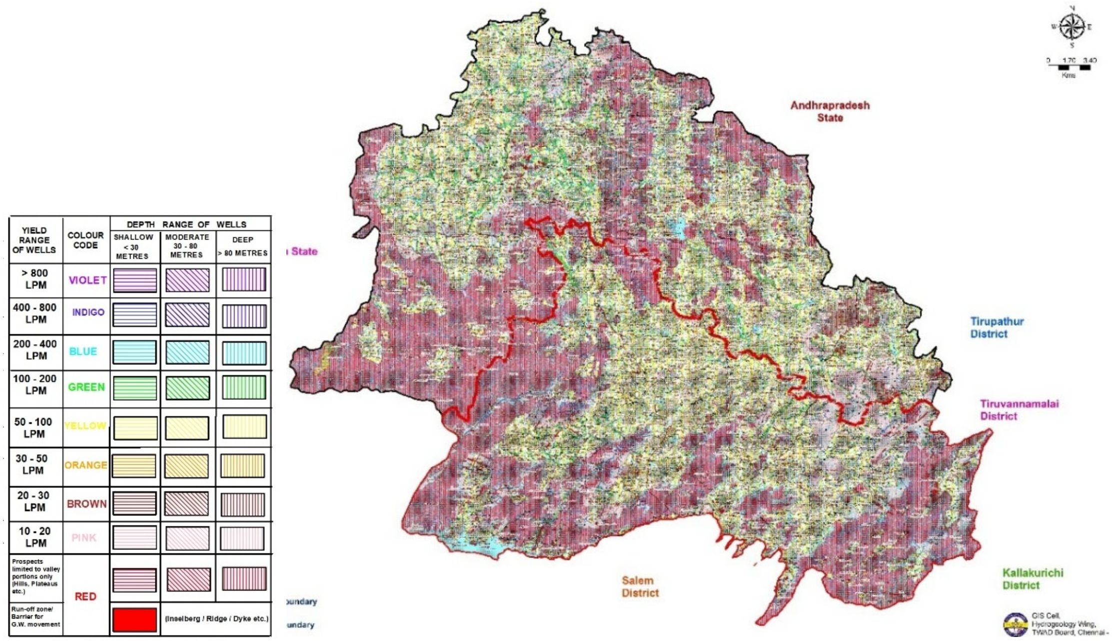
2.3.3 Water Bodies

(1) Surface Water

The main rivers in the target area are the Cauvery River in the west and the Pennvaiyar River in the east (see Figure 4.5.1). The Cauvery River serves as the water source for both the Previous Hogenakkal Project and the current project. Further details are provided in Chapter 4.

(2) Groundwater

The groundwater potential in the target area is illustrated in Figure 2.3.5. The green zones in the figure represent regions where the well extraction capacity is estimated to range between 100 and 200 L/min, primarily used for irrigation purposes. In contrast, the brown, pink, and red zones represent areas with an extraction capacity of less than 30 L/min, indicating limited groundwater availability.



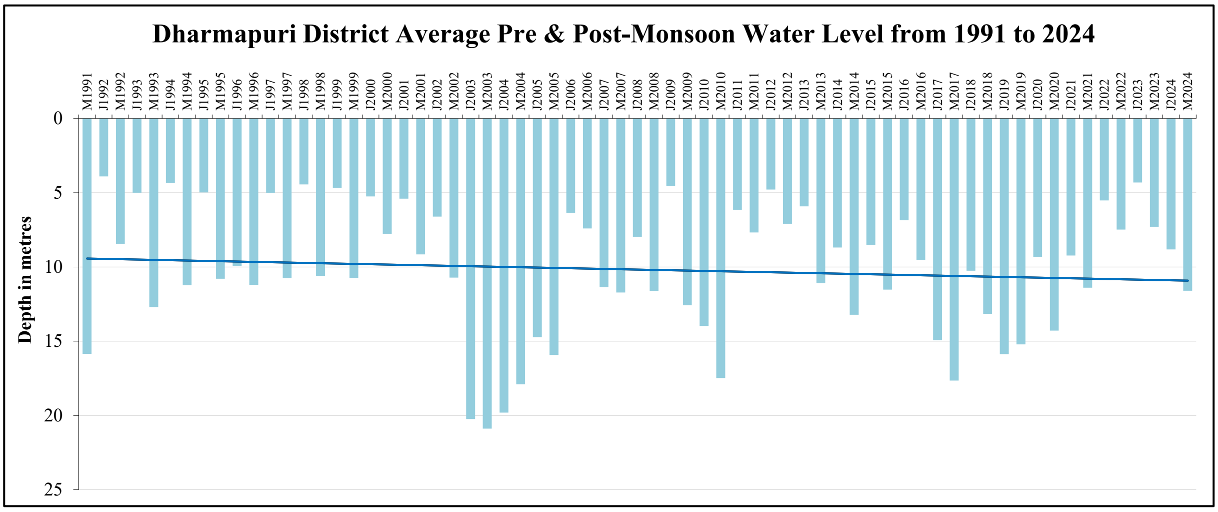
Source: TWAD

Figure 2.3.5 Groundwater Potential Map in the Target Area

The long-term trend of groundwater levels is depicted in Figure 2.3.6 and Figure 2.3.7. Based on changes observed over the past 34 years, groundwater levels tend to decline significantly during drought years but generally recover in the following year. Therefore, no substantial long-term

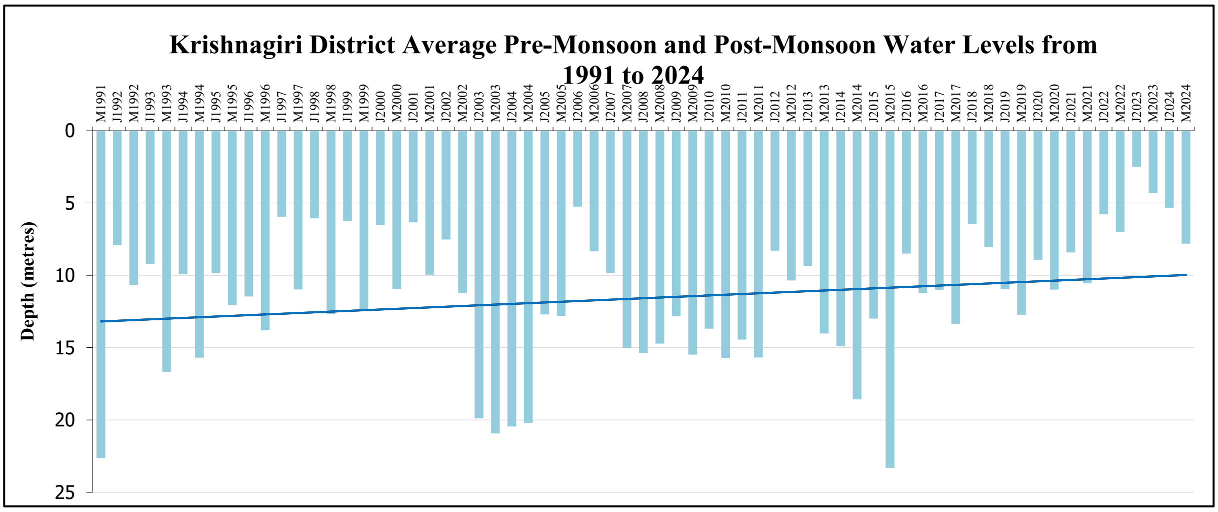
[33] The actual observation data for 2023 provided by TWAD

depletion of groundwater has been observed. As a water source, however, groundwater is considered a less reliable source for water supply due to its significant decline during drought years.



Source: TWAD

Figure 2.3.6 Groundwater Level in Krishnagiri (1991–2024)



Source: TWAD

Figure 2.3.7 Groundwater Level in Dharmapuri (1991-2024)

Regarding water quality, Table 2.3.1 and Table 2.3.2 present the groundwater quality data for 2020-2022. The target area is highly prone to drought conditions. Of particular concern is the concentration of fluoride, which exceeds the permissible limit of 1.50 mg/L in several regions, such as the Pochampalli and Palacode, as indicated by the results.[34]

[34] TWAD BOARD (https://twadboard.tn.gov.in/content/hognekkal-ws-fmp)

Table 2.3.1 Groundwater Quality in Target Area (Krishnagiri)

Parameter	Unit	Denkanikottai		Hosur		Krishnagiri		Pochampalli		Sulagiri		Uthangarai	
		Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun
pH	-	7.94	7.90	7.93	7.92	7.93	7.95	7.85	7.71	8.13	7.87	8.06	7.81
EC	cm	1254.21	1736.00	1295.11	1757.00	1735.13	1744.72	2760.00	3104.17	1466.67	1570.00	1823.33	1756.67
TDS	mg/L	729.01	1056.31	779.39	1069.93	1024.18	1024.72	1508.08	1783.17	867.67	964.00	1016.17	1001.37
$NO_2 + NO_3$	mg/L	12.45	13.11	17.73	12.77	9.59	7.21	6.58	11.75	21.67	11.33	12.07	12.63
Ca	mg/L	76.49	96.49	82.56	100.07	91.00	82.55	110.17	135.67	69.33	95.33	87.80	86.73
Mg	mg/L	34.50	46.84	33.93	41.60	51.79	47.90	103.27	100.24	59.54	36.45	69.09	64.23
Na	mg/L	126.85	183.49	131.53	201.90	207.27	213.59	307.17	357.25	140.33	181.00	186.00	175.63
K	mg/L	18.56	25.18	17.30	17.50	13.58	9.89	6.51	9.50	15.33	8.33	9.87	14.37
Cl	mg/L	178.57	182.58	168.13	196.67	335.21	252.33	658.17	583.25	236.33	135.67	288.03	261.53
SO_4	mg/L	98.57	310.73	136.86	312.47	114.18	228.81	105.58	359.42	138.00	321.33	137.60	158.70
CO_3	mg/L	3.80	2.70	3.09	0.50	1.97	2.08	0.00	0.00	0.77	0.58	5.96	0.20
HCO_3	mg/L	258.74	291.70	244.82	279.61	317.73	304.25	375.66	371.09	217.56	262.89	352.88	362.76
F	mg/L	0.48	0.76	0.50	0.64	0.91	0.98	1.29	1.70	0.56	0.48	1.14	1.33
Hardness as $CaCO_3$	mg/L	333.21	434.00	346.02	421.33	440.62	403.52	700.42	751.67	418.33	388.33	503.83	481.17
Sodium Adsorption Ratio	-	3.03	3.75	3.29	4.26	4.44	4.67	5.17	5.74	3.01	3.67	3.71	3.77
Sodium Percentage	%	40.42	43.73	42.87	47.65	48.74	50.80	48.27	49.12	33.57	44.00	41.71	43.10
Residual Sodium Carbonate	meq/L	0.21	0.04	0.05	0.00	0.30	0.17	0.03	0.00	0.00	0.00	0.04	0.23

Note: January and June values for each region are averages of the 2020-2022 results.

Source: JST based on Government of Tamil Nadu Water Resources Department

Table 2.3.2 Groundwater Quality in Target Area (Dharmapuri)

Parameter	Unit	Dharmapuri		Harur		Karimangalam		Nallampalli		Pappireddipatti		Pennagaram		Palacode	
		Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun	Jan	Jun
pH	-	7.89	8.00	7.98	8.17	7.70	8.05	8.23	7.93	8.02	8.12	7.83	8.17	7.87	8.11
EC	cm	1519.26	1879.26	1513.09	1383.64	2240.00	3645.00	878.33	1748.33	1516.67	1668.00	2088.75	2224.17	1585.33	2173.33
TDS	mg/L	865.15	1080.59	859.82	802.57	1277.50	2208.50	506.67	1072.50	879.73	987.07	1213.42	1357.09	919.60	1263.80
$NO_2 + NO_3$	mg/L	18.22	16.96	20.25	9.55	34.00	55.00	8.17	18.00	32.93	16.40	32.17	26.59	20.88	21.27
Ca	mg/L	96.30	86.74	98.12	79.33	182.00	180.00	94.67	104.33	111.20	119.33	120.83	122.50	99.47	97.47
Mg	mg/L	63.50	79.34	54.60	49.48	60.75	91.13	19.44	45.16	57.43	52.41	76.44	70.67	53.06	82.94
Na	mg/L	113.45	184.11	120.02	130.91	164.50	439.50	58.50	197.17	105.67	144.53	186.50	219.88	142.77	216.83
K	mg/L	12.48	8.48	18.24	9.10	27.00	36.00	4.50	7.33	8.20	6.54	16.79	33.67	17.90	21.37
Cl	mg/L	216.44	197.59	210.16	145.45	446.50	652.00	117.17	172.17	193.47	206.60	312.13	229.42	215.23	307.03
SO_4	mg/L	119.59	235.15	96.68	180.43	96.00	353.00	48.83	314.83	93.20	238.60	167.54	371.92	108.30	255.70
CO_3	mg/L	3.97	8.04	8.42	6.30	18.00	0.00	11.99	1.00	1.98	4.13	8.07	14.09	8.50	11.59
HCO_3	mg/L	308.40	417.91	319.65	306.63	265.35	427.00	205.37	300.93	322.17	277.71	361.88	351.20	356.29	350.58
F	mg/L	0.60	1.01	0.56	0.88	0.12	0.68	0.32	0.59	0.56	0.72	0.57	1.16	0.58	2.01
Hardness as $CaCO_3$	mg/L	502.04	543.34	469.98	401.97	705.00	825.00	316.67	446.67	514.33	514.00	616.67	597.09	467.00	585.00
Sodium Adsorption Ratio	-	2.41	3.88	2.45	2.88	3.10	6.78	1.45	4.85	2.08	2.87	3.35	4.02	2.90	4.23
Sodium Percentage	%	32.76	41.88	33.13	37.88	33.69	53.34	29.28	52.38	30.50	36.39	39.82	42.40	36.98	44.01
Residual Sodium Carbonate	meq/L	0.41	1.04	0.18	0.33	0.00	0.00	0.00	0.00	0.04	0.00	0.12	0.00	0.26	0.17

Note: January and June values for each region are averages of the 2020-2022 results, except for Karimangalam, which is an average of the 2021-22 results.

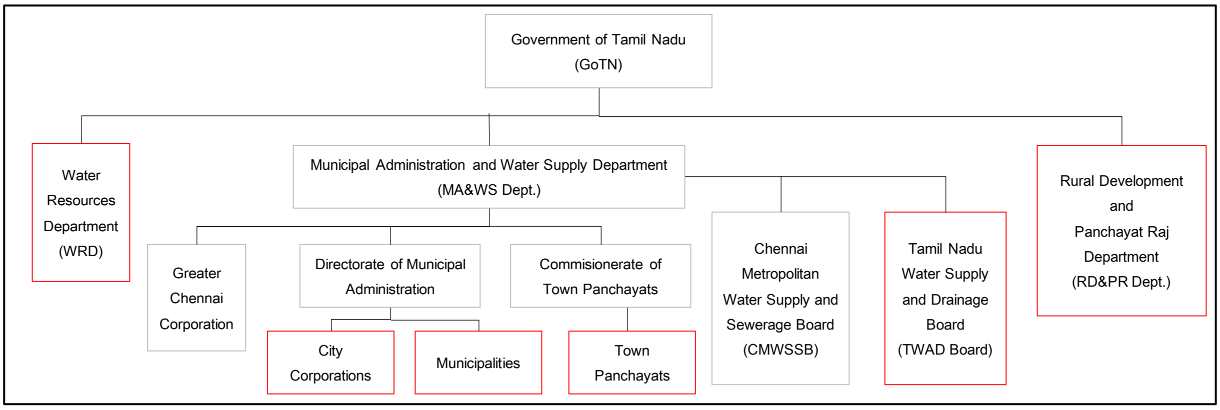
Source: JST based on Government of Tamil Nadu Water Resources Department

Chapter 3 Present Water Supply Conditions in the Project Area

3.1 Waterworks Operation System in Tamil Nadu

3.1.1 Overview

Three departments are involved in Tamil Nadu's water supply: 1) the Water Resources Department (WRD), 2) the Municipal Administration and Water Supply (MA&WS) Department, and 3) the Rural Development and Panchayat Raj (RD&PR) Department. Figure 3.1.1 shows the organization structure related to the water supply in Tamil Nadu.



Source: JST based on the information from TWAD

Figure 3.1.1 Organization Structure Related to the Water Supply in Tamil Nadu

Objectives/roles of the red-colored organizations, which are related to the Project, are as follows:

<u>Tamil Nadu Water Supply and Drainage Board (TWAD): Executing Agency of the Project</u>

TWAD is the key agency responsible for providing bulk water supply and drainage services in rural and urban areas of Tamil Nadu, excluding the Chennai Metropolitan area. It implements and maintains combined water supply schemes (CWSSs). A CWSS is a bulk water supply scheme that supplies water to local bodies (city corporation, municipalities, town panchayats, and village panchayats), except Chennai.

There are 544 CWSSs in the Tamil Nadu State. Table 3.1.1 shows the CWSSs by source type and their designed supply volume.

Table 3.1.1 Number of CWSSs by Source Type

Source Type	No. of CWSSs	Designed Supply Volume (MLD)
Surface water		
River water	121*	1,499,91
Riverbed water	291	992.32
Groundwater		
Dug well	18	7.03
Borehole	114	34.74
Total	544	2,534

Note: * 75 CWSSs out of 121 CWSSs have WTP.
Source: TWAD

Table 3.1.2 shows the category and number of beneficiaries, along with their design water supply volume, totaling 2,534 MLD.

Table 3.1.2 Beneficiaries and Design Supply Volume by Category

Beneficiary		Design Water Supply Volume (MLD)
Category	No. of Beneficiaries	
Corporations	13	533
Municipalities	70	293
Town Panchayats	323	390
Rural Habitations	51,048	1,253
Industry	576	65
Total	52,030	2,534

Source: TWAD

Urban Local Bodies (ULBs[35]: City Corporations, Municipalities, and Town Panchayats):

ULBs are municipalities under the jurisdiction of the MA&WS. They manage and execute the operation and maintenance (O&M) of water distribution facilities to provide water supply services to residents/customers within their respective ULBs.

Rural Development and Panchayat Raj Department (RD&PR Department):

The RD&PR Department is responsible for implementing policies and programs aimed at enhancing the quality of life in rural areas. Single Village Schemes are executed by the department, while village panchayats maintain water supply schemes in rural areas under the management of the RD&PR Department.

Water Resources Department (WRD):

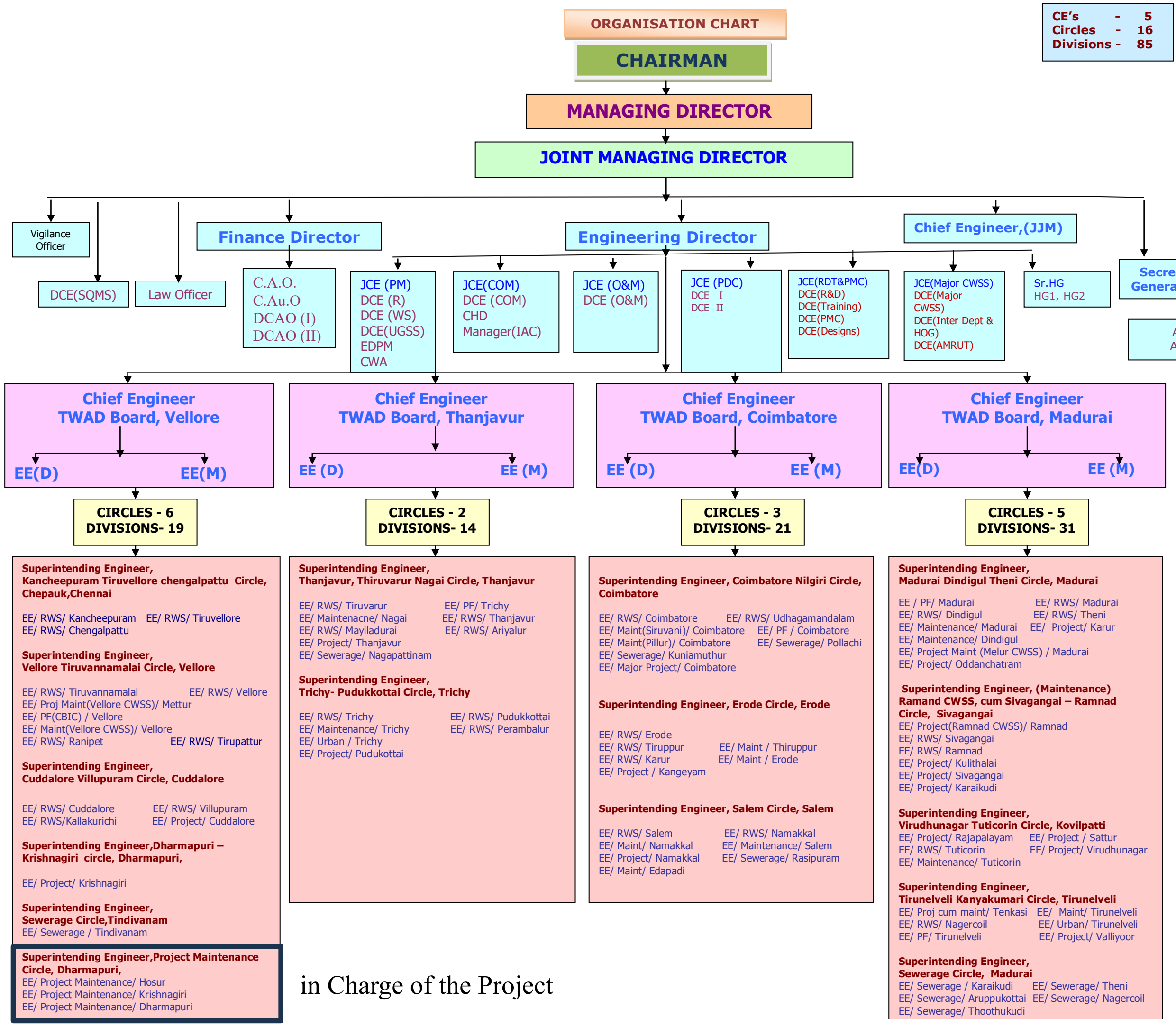
The main objective of the WRD is to conserve surface water and recharge groundwater to provide equitable irrigation up to tail-end areas and to meet the various demands, including water supply. The quantity and quality of the groundwater are continuously monitored and assessed by the WRD.

3.1.2 Organization Structure of the TWAD

(1) Organization Structure and Number of Staff

The organization structure of the TWAD is shown in Figure 3.1.2. The “Superintending Engineer, Project Maintenance Circle, Dharmapuri” shown in the figure is in charge of the Project.

[35] ULB is a generic term for City Corporation, Municipality, and Town Panchayat.



A.O –Administrative Officer
CAO –Chief Accounts Officer
CAuO–Chief Audit Officer
CWSS –Combined Water Supply Scheme
COM–Contracts Management
CWA –Chief Water Analyst
CHD –Chief Head Draughting Officer
DCE –Deputy Chief Engineer
DCAO –Deputy Chief Accounts Officer
EE –Executive Engineer
EDPM –Electronic Data Processing Manager
HG –Hydro Geologist
JCE –Joint Chief Engineer
JJM- Jal Jeevan Mission
O&M –Operation and Maintenance
PDC –Project Development Cell
PM –Programme Management
RDT & PMC –Research, Design, Training and Project Management Cell
RWS- Rural Water Supply
SQMS –Schemes Quality Monitoring Squad
UGSS –Under Ground Sewerage Scheme
(D)-Design

Source: TWAD (2024)

Figure 3.1.2 Organisation Structure of the TWAD

The number of staff is shown in Table 3.1.3.

Table 3.1.3 Number of Staff of TWAD

Name of the Post	Number of staff	Name of the Post	Number of staff
Managing Director	1	Assistant Accounts Officer	9
Joint Managing Director	1	Administrative Officer	2
Secretary cum General Manager	1	Superintendent	70
Finance Director	1	Assistant/AA/ASO	52
Engineering Director	1	Junior Assistant	99
Vigilance Officer	1	Steno Typist	4
Chief Audit Officer	1	Typist	10
Law Officer	1	Record Clerk	96
Chief Engineer	2	Office Assistant/A Non-commissioned officer	133
J.C.E./S.E.	12	Driver	78
Exe. Engineer/DCE	80	Watchman	53
Asst.Exe. Engineer	268	Sweeper	10
Asst. Engr/Jr. Engr	174	EDP Manager	1
Chief Head Draftsman	6	Technical Assistant	3
Special Gr. Draughting Officer*	10	**Maintenance Wing**	
Senior Draughting Officer	21	Electrical Superintendent	26
Draughting Officer	37	Electrician Gr.I/II	195
Jr. Draughting Officer	99	Fitter Gr.I/II	138
A D Man	2	Turn Cock	3
Dy. Hydrogeologist	18	Lascar	2
Asst. Hydrogeologist	12	Maintenance Assistant	311
Chief Water Analyst	1	**Mechanical Staff**	
Asst. Water Analyst	3	Mechanic	3
Junior Water Analyst	13	Assistant Driller	7
Laboratory Attendant	0	Helper	2
Dy. CAO	1	**Total**	2,079
Accounts Officer	5		

Note: AA-Audit Assistant. A D Man-Assistant Draftsman, ASO-Assistant Section Officer, Asst-Assistant, Exe-Executive, Dy-Deputy, Draughting Officer: responsible for developing and maintaining engineering drawings, Gr-Grade,
Source: TWAD (2024)

(2) Roles of Each Department and Official

The roles of each department (Chief Engineer) and officials are shown in Table 3.1.4 and 3.1.5. The Chief Engineer of TWAD oversees new investigation works, the preparation of Detailed Project Report (DPR), the implementation of new water supply schemes/ Combined Water Supply Scheme (CWSS, and Under Ground Sewerage Schemes (UGSS), as well as the maintenance of the TWAD water supply schemes in each of the districts mentioned below.

Table 3.1.4 Roles of Each Department

Regional Chief Engineer	Districts in Charge
Chief Engineer, Vellore	Chengalpattu, Cuddalore, Dharmapuri, Kallakurichi, Kanchipuram, Krishnagiri, Ranipet, Tirupathur, Tiruvallur, Tiruvannamalai, Vellore, Viluppuram
Chief Engineer, Thanjavur	Ariyalur, Nagapattinam, Perambalur, Pudukkottai, Thanjavur, Tiruchirappalli, Tiruvarur
Chief Engineer, Coimbatore	Coimbatore, Erode, Karur, Namakkal, Nilgiris, Salem Tiruppur
Chief Engineer, Madurai	Dindigul, Madurai, Ramanathapuram, Sivaganga, Tenkasi, Theni, Thoothukudi (Tuticorin), Tirunelveli, Virudhunagar, Kanyakumari

Source: TWAD (2024)

Table 3.1.5 Roles of Officials

<table>
<tr><th>Name of the Post</th><th>Roles</th></tr>
<tr><td>Managing Director</td><td>Head of the Department</td></tr>
<tr><td>Joint. Managing Director</td><td>Second Head of the Department</td></tr>
<tr><td>Engineering Director</td><td>Technical Head of TWAD</td></tr>
<tr><td>Finance Director</td><td>In charge of TWAD’s Financial Affairs</td></tr>
<tr><td>Secretary cum General Manager</td><td>In charge of TWAD’s Establishment Affairs</td></tr>
<tr><td>Vigilance Officer</td><td>In charge of TWAD’s Vigilance Matters</td></tr>
<tr><td>Chief Audit Officer</td><td>In charge of TWAD’s Audit</td></tr>
<tr><td>Law Officer</td><td>In charge of TWAD’s Legal Affairs</td></tr>
<tr><td>Chief Engineer</td><td rowspan="5">In charge of TWAD’s Project Implementation – Oversees new investigation works, preparation of DPR, implementation of new WSS, CWSS, and UGSS as well as maintenance of existing TWAD water supply schemes</td></tr>
<tr><td>J.C.E./S.E.</td></tr>
<tr><td>Executive Engineer/DCE</td></tr>
<tr><td>Assistant Executive Engineer</td></tr>
<tr><td>Assistant Engineer/Jr. Engineer</td></tr>
<tr><td>Chief Head Draftsman</td><td rowspan="6">In charge of procurement of contractors</td></tr>
<tr><td>Special Gr. Draughting Officer</td></tr>
<tr><td>Senior Draughting Officer</td></tr>
<tr><td>Draughting Officer</td></tr>
<tr><td>Jr. Draughting Officer</td></tr>
<tr><td>A D Man</td></tr>
<tr><td>Dy. Hydrogeologist</td><td rowspan="2">In charge of source identification of schemes</td></tr>
<tr><td>Assistant Hydrogeologist</td></tr>
<tr><td>Chief Water Analyst</td><td rowspan="2">In charge of water quality monitoring</td></tr>
<tr><td>Assistant Water Analyst</td></tr>
</table>

Source: TWAD (2024)

The hierarchy in descending order is as follows:

Chief Engineer, Draughting Officers, Establishments and Accounts Personnel

↓

Superintending Engineer, Hydrogeologist, Draughting Officers, Establishments and Accounts Personnel

↓

Executive Engineer, Hydrogeologists, Draughting Officers, Establishments and Accounts Personnel

↓

Assistant Executive Engineer/Assistant Engineer/Junior Engineers

Source: TWAD (2024)

Figure 3.1.3 The Hierarchy of the TWAD in Descending Order

3.1.3 Water Supply Operation System of the TWAD[36]

(1) Water Works O&M System of the TWAD

The TWAD is responsible for the design, implementation, commissioning, and maintenance of CWSS that serve groups of rural villages, as well as schemes combining rural and urban areas. The distribution system for urban areas is executed by the TWAD and handed over to the local urban bodies for maintenance after the contractor's maintenance period. The distribution system for rural areas is executed by the Rural Development Department through the local bodies and maintained by it.

TWAD maintains all CWSSs by engaging contractors. The contractors are solely responsible for attending to leaks and bursts, carrying out repairs and renewals of electromechanical items, and ensuring earmarked bulk supply of water to all the rural, urban, and other beneficiaries.

(2) Ownership of Core Facilities for Water Supply

TWAD retains ownership of the core facilities up to the OHTs of the local bodies. From there, other facilities are owned by the local bodies concerned.

(3) Present Water Supply Condition

As mentioned in Section 3.1.1, TWAD currently manages 544 CWSS. Table 3.1.6 shows the planned water supply volume and the average supply records by beneficiary category.

Table 3.1.6 Planned Water Supply Volume and Average Supply Record According to Beneficiary

Beneficiary		Planned Water Supply (MLD)	Average Supply Record (MLD)
Category	Number		
City Corporation	13	533	452
Municipality	70	293	253
Town Panchayat	323	390	345
Rural Habitation	51,048	1,253	1,199
Industry	576	65	37
Total	52,030	2,534	2,286 (90%)

[36] Source: TWAD (2024)

Source: TWAD

Causes of the average supply volume being below the planned volume include: 1) pump shutdowns due to power outages, and 2) water leakage incidents in water pipelines.

Table 3.1.7 shows the production volume of the WTP, and water volume delivered to the OHTs or Panchayat MBRs (the volume as the basis for the payment to the water transmission facility operator) of the Previous Hogenakkal Project in 2024.

Table 3.1.7 Production Volume of WTP and Water Volume Delivered to OHT/Panchayat MBR

	Production at WTP ($1,000\ m^3$)	**Transmission Volume *(Recognition Volume)* ($1,000\ m^3$)**	
	A	B	B/A
January	4,412	4,388	99%
February	4,052	*4,176*	*103%*
March	4,417	4,148	94%
April	4,183	*4,266*	*102%*
May	4,289	4,220	98%
June	4,104	*4,197*	*102%*
July	4,011	*4,099*	*102%*
August	4,157	4,113	99%
September	3,880	*4,373*	*113%*
October	4,418	4,360	99%
November	4,267	*4,338*	*102%*
December	4,386	4,232	96%
Total	50,577	*50,910*	*101%*
Total (excluding the month with recognition)	26,079	25,461	98%

Source: TWAD

From the table above, the months where the transmission volume exceeds the production at the WTP corresponds to the months when the recognized volume by TWAD is indicated. These months indicate periods when the planned volume of water could not be delivered to the distribution reservoirs due to a drop in water production, caused by intake stoppages from increased raw water turbidity or power outages at the intake and/or pump stations. Excluding these months, the ratio of the delivered water volume to the production volume at the WTP is approximately 98%, indicating that the loss from the WTP to the OHTs is about 2%. The TWAD outsources regular facility inspections to private companies and estimates the amount of water leakage based on the difference between the actual production volume at the WTP and the actual transmission volume.

In 2024, there were 68 days when the planned volume of water could not be delivered to the OHTs of the Previous Hogenakkal Project. The reasons for the interruptions are as follows:

- Water intake stoppage due to increased raw water turbidity: 26 days
- Repair of valves at water transmission mains, suspension of water transmission due to pipe damage caused by natural disasters and its repairs: 17 days
- Suspension of water transmission at booster pump stations due to power outages: 14 days

- Shutdown of intake/pump stations, the WTP, and transmission and booster pump stations due to intermittent momentary power outages: 7 days
- Others: 4 days

Contractors are responsible for repairing facilities; however, in cases of force majeure—such as natural disasters, power supply interruptions, or reduced water availability due to high turbidity of raw water—they are exempted from payment reductions based on the volume of water delivered.

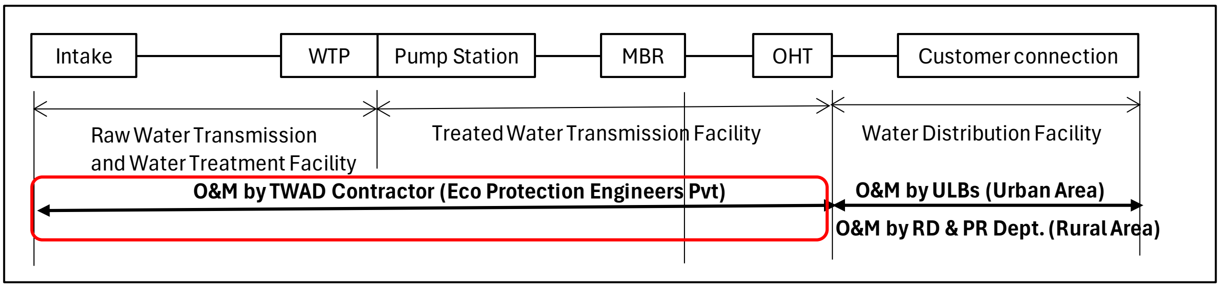
(4) Services for Beneficiaries

The TWAD's water supply services are managed by the Maintenance Division, headed by an Executive Engineer with support from both technical and non-technical personnel. An Emergency Information and Redressal Centre operates 24 hours a day at the head office in Chennai and is well connected to all district-level division offices. Any service requests and grievances received from the beneficiaries or the public are promptly attended to.

(5) Private Companies Engaged in O&M of the Facilities

In the Previous Hogenakkal Project, the O&M contractor is M/s. Eco Protection Engineers Private Limited, who are responsible for maintaining the facilities and supplying the earmarked quantity of water. The contract period lasted from December 2022 to February 2025. Currently, bidding for the next O&M contract is underway, and the existing contract will be extended until a new contractor is selected. Sections IV and V are temporarily contracted to RAJA & Co.

The scope of work for the O&M contractor is shown in Figure 3.1.4.



Source: TWAD

Figure 3.1.4 Scope of O&M Contractor

The scope of work of the O&M contractor is outlined as follows:

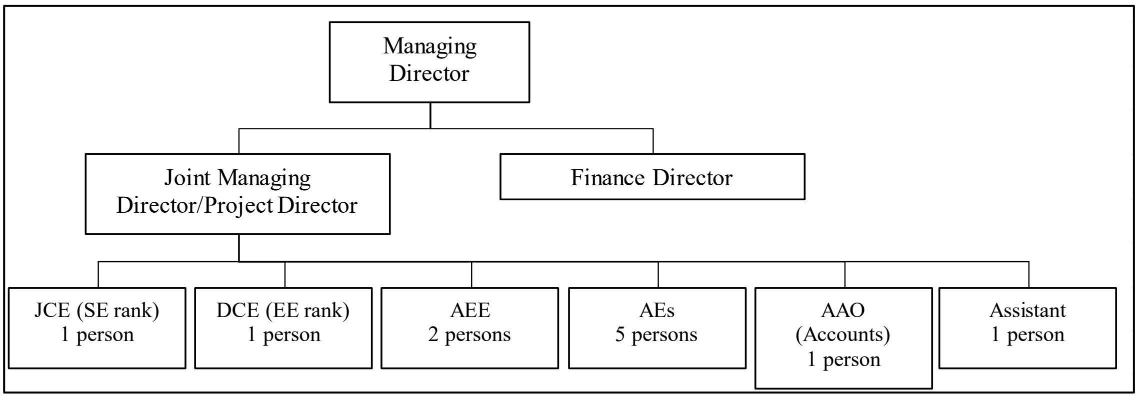
- Ensure that the earmarked quantity is supplied to all local beneficiaries. The supplied quantity should be billed, and the billed amount collected from the beneficiaries.
- Update the daily pumped and supplied quantities for each beneficiary in the project management software without fail.
- Regularly inspect and monitor the CWSS to ensure that the earmarked quantity is supplied up to the tail-end habitations.
- Regularly supply the earmarked quantity to all beneficiaries, including the tail habitations, as per the agreement provisions.

- Check for any leakage in the transmission pipeline and ensure immediate repairs.
- In the event that the facility is damaged by external parties, the damages shall be claimed immediately in accordance with the terms and conditions of the contract.
- Conduct preventive maintenance for all pumping stations in accordance with the agreement conditions.

(6) O&M Costs of the Previous Hogenakkal Project

(7) Project Management Unit (PMU) of the Previous Hogenakkal Project

The Project Management Unit (PMU) was set up at the TWAD Head Office in Chennai, as shown in Figure 3.1.5.



Source: TWAD

Figure 3.1.5 PMU of the Previous Hogenakkal Project

(8) Present Condition of the TWAD's Water Transmission Monitoring

At present, there are 3,797 flow meters—both conventional mechanical and electromagnetic types—across 197 CWSSs. To provide additional flow meters in a phased manner for all schemes under TWAD's maintenance, TWAD has prepared a DPR amounting to INR 2,890.7 million for the installation of 8,022 IoT-based water meters with a centralized monitoring system in 97 schemes under the Jal Jeevan Mission.[37]

(9) Summary of TWAD's Public Relations and Proposed Improvement Measures

The TWAD is responsible for providing water supply and drainage services across Tamil Nadu, excluding the Chennai Metropolitan Area. While the Board primarily serves local authorities, it has also established mechanisms to address public concerns and enhance customer service.

To ensure the timely resolution of public grievances related to service delivery (such as partial or no supply), damages, and leakages in CWSS maintained by TWAD, and to achieve a foolproof monitoring system, an Emergency Information Receiving Centre (EIRC) comprising of two special teams with specific duties and responsibilities are formed at the Head Office under the management of the Joint Chief Engineer (O&M). Immediate action is taken to address grievances related to TWAD services.

Additionally, the TWAD operates water testing laboratories in all districts, allowing the public to verify water quality. It also provides services to local authorities, who directly engage with the public. This approach highlights the mutual role of local authorities in disseminating information and gathering public feedback on water-related policies. The TWAD has also implemented various measures—such as websites, social media platforms, and press releases—to enhance public relations and customer service.

It is recommended that the financial status of the TWAD and the revenue shortfall from water supply services to local bodies be presented in public communications. These shortages are covered by the gap fund. However, water tariffs being paid by the users may need to be increased in the future to ensure that they will be supplied with enough water. To continue providing a sustainable water supply, it is necessary to gain understanding from the perspective of the users.

3.1.4 Water Supply Operation System of Local Bodies

The facilities from the water source to the water distribution reservoir (OHT/Panchayat MBR) are under the control of the TWAD, which outsources their operation to an O&M contractor. The distribution pipelines and service connections from the distribution reservoirs are under the control of each local body.

Each local body pays a bulk charge to TWAD based on the monthly water supply from TWAD, applying the rate approved by the state government. In turn, each local body collects water tariffs from individual households. The household water tariff currently uses a flat rate—meaning that while the amount of

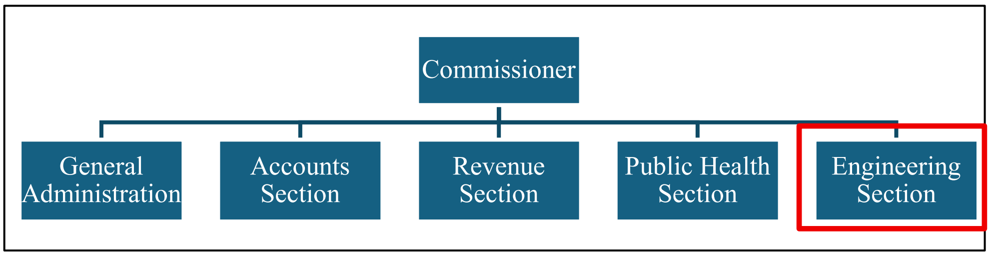
[37] The Jal Jeevan Mission (JJM) aims to assist, strengthen, and promote the following: to support States and Union Territories in planning a participatory rural water supply strategy that ensures long-term potable drinking water security for every rural household and public institution, including Gram Panchayat buildings, schools, Anganwadi centres, health centres, and wellness centres. (Source: https://jaljeevanmission.gov.in/about_jjm, accessed on December 23rd, 2024)

water delivered by the TWAD to the distribution reservoirs is measured, the amount of water distributed from the distribution reservoir to each household is not. The transition to a metered water tariff system is currently under consideration in urban areas; however, this requires the decision of the state government and approval by the state assembly. At present, the transition to a metered water tariff system is not being considered for rural areas.

The water supply operation system of each local body is described below.

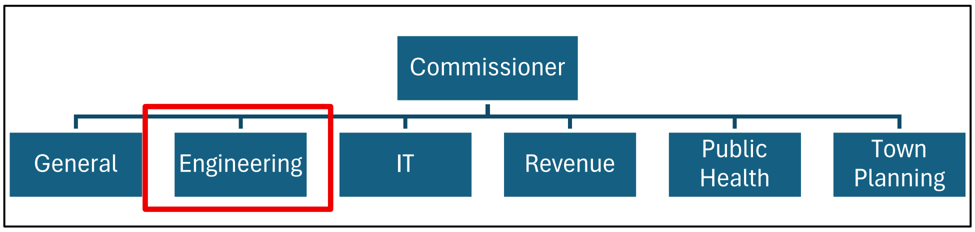
(1) Water Supply Operation System of City Corporations and Municipalities

Figure 3.1.6 shows the organizational chart of the Hosur City Corporation, and Figure 3.1.7 shows the organizational structures of the Krishnagiri and Dharmapuri municipalities.



Source: Hosur City Corporation (Officers Details – Hosur City Municipal Corporation, accessed March 4th, 2025)

Figure 3.1.6 Organization of the Hosur City Municipal Corporation



Source: Krishnagiri Municipality, Dharmapuri Municipality

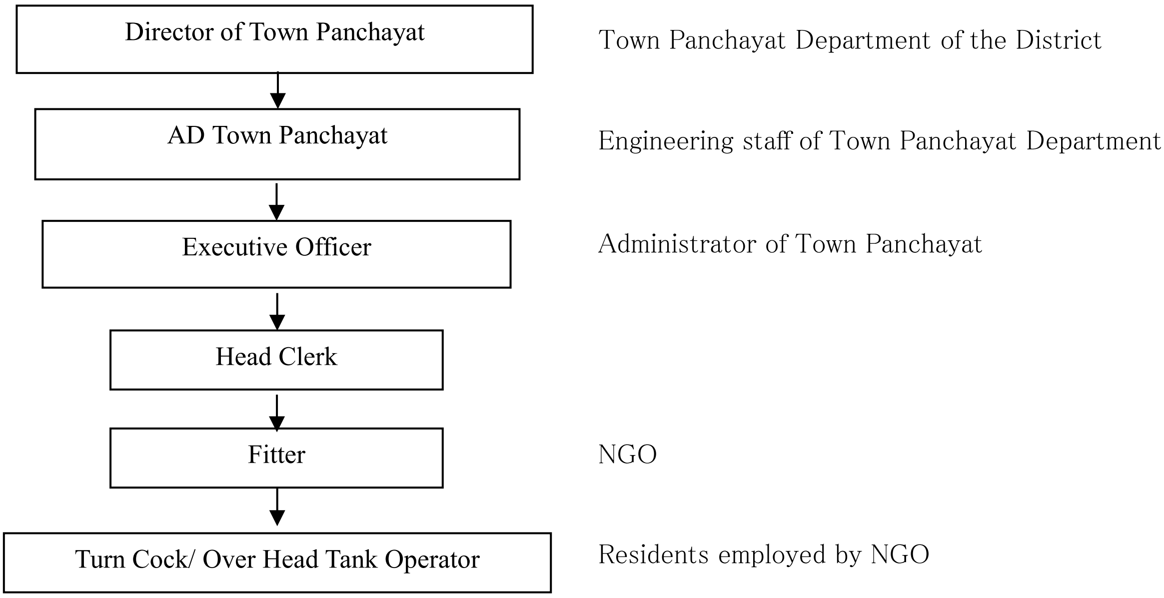
Figure 3.1.7 Organization of the Krishnagiri Municipality and Dharmapuri Municipality

In the Hosur City Corporation, Krishnagiri Municipality, and Dharmapuri Municipality, the water distribution facilities are operated and maintained by the Engineering Section of each local body, which is also responsible for the operation and maintenance of road and drainage facilities. Valve operation for water distribution pipelines is performed by operators employed by the respective local bodies. In certain areas of the Hosur City Corporation, the operation has been outsourced to an NGO.

(2) Water Supply Operation System of Town Panchayats

A town panchayat (TP) is an organization under the management of the Town Panchayat Department (Director of Town Panchayat) in each district, which functions as a branch organization of the Municipalities and Water Supply Department of the State Government. There are ten TPs in Dharmapuri District and six TPs in Krishnagiri District. The population size of each TP ranges from 10,000 to 26,000. Each town panchayat provides basic services such as water supply, sanitation, and infrastructure. The Town Panchayat operates several OHTs, with each OHT assigned to a specific water distribution zone.

Valve operation for each water distribution zone is outsourced to an NGO, and the operations are conducted by local residents employed by the NGO under the supervision of the town panchayat's engineering staff. Figure 3.1.8 shows the O&M system of water supply facilities.



Note: AD = Assistant Director

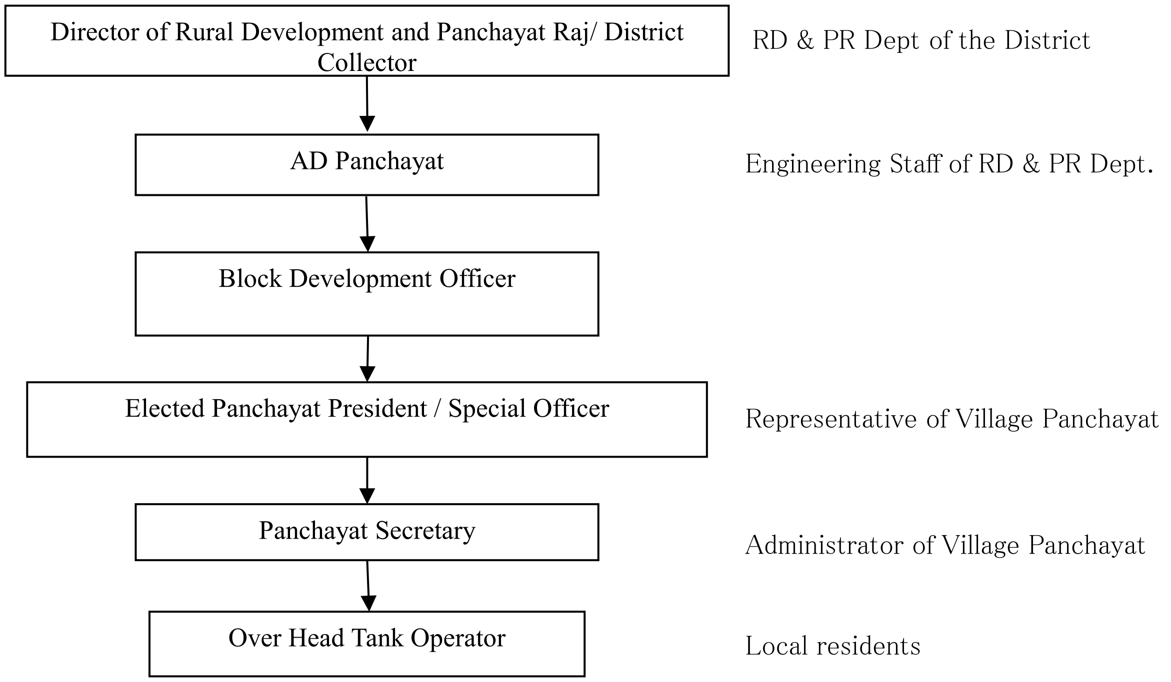
Source: Town Panchayats in Dharmapuri and Krishnagiri Districts

Figure 3.1.8 Organization of the Town Panchayats

(3) The Water Supply Operation System of the Village Panchayats

A Village Panchayat is the smallest administrative unit in rural areas and functions under the jurisdiction of the RD&PR Department, a state branch organization of the state government. There are 247 village panchayats in Dharmapuri District and 338 in Krishnagiri District, with an average population of 5,300. Each rural union or block consists of 10 to 30 village panchayats, and there are ten unions/blocks in each of the two districts. However, the administrative activities are carried out at the village panchayat level.

Village panchayats govern an average of 11 habitations and provide basic services such as water supply, road infrastructures, sanitation, and education. They may also manage local wells, manual pumps, and small water distribution systems. Each village panchayat typically operates several OHTs, with one OHT serving one distribution zone consisting of one or more habitations. Valve operation within each distribution zone is carried out by local residents employed by the respective village panchayats, under the supervision of the engineering staff of the RD&PR Department at the district level. Figure 3.1.9 shows the O&M system of water supply facilities.



Source: Village Panchayats in Dharmapuri and Krishnagiri Districts

Figure 3.1.9 Organization of Village Panchayats

(4) TWAD Assistance to Local Bodies for O&M

In the event of O&M issues in the water distribution facilities managed by local bodies, the TWAD provides technical support by dispatching an Assistant Executive Engineer (AEE) and Assistant Engineer (AE) under the supervision of the Executive Engineer (EE) in charge of each district within the Project Maintenance Circle, Dharmapuri Office. These officers coordinate closely with the engineering staff of the concerned local bodies.

Since water meters are not installed in the distribution pipes from the OHT or at individual house service connection pipes, water leakage and theft cannot be quantitatively monitored. However, when such issues are identified, repairs are handled by each local body's personnel in charge. For repair works that cannot be managed by local staff, TWAD extends technical assistance as described above.

3.2 Existing Water Supply Facilities

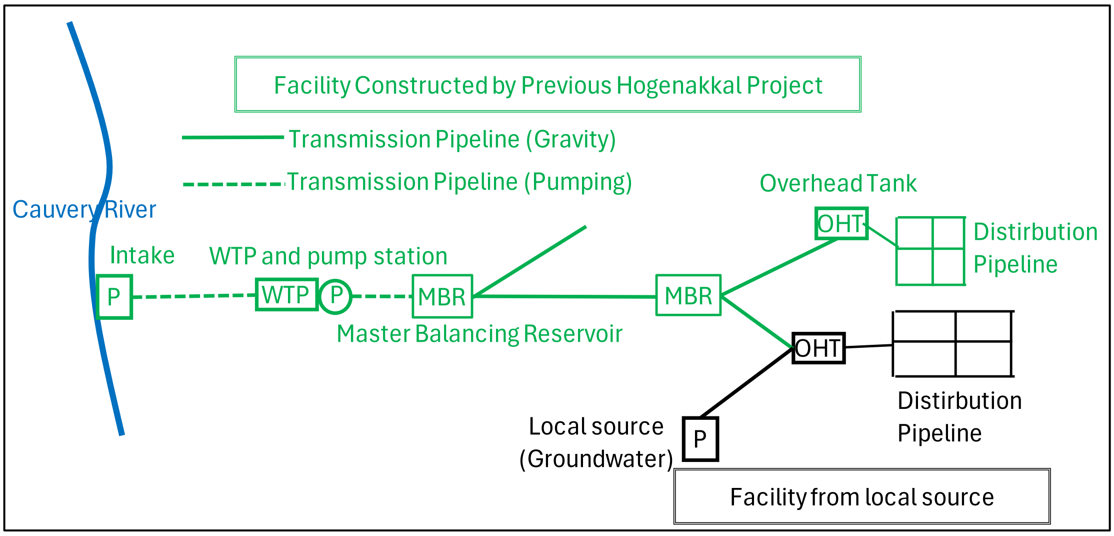
3.2.1 Overview

(1) Outline of the Existing Water Supply Facilities

The existing water supply facilities in the Project area consist of the following:

- Water supply facilities constructed under the Previous Hogenakkal Project
- Water supply facilities utilizing local sources (groundwater) constructed prior to the Previous Hogenakkal Project

Residents and customers are supplied with water by gravity via the distribution pipeline network from the OHTs located within their respective distribution areas. Figure 3.2.1 illustrates the configuration of the existing water supply facilities.



Source: JST

Figure 3.2.1 Image of the Existing Water Supply Facilities

Before the implementation of the Previous Hogenakkal Project, the water supply was undertaken only through locally sourced groundwater facilities. Table 3.2.1 shows the main features of the existing water supply facilities.

Table 3.2.1 Main Features of the Existing Water Supply Facilities

Main Feature			Remarks
Basic Condition applied in Planning Previous Hogenakkal Project			
Water Supply Area	Entire Dharmapuri and Krishnagiri districts (9,640 km^2)		
Planned Water Supply Population (2036)	Municipalities: 474,000 Town Panchayats: 297,078 Rural Unions: 3,270,281 Total 4,041,359		
Planned per Capita Domestic Supply	Municipalities: 90 lpcd for 70%, 40 lpcd for 30% Town Panchayats: 70 lpcd for 70%, 40 lpcd for 30% Rural Unions: 30 lpcd		
Main Feature of the Facility Constructed under the Previous Hogenakkal Project			
Developed Capacity	160 MLD		Including 10% loss
Salient Features of the Facility	Intake Facility	- Water intake pump 160 MLD	6 nos. (incl. 2 stand by)
	Raw Water Transmission Facilities	- Pipeline D1500 L = 6.15 km	Mild Steel (MS) pipe
	WTP	- 160 MLD at Yanaipallam Village	
	Treated Water Transmission Facilities	- 1 BPSs up to MBR at Madam - MBR at Madam - 5 BPS on the transmission main up to Hosur City - BPT at Kaveripattinam on the transmission main up to Krishnagiri Municipality - 560 MBRs; - 537 sumps and BPS/BPT; - Pipeline MS/DI/HDPE D1500 – D50 L= 10,269 km	MBR: Master Balancing Reservoir BPS: Booster Pump Station BPT: Break Pressure Tank DI: Ductile Iron HDPE: High Density Polyethylene
	Water Distribution Facilities	- 530 OHTs The distribution pipelines were laid	OHT: Overhead Tank

<table>
<tr><th colspan="3">Main Feature</th><th>Remarks</th></tr>
<tr><td rowspan="2"></td><td></td><td>mainly by another funded scheme.</td><td></td></tr>
<tr><td>SCADA System</td><td>74 monitoring points
(water pressure, level, flow)</td><td></td></tr>
<tr><td colspan="4">Approximate Capacity Existed in the Project area Before Implementation of the Previous Hogenakkal Project</td></tr>
<tr><td>Dharmapuri Municipality</td><td colspan="2">2 MLD</td><td rowspan="5">In addition, several privately owned small boreholes with limited capacity exist.</td></tr>
<tr><td>Hosur City Corporation</td><td colspan="2">15 MLD</td></tr>
<tr><td>Krishnagiri Municipality</td><td colspan="2">6 MLD</td></tr>
<tr><td>Town and Village Panchayats</td><td colspan="2">14 MLD</td></tr>
<tr><td>Total</td><td colspan="2">37 MLD</td></tr>
</table>

Source: TWAD

(2) Outline of the Water Supply System Developed by the Previous Hogenakkal Project

Figure 3.2.2 shows the schematic diagram of the water supply system. Treated water is first transmitted to the MBRs through the transmission pipeline. From the MBRs, water is transmitted to the OHTs in each water distribution area and is subsequently distributed to the customers. The treated water transmission system consists of the following components:

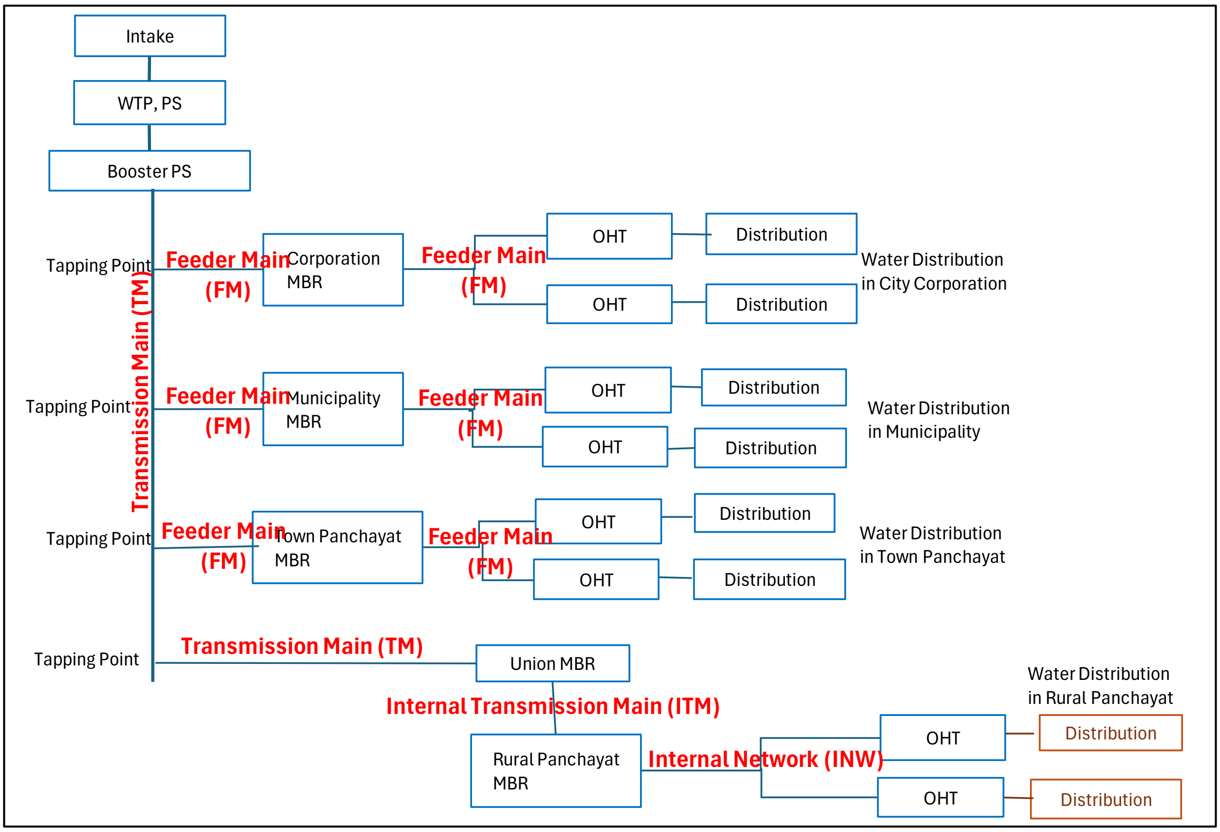
Transmission Main (TM): Transmission pipeline from the WTP to the Union MBRs

Feeder Main (FM): The transmission pipeline branched from the TM to the OHTs in urban distribution areas through corporation, municipality, or town panchayat MBRs.

Internal Transmission Main (ITM):
The transmission pipeline from the Union MBRs to the Rural Panchayat MBRs in each union of village panchayats.

Internal Network (INW): The Transmission pipeline from the Panchayat MBRs to the OHTs in rural distribution areas.

The water flow at each tapping point is monitored by the SCADA system. The inflow at the MBRs is measured using water meters, which serve as the basis for billing the respective local bodies (corporation, municipality, town panchayats, and village panchayats).



Source: JST

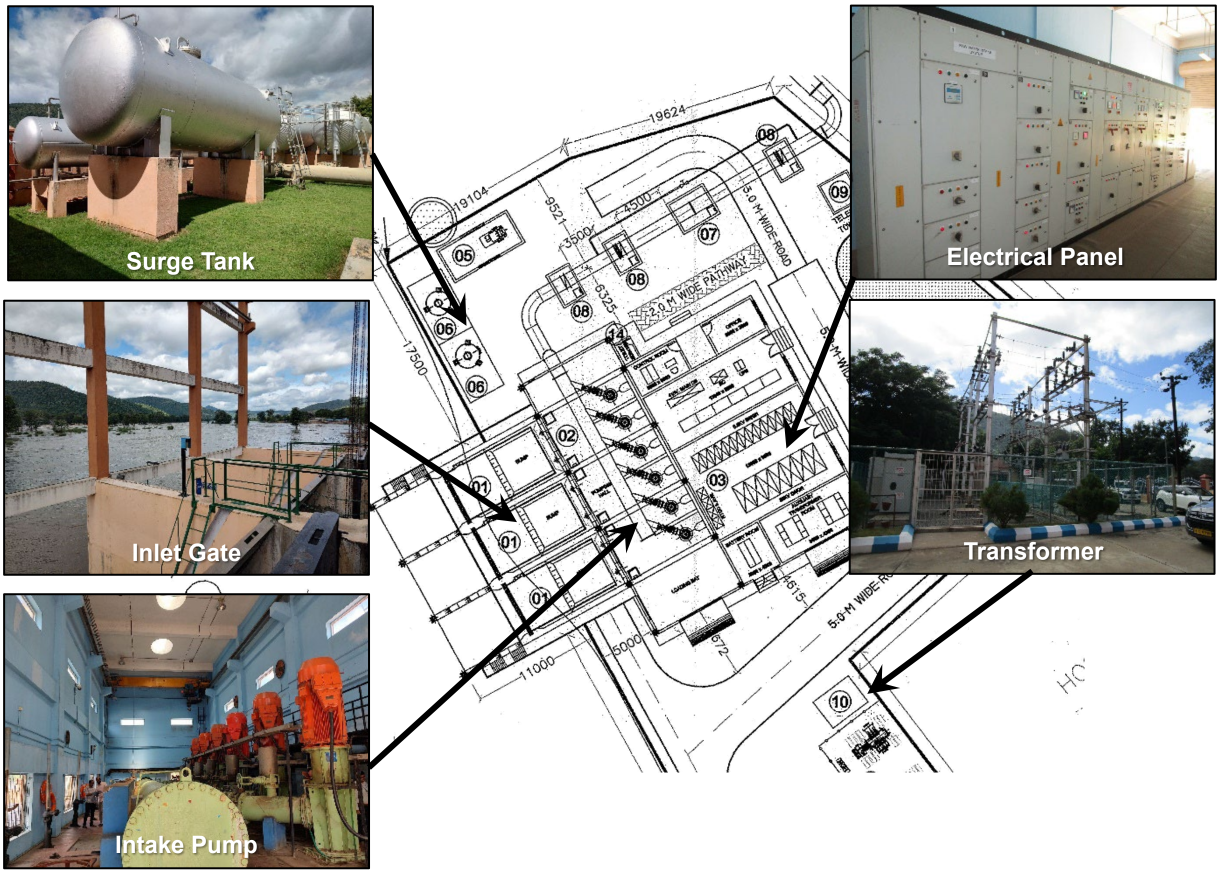
Figure 3.2.2 Schematic of the Water Supply System under the Previous Hogenakkal Project

The salient features of each facility are described in the following sections. The overall outline of the Previous Hogenakkal Project is presented in Appendix-3.1.

3.2.2 Intake Facility of the Previous Hogenakkal Project

(1) Location of the Water Source and Alignment of Conveyance Lines

The water source for the WTP is the Cauvery River (Kaveri River). The intake facility, with a design capacity of 160,000 m^3/day (160 MLD), is located on the left bank of the river. After debris removal through fine screens, the raw water is lifted to the WTP, located approximately six km away, with an elevation difference of 69.35 m. This is accomplished using four vertical turbine pumps operating through a single 1,500 mm-diameter conveyance pipeline.



Source: JST

Figure 3.2.3 Location of the Existing Intake and Conveyance Facilities

The intake structure is divided into three channels by partition walls. Of these, two channels are normally used for operation, while the remaining channel serves as a standby unit, with sequential switching operations being implemented. The main mechanical equipment consists of three-tier bar screens, stop logs, inlet gates, two vertical turbine pumps per basin, and a surge tank.

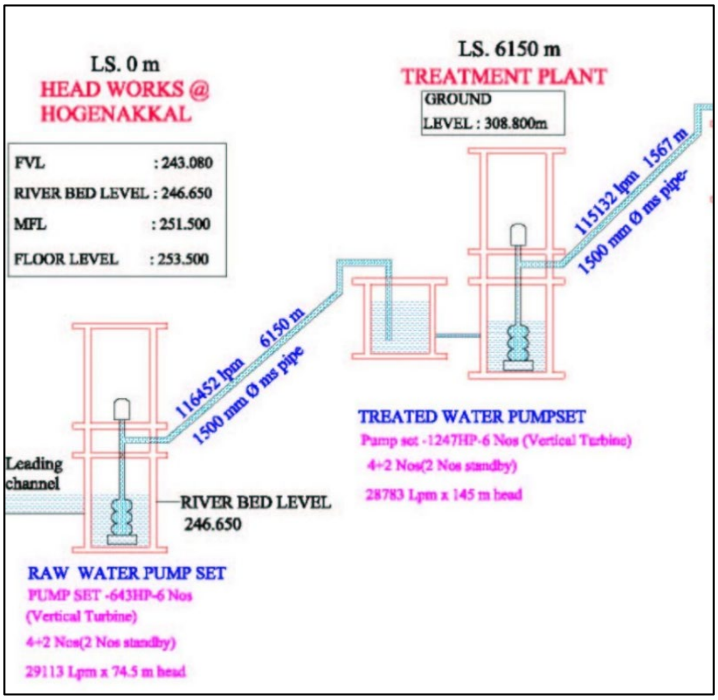
Typically, three to four intake pumps are operated continuously, while two pumps remain on standby. The pump operation and monitoring is managed through the SCADA system, which is installed on local control panels and can also be controlled remotely from the WTP. However, due to the lack of a generator, water intake operations are suspended during power outages. The specifications of the existing intake facility are shown in Table 3.2.2

Table 3.2.2 Specifications of Existing Intake Facility at Hogenakkal

Item		Specification	No.
Civil and Architecture			
	Intake Channel	16.7 m x 5.3 m	3
	Pump House	8.5 m x 25.5 m	1
	Electrical Room	13 m x 22.5 m	1
Equipment			
	Bar Screen	Bar Screen Opening 20 mm	3
	Stop Log	Steel	3
	Inlet Gate	Rectangular Sluice Gate	3
	Drainage Pump	Submersible Pump	3
	Intake Pump	Vertical Turbine 29,113 L/min x 74.5 m	Duty 4 + Standby 2
	Surge Tank	Horizontal Steel Tank	Duty 2 + Standby 1

Source: JST based on As-built documents

Figure 3.2.4 shows the schematic diagram of the pumping system.



Source: As-built drawings

Figure 3.2.4 Schematic Diagram of the Pumping System (Existing Intake Facility)

Despite being in operation for over ten years, the facilities appear to be well-maintained through periodic overhauls—as maintenance has been outsourced to a private contractor since installation. During the site inspection conducted immediately after heavy rainfall, the river water level was approximately one meter below the design maximum level of +252.06 m. According to the operation engineer, the water level has never risen high enough to overflow the upper screen of the third tier, and the volume of incoming debris has remained consistently manageable. Figure 3.2.5 shows the present conditions of the intake facility.

	
The sediment deposited in the vicinity of the intake facility is dredged annually.	The intake pumps consist of six units, of which four were operating during the site visit, while two units were on standby. The pumping equipment was manufactured by an Indian company.

The bar screen has 20 mm spacing, designed to remove debris and protect the pumps.

Vibration gauge display (three locations per unit).

Thermometer indicators for each pump motor, etc. (six stations per unit).

Vibration sensor (three locations per unit).

A surge tank is installed to prevent water hammer effects during power failures.

The power receiving equipment consists of two incoming lines operating at 33 kV.

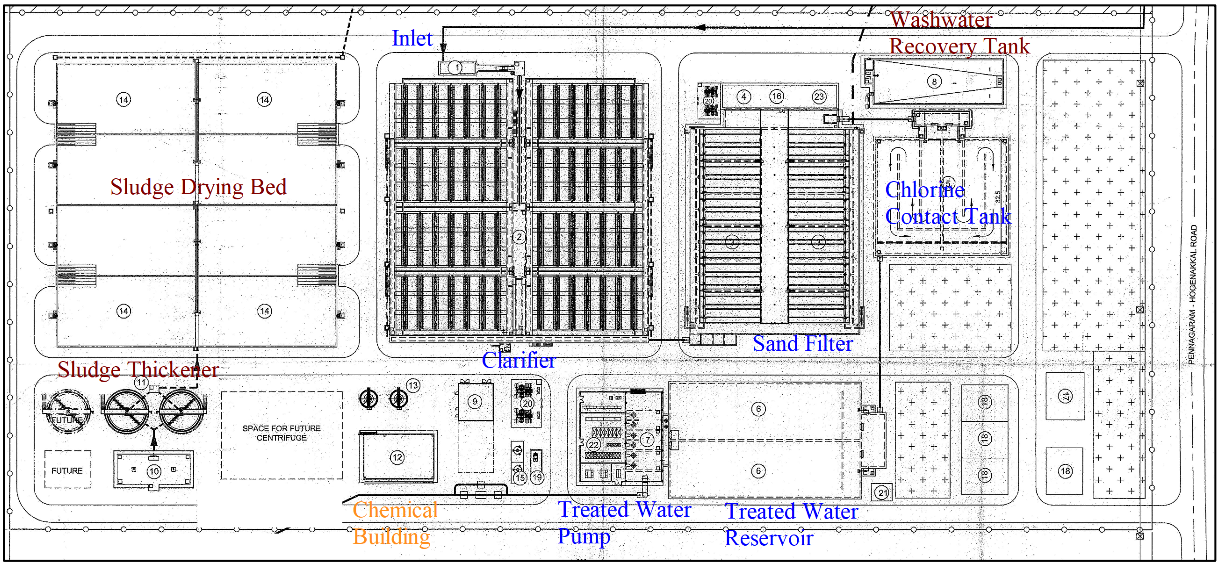
Source: JST

Figure 3.2.5 Present Condition of the Intake Facility

3.2.3 Water Treatment Facility of the Previous Hogenakkal Project

(1) Outline and Capacity

The existing water treatment plant, constructed in Yanaipallam Village, serves Dharmapuri and Krishnagiri districts with a design capacity of 160 MLD (160,000 m^3/day). The treatment process begins as raw water enters the cascade aerator, where flow measurement is conducted using a Parshall flume. Raw water from the intake pumping station flows into the sedimentation basin, which consists of eight parallel units. Pre-chlorine and aluminium sulphate (alum) are added, followed by rapid mixing utilizing hydraulic energy generated by the difference in water levels. After sedimentation, the clarified water passes through 12 rapid sand filter beds, after which post-chlorine is applied before entering the clear water tank. From there, it is pumped by vertical turbine pumps through a 1,500 mm diameter transmission main pipeline to the Kanavai Booster Pump Station, located approximately 1.6 km away at an elevation difference of 140 m.



Source: Prepared by JST based on as-built drawings

Figure 3.2.6 Existing Water Treatment Plant Layout

Table 3.2.3 Details of the Existing Water Treatment Plant at Hogenakkal

Item	Specifications	Number of Units
Civil Engineering		
Sedimentation Tank	15 m x 31.8 m	8
Sand Filter	Gravitational downflow Sand bed 0.9 m, small gravel 0.15 m, large gravel 0.15 m	12
Chlorination Chamber	37 m x 32 m	1
Clear Water Tank	16 m x 55 m	1
Pump House	10 m x 25 m	1
Backwash Tank	37 m x 12 m	1
Sludge Storage Tank	8 m x 10 m	2
Sludge Thickener	Dia.11 m	2
Chemical Building	20 m x 15 m	1
Chlorine Building	10 m x10 m	1

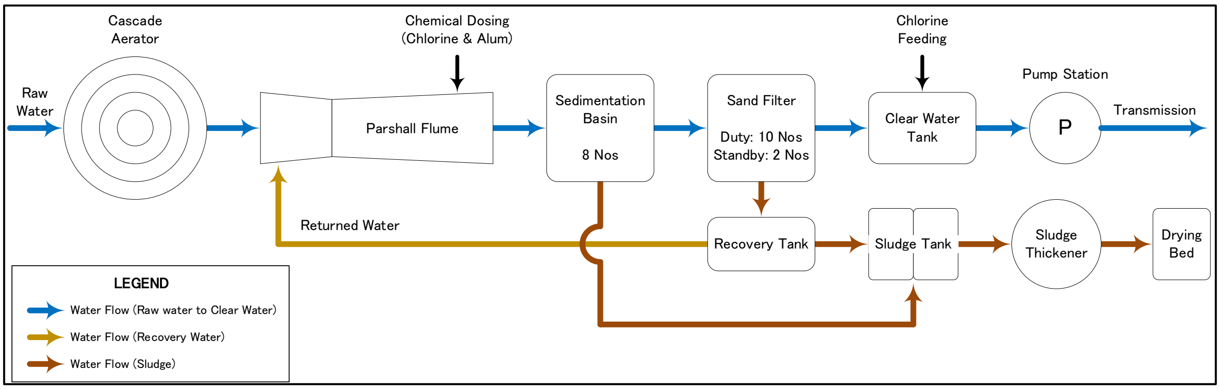
Item	Specifications	Number of Units
Sludge Drying Bed	20 m x 40 m	8
Control Building	33 m x 12 m	1
Backwash Tank	1000 m^3	1
Equipment		
Flow Meter	Parshall flume	1
Inlet Gate	Sluice gate	8
Sedimentation Tank	Sludge Blanket (De-sludge valve)	8
Sand Filter	Automatic control valves	12 set
Alum Injection Facility	Agitation pump, dosing pump	1 set
Lime Injection Facility	Dosing pump	1 set
Chlorine Injection Facility	Chlorine gas cylinders and chlorinator	1 set
Transmission Pump	Vertical turbine 28,783 Lpm x 145 m	Duty 4 + Standby 2
Surge Tank	Horizontal steel tank	1 set
Backwash Facility	Float device, return pump	1 set
Sludge Storage Facility	Submersible mixer, pump	1 set
Sludge Thickener	Clarifier	1 set

Source: JST based on the as-built documents

(2) Water Treatment Process

The water treatment plant was designed to handle raw water with a turbidity of 20 Nephelometric Turbidity Units (NTU). However, during the inspection conducted following heavy rainfall, turbidity levels reach 70 NTU. Peak turbidity events, which typically occur every three to four years, can reach up to 400 NTU, necessitating the temporary suspension of water intake. When such high turbidity levels occur, plant operators temporarily halt raw water intake to protect the treatment process and ensure the quality of treated water.

The simplified water treatment flow diagram of the existing WTP is illustrated in the figure below. This schematic representation provides an overview of the key treatment processes employed in the facility.



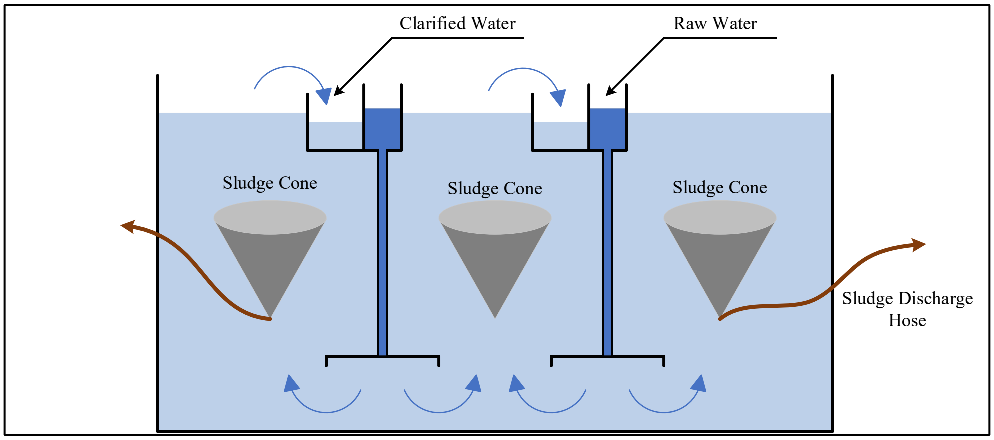
Source: Prepared by JST based on as-built drawings

Figure 3.2.7 Water Treatment Flow in the Existing Water Treatment Plant

1) Coagulation and Sedimentation

The treatment process begins with coagulation and flocculation, where solid alum (aluminium sulfate) is dissolved in dissolution tanks and pumped to dilution tanks located on the second floor of the chemical building using circulation pumps. The solution is then delivered to the Parshall flume via chemical injection pumps. Lime injection is implemented only when pH adjustment of the raw water is necessary.

A Spanish technology, known as the "Flat Bottom Suspended Sludge Blanket Clarifier," is adopted in the existing water treatment plant.



Source: Prepared by JST based on as-built drawings

Figure 3.2.8 Section of Flat Bottom Clarifier

The clarified water at the outlet of the clarifiers exhibits a turbidity of approximately five NTU, indicating that the treatment process is satisfactory. Based on operational and maintenance experience at the existing WTP by the TWAD, the clarifiers demonstrate satisfactory performance with raw water turbidity levels up to 25 NTU. However, operational challenges are encountered when turbidity exceeds 40 NTU.

2) Sand Filter

The filters are of the single-bed type, using sand as the filter medium. The total depth of each filter is 1.25 m, with a deep sand layer having an effective media size ranging from 0.6 mm to 1.18 mm. The filters are equipped with false floors and nozzles to ensure uniform distribution and collection of water. Backwash is carried out using a combination of air and water for a duration of 18 minutes.

3) Sludge

Regarding sludge treatment, the settled sludge accumulated in 12 storage cones per basin is sequentially extracted by gravity flow to the sludge pit through the opening and closing of individual electromagnetic valves. From there, submersible pumps transfer the sludge to a sludge storage tank. Finally, the sludge flows by gravity from the thickener to the sludge drying beds.

4) Status of the Facility

Similar to the intake pumping station, more than ten years have passed since the commencement of operation. However, O&M was conducted by a contractor for eight years—comprising the original five-year contract and a three-year extension. Since 2022, the O&M has been outsourced to a specialized company. As a result of regular overhauls, the facility is well maintained. Although there were time constraints during the site survey, the main status is as follows:

- Chlorine and coagulants are injected into the inlet well, and rapid mixing is achieved using the water level difference.
- Both pre-chlorination and post-chlorination treatments are implemented. The chlorinator consists of two units, with one standby, and is reported to be in good working condition.
- The current water quality is good, with a turbidity around 5 NTU at the effluent of the sedimentation basin and below 1 NTU at the effluent of the filtration basin. These results indicate that the rapid mixing by water level difference, control valves, and backwash system are functioning as intended.
- The sedimentation basin consists of eight units in total, including one standby unit, and employs a sludge blanket system. Numerous solenoid valves are installed on each cone as sludge withdrawal valves, and according to interviews, no particular problems have been encountered.
- The sludge balancing tank consists of two tanks, including one standby unit. The sludge is transferred from the settled sludge pit using submersible pumps, and settled sludge is also transferred from the backwash recovery tank. Submersible mixers are installed to maintain a constant sludge concentration, and the sludge is pumped to the sludge thickener.
- Currently, backwash water is separated into sludge and supernatant by a float valve. The sludge is transferred to the sludge balancing tank, while the supernatant is transferred to the inlet well.
- The coagulant system dissolves aluminium blocks containing impurities in two dissolving tanks alternately. After switching valves, the solution is pumped by circulation pumps to the dilution tank located on the second floor, where the concentration is adjusted as needed before being injected into the inlet well through chemical injection pumps.
- Due to the high pH of the raw water, the lime injection system is rarely used.

The entire facility operates for 23 hours per day. The clear water pump system, which uses the same model as the intake facility, has required fewer repairs compared with the intake pumps and is currently operating well.

Figure 3.2.9 represents the present conditions of the WTP.

Chlorine and alum were injected into one receiving well.	Aggregate sedimentation by up flow.
	
Backwashing of the filter basin starts automatically at the set water level and is performed once a day.	Central monitoring and control are conducted from a single management building in the water purification plant, covering all intake facilities to water transmission facilities.
	
Chlorine gas storage facility.	Chlorine gas injection equipment.
	
Clearwater transmission facility (vertical turbine pump).	Lime saturator (not in use).

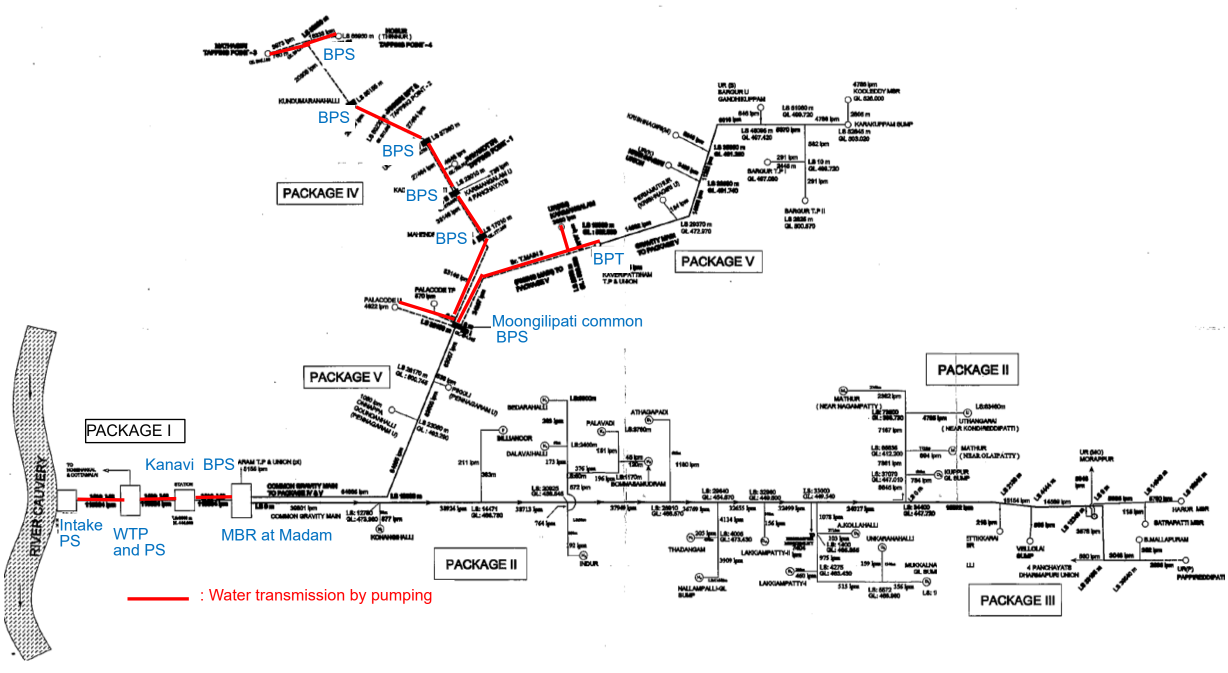
	
Aluminium sulfate blocks (local product).	The solar drying floor has a depth of one meter. Landfill treatment is carried out about once a year, and the sludge cake is not reused.

Source: JST

Figure 3.2.9 Present Condition of the WTP

3.2.4 Water Transmission Main Pipeline of the Previous Hogenakkal Project

Figure 3.2.10 shows the schematic diagram of the entire water transmission system of the Previous Hogenakkal Project.

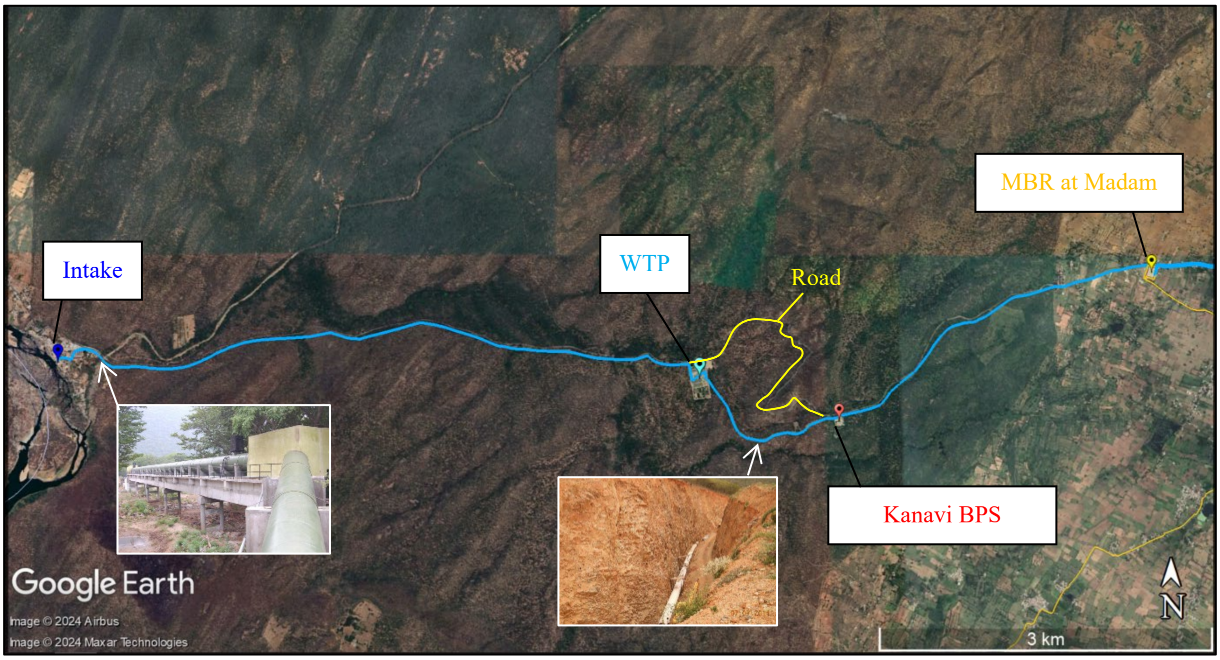


Source: TWAD

Figure 3.2.10 Water Transmission System of the Previous Hogenakkal Project

(1) Transmission Main Pipeline up to the MBR at Madam (Package I)

Figure 3.2.11 shows the water transmission pipeline from the intake to the MBR at Madam (Package I). The salient features of the pipeline are summarized in Table 3.2.4.



Source: JST, using photos from the TWAD O&M Manual (June 2017)

Figure 3.2.11 Location Map of the Water Transmission Main (Intake – MBR at Madam)

It should be noted that, for the section from the WTP to the BPS, the pipeline runs through a valley rather than along the road through the mountainous area.

Table 3.2.4 Salient Features of the Water Transmission Pipeline (Intake – MBR at Madam)

Items	Section		
	Intake – WTP	**WTP – BPS**	**BPS – MBR**
Pipe Diameter Size (mm)	1,500 + 10 (Thickness)	1,500 + 14 (Thickness)	1,500 + 11 (Thickness)
Pipeline Length (km)	6.150	1.567	3.422
Air Valve (Nos.)	12 (Double Air Valve, 200 mm dia.)	4	6
Scour Valve (Nos.)	2 (300 mm dia.)	1	
Sluice Valve (Nos.)	1 (1,500 mm dia.)	1	

Source: TWAD Operation and Maintenance Manual (June 2017)

(2) Transmission Main Pipeline from the MBR at Madam (Package II to Package V)

Figure 3.2.12 shows the general facility layout of the Project. The transmission main pipeline of the Previous Hogenakkal Project is shown in green lines. Table 3.2.5 shows the salient features of the transmission main for each package.

Source: TWAD

Figure 3.2.12 General Layout of the Project

Table 3.2.5 Salient Features of the Transmission Main

Unit: km

Pipe Material	Package II	Package III	Package IV	Package V	Total
Mild Steel (MS)	55.91	12.12	66.4	70.11	204.54
Ductile Iron (DI)	26.48	26.77	0	19.36	72.61
Grand Total	82.39	38.89	66.4	89.47	277.15

Source: TWAD

(3) Water Transmission Facilities Branched from the Transmission Main (TM)

The branch pipelines from the TM are connected to reservoirs, from which water is transmitted to Over Head Tanks (OHTs). The elevated-type reservoir is called an MBR, while the ground-level type equipped with horizontal-axis pumps or submersible pumps is called SUMP.

Figures 3.2.13 and 3.2.14 show photographs of each facility, and Table 3.2.6 summarizes their numbers.

	
(a) Union-MBR (Thandukaranahalli, 400 m^3)	(b) Panchayat-MBR (Erraraseegalahalli, 60 m^3)
	
(c) Union-SUMP (Mukkalanaickanpatti, 100 m^3)	(d) OHT (Bannihalli, 30 m^3)

Source: JST

Figure 3.2.13 Photos of Each Structure

The SCADA Control Office, chlorine-injection facilities, and water distribution pumps are installed together.

The OHT near the Union SUMP.

BPS (Horizontal Split-casing Type).

Chlorine Injection Facility and Pumps for Chlorine.

Monitor

Chlorine Injection Chamber

Source: JST

Figure 3.2.14 Photos of Union Sump

Table 3.2.6 Number of Transmission Facility Structures

Union	Union MBR	Panchayat MBR	Union SUMP	Panchayat SUMP	Booster PS / Brake Pressure Tank
DHARMAPURI DISTRICT					
Pennagram	0	25	3	45	0
Nallampalli	1	26	1	29	0
Dharmauri	1	23	3	24	0
Morappur	1	45	3	31	0
Pappireddipatty	1	13	1	31	0
Harur	2	31	5	37	2
Palacode	1	33	1	30	1
Karimangalam	1	31	2	21	2
Subtotal	**8**	**227**	**19**	**248**	**5**
KRISHNAGIRI DISTRUCT					
Mathur	2	22	0	20	0
Ythangarai	1	36	0	13	0
Kelamangalam	2	28	2	20	9
Shoolagiri	0	40	0	18	4
Hosur	1	26	1	18	0
Veppanapalli	0	26	0	16	1
Thally	0	51	0	41	16
Kaveripattinam	1	35	0	23	0
Krishnagiri	0	24	0	28	0
Bargur	1	29	3	31	1
Subtotal	**8**	**317**	**6**	**228**	**31**
Grand Total	**16**	**544**	**25**	**476**	**36**

Source: TWAD

(4) Water Transmission Pipelines Branched from the Transmission Main

The water transmission pipeline branched from the tapping points of the TM are classified as follows: the feeder main (mains up to OHTs in urban areas), internal transmission main (mains from Union MBRs to Panchayat MBRs in rural areas), and the internal network (mains from Panchayat MBRs to OHTs in rural areas). The pipe materials and lengths of each pipeline are summarized in Table 3.2.7.

Table 3.2.7 Salient Features of the Water Transmission Pipeline Constructed under the Previous Hogenakkal Project

Description	Pipe Material	Package II	Package III	Package IV	Package V	Total
Feeder Main (km)	MS	0.00	0.00	0.00	0.03	0.03
	DI	54.84	22.24	7.27	16.71	101.06
	HDPE	0.00	1.15	0.00	10.23	11.38
	Subtotal	**54.84**	**23.39**	**7.27**	**26.97**	**112.47**
Internal Transmission Main (km)	MS	0.00	0.00	0.00	0.08	0.08
	DI	322.30	298.07	641.92	552.37	1,814.66
	HDPE	250.08	136.23	277.03	166.82	830.16
	Subtotal	**572.38**	**434.30**	**918.95**	**719.27**	**2,644.90**
Internal Network (km)	MS	0.00	0.00	0.00	0.00	0.00
	DI	25.55	25.20	80.79	56.36	187.90
	HDPE	1,663.23	1,214.76	2,048.69	2,119.90	7046.58
	Subtotal	**1,688.78**	**1,239.96**	**2,129.48**	**2,176.26**	**7,234.48**
Grand Total	**-**	**2,316.00**	**1,697.65**	**3,055.70**	**2922.50**	**9,991.85**

Source: TWAD

3.2.5 Distribution and Service Facilities

Table 3.2.8 shows the salient features of the distribution facilities in Hosur City Corporation, Dharmapuri and Krishnagiri municipalities, and eight town panchayats where the distribution facilities will be constructed by the Project.

Table 3.2.8 Salient Features of Distribution Facilities in Hosur City Corporation, Dharmapuri and Krishnagiri Municipalities, and Eight Town Panchayats

	Population (2011 census)	Nos. of OHT	Distribution Pipeline	Service Connection	Public Tap
Dharmapuri Municipality	68,619	6 (4 by Previous Hogenakkal Project)	77 km	Domestic: 11,206 (Service ratio: 66%) Non-domestic: 631	168 nos.
Hosur City Corporation	244,518	14	525 km	Domestic: 40,469 (Service ratio: 66%) Non-domestic: 199	161 nos.
Krishnagiri Municipality	71,323	6 (2 by Previous Hogenakkal Project)	53 km	Domestic: 10,057 (Service ratio: 59%) Non-domestic: N/A	64 nos.
Kadathur TP	11,382	NA	17 km	Domestic: 1,250 (Service ratio: 34%)	NA
B Mallapuram TP	12,705	3	13 km	Domestic: 95 (Service ratio: 3%)	NA
Denkanikottai TP	24,252	1	NA	Domestic: 1,384 (Service ratio: 21%)	NA
Keelamangalam TP	13,321	2	NA	Domestic: 1,008 (Service ratio: 25%)	NA
Bargur TP	16,366	5	36 km	Domestic: 1,721 (Service ratio: 40%)	NA
Karimangalam TP	13,511	4	28 km	Domestic: 2,050 (Service ratio: 40%)	NA

	Population (2011 census)	Nos. of OHT	Distribution Pipeline	Service Connection	Public Tap
Marandahalli TP	12,451	1	15 km	Domestic: 3,290 (Service ratio: 62%)	NA
Nagojanahalli TP	9,953	NA	14 km	Domestic: 1,061 (Service ratio: 38%)	NA

Source: Dharmapuri Municipality, Hosur City Corporation, Krishnagiri Municipality, DPR

As shown in Figure 3.1.4, the distribution pipelines, service connections, and public taps are managed by the respective municipalities and corporations.

In the town and village panchayats, approximately 7,900 OHTs with a 10 m^3 capacity were constructed by the RD&PR Department. In addition, 530 OHTs were constructed under the Previous Hogenakkal Project, as shown in Table 3.2.9.

Table 3.2.9 Number of OHTs Constructed under the Previous Hogenakkal Project

Distinct	More than 10 m^3 Capacity		10 m^3 Capacity
	16 m Staging	6 m Staging	6 m Staging
Dharmapuri District	2	7	295
Krishnagiri District	2	6	218

Source: TWAD

Table 3.2.10 shows the number of households in rural areas with individual water connections.

Table 3.2.10 Number of Households with Individual Water Connections in Rural Areas within the Project Target Area

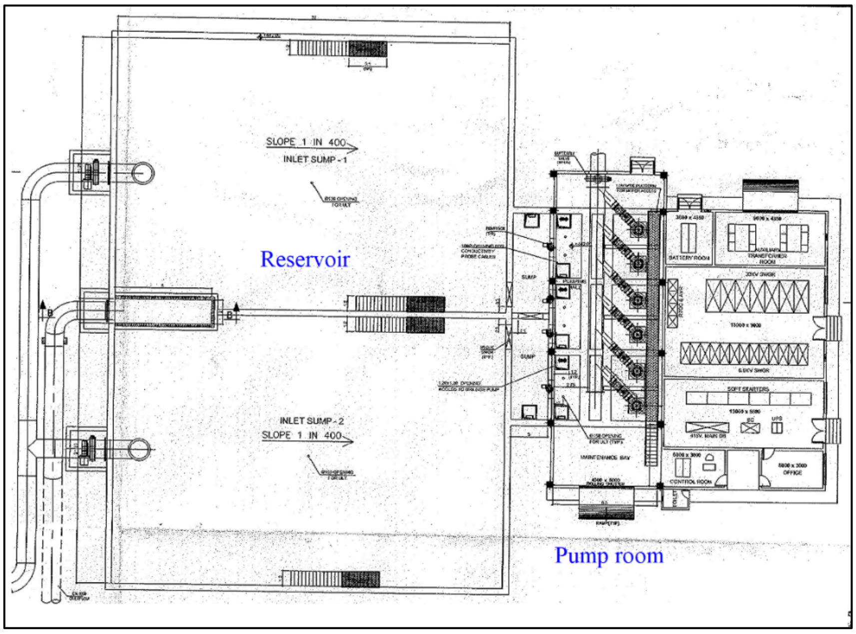
Distinct	Total Households	Households with Individual Connections	Individual Connection Rate (%)
Dharmapuri District	342,782	207,691	60.59 %
Krishnagiri District	409,435	296,953	72.53%

Source: JJM Website（https://ejalshakti.gov.in/jjmreport/JJMBlockMapView.aspx）

3.2.6 Major Booster Pump Stations under the Previous Hogenakkal Project

(1) Kanavi Booster Pump Station

Clear water from the water treatment plant flows into a reservoir with a one hour detention time. It is then pumped by vertical turbine pumps through a single 1,500 mm-diameter transmission main to the MADAM MBR, located approximately 3.5 km from the WTP, with an elevation difference of 95.6 m. The type, number, and operating method of the pumping stations are the same as those at the water treatment plant.



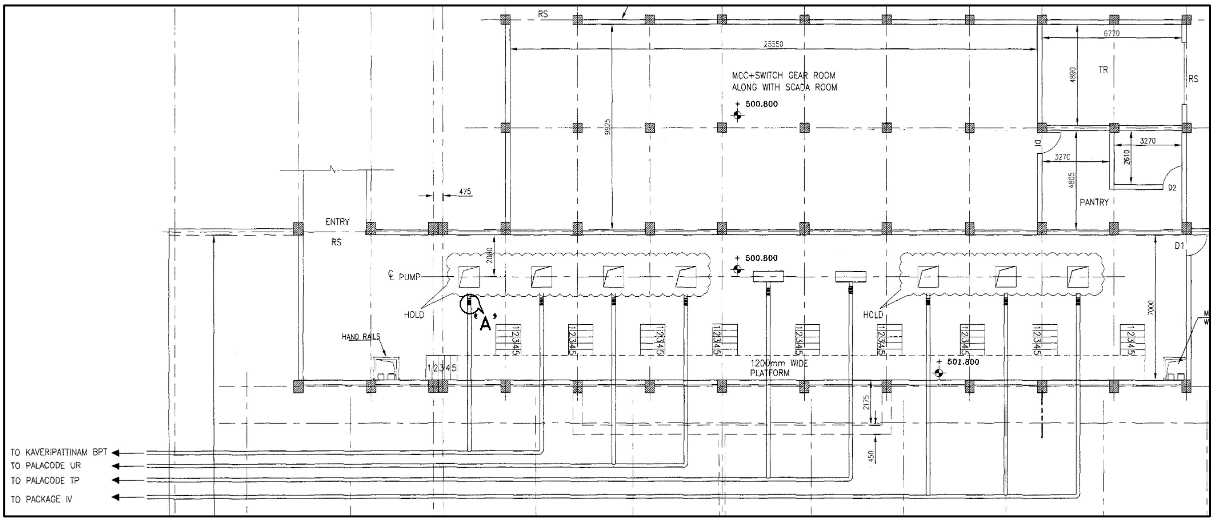
Source: As build drawing

Figure 3.2.15 Kanavi BPS Layout

As the MADAM MBR is located at a higher elevation, it can supply water by gravity to two separate systems. One system transfers water to the Moongilpatti Common BPS, which serves as the main supply for Packages IV and V, while the other supplies the system for Packages II and III. Since the service area for Packages II and III is at a lower elevation, the system allows water to flow by gravity to the end of the transmission main. However, the area for Packages IV and V lies at a higher elevation; therefore, four additional BSPs are required to supply water from the Moongilpatti Common BPS.

(2) Moongilpatti Common BPS for Package IV and V

Clear water from the MADAM MBR flows by gravity into the distribution reservoir, which has a detention time of 3.5 hours. Subsequently, it is pumped from the main pumping station to four distribution zones. This MBR plays a very important role as an intermediate point for the distribution zones of Packages IV and V. In particular, Line ④, as shown in the following distribution flow chart to Package IV, is of great importance as it supplies water to the elevated water tank in Hosur City via several booster pumping stations (BPS). Each pumping system is equipped with two pumps, with the operating pump switched daily.



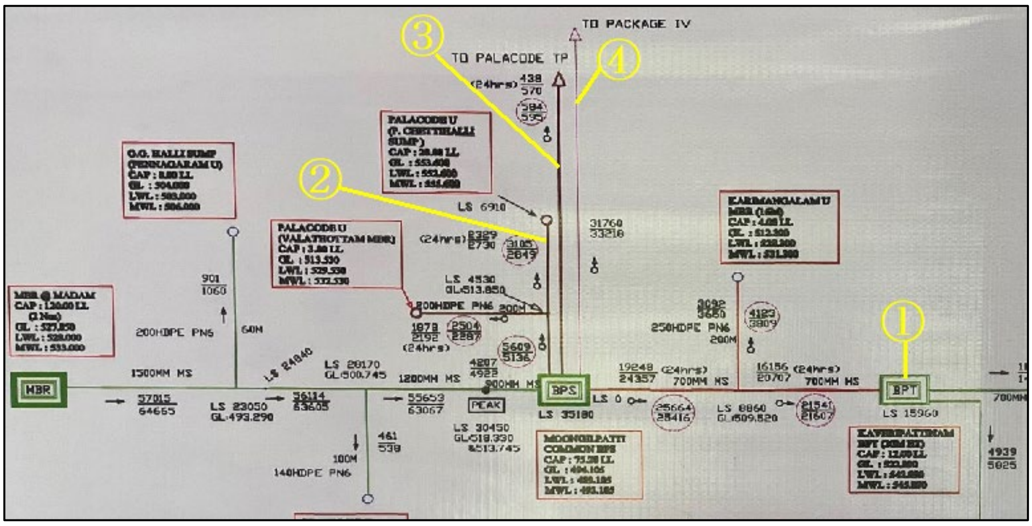
Source: As build drawing

Figure 3.2.16 Moongilpatti Common BPS Layout

Table 3.2.11 Specifications of Major Facilities at the Moongilpatti Common BPS

Item		Specifications	No. of Units
Civil and Architecture			
	Clear Water Reservoir	35 m x 55 m (dwell time 3.5 hours)	1
	Pump Room	7.45 m x 43 m	1
	Electric Room	10.2 m x 33 m	1
Equipment			
	Transmission Pump for Package V	Vertical Turbine 995 m^3/hr x 109 m	Duty 1 + Standby 1
	Transmission Pump	Horizontal Sprit Casing 11kW	Duty 1 + Standby 1
	Transmission Pump for Package IV	Vertical Turbine 308 m^3/hr	Duty 1 + Standby 1
	Transmission Pump for Package IV	Vertical Turbine 1,525 m^3/hr x 77 m	Duty 1 + Standby 1
	Surge Tank	Horizontal Steel Tank	1 set

Source: JST

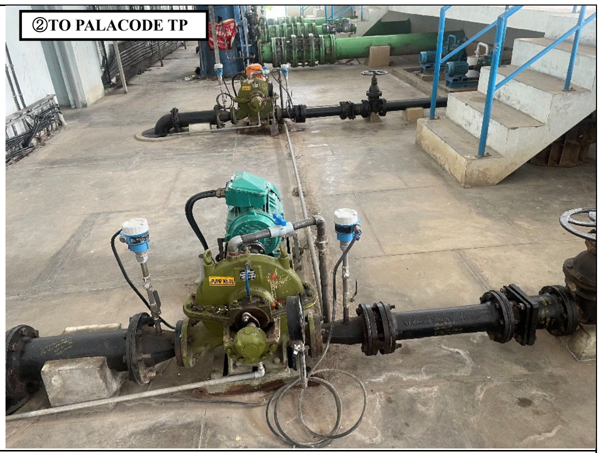


Source: As-built drawing — ① To Package V, ② To small area, ③ and ④ To Package IV

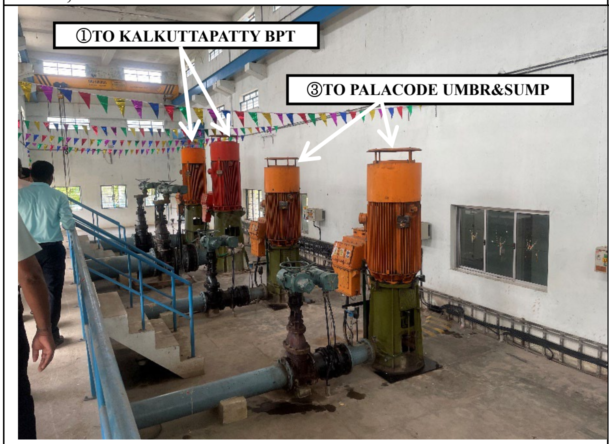
Figure3.2.17 Distribution Flow Chart to Packages IV and V

Figure 3.2.18 shows the present conditions of the BPS.

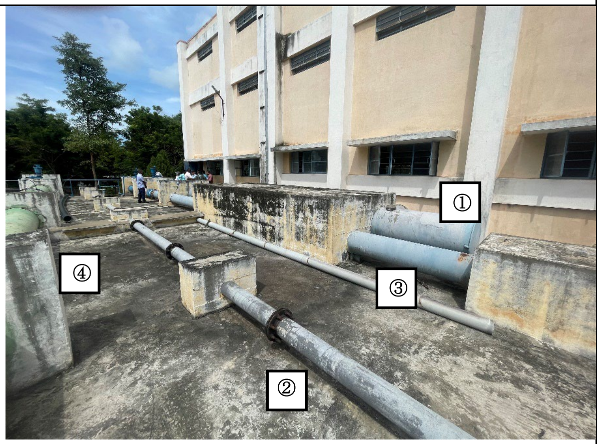
Transmission Pump ④
Water is supplied to the BPS of Package IV. There are three, but one is under maintenance.



Transmission Pump ②
The horizontal shaft suction pumps feed water to the TP at PALACODE.



Transmission Pump ①③
Water is supplied to the UMBR･SUMP and the KALKUTTAPATTY BPT of PALACODE for Package V.



Water is transferred to each destination area.

Source: JST

Figure 3.2.18 Present Conditions of the Moongilipatti Common BPS

3.2.7 Power Receiving Facility of the Previous Hogenakkal Project

(1) Power Receiving Facility

The existing intake pumping stations, water treatment plants, booster pumping stations, and other major facilities receive power from an open-air, 33 kV, 50 Hz system with a dual incoming line (duty and standby). The transformers are also outdoor oil-filled transformers with two banks—one for duty and one for standby—with a secondary voltage of 6.6 kV to match the large motors. Each transformer capacity covers 100% of the maximum power demand. The low-voltage transformer (6.6 kV/420 V) is installed in an independent electrical room indoors. No emergency generators are installed in any of the facilities as a countermeasure against power outages.

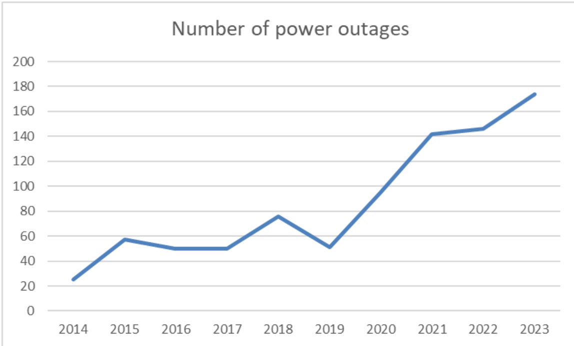
Source: JST

Figure 3.2.19 Outdoor 33 kV Power Receiving Facilities

An indoor metal-enclosed switchgear is adopted for the 6 kV distribution panel, and a motor control center (MCC) is adopted for the low-voltage power panel, each installed in a separate electrical room. A reactor starter is adopted to start the 6 kV motors of large pumps, such as the intake pumps. Flow control is not provided by the VFD; flow adjustment is done by the pump discharge valves, with pumps operating at a fixed speed in principle. Therefore, water volume is adjusted only by turning the pumps on and off. Automatic operation by the PLC is used for major operational controls, such as the washing process of the filtration. All equipment for power receiving, transformer, and motor control facilities is manufactured in India. Although the maintenance frequency is higher, good maintenance conditions are maintained.

(2) Power Outage Record

According to available data on power outages at the water treatment plants from 2014 to 2023, there have been more than 100 outages per year in the last three years—a significant number that has shown an increasing trend yearly. Although most outages last for less than 30 minutes and do not affect the water supply, 22 outages exceeding 3.5 hours—the storage time of the water distribution reservoirs—have occurred in the last three years. Among these, 11 outages exceeded eight hours. This situation may be due to the fact that, even though power is received from two lines, it is still transmitted from the same substation, making it susceptible to accidents and disasters. In addition, the power company also experiences scheduled blackouts. Blackouts exceeding 3.5 hours pose a risk of water interruptions, and frequent blackouts exceeding eight hours would necessitate the installation of emergency generators or other countermeasures. It is also desirable to install emergency generators when aiming for a 24-hour water supply in the future, but the high cost of equipment and fuel is preventing the adoption of such measures.



Source: TWAD

Figure 3.2.20 Frequency of Power Outages

Table 3.2.12 Frequency and Duration of Outages per Year

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of power outages	25	57	50	50	76	51	95	142	146	174
Power outages exceeding 3.5 hours [Risk of suspension]	3	11	5	1	5	12	7	5	10	7
Power outages exceeding 8 hours [Generator considered]	0	1	0	0	1	1	1	2	7	2
Power outages of 30 minutes or less [No risk of suspension]	0	8	6	16	22	11	53	76	74	105

Source: TWAD

3.2.8 Instrumentation and SCADA of the Previous Hogenakkal Project

(1) Instrumentation

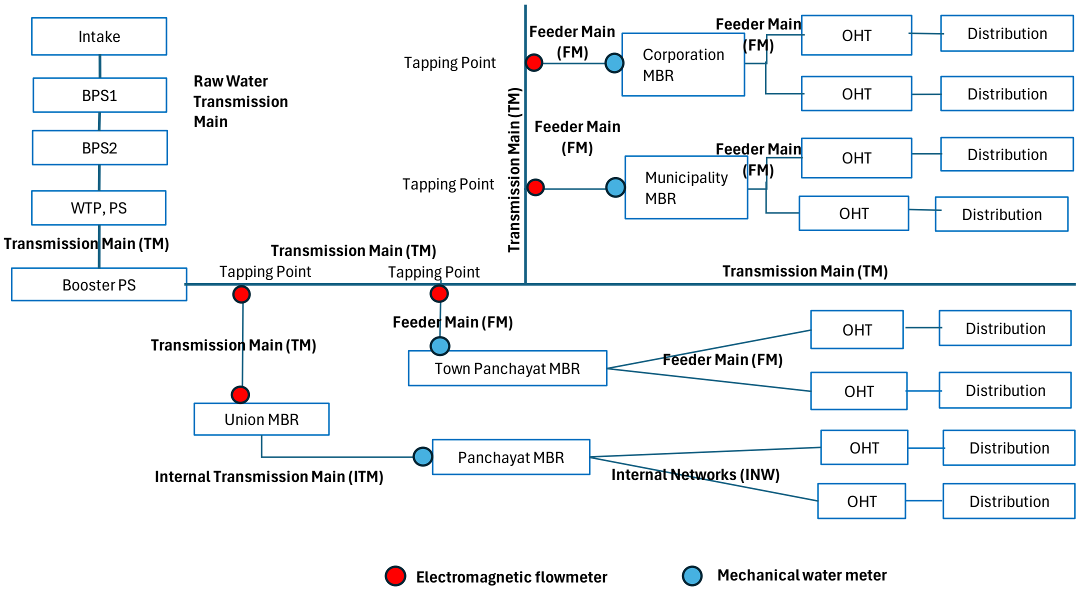
Instrumentation necessary for automatic operation and facility management—such as flow meters, water level meters, and water quality meters—have been installed at the intake, WTP, and pumping stations, and generally operates seamlessly. Large motors are equipped with temperature and vibration sensors, which are effectively used for maintenance management. All measurement items are centralized and monitored through the SCADA system using optical cables. The collected data are stored on a server, allowing historical records and operational trends to be confirmed.

Source: TWAD

Figure 3.2.21 Flowmeter Transmitter

The flowmeter type is mainly an electromagnetic flowmeter, which is a European brand manufactured at an Indian factory. Other instrumentation equipment are also manufactured at Indian factories.

Flowmeters are also installed at key locations along the water transmission line and are centrally monitored at the water treatment plant. Figure 3.2.22 presents a summary of the flow meter installations at each facility, from the intake to the House Service Connection (HSC). The flow rate of water delivered can be remotely monitored by electromagnetic flow meters up to the distribution reservoirs (U.MBR) and pumping stations (U.Sump), called "Unions", which integrate several Panchayats. Beyond this point, mechanical flow meters are installed at the distribution reservoirs (P.MBR) and pumping stations (P.Sump) of each panchayat. The collection of fees from each municipality is done by visual meter reading from these mechanical flow meters.



Source: JST

Figure 3.2.22 Status of Flowmeter Installation in the Water Supply Line

Pressure-type water level meters are installed in the U.MBR and U.Sump and are monitored through the SCADA. However, there is no control linked to the valves to prevent overflow or any other measures. In principle, the U.MBR and U.Sump are attended by personnel, and therefore, any response to the situation is performed manually.

After each panchayat, water level meters have not been installed, so the water levels cannot be monitored. Likewise, no control devices such as float valves are in place. The reason for this is that overflow rarely occurs due to consistently high water demand. Nevertheless, for more efficient water transmission management, centralized management of reservoir water levels and automatic control systems to prevent overflow are expected.

(2) SCADA System

A PLC-based SCADA system has been adopted for the existing facilities. The central monitoring room is located in the WTP administration building, while PLCs are installed in a distributed manner at each facility. Both the servers and PLCs are designed with redundancy, and communication between the intake facility, water treatment plant facilities, booster pump stations, and the common MBR is established via redundant optical cable. For facilities such as the U.MBR, which are widely dispersed, V-SAT satellite communication serves as the primary network, with a GPRS modem provided as a backup.

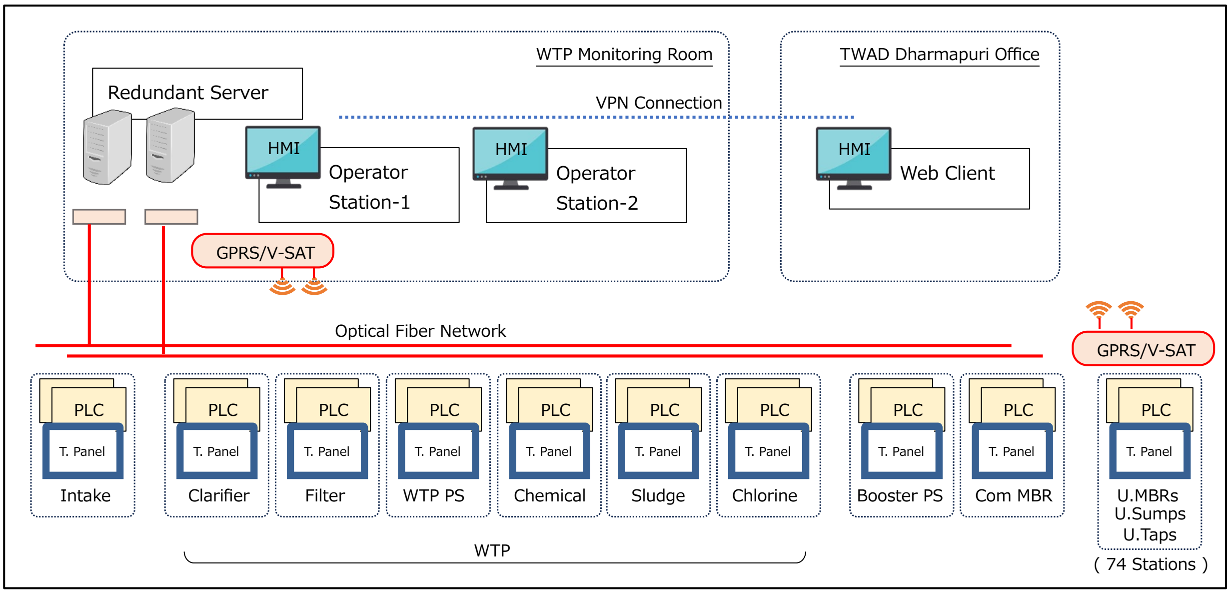
Source: JST

Figure 3.2.23 SCADA Monitoring Room

Each PLC station is equipped with a touch panel installed on the PLC panel, serving as the HMI for each station. A simplified SCADA system diagram is shown in Figure 3.2.24.

The SCADA system monitors flow rate and other key parameters, pump operating conditions, and alarm statuses, and also allows remote control of pumps. The system is well maintained and operating reliably. The PLC is supplied by Rockwell Automation, a U.S. company, and the system integration was carried out by an Indian company.

In the Project, since there is an overlap between the existing water transmission and distribution areas, SCADA integration and data acquisition from existing data will be required to enable comprehensive management of water transmission flow.



Source: JST

Figure 3.2.24 Existing SCADA System Diagram

3.3 Operation Conditions of the Existing Facilities

3.3.1 Operation Principle

The production volume is determined according to the earmarked volume of water based on the population and prescribed per capita volume of each distribution area. The O&M contractor is obliged for transmitting the earmarked volume of water to each OHT. The water production and transmission are controlled by adjusting the running hours of the pumps and the valve opening hours at the tapping points along the transmission main and at the inlets of each OHT. Water flow at the tapping points is monitored through the SCADA system. While water distribution beyond the OHTs is managed by staff of the respective local bodies—City Corporations, Municipalities, and Town or Village Panchayats—or by valve operators hired by these local bodies.

The operation conditions of each facility are described in the following sections.

3.3.2 Intake and Raw Water Transmission of the Previous Hogenakkal Project

JST received and chronologically analyzed operational daily reports from TWAD covering the period from July 2021 to September 2024, . The graph of raw water intake volume is shown in Figure 3.3.1. It can be observed that approximately 140,000 m³/day is consistently drawn from the river on a daily basis. In accordance with internal regulations, the pumps operate for 23 hours daily. To maintain the treated water quality within the standard limits, the O&M team at the existing water treatment plant reduces the intake water volume when the raw water exhibits high turbidity. This operational adjustment accounts for the variations in intake volume observed in the graph.

Table 3.3.1 Daily Raw Water Intake Volume (2021–2024)

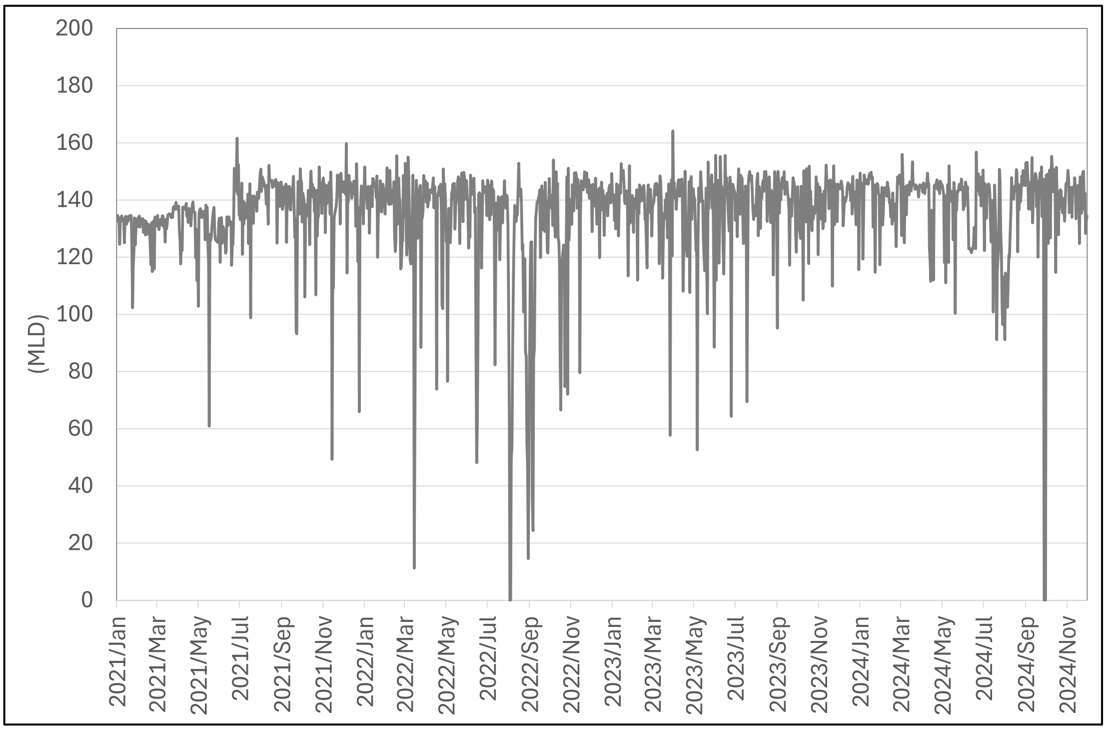
Year / Month		Max (MLD)	Min (MLD)	Total (ML/month)	Average (MLD)	Utilization Rate (%)	
						Max	Average
2021							
	Jan	134.68	102.33	4,038.95	130.29	84.17	81.43
	Feb	134.41	114.99	3,631.06	129.68	84.01	81.05
	Mar	139.19	125.30	4,147.78	133.80	86.99	83.62
	Apr	139.36	111.78	3,965.85	132.20	87.10	82.62
	May	138.24	60.90	3,975.49	128.24	86.40	80.15
	Jun	161.64	117.22	4,014.18	133.81	101.02	83.63
	Jul	149.07	98.78	4,248.38	137.05	93.17	85.65
	Aug	152.11	124.93	4,475.90	144.38	95.07	90.24
	Sep	150.90	93.22	4,131.68	137.72	94.31	86.08
	Oct	151.62	106.09	4,266.37	137.63	94.76	86.02
	Nov	149.82	49.30	4,107.55	136.92	93.64	85.57
	Dec	159.76	65.97	4,293.41	138.50	99.85	86.56
2022							
	Jan	151.56	120.01	4,376.37	141.17	94.73	88.23
	Feb	155.50	115.90	3,869.22	138.19	97.19	86.37
	Mar	155.02	11.25	3,987.36	128.63	96.89	80.39
	Apr	150.86	73.87	4,126.59	137.55	94.29	85.97
	May	151.56	120.01	4,376.37	141.17	94.73	88.23
	Jun	155.50	115.90	3,869.22	138.19	97.19	86.37
	Jul	146.96	82.38	4,208.41	135.76	91.85	84.85
	Aug	152.88	0.00	3,062.25	98.78	95.55	61.74
	Sep	147.55	24.42	3,683.47	122.78	92.22	76.74
	Oct	154.04	66.61	3,837.76	123.80	96.27	77.37
	Nov	149.85	79.60	4,247.50	141.58	93.66	88.49
	Dec	149.27	119.86	4,317.69	139.28	93.29	87.05
2023							
	Jan	152.76	113.44	4,328.69	139.64	95.48	87.27
	Feb	145.30	112.01	3,839.41	137.12	90.81	85.70
	Mar	164.16	57.70	4,197.11	135.39	102.60	84.62
	Apr	150.10	107.64	4,123.41	137.45	93.81	85.90
	May	153.28	52.62	4,054.45	130.79	95.80	81.74
	Jun	155.63	64.32	4,082.88	136.10	97.27	85.06
	Jul	150.94	69.43	4,243.96	136.90	94.34	85.56
	Aug	149.96	113.77	4,384.89	141.45	93.73	88.41
	Sep	150.02	95.23	4,178.24	139.28	93.76	87.05
	Oct	151.88	105.00	4,232.96	136.55	94.93	85.34
	Nov	152.25	109.90	4,213.77	140.46	95.16	87.79
	Dec	148.29	115.68	4,375.20	141.14	92.68	88.21
2024							
	Jan	149.70	114.75	4,409.10	142.23	93.56	88.89
	Feb	148.80	123.68	4,061.58	140.05	93.00	87.53
	Mar	155.95	125.06	4,437.41	143.14	97.47	89.46
	Apr	149.38	111.58	4,202.35	140.08	93.36	87.55
	May	151.98	100.39	4,295.08	138.55	94.99	86.59
	Jun	156.74	121.62	4,106.39	136.88	97.96	85.55
	Jul	150.78	91.17	3,989.88	128.71	94.24	80.44
	Aug	150.66	91.16	4,158.70	134.15	94.16	83.84
	Sep	154.86	0.00	3,896.77	129.89	96.79	81.18
	Oct	155.28	114.68	4,392.62	141.70	97.05	88.56
	Nov	150.38	124.79	4,247.28	141.58	93.99	88.49

Source: JST, based on data provided by TWAD

Table 3.3.2 Summary of Annual Raw Water Volume

Volume / Period	Max (MLD)	Min (MLD)	Average (MLD)
2021	161.64	49.30	135.02
2022	155.50	0.00	131.27
2023	164.16	52.62	137.69
2024/JAN - 2024/NOV	156.74	0.00	137.91

Source: JST, based on data provided by TWAD



Source: JST, based on data provided by TWAD

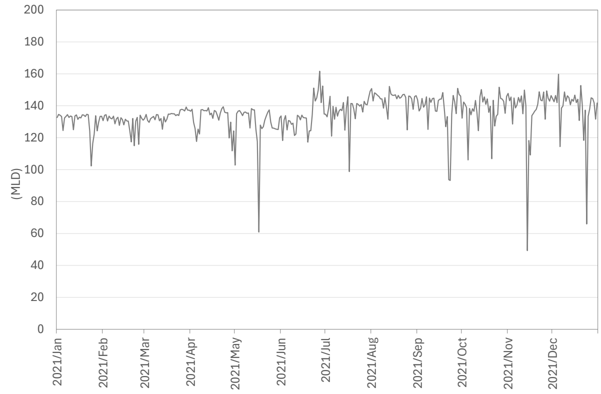
Figure 3.3.1 Water Intake Volume (2021–2024)

The reasons for the shortfall in pump operation are categorized in Table 3.3.3, and the annual variations in intake volume for a single year between July 2021 and September 2024 are presented in Figures 3.3.2 to 3.3.5.

Table 3.3.3 Reasons for Shortfall of Intake Pump Operation

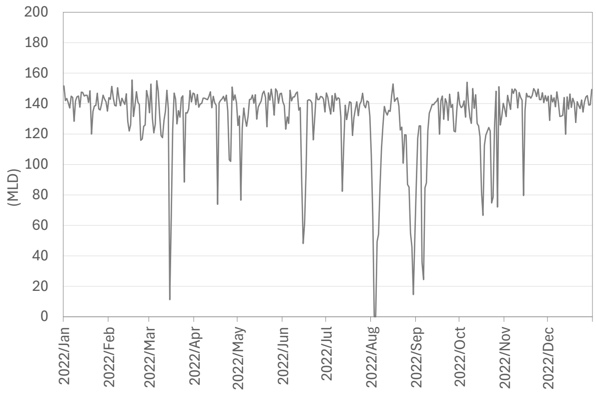
Power Supply Issues	On numerous dates, a reduction in intake volume was caused by power supply interruptions. Particularly in the Package 1 pumping station, several instances were recorded where all pumps ceased operation due to power outages.
Maintenance Activities	Regular maintenance activities were carried out, during which pump operations were restricted. Examples include the dismantling of VT pump NRVs and cleaning of clarifiers.
High Turbidity of Raw Water	When the Cauvery River's raw water recorded high turbidity level (35 NTU), pump operations were restricted, leading to a decreased intake volume.
Leak Repair Work	Water intake was also reduced during pipeline leak repair works, primarily affecting transmission lines in Package V.

Source: JST, based on data provided by TWAD



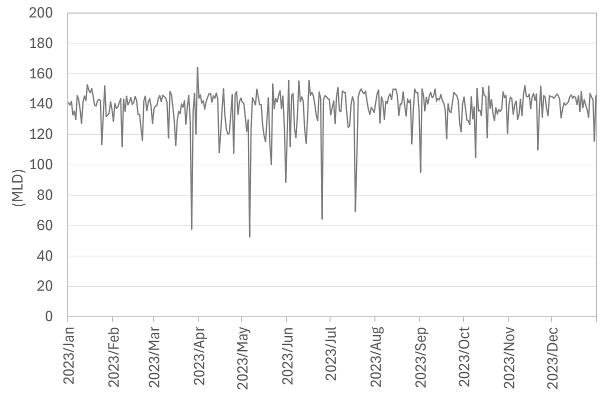
Source: JST, based on data provided by TWAD

Figure 3.3.2 Daily Water Intake Volume (2021)



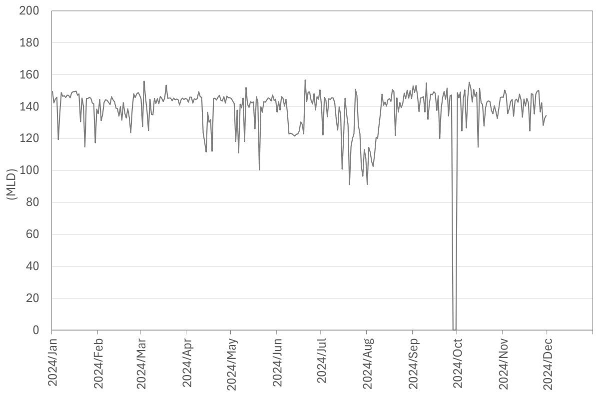
Source: JST, based on data provided by TWAD

Figure 3.3.3 Daily Water Intake Volume (2022)



Source: JST, based on data provided by TWAD

Figure 3.3.4 Daily Water Intake Volume (2023)



Source: JST, based on data provided by TWAD

Figure 3.3.5 Daily Water Intake Volume (2024)

3.3.3 Water Treatment of the Previous Hogenakkal Project

Similarly, the treated water volume data over the past four years have been graphed and are shown in Figure 3.3.6. It exhibits the same trend as the intake volume, which is due to the adjustment of intake volume based on the turbidity of the raw water, as previously mentioned. Notably, in the existing water treatment plant, backwash water is returned to the Parshall flume, employing a closed system. As a result, water loss in the water treatment process has remained remarkably low, at approximately 0.045% over the past four years. The average utilization rate generally stays within the 80-90% range, indicating stable operations, while the maximum utilization rate fluctuates between 90-100%, showing periods when the facility operates at full capacity.

Table 3.3.4 Daily Treated Water Volume Trend

Year / Month		Max (MLD)	Min (MLD)	Total (ML/month)	Average (MLD)	Utilization Rate (%)	
						Max	Average
2021							
	Jan	133.04	101.66	4,004.47	129.18	83.15	80.74
	Feb	133.09	114.26	3,598.85	128.53	83.18	80.33
	Mar	138.00	123.47	4,100.91	132.29	86.25	82.68
	Apr	137.90	112.29	3,940.16	131.34	86.19	82.09
	May	136.43	63.83	3,945.18	127.26	85.27	79.54
	Jun	161.11	117.13	4,001.56	133.39	100.69	83.37

Year / Month		Max (MLD)	Min (MLD)	Total (ML/month)	Average (MLD)	Utilization Rate (%)	
						Max	Average
	Jul	146.81	99.78	4,242.04	136.84	91.75	85.53
	Aug	152.25	124.34	4,460.66	143.89	95.16	89.93
	Sep	150.53	91.28	4,134.15	137.81	94.08	86.13
	Oct	150.43	106.35	4,266.04	137.61	94.02	86.01
	Nov	150.01	53.13	4,108.76	136.96	93.76	85.60
	Dec	158.04	67.06	4,287.39	138.30	98.78	86.44
2022							
	Jan	152.26	118.28	4,342.84	140.09	95.16	87.56
	Feb	155.13	113.11	3,857.84	137.78	96.96	86.11
	Mar	157.79	12.32	3,975.22	128.23	98.62	80.15
	Apr	150.62	75.34	4,143.18	138.11	94.14	86.32
	May	148.60	84.14	4,210.16	135.81	92.88	84.88
	Jun	152.26	118.28	4,342.84	140.09	95.16	87.56
	Jul	155.13	113.11	3,857.84	137.78	96.96	86.11
	Aug	151.82	1.77	3,065.85	98.90	94.88	61.81
	Sep	144.81	24.08	3,668.88	122.30	90.51	76.44
	Oct	152.99	67.79	3,825.58	123.41	95.62	77.13
	Nov	149.51	79.26	4,237.92	141.26	93.44	88.29
	Dec	149.49	121.46	4,326.26	139.56	93.43	87.22
2023							
	Jan	153.97	113.42	4,343.47	140.11	96.23	87.57
	Feb	145.23	112.51	3,848.74	137.46	90.77	85.91
	Mar	162.32	56.55	4,197.42	135.40	101.45	84.63
	Apr	149.07	107.52	4,113.01	137.10	93.17	85.69
	May	153.92	53.81	4,053.59	130.76	96.20	81.73
	Jun	154.91	63.43	4,070.89	135.70	96.82	84.81
	Jul	152.52	70.68	4,252.88	137.19	95.33	85.74
	Aug	154.38	114.45	4,393.42	141.72	96.49	88.58
	Sep	149.45	93.93	4,185.49	139.52	93.40	87.20
	Oct	151.57	105.80	4,243.80	136.90	94.73	85.56
	Nov	153.72	109.63	4,226.84	140.90	96.07	88.06
	Dec	147.94	115.65	4,384.63	141.44	92.46	88.40
2024							
	Jan	149.75	116.35	4,412.16	142.33	93.60	88.96
	Feb	148.19	124.41	4,052.36	139.74	92.62	87.34
	Mar	155.68	125.05	4,416.54	142.47	97.30	89.04
	Apr	149.07	112.20	4,183.18	139.44	93.17	87.15
	May	151.87	100.74	4,289.37	138.37	94.92	86.48
	Jun	155.41	121.50	4,104.16	136.81	97.13	85.50
	Jul	150.94	92.04	4,010.93	129.39	94.34	80.87
	Aug	151.53	94.85	4,157.41	134.11	94.71	83.82
	Sep	153.16	0.00	3,880.03	129.33	95.72	80.83
	Oct	155.73	113.61	4,417.52	142.50	97.33	89.06
	Nov	150.05	126.63	4,267.29	142.24	93.78	88.90

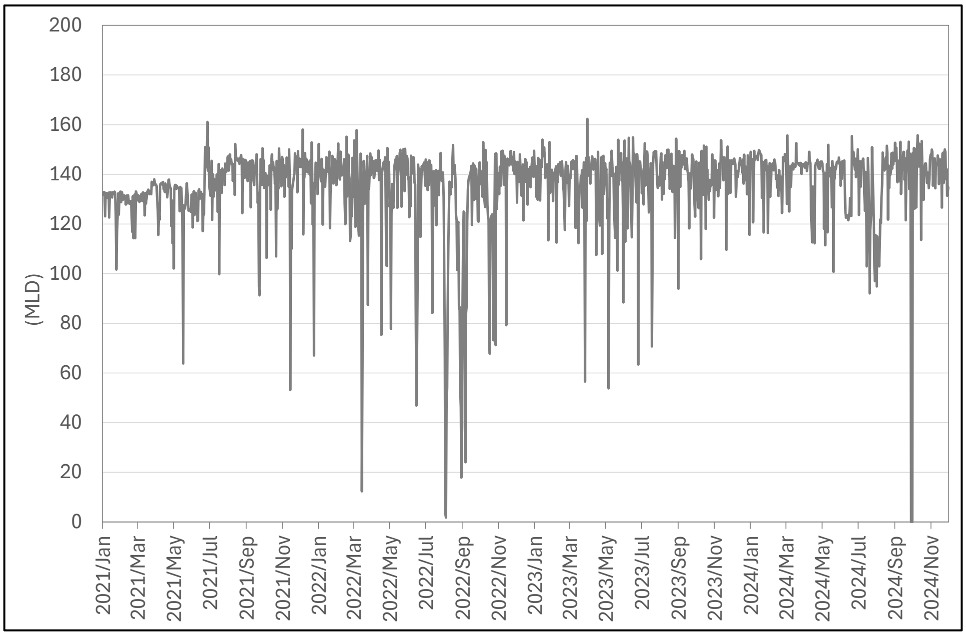
Source: JST based on the data provided from TWAD

Table 3.3.5 Summary of Annual Treated Water Volume

Period \ Volume	Max (MLD)	Min (MLD)	Average (MLD)
2021	161.11	53.13	134.45
2022	157.79	1.77	131.12
2023	162.32	53.81	137.85
2024/JAN - 2024/NOV	155.68	0.00	137.88

Source: JST based on the data provided from TWAD

The operations were suspended due to high turbidity of water in the Cauvery River, recorded on August 3 and 4, 2022. As a result, the minimum treated water volume in 2022 was 1.77 MLD.



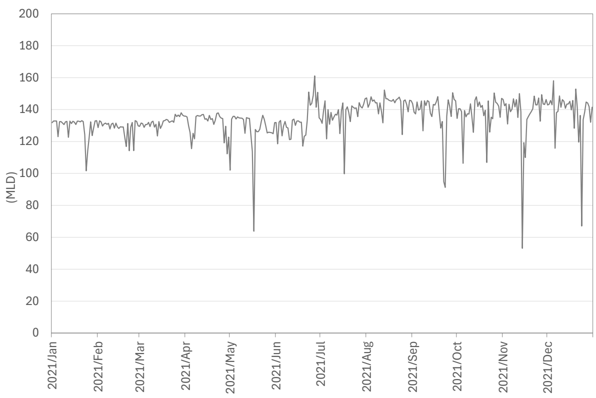
Source: JST, based on data provided by TWAD

Figure 3.3.6 Daily Treated Water Volume (2021 – 2024)

Overall, no significant fluctuations were observed, and stable water treatment operations were maintained throughout the year. However, as previously mentioned, temporary suspensions of water treatment were confirmed due to reasons such as power outages, maintenance activities (including cleaning), high raw water turbidity, and repair work on transmission pipelines.

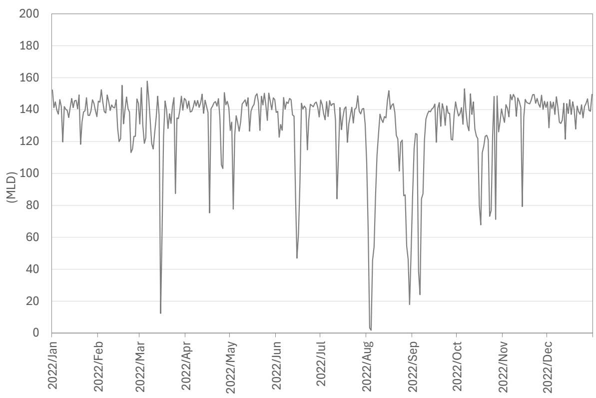
The number of days when the daily treated water volume fell below 50% of the facility's nominal capacity (160 MLD) was as follows: 3 days in 2021, 23 days in 2022, 4 days in 2023, and 3 days in 2024 (up to November). The higher number of days in 2022 was mainly due to concentrated intake pump repairs and scheduled maintenance activities.

Annual variations in treated water volume for a single year between July 2021 and September 2024 are presented in Figures 3.3.7 to 3.3.10.



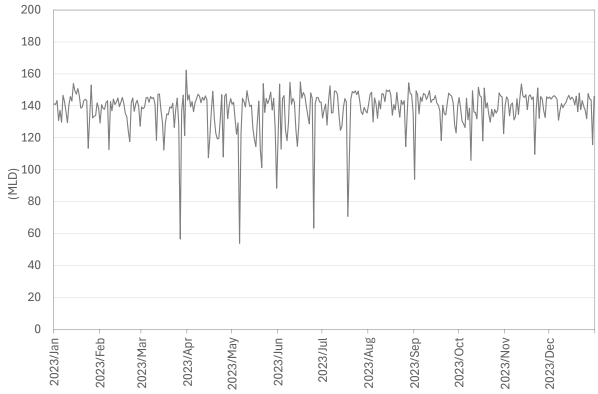
Source: JST, based on data provided by TWAD

Figure 3.3.7 Daily Treated Water Volume (2021)



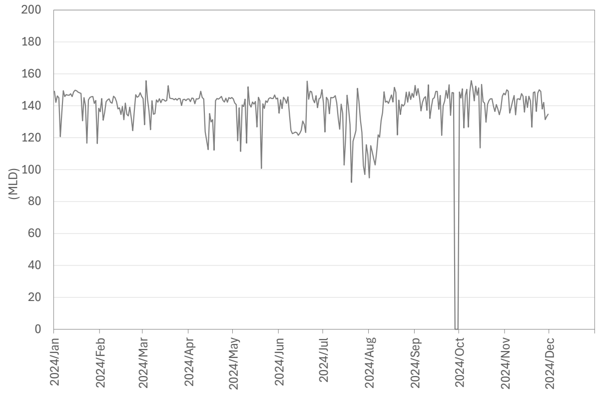
Source: JST, based on data provided by TWAD

Figure 3.3.8 Daily Treated Water Volume (2022)



Source: JST, based on data provided by TWAD

Figure 3.3.9 Daily Treated Water Volume (2023)



Source: JST, based on data provided by TWAD

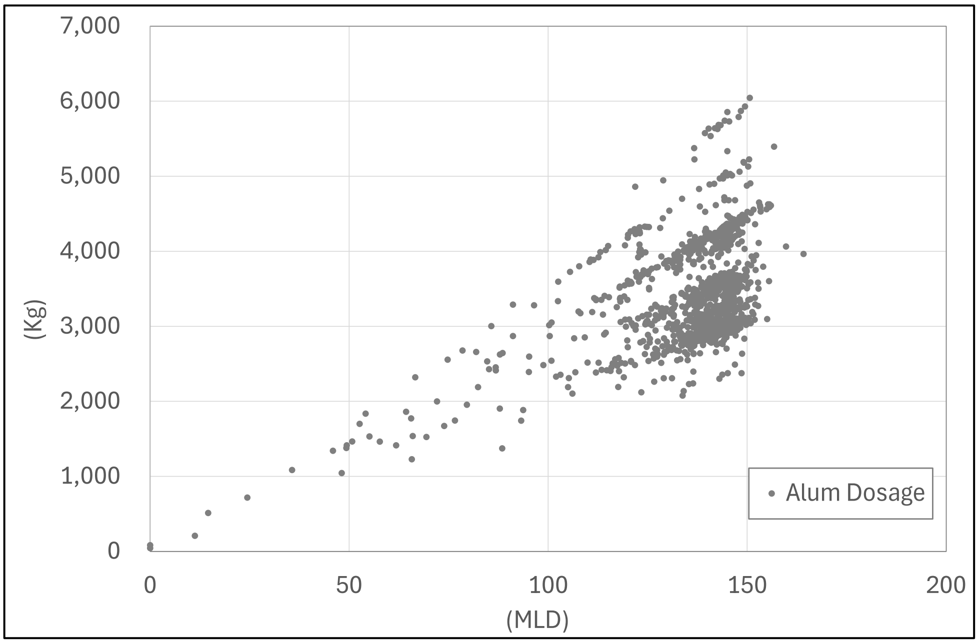
Figure 3.3.10 Daily Treated Water Volume (2024)

Table 3.3.6 Trend of Treated Water Volume and Chemical Consumption

Year / Month		Treated Water Volume		Alum Consumption		Chlorine Consumption		Total Starch Consumption	Total NaOH Consumption
		Total (ML/month)	Average (MLD)	Total (kg/month)	Average (kg/day)	Total (kg/month)	Average (kg/day)	(kg/month)	(kg/month)
2021									
	Jan	4,004.47	129.18	58,756	1,895.35	12,012	387.48	0	0
	Feb	3,598.85	128.53	70,994	2,535.50	9,671	345.39	0	0
	Mar	4,100.91	132.29	73,423	2,368.48	10,321	332.94	0	0
	Apr	3,940.16	131.34	60,648	2021.60	9,597	319.90	0	0
	May	3,945.18	127.26	87,683	2,828.48	15,528	500.90	0	0
	Jun	4,001.56	133.39	61,044	2034.80	13,983	466.10	0	0
	Jul	4,242.04	136.84	104,267	3,363.45	9,860	318.06	299	74
	Aug	4,460.66	143.89	107,946	3,482.13	9,517	307.00	0	0
	Sep	4,134.15	137.81	84,690	2,823.00	9,344	311.47	0	0
	Oct	4,266.04	137.61	98,641	3,181.97	10,168	328.00	922	230
	Nov	4,108.76	136.96	108,480	3,616.01	12,194	406.47	1,470	366
	Dec	4,287.39	138.30	100,567	3,244.10	12,814	413.35	0	0
2022									
	Jan	4,342.84	140.09	90,728	2,926.71	14,063	453.65	0	0
	Feb	3,857.84	137.78	84,898	3,032.07	13,289	474.61	0	0
	Mar	3,975.22	128.23	73,650	2,375.81	12,930	417.10	0	0
	Apr	4,143.18	138.11	91,619	3,053.97	15,681	522.70	0	0
	May	4,276.96	137.97	98,322	3,171.68	16,901	545.19	363	89
	Jun	3,899.12	129.97	90,145	3,004.83	13,687	456.23	56	14
	Jul	4,210.16	135.81	108,770	3,508.71	15,539	501.26	1,132	281
	Aug	3,065.85	98.90	87,414	2,819.81	11,502	371.03	1,309	328
	Sep	3,668.88	122.30	100,190	3,339.67	12,537	417.90	1,219	302
	Oct	3,825.58	123.41	106,781	3,444.55	14,300	461.29	1,376	342
	Nov	4,237.92	141.26	104,379	3,479.30	13,866	462.20	464	115
	Dec	4,326.26	139.56	100,851	3,253.27	12,799	412.87	333	83
2023									
	Jan	4,343.47	140.11	90,948	2,933.81	9,820	316.77	0	0
	Feb	3,848.74	137.46	81,628	2,915.29	11,758	419.93	0	0
	Mar	4,197.42	135.40	96,157	3,101.84	14,189	457.71	0	0
	Apr	4,113.01	137.10	114,419	3,813.97	14,565	485.50	0	0
	May	4,053.59	130.76	123,439	3,981.90	15,308	493.81	867	216
	Jun	4,070.89	135.70	121,237	4,041.24	14,327	477.57	0	0
	Jul	4,252.88	137.19	108,812	3,510.06	15,618	503.81	406	101
	Aug	4,393.42	141.72	100,111	3,229.39	16,914	545.61	14	4
	Sep	4,185.49	139.52	94,299	3,143.30	14,953	498.43	174	43
	Oct	4,243.80	136.90	91,504	2,951.74	14,135	455.97	252	62
	Nov	4,226.84	140.90	99,729	3,324.30	11,942	398.07	271	68
	Dec	4,384.63	141.44	90,455	2,917.91	10,627	342.81	0	0

Year / Month		Treated Water Volume		Alum Consumption		Chlorine Consumption		Total Starch Consumption	Total NaOH Consumption
		Total (ML/month)	Average (MLD)	Total (kg/month)	Average (kg/day)	Total (kg/month)	Average (kg/day)	(kg/month)	(kg/month)
2024									
	Jan	4,412.16	142.33	91,613	2,955.24	12,617	407.00	0	0
	Feb	4,052.36	139.74	115,949	3,998.23	13,222	455.93	0	0
	Mar	4,416.54	142.47	131,125	4,229.84	13,589	438.35	0	0
	Apr	4,183.18	139.44	123,555	4,118.50	12,643	421.43	0	0
	May	4,289.37	138.37	124,365	4,011.77	13,141	423.90	683	169
	Jun	4,104.16	136.81	135,565	4,518.83	14,972	499.07	642	160
	Jul	4,010.93	129.39	129,865	4,189.19	13,900	448.39	1,072	268
	Aug	4,157.41	134.11	155,775	5,025.00	12,909	416.42	1,950	488
	Sep	3,880.03	129.33	111,795	4,299.81	11,347	436.42	0	0
	Oct	4,417.52	142.50	134,035	4,323.71	12,886	415.68	988	247
	Nov	4,267.29	142.24	115,335	3,844.5	10,010	333.67	0	0

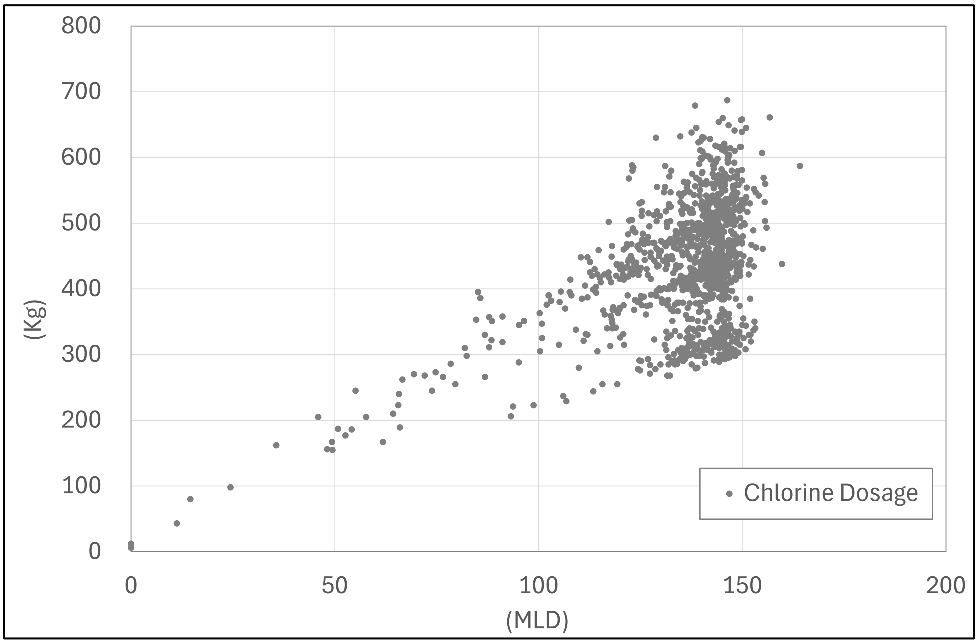
Source: JST, based on data provided by TWAD



Source: JST, based on data provided by TWAD

Figure 3.3.11 Treated Water Volume and Alum Consumption

From the graph above, it can be observed that as the water volume increases, the dosage of aluminium sulfate (alum) also tends to increase, suggesting a certain correlation. Since the raw water turbidity is not constant, some variations in alum dosage were recorded. This indicates that the water treatment plant staff are appropriately adjusting the coagulant dosage in response to changes in raw water turbidity.



Source: JST, based on data provided by TWAD

Figure 3.3.12 Treated Water Volume and Chlorine Consumption

From the graph above, it can be observed that as the water volume increases, the chlorine dosage also tends to increase, suggesting a certain correlation. Variation in chlorine dosage is observed when the chlorine concentration falls below 0.3 mg/L at the Parshall flume outlet, the pre-chlorination dosage is increased accordingly.

3.3.4 Water Quality Management of the Previous Hogenakkal Project

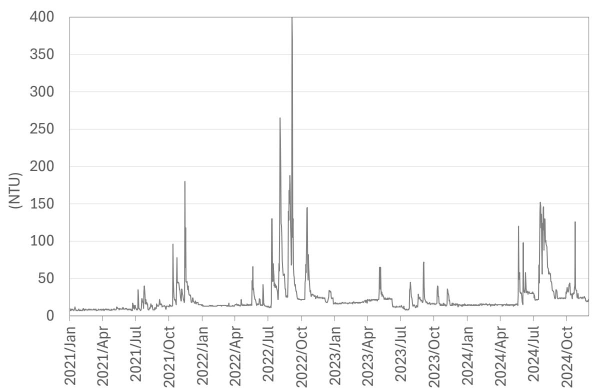
The data on turbidity, color, and pH of raw water and treated water from daily reports between July 2021 and September 2024 have been organized and summarized in Table 3.3.7, with time series trends illustrated in Figures 3.3.13 and 3.3.14.

Table 3.3.7 Trend of Turbidity, Color and pH in Raw and Treated Water

Year / Month	Turbidity				Color			pH				Fluoride	
	Raw Water		Treated Water		Raw Water		Treated Water	Raw Water		Treated Water		Raw Water	Treated Water
	Max	Average	Max	Average	Max	Average	Max	Max	Min	Max	Min	Max	Max
	(NTU)				(Hazen Units)			(-)				(mg/L)	
2021													
Jan	12	8	0.46	0.30	5	3	1	8.40	8.22	8.06	7.85	N/A	N/A
Feb	10	8	0.75	0.33	4	3	1	8.40	8.26	8.08	7.84	N/A	N/A
Mar	9	8	0.36	0.30	4	3	1	8.49	8.29	8.01	7.81	N/A	N/A
Apr	9	8	0.65	0.33	4	3	1	8.46	8.29	8.05	7.80	N/A	N/A
May	12	9	0.90	0.58	5	4	1	8.75	8.21	8.15	7.74	N/A	N/A
Jun	17	10	0.65	0.52	9	4	1	8.90	8.34	8.31	7.93	N/A	N/A
Jul	40	17	0.48	0.30	18	6	1	8.47	8.19	7.98	7.64	0.09	0.08
Aug	18	11	0.46	0.31	7	5	1	8.45	8.25	7.97	7.69	0.09	0.08
Sep	22	14	0.64	0.42	10	6	1	8.46	8.20	8.07	7.89	0.09	0.07
Oct	96	30	0.95	0.66	35	13	1	8.47	8.35	8.07	7.91	0.09	0.06
Nov	180	40	0.96	0.86	60	17	1	8.46	8.27	8.08	7.94	0.09	0.06
Dec	24	17	0.95	0.77	11	7	1	8.48	8.32	8.11	7.94	0.09	0.05
2022													
Jan	15	13	0.70	0.54	7	6	1	8.54	8.35	8.18	7.99	0.09	0.07
Feb	14	14	0.90	0.65	7	6	1	8.54	8.36	8.21	8.05	0.09	0.08

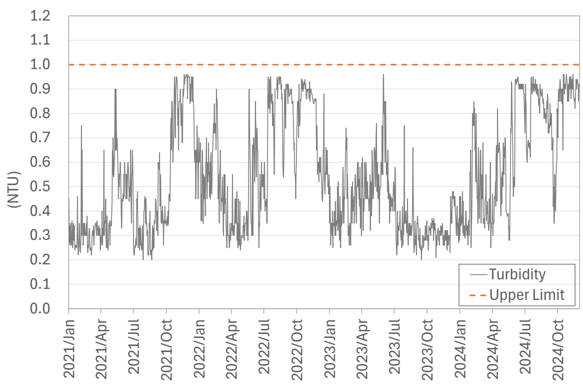
Year / Month		Turbidity				Color			pH				Fluoride	
		Raw Water		Treated Water		Raw Water		Treated Water	Raw Water		Treated Water		Raw Water	Treated Water
		Max	Average	Max	Average	Max	Average	Max	Max	Min	Max	Min	Max	Max
		(NTU)				(Hazen Units)			(-)				(mg/L)	
	Mar	17	14	0.65	0.39	7	6	1	8.54	8.40	8.18	8.02	0.09	0.06
	Apr	22	15	0.55	0.34	9	7	1	8.58	8.42	8.18	8.02	0.09	0.07
	May	66	21	0.90	0.41	30	10	1	8.58	8.42	8.18	8.02	0.09	0.08
	Jun	42	17	0.85	0.56	17	7	1	8.58	8.45	8.20	8.02	0.09	0.08
	Jul	130	40	0.95	0.69	50	16	1	8.57	8.45	8.18	8.00	0.09	0.08
	Aug	190	84	0.95	0.85	100	36	1	8.60	8.42	8.20	8.02	0.09	0.09
	Sep	400	69	0.92	0.79	80	24	1	8.60	8.45	8.20	8.07	0.09	0.09
	Oct	145	46	0.94	0.87	67	20	1	8.60	8.47	8.21	8.11	0.09	0.09
	Nov	29	25	0.93	0.83	13	11	1	8.60	8.52	8.22	8.11	0.09	0.08
	Dec	34	23	0.88	0.56	23	11	1	8.60	8.47	8.24	8.11	0.09	0.08
2023														
	Jan	18	17	0.52	0.36	8	7	1	8.62	8.52	8.27	8.15	0.14	0.11
	Feb	19	17	0.74	0.44	8	8	1	8.64	8.56	8.22	8.14	0.16	0.13
	Mar	21	18	0.60	0.45	10	8	1	8.64	8.52	8.24	8.10	0.16	0.14
	Apr	22	21	0.65	0.48	10	10	1	8.66	8.55	8.24	8.14	0.16	0.15
	May	65	29	0.94	0.56	30	13	1	8.66	8.25	8.24	8.01	0.17	0.14
	Jun	23	15	0.96	0.56	11	7	1	8.47	8.28	8.17	8.02	0.16	0.14
	Jul	45	15	0.75	0.36	18	6	1	8.44	8.33	8.22	7.92	0.17	0.14
	Aug	29	17	0.66	0.34	12	8	1	8.46	8.32	8.24	8.00	0.17	0.14
	Sep	72	22	0.38	0.29	32	9	1	8.47	8.29	8.17	8.00	0.30	0.16
	Oct	40	18	0.37	0.31	17	7	1	8.46	8.36	8.20	8.01	0.17	0.16
	Nov	36	18	0.35	0.30	15	8	1	8.46	8.30	8.16	8.04	0.18	0.14
	Dec	16	15	0.48	0.38	7	6	1	8.48	8.30	8.18	8.04	0.17	0.14
2024														
	Jan	15	14	0.65	0.37	6	6	1	8.48	8.34	8.19	8.04	0.17	0.15
	Feb	16	15	0.85	0.58	7	6	1	8.54	8.34	8.24	8.10	0.22	0.17
	Mar	16	15	0.68	0.41	7	6	1	8.52	8.42	8.22	8.06	0.20	0.16
	Apr	16	15	0.82	0.52	7	6	1	8.50	8.40	8.18	8.04	0.19	0.16
	May	120	25	0.93	0.55	40	11	1	8.50	8.38	8.19	8.04	0.19	0.16
	Jun	98	34	0.95	0.88	28	13	1	8.61	8.42	8.26	8.05	0.22	0.22
	Jul	152	68	0.95	0.80	65	28	1	8.54	8.44	8.19	8.12	0.20	0.19
	Aug	130	59	0.92	0.85	55	23	1	8.55	8.44	8.18	8.13	0.12	0.10
	Sep	35	25	0.88	0.66	13	11	1	8.58	8.46	8.16	8.02	0.20	0.18
	Oct	126	36	0.96	0.89	60	16	1	8.58	8.46	8.18	8.06	0.34	0.22
	Nov	30	23	0.96	0.91	12	10	1	8.59	8.45	8.18	8.06	0.36	0.32

Source: JST based on the data provided by TWAD



Source: JST based on data provided by TWAD

Figure 3.3.13 Changes in Raw Water Turbidity

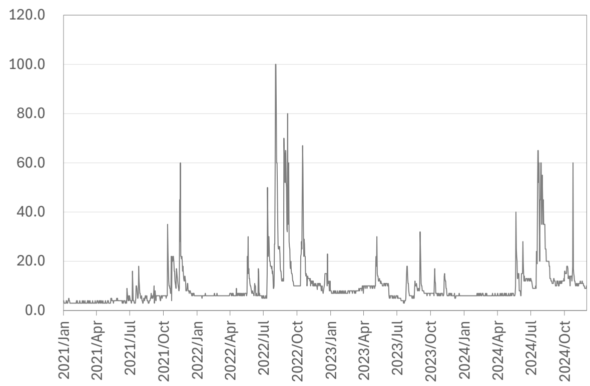


Source: JST based on data provided by TWAD

Figure 3.3.14 Changes in Treated Water Turbidity

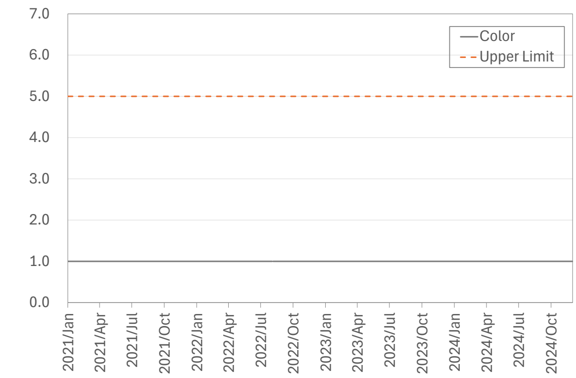
The turbidity of raw water ranged from a minimum of eight (8) NTU to a maximum of 400 NTU, recorded on September 5, 2022. On average, daily turbidity levels were between 10 and 30 NTU. The turbidity of treated water consistently met the standard, remaining below the upper limit of 1.0 NTU, with most days recording values below 0.9 NTU, indicating stable treatment processes. Due to heavy flooding in the Cauvery River on September 5, 2022, raw water turbidity increased from 70 NTU to 400 NTU within two hours

The fact that the treated water turbidity consistently stayed below 1 NTU demonstrates the effectiveness of the water treatment process. Even on days with high raw water turbidity, treated water remained within standards, confirming the appropriate decrease in water intake volume.



Source: JST based on data provided by TWAD

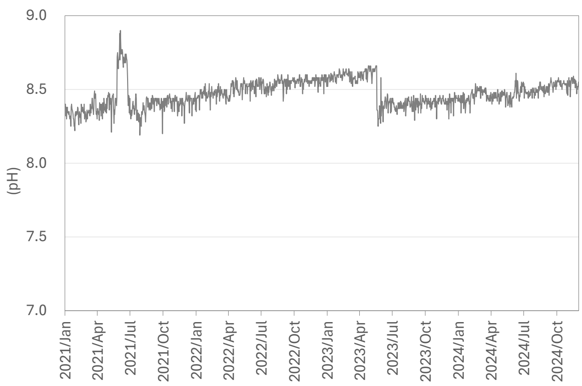
Figure 3.3.15 Changes in Raw Water Color



Source: JST based on data provided by TWAD

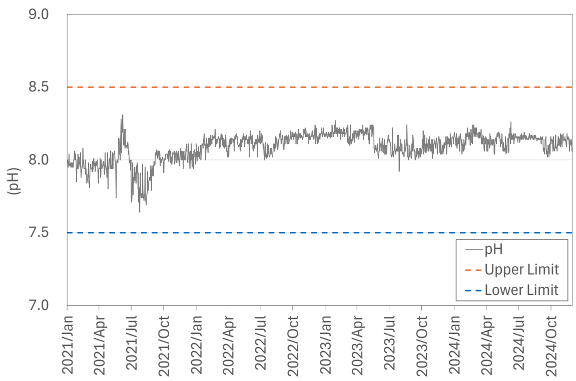
Figure 3.3.16 Changes in Treated Water Color

The color of raw water reached a maximum of 100, recorded on August 3 and 4, 2022, but generally ranged between 3 to 20. The color of treated water consistently remained below the upper limit of five, often measuring one or less.



Source: JST based on data provided by TWAD

Figure 3.3.17 Changes in Raw Water pH

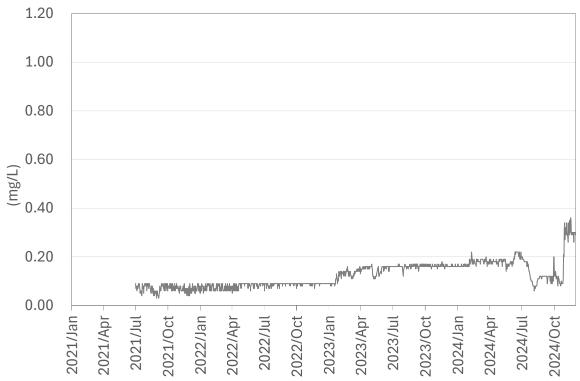


Source: JSTbased on data provided by TWAD

Figure 3.3.18 Changes in Treated Water pH

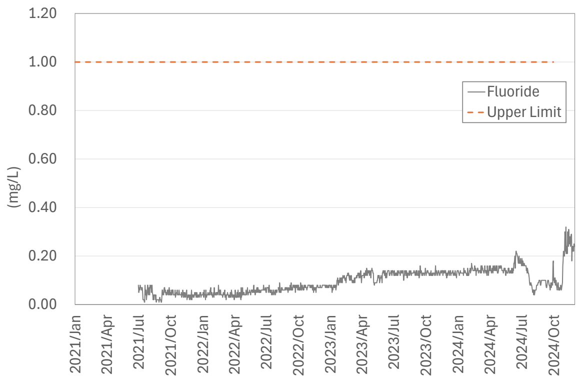
The pH of raw water fluctuated between 8.2 and 8.6, showing relatively consistent values. The pH of treated water remained within the standard control range of 7.5 to 8.5, averaging between 8.0 and 8.2, indicating stable conditions.

The stability of pH levels within the standard range, even when raw water pH was high, demonstrates the effectiveness of the adjusted treatment process in maintaining the efficiency of pH control measures.



Source: JST based on data provided by TWAD

Figure 3.3.19 Changes in Raw Water Fluoride



Source: JST based on data provided by TWAD

Figure 3.3.20 Changes in Treated Water Fluoride

The fluoride in both raw and treated water remained significantly below the water quality standard of 1.0 mg/L throughout the entire period, confirming that good water quality was maintained. Raw water fluoride generally ranged from 0.06 to 0.22 mg/L, with the highest concentration of 0.22 mg/L recorded in mid-June 2024. This value represents approximately one-fifth of the water quality standard and is considered to be at a non-problematic level.

3.3.5 Treated Water Transmission (SCADA Monitoring) of the Previous Hogenakkal Project

The SCADA data on transmission flows from BPS and MBRs, collected from daily reports between July 2021 and September 2024, have been organized and summarized in Table 3.3.8. For details on the SCADA monitoring methodology, kindly refer to Section 3.2.9 of this report.

Table 3.3.8 Trend of Transmission Flows (BPS and MBR)

Year / Month		Treated Water	BPS Flow			MBR Flow		
		Average (MLD)	Max (MLD)	Min (MLD)	Average (MLD)	Max (MLD)	Min (MLD)	Average (MLD)
2021								
	Jul	137	146	99	137	145	100	136
	Aug	144	151	124	144	151	125	144
	Sep	138	151	89	137	153	76	138
	Oct	138	151	106	137	150	100	138
	Nov	137	150	51	137	149	68	137
	Dec	138	159	67	138	152	85	138
2022								
	Jan	140	151	118	140	149	118	140
	Feb	138	155	113	138	147	107	137
	Mar	128	158	12	128	149	26	128
	Apr	138	151	76	138	147	86	138
	Mar	138	150	77	137	148	84	137
	Apr	130	147	45	129	146	25	130
	May	136	147	82	135	143	92	135
	Jun	99	153	2	98	145	2	98
	Jul	122	144	23	122	144	35	122
	Aug	123	154	66	123	145	70	124
	Sep	141	149	79	141	150	87	141
	Oct	140	148	121	139	147	123	139
	Nov	140	151	118	140	149	118	140
	Dec	138	155	113	138	147	107	137

Year / Month		Treated Water	BPS Flow			MBR Flow		
		Average (MLD)	Max (MLD)	Min (MLD)	Average (MLD)	Max (MLD)	Min (MLD)	Average (MLD)
2023								
	Jan	140	153	112	140	150	114	140
	Feb	137	145	113	137	149	115	137
	Mar	135	163	56	135	149	67	136
	Apr	137	149	108	137	147	106	137
	May	131	155	53	131	148	63	131
	Jun	136	156	63	136	149	82	136
	Jul	137	153	70	137	150	72	137
	Aug	142	153	114	141	150	114	141
	Sep	140	150	93	139	148	111	139
	Oct	137	151	105	136	147	121	136
	Nov	141	154	109	141	151	103	141
	Dec	141	148	115	141	148	115	141
2024								
	Jan	142	149	115	142	152	112	142
	Feb	140	148	124	140	149	125	140
	Mar	142	155	126	142	147	127	143
	Apr	139	149	112	140	148	112	140
	May	138	152	98	138	148	105	138
	Jun	137	157	122	137	150	117	137
	Jul	129	150	89	128	146	85	128
	Aug	134	151	93	133	152	92	133
	Sep	144	152	120	143	151	121	142

Source: JST based on data provided by TWAD

3.3.6 Water Distribution

In each urban local body, multiple OHTs are installed, with each OHT assigned to a water distribution zone. Each OHT receives a defined daily volume of water delivered by TWAD's O&M contractor. Distribution pipelines from the OHT are operated and managed by each urban local body. Valve operators are employed in each distribution zone to open and close valves at fixed times each day. Each resident to whom water is distributed opens their tap at the same time to store for two days' worth of water consumption, causing the flow rate in the distribution pipes to exceed the design flow rate. Since the distribution of water to entire zones simultaneously would cause water distribution problems, each zone is usually further divided into several subzones, and water is distributed to these subzones by opening and closing the valves per subzone. In other words, water is delivered to each zone daily, but water is distributed to each subzone once every other day for one to two hours at a time. Since there is no quantitative control or metering, the water distribution time and volume are not equal throughout the zones.

In village panchayats, a specified amount of water is transmitted daily to the OHT of each village via the union MBR and the panchayat MBR by the O&M contractor of TWAD. The water distribution facilities from the OHT to service connections are managed by the village panchayat. The amount of water transmitted to each OHT is controlled by the water level in the OHT; therefore, water cannot be distributed during the time when water is being transmitted to the OHT.

Each resident to whom water is distributed opens the tap at the same time to store two days' worth of water, causing the flow rate in the distribution pipes to exceed the design capacity. Therefore, simultaneous distribution to the entire village panchayat would result in water distribution problems. To manage this, water is distributed to each OHT sequentially by opening and closing the valves in turn. In other words, while water is delivered to each panchayat daily, service connections receive water once every alternate day for one to two hours at a time. Since there are no quantitative control and metering, both the timing and volume of water distribution are uneven throughout the panchayat.

3.4 Hygiene and Water Supply Conditions in the Project Area

3.4.1 Current Status of the Fluorosis Mitigation Program and Water-related Diseases

(1) Trend and Current Situation of Water-related Diseases in the Project Area

The numbers of water-related diseases in Dharmapuri District (2010-2024) and Krishnagiri District (2010-2024) are shown in Tables 3.4.1 and 3.4.2. In Dharmapuri District, the percentage of acute diarrhoea disease (ADD) decreased from 99% to 26% in 2017, with a slight increase observed from 2018 to 2024. In Krishnagiri District, ADD accounted for 66-91% of the total number of water-related diseases. The number of ADD in Krishnagiri decreased significantly from 2010 to 2024. No deaths caused by water-related diseases were reported in either Krishnagiri and Dharmapuri during this period.

Table 3.4.1 Number of Water-related Diseases and Deaths in Dharmapuri District (2010-2024)

Name of Disease / Number of Deaths	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Jaundice	-	-	-	-	-	-	-	
Acute Diarrhoea Disease (ADD)	9,961	11,524	14,031	9,001	8,182	8,454	13,025	
Acute Hepatitis	8	20	34	15	12	14	22	
Dysentery	-	-	-	-	-	-	-	
Typhoid	102	395	512	600	588	1,269	771	
Leptospirosis	1	0	3	71	15	1	2	
Number of Deaths from Water-related Diseases	0	0	0	0	0	0	0	
Total	11,713	16,514	21,371	12,571	11,718	13,105	17,069	
Name of Disease / Number of Deaths	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024 Apr.-- Nov.**
Jaundice	-	-	-	-	5	3	0	0
ADD	503	617	1,152	1,898	1,580	942	819	1,111
Acute Hepatitis	9	6	12	18	7	1	0	0
Dysentery	-	-	-	-	168	168	193	225
Typhoid	1,442	654	515	100	361	559	324	148
Leptospirosis	3	1	15	0	-	-	-	-
Number of Deaths from Water-related Diseases	0	0	0	0	0	0	0	0
Total	1,957	1,278	1,694	2,016	2,121	1,673	1,336	1,484

Source: TWAD (2024)

Table 3.4.2 Number of Water-related Diseases and Deaths in Krishnagiri District (2010-2024)

Name of Disease / Number of Deaths	2010	2011	2012	2013	2014	2015	2016	
Jaundice	-	-	-	-	-	-	-	
ADD	17,206	18,134	14,529	10,762	13,112	21,242	15,998	
Acute Hepatitis	245	547	525	396	308	775	466	
Dysentery	-	-	-	-	-	-	-	
Typhoid	1,507	4,443	6,815	3,174	3,228	3,876	3,578	
Leptospirosis	0	1	1	50	15	7	0	
Number of Deaths from Water-related Diseases	0	0	0	0	0	0	0	
Total	18,958	23,125	21,870	14,382	16,663	25,900	20,042	
Name of Disease / Number of Deaths	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024 Apr.-- Sep.**
Jaundice	-	-	-	-	1	1	37	3
ADD	16,875	14,785	15,716	0	997	2,414	2,803	2,904
Acute Hepatitis	375	472	395	0	3	9	35	25
Dysentery	-	-	-	-	231	404	266	361
Typhoid	4,589	3,895	3,547	0	162	415	415	161
Leptospirosis	3	0	3	0	-	-	-	-
Number of Deaths from Water-related Diseases	0	0	0	0	0	0	0	0
Total	21,842	19,152	19,661	0	1,394	3,243	3,556	3,454

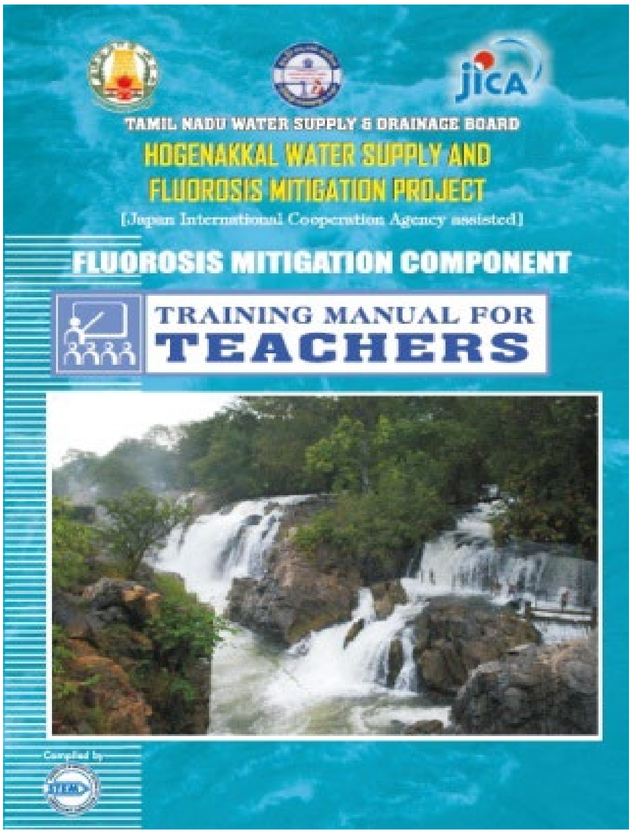
Source: TWAD (2024)

(2) Implementation Results of the Fluorosis Mitigation Component of the Previous Hogenakkal Project and Current Fluorosis Situation in the Project area.[38]

The fluorosis mitigation was carried out through the following three approaches:

- School Approach:
  - Teachers in Dharmapuri and Krishnagiri districts were trained on all aspects of fluorosis. Leveraging these trained teachers, student health surveys were conducted. At least one teacher per school was trained, with more teachers trained in schools with more than 250 students. The selection method for teachers is unknown. A total of 1,694 teachers in Dharmapuri and 2,091 teachers in Krishnagiri were trained from 2011 to 2012.
  - School teachers were trained to identify students affected by fluoride and provide counselling for mitigation through Do’s & Don'ts chart. The training manual for teachers is shown in Figure 3.4.1 and was used to disseminate prevention of fluorosis.

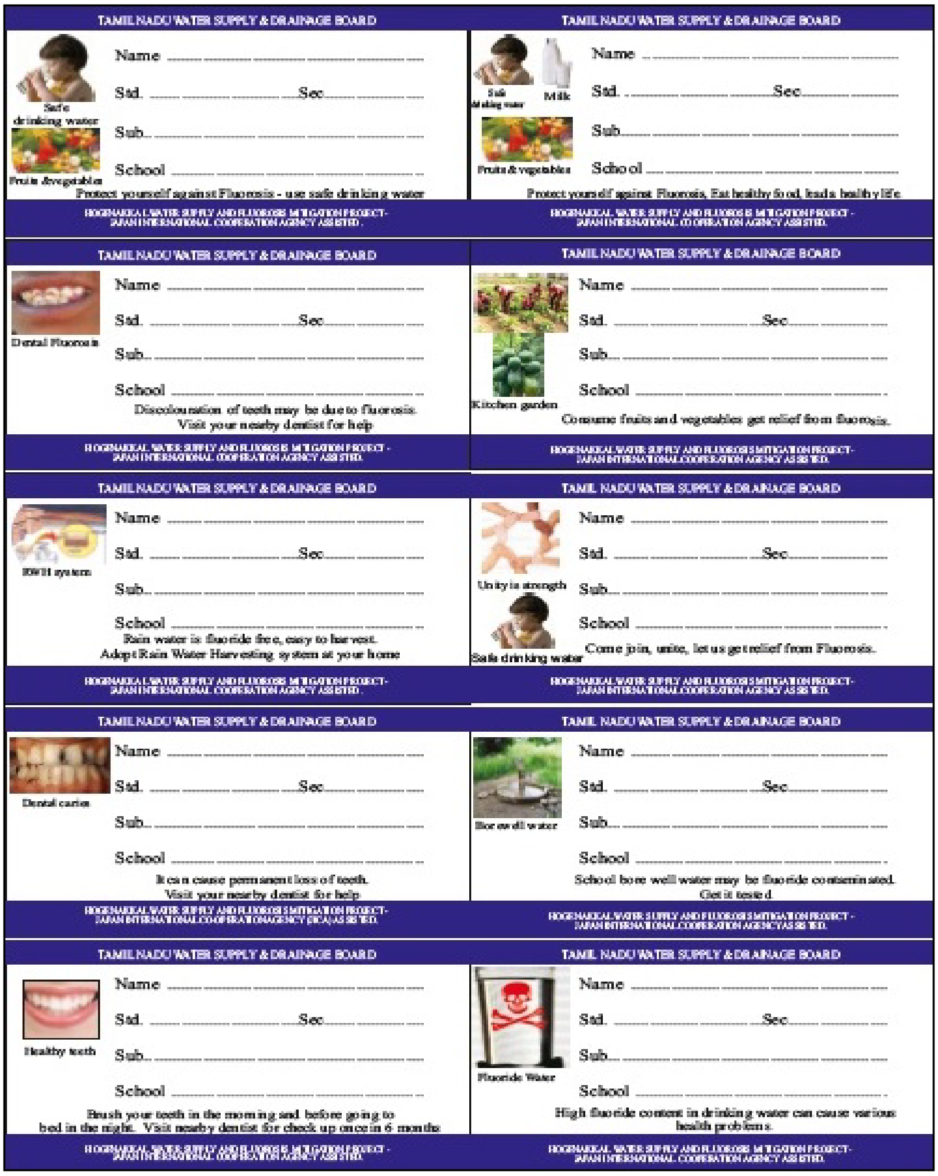
[38] TWAD (2024)



Source: TWAD (2025)

Figure 3.4.1 Training Manual for Teachers

- Regular monitoring of fluoride levels in water sources was conducted, and measures were implemented to mitigate high fluoride concentrations. The specific mitigation measures under the Previous Hogenakkal Project included the following:
  1) To assess the endemicity of fluorosis among school children.
  2) To assess the prevalence of dental fluorosis in school children.
  3) To provide counselling for the adoption of safe drinking water and a nutrition-rich diet.
- Students were provided with stickers with a message on safe water consumption and the importance of diets rich in minerals and vitamins, to create awareness among students on fluorosis and preventive measures. Examples of the stickers are shown in Figure 3.4.2.



Source: TWAD (2025)

Figure 3.4.2 Stickers Provided at Schools

- ➢ Essay and speech competitions were conducted to actively engage students in learning about fluorosis and preventive measures, and to disseminate this information to the community. Prizes were awarded to winners among 5,716 students covering eight blocks in Dharmapuri District and ten blocks in Krishnagiri District.

Table 3.4.3 Numbers of Prizes for Essay and Speech Competition

No.	Name of District	Essay	Speech	Total
1	Dharmapuri	1,212	1,152	2,364
2	Krishnagiri	1,677	1,675	3,352
Total		2,889	2,827	5,716

Source: TWAD (2025)

- Hospital Approach:
- ➢ A team comprising three orthopaedic surgeons, three dentists, one engineer, and two lab technicians underwent training at Osaka University, Japan, focusing on fluorosis and its treatment. The trainees

feed the knowledge gained in training with other doctors at government hospitals and primary health center.

- Five-day training sessions were conducted for 27 government dentists in five batches at M/s. Indian Dental Academy, Hyderabad from July 13, 205 to December 4, 2015, aimed at enhancing knowledge in treating dental fluorosis.
- Laboratory technicians from Dharmapuri and Krishnagiri districts were trained to test fluoride levels in urine, blood, and water using ION meters at the Fluorosis Research and Rural Development Research Foundation, Delhi.
- Medical camps were organized in both districts to identify patients with skeletal fluorosis for corrective surgery.
- Dental treatment was given to girls.
- 17 dental chairs were procured and distributed to government hospitals and primary health centers in both districts. Additionally, three fully automated analyzers were procured and distributed to government hospitals in Dharmapuri District. All medical equipment is utilized by the hospitals concerned and primary health centers. A high-end C-arm image intensifier was procured and installed at Government Dharmapuri Medical College Hospital.

● Community Approach:

- Village health nurses (VHNs) and village volunteer forces (VVFs) were trained in all aspects of fluorosis, including counselling skills, and were made aware of their responsibilities: household health survey, collection of water samples from community water sources, counselling, and impact assessment.
- Household health surveys were conducted by village volunteer forces in all households to identify dental fluorosis, skeletal fluorosis, and non-skeletal fluorosis.
- IEC activities, like street plays and radio talks, were done.
- Urine samples were collected from non-skeletal fluorosis patients for preliminary and impact analysis.
- Micronutrients tablets, like calcium lactate, ascorbic acid, folic acid, and ferrous sulphate with folic acid, were issued to non–skeletal fluorosis patients by VHNs of respective government primary health centers as supplement during group counselling conducted in villages.
- A total of 1,887 VVFs (engaged through NGOs) and 418 VHNs were trained in two-day training on all aspects of fluorosis, including impart counselling, skills, and assigned responsibilities, like household health survey, collection of water samples from community water sources, counselling, and impact assessment. The training program was conducted for VHNs from September 14, 2012 to November 17, 2012, and for VVFs from September 6, 2012 to December 3, 2012, in batches. Photos are shown in Figure 3.4.3.


Source: TWAD (2025)

Figure 3.4.3 Trainings of VHNs and VVFs

According to the National Program for Prevention and Control of Fluorosis (NPPCF), the number of fluorosis cases decreased after 2010. Increases were observed in 2015-16, 2019 (only Dharmapuri), 2020, and 2023, but numbers declined after the relevant years. The number of fluorosis cases from 2010 in Dharmapuri and Krishnagiri districts is shown in Table 3.4.4.

According to TWAD, with the implementation of the Project, the number of people relying on well waters is expected to decrease, with the number of fluorosis patients to decrease even further due to the use of piped water. Therefore, no new measures are considered necessary. However, some teachers who previously participated in the school-based training have since resigned, and new teachers have joined after the program. Thus, in order to reduce the number of fluorosis patients, it is recommended to provide training for new staff and counselling on accessing safe drinking water and maintaining good diet, as shown in 9.4.2 (Chapter 9).

Table 3.4.4 Numbers of Fluorosis in the Target Areas

Number of Fluorosis Cases	2010	2011	2012	2013	2014	2015	2016	2017
Dharmapuri	4,540	3,774	1,025	1,635	507	2,399	2,232	768
Krishnagiri	4,210	3,442	754	1,682	4,388	2,543	2,341	736
Number of Fluorosis Cases	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**Total**
Dharmapuri	743	2,839	3,693	52	283	1,169	592	26,251
Krishnagiri	876	433	3,467	544	896	1,289	649	28,250

Source: TWAD (2024)

3.4.2 Results of Social Condition Survey

The social condition survey was conducted from October 2024 to January 2025 to understand the current socio-economic conditions, the status of water supply and sanitation systems, patterns of usage, as well as the related knowledge of the people in the target area. The survey was subcontracted to Kalpatharu Technologies Private Limited, which has good experience in water supply, rural community development, and conducting various surveys in the area.

A total of 319 households, 14 schools, 27 establishments (including 13 hospitals), 39 offices of municipalities, city corporations, town panchayats, and panchayat unions in the 39 sample places and 2 district offices were chosen and interviewed using questionnaires. In addition, interviews with district office representatives were conducted to understand their role in the water supply system. The contents of the survey questions are shown in Table 3.4.5.

Table 3.4.5 Contents of Survey Questions

Survey	Subjects	Question Items
Household Survey	General Information and Socio-economic Profile of Respondents and Households	Name, gender, education, house ownership, type of house, electricity, monthly income and expenditure, etc.
	Household Water Supply	Type of water supply, water usage and treatment, supply schedule, tariff system, water-related expenses, persons to go, frequency, distance, average time required for water collection, etc.
	Water Demand	Important sources, treatment methods, daily water volume requirement, satisfaction level, problems encountered, willingness to pay, etc.
	Health and Hygiene Situation	Morbidity of waterborne diseases including fluorosis, related expenses, latrine ownership and type, sewer connection, cleaning, situation of girls and women, etc.
Establishments	General Information	Name, address, type of business, opening hours, facilities, number of employees, etc.
	Water Supply	Source of water, availability, connection schedule, tariff system, water-related expenses, persons to go, frequency, distance, average time required for water collection, etc.
	Water Demand	Required daily water volume, satisfaction level, willingness to pay, etc.
Hospitals	General Information	Name, address, level of patient care, opening hours, facilities, number of employees, etc.
	Water Supply	Type of water supply, water use and treatment, supply schedule, tariff system, water-related expenses, persons to go, frequency, distance, average time required for water collection, etc.
	Water Demand	Important source, treatment, required volume of water for daily use, satisfaction level, willingness to pay, etc.
	Health and Hygiene Situation	Morbidity of waterborne diseases, including fluorosis, expenses, type of latrine, type of handwashing facilities, sewer connection, availability of soap, etc.
School Survey	General Information	Name, type of school, address, number of students and teachers, opening hours, facilities, etc.
	Water Supply	Type of water supply, water use and treatment, supply time, tariff system, water-related expenses, persons to go, frequency, distance, average time required for collecting water, etc.
	Water Demand	Required daily water volume, satisfaction level, willingness to pay, etc.
	Sanitation Situation and Gender	Latrine existence and type, construction costs of latrine, sewer connection, cleaning, equipment and facilities, etc.
Panchayat Offices	General Information	Name, address, respondents, population, etc.
	Roles in Water Supply Services	Type of current services, prospective services in the future, etc.
District Offices	General Information	Name, address, respondents, population, etc.
	Roles in Water Supply Services	Type of current services, prospective services in the future, etc.

Source: JST

The field survey was conducted between November and December in 2024. The information obtained through the survey will be combined with information from other sources to analyze the current situation in the target area. The draft final report was submitted to JST in mid-January 2025.

Table 3.4.6 shows the main points of the social conditions survey. Detailed explanation regarding user satisfaction of households, duration of water supply for households, water use purpose and source of water for households, willingness to pay, and affordability are provided in the following sections.

Table 3.4.6 Main Points of the Survey Results

Question	Results	India National Average
Household Survey		
Average Family Size	4 people in a household	4.4 people[39]
Average Monthly Household (HH) Income	INR 15,000-30,000/household	INR 26,000 / household[40]
Primary Occupation	Business: 38%, Agricultural labor: 27 %, Salaried: 13 %, Other Labor: 12 %	Agriculture: 42.86%, Industry: 26.12%, Service: 31.02%[41]
Source of Water Use*	HH connection: 81 %, Standpost: 38 %, Dug well: 15 %, Tube well: 14 %, Tanker: 3 %, Bottled water: 2 %, Other source: 1 %	Ground Water: 80%[42]
Water Treatment Undertaken	No treatment: 28 %, Filtering by cloth: 26 %, Boiling: 22 %, Aqua guard/gadgets: 20 %	N.A.
Duration of Water Supply (Days / Week)	1. HH connection: Every day (18 %), 1 Day (5 %), 2 Days (34 %), 3 Days (3 3%), 4 Days (8 %) 2. Standpost: Every day (30 %), 1 Day (3 %), 2 Days (25 %), 3 Days (32 %), 4 Days (18 %)	2-3 hours per day[43]
Water Usage (Liters / Day)	50-100: 0.9 %, 100- 200: 6.2 %, 200- 300: 5.4 %, 300-400: 39.8 %, 400-500: 35.0%	55 liters per capita in rural areas[44]
Connection / Maintenance Charges for HH (INR):	Less than 5,000: 80.6%, 5,000 - 6,000: 16.8%, 6,000 - 7,000: 2.6%	N.A.
Tariff for HH (INR/month)	100 or less: 51.1%, 100- 150: 45.5%, 150 - 200: 3.0%, > 200: 0.3%	INR 12/m^3 (average in 13 cities)[45]
Type of HH Connection	Metered: 0.3%, Unmetered: 99.7%	N.A.
Time Spent / Day on Collection of Water	1 hour: 63.8%, 2 hours: 19.8%, 3 hours: 16.4%	45.5 minutes per day[46]
Most Important Aspect of Water Supply Service	Quantity: 61.1%, Cost: 14.1%, Accuracy of supply time: 11.5%, Pressure: 7.8%, Distance: 5.5%	N.A.
Status of Connection to the Sewer Network	No: 89.5% Yes: 10.5 %	Yes: 12.2%[47]
Status of Toilet Availability in the House	Available: 100 %	78%[48]
Average Water Usage per Day (in buckets)	Bath: 4 - 6 Buckets, Toilet: 3 - 4 Buckets, Kitchen: 3 - 4 Buckets, Gardening: 1 - 2 Buckets, Others: 3 - 4 Buckets	N.A.

[39] Global Data (Average Size of Households in India (2010 - 2021) - GlobalData accessed on February 19, 2025)
[40] Statistia (India: household income distribution 2021 | Statista accessed on February 19, 2025)
[41] Statistia (India - Distribution of the workforce across economic sectors 2022 | Statista accessed on February 19, 2025)
[42] World Sustainable Development Summit 2022 (water-factsheet.pdf accessed on February 20, 2025)
[43] Kavita Wankhade et al (RF-WATSAN_reduced_sized.pdf accessed on February 19, 2025)
[44] Smartwater (India Water Factsheet 2019_6 accessed on February 19, 2025)
[45] Nilanjan Ghosh et al. (Water Valuation and Pricing in India: Imperatives for Sustainable Water Governance accessed on February 20, 2025)
[46] Ministry of Health and Family Welfare (Press Release:Press Information Bureau accessed on February 20, 2025)
[47] Statistia (India: population with sewer connections 2000-2022 | Statista accessed on February 20, 2025)
[48] World Development Indicators, World Bank (https://www.dataforindia.com/charts/cb9ea6d221fd433eaef4161e89b7e183 accessed on February 20, 2025)

Question	Results	India National Average
Occurrence of Diarrhoea in the Family in the Past Two Weeks	No: 99.1% Yes: 0.9%	N.A.
Cost of Treatment of Diarrhoea (INR)	INR 500 or less:100%	INR 1,186 per patient[49]
Occurrence of Fluorosis in the Family in the Past	No: 90.9% Yes: 9.1%	N.A.
Cost of Treatment of Fluorosis in the Past 1 month (INR)	500 or less: 78.1% 500-1,000: 21.9%	INR 3,500 per patient[50]
Frequency of Cleaning of Household Toilet	Daily: 51.3%, Weekly: 45.8%, As and when it gets dirty: 2.9%	N.A.
Hospitals Survey		
Water Use Purpose and Source of Water	1. Drinking: Water Supply Connection (100%), 2. Hand washing: Water Supply Connection (81%), Own Hand Pump/Tube Well with motor pump (19%), 3. Delivery: Water Supply Connection (79%), Own Hand Pump/Tube Well with motor pump (21%) 4. Others: Water Supply Connection (33%), Own Hand Pump/Tube Well with motor pump (67%)	Water use purpose: Agriculture (85%), Cooking (6 - 8%),[51] Source of water: Ground water (80%)[52]
User Satisfaction	1. Overall: Neutral (23%), Satisfied (69%), Very Satisfied (8%), 2. Supply time (Accuracy): Neutral (46%), Satisfied (46%), Very Satisfied (8%) 3. Quantity (Duration): Neutral (31%), Satisfied (62%), Very Satisfied (8%) 4. Pressure: Neutral (54%), Satisfied (46%) 5. Quality: Neutral (54%), Satisfied (38%), Very Satisfied (8%) 6. Cost: Neutral (54%), Satisfied (38%), Dissatisfied (8%)	N.A.
Hours of Water Supply in Water Supply Connection	All time: 85%, 10-12 hours: 15%	4 hours[53]
Tariff per Month (INR)	More than 500	INR 12/m^3 (average in 13 cities)[54]
School Survey		
Source of Water Use*	HH connection: 79%, Standpost: 23%, Public Hand Pump: 8%, Own Hand Pump: 21%, Dug Well: 17%, Rainwater Harvesting: 8%, Tanker: 25%, Bring from Home: 29%	Ground Water: 80%[55]
User Satisfaction	1. Overall: Neutral (21%), Satisfied (71%), Dissatisfied (7%), 2. Supply time (Accuracy): Neutral (36%), Satisfied (64%) 3. Quantity (Duration): Neutral (36%), Satisfied (57%), Very Satisfied (7%) 4. Pressure: Neutral (29%), Satisfied (64%), Dissatisfied (7%), 5. Quality: Neutral (36%), Satisfied (64%) 6. Cost: Neutral (50%), Satisfied (50%)	N.A.
Tariff per Month (INR)	100 - 200: 29%, 200 - 500: 50%, Nil: 21%	INR 12/m^3 (average in 13 cities)[56]
Presence of Soap in Hand	Yes: 79%	70%[57]

[49] Indian Journal of Public Health (Indian Journal of Public Health accessed on February 20, 2025)
[50] Total dental care (What does a fluoride treatment do for your teeth? – Sabka Dentist – Top Dental Clinic Chain In India | Best Dentists Near Me accessed on February 20, 2025)
[51] World Sustainable Development Summit 2022 (water-factsheet.pdf accessed on February 20, 2025)
[52] World Sustainable Development Summit 2022 (water-factsheet.pdf accessed on February 20, 2025)
[53] International Water Association (Intermittent water supply interventions for India's cities - The Source accessed on February 20, 2025)
[54] Nilanjan Ghosh et al. (Water Valuation and Pricing in India: Imperatives for Sustainable Water Governance accessed on February 20, 2025)
[55] World Sustainable Development Summit 2022 (water-factsheet.pdf accessed on February 20, 2025)
[56] Nilanjan Ghosh et al. (Water Valuation and Pricing in India: Imperatives for Sustainable Water Governance accessed on February 20, 2025)
[57] Manas Ranjan Pradhan et al. (Pattern, predictors and clustering of handwashing practices in India - PMC accessed on February 20, 2025)

Question	Results	India National Average
Wash Facility	No: 21	
Establishment Survey		
Source of Water Use	Water supply Connection: 54%, Stand Post: 8%, Own Hand Pump/Tube Well with motor pump: 35%, Dug well/Bore well: 4%	Ground Water: 80%[58]
Hours of Water Supply in Water Supply Connection	All time: 57%, 4-6 Hours: 21%, 7-10 Hours: 21%	4 hours[59]
Tariff per Month (INR)	Less than 100: 14%, 100-200: 14%, 200-500: 21%, More than 500: 50%	INR 12/m^3 (average in 13 cities)[60]
Panchayats Offices Survey		
Presence of Fluorosis Patients	None: 67%, Less than 25: 15%, 25-50: 13%, 50-100: 3%, More than 100: 3%	N.A.
Whether there are people who are engaged in service/activities related to water supply or sanitation	Yes: 98% No: 2%	-
Major Services for Water Supply	Operation and maintenance, tariff collection/issuing invoices and receipts, taking complaints about water supply	-
District Offices Survey		
Major Services for Water Supply	Operation and maintenance, taking complaints about water supply, tariff collection/issuing invoices and receipts	-

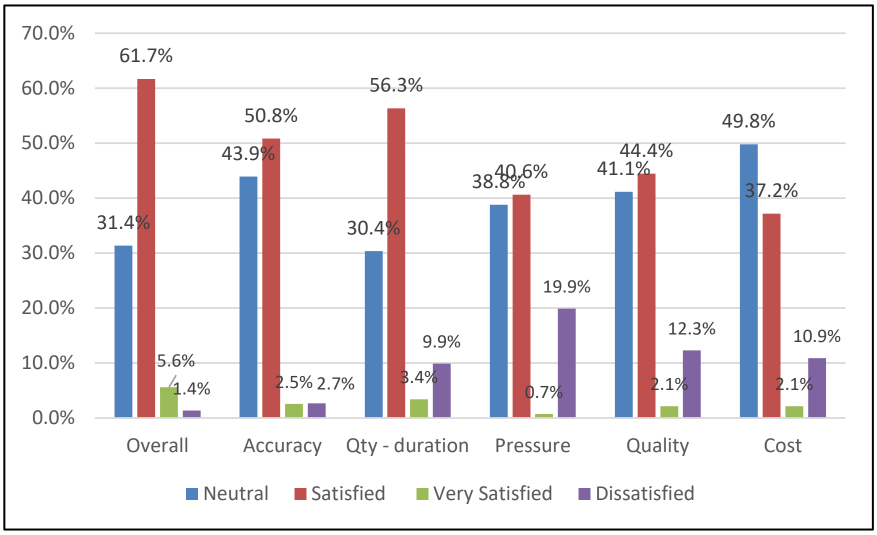
*Note: Some respondents select multiple sources of water use.
Source: JST

(1) User Satisfaction of Households

User satisfaction of households is shown in Figure 3.4.4. About 62% of respondents are satisfied with the overall water supply services, while 31% of them are neutral. Regarding supply time (accuracy), 51% are satisfied and 44% are neutral. Fifty-six percent are satisfied with quantity (duration) and 30% are neutral. Forty-one percent are satisfied with pressure and 39% are neutral. Around 44% are satisfied with quality and 41% are neutral. Additionally, 50% are neutral about cost and 37% are satisfied.

The dissatisfaction levels with the overall water supply services and supply time are low (1% and 3%). The highest dissatisfaction is observed for pressure (20%), followed by the quality and cost.

[58] World Sustainable Development Summit 2022 (water-factsheet.pdf accessed on February 20, 2025)
[59] International Water Association (Intermittent water supply interventions for India's cities - The Source accessed on February 20, 2025)
[60] Nilanjan Ghosh et al. (Water Valuation and Pricing in India: Imperatives for Sustainable Water Governance accessed on February 20, 2025)



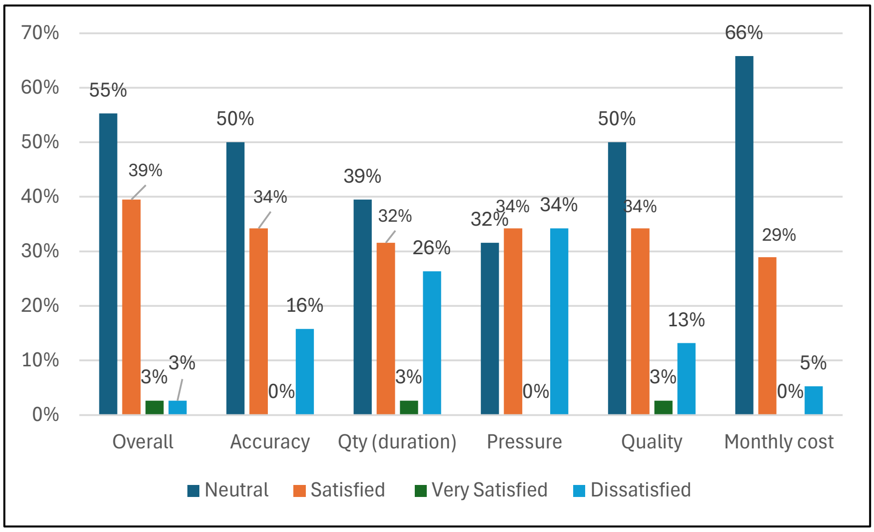
Source: JST

Figure 3.4.4 User Satisfaction of Households

(2) Regional Analysis of User Satisfaction of Households

The Regional Analysis of User Satisfaction is discussed in this section. User satisfaction of households in municipalities and a city corporation is shown in Figure 3.4.5. From this, 39% of respondents are satisfied with the overall water supply services, while 55% are neutral. Regarding supply time (accuracy), 34% are satisfied and 50% are neutral. For the quantity (duration), 32% are satisfied and 39% are neutral. For the water pressure, 34% are satisfied and 32% are neutral. While quality satisfaction is 34% for those who are satisfied and 50% are neutral. Additionally, 66% are neutral about cost, and 29% are satisfied. Percentages of "satisfied" respondents in municipalities and the city corporation for all items are lower than those of all areas.

The percentages of dissatisfied people with overall and monthly cost are low (3% and 5%). The highest percentage of dissatisfied people is 34% for pressure, followed by quantity and accuracy.

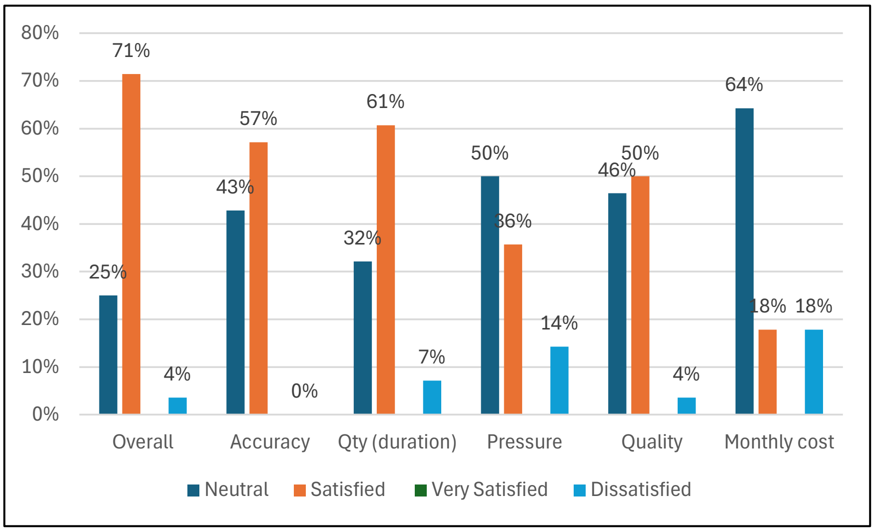


Source: JST

Figure 3.4.5 User Satisfaction of Households in Municipalities and a City Corporation

The user satisfaction of households in town panchayats is shown in Figure 3.4.4. where 71% of respondents are satisfied with the overall water supply services, while 25% of them are neutral. Regarding supply time (accuracy), 57% are satisfied and 43% are neutral. For the quantity (duration) 61% are satisfied, and 32% are neutral. While for the experienced water pressure, 36% are satisfied and 50% are neutral. 50% are satisfied with quality, and 46% are neutral. Additionally, 64% are neutral about cost, and 18% are satisfied. Percentages of "satisfied" respondents in town panchayats for all items, excluding pressure and cost, are higher than those of all areas.

The percentages of dissatisfied people with the overall services and quality are low (4%). The highest percentage of dissatisfied people is 18% for monthly costs, followed by pressure, then quality.

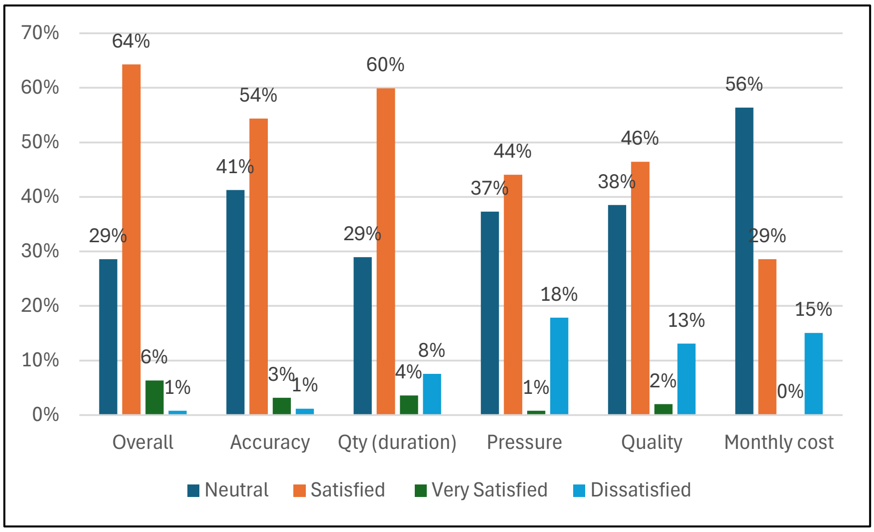


Source: JST

Figure 3.4.6 User Satisfaction of Households in Town Panchayats

User satisfaction of households in town panchayats is shown in Figure 3.4.7. From this, 64% of respondents are satisfied with the overall water supply services, while 29% of them are neutral. Regarding supply time (accuracy), 54% are satisfied and 41% are neutral. For quantity (duration) 60% are satisfied, and 29% are neutral. While for the experienced pressure 44% are satisfied, and 37% are neutral. Around 46% are satisfied with quality, and 38% are neutral. Additionally, 29% are neutral about cost, and 56% are satisfied. Percentages of "satisfied" respondents in village panchayats for all items, excluding cost, are higher than those of all areas.

The percentages of dissatisfied people with the overall services and accuracy are low (1%). The highest percentage of dissatisfied people is 18% in pressure, followed by monthly costs, then quality.

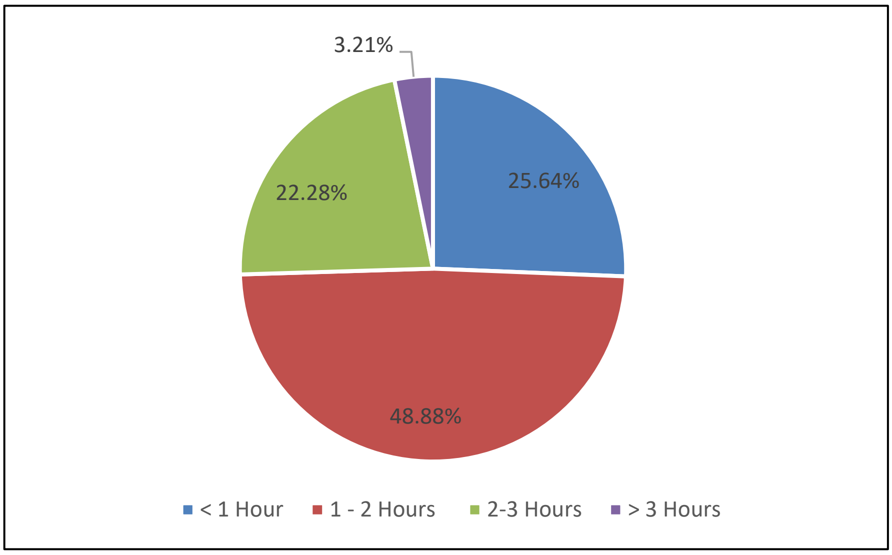


Source: JST

Figure 3.4.7 User Satisfaction of Households in Village Panchayats

(3) Duration of Water Supply for Households

The duration of water supply (hours per day) for household connections is shown in Figure 3.4.8. More than 49% of respondents receive water for one to two hours per day, while 26% have water for less than an hour. About 22% of respondents receive water for two to three hours, and only 3% have water for more than three hours per day.

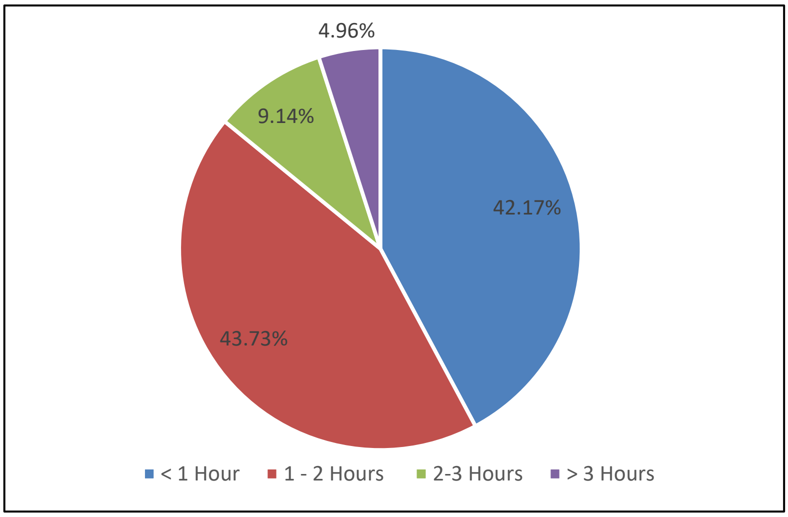


Source: JST

Figure 3.4.8 Duration of Water Supply in Household Connection

As shown in Table 3.4.6, the average water supply time in the target area is approximately 2.3 hours, which is slightly less than the national average of two to three hours.

The duration of water supply at standposts is shown in Figure 3.4.9. More than 44% of standposts users receive water supply for one to two hours a day, 42% for less than an hour, 9% for two to three hours, and only 5% for more than three hours per day.



Source: JST

Figure 3.4.9 Duration of Water Supply at Standposts

(4) Water Use Purpose and Sources of Water for Households

Table 3.4.7 shows the purposes of water use and the sources of water for households. Some respondents reported using multiple water sources for different purposes. HH connections are mainly used for drinking and cooking, while standposts are primarily used for drinking. The use of bottled water for drinking is very limited, accounting only for 1.9%.

Table 3.4.7 Water Use Purpose and Sources of Water for Households

Water Use	Drinking	Cooking	Others
HH Connection	80.7%	80.0%	68.2%
Standpost	27.8%	36.5%	34.0%
Dug Well	3.2%	4.5%	15.0%
Tube Well	1.7%	4.2%	14.1%
Tanker	0.0%	0.0%	2.7%
Bottled Water	1.9%	0.0%	0.0%
Other Source	0.0%	0.0%	0.6%

Source: JST

(5) Willingness to Pay (WTP)

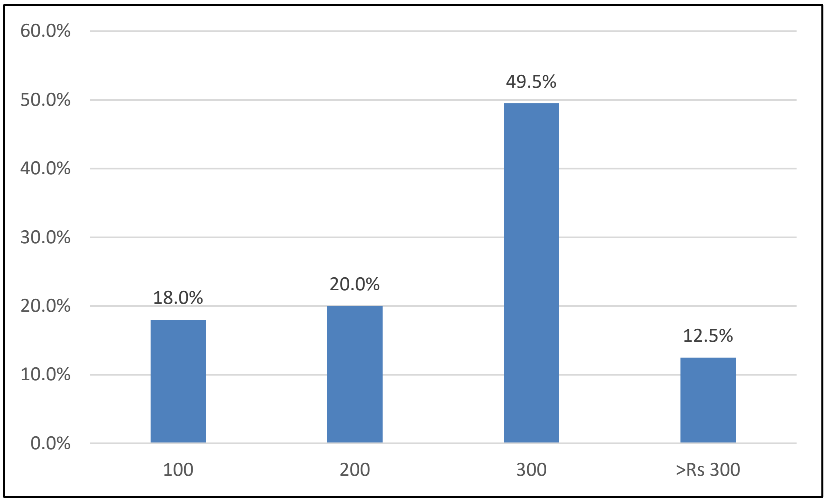
According to the social survey in the Study, around 18% of households confirmed their willingness to pay for a higher level of water supply service. The amount of monthly payment is INR 257 (JPY 488) per month per household, and the percentages of answers regarding willingness to pay for monthly charges are shown in Figure 3.4.10. Specifically, 18% of respondents are willing to pay INR 100 per month, 20% are willing to pay INR 200. 50% are willing to pay INR 300, and 13% are willing to pay more than INR 300 per month. The water demand per capita in municipalities is 135 lpcd, while that in town panchayats is 70 lpcd. That in village panchayats is 55 lpcd based on Chapter 5. Moreover, 20% and 7% of beneficiaries live in municipalities and town panchayats, while 73% live in village panchayats.

The average household size is four people, based on the social conditions survey. The volume of water use is determined based on the target of the Project, and the WTP per m^3 is calculated as follows:

(135 * 0.20 + 70 * 0.07 + 55 * 0.73) lpcd x 30 days x 4 people/1,000 = 8.6 m^3

WTP per m^3 = INR 257/8.6 m^3 = INR 29.8/m^3

Therefore, WTP is INR 29.8/m^3.



Source: JST

Figure 3.4.10 Willingness to Pay for Monthly Charges

The monthly WTP is INR 257, which represents approximately 1.1% of the average monthly household income (INR 15,000-30,000) in the target area. This is lower than the ATP benchmark of 4% of average monthly income, which serves as the benchmark for assessing residents' cost burden.[61]

(6) Regional Analysis of Willingness to Pay

This section analyses trends in WTP across municipalities, city corporations, town panchayats, and village panchayats. In municipalities and city corporations, none of the respondents expressed willingness to pay more for improved services. The average WTP in town panchayats is INR 242 per month per household. The WTP per m^3 is calculated as follows:

70 lpcd x 30 days x 4 people/1,000 = 8.4 m^3

WTP per m^3 = INR 242/8.4 m^3 = INR 28.8/m^3

Therefore, the WTP in town panchayats is INR 28.8/m3. The monthly WTP for town panchayat is INR 242, which is approximately 1.5% of the average monthly household income of INR 16,125 in the Project area. This is lower than the ATP benchmark of 4% of average monthly income, which serves as the benchmark for assessing residents' cost burden.

[61] JICA (2002) "Study on Economic Evaluation Methods for Development Surveys"

The average WTP in a village panchayats is INR 265 per month per household. The WTP per m^3 is calculated as follows:

55 lpcd x 30 days x 4 people/1,000 = 6.6 m^3

WTP per m^3 = INR 265/6.6 m^3 = INR 40.2/m^3

Therefore, the WTP in village panchayats is INR 40.2/m^3. This amount is around 1.4 times that of town panchayats and around 1.3 times that of all target areas. The monthly WTP for village panchayats is INR 265, which represents approximately 1.5% of the average monthly household income of INR 18,269 in the Project area. This value is lower than the ATP benchmark of 4% of average monthly income, which serves as the benchmark for residents' cost burden.

(7) Affordability to Pay (ATP)

As shown in Table 3.4.8, the affordability to pay (ATP) is calculated at INR 54.9/m^3. Affordability to pay per month per household is INR 269.0, based on the social conditions survey. The current average monthly water usage per household is 4.9 m^3, according to TWAD data and the average family size indicated in the above survey. The ATP is calculated as follows:

269/ 4.9 ≒ 54.9 (INR/m^3)

The ATP is higher than the price level of the current situation, and is around 1.8 times than the WTP. The monthly ATP in the target area is INR 269, which is approximately 1.2% of the average monthly household income (INR 15,000-30,000). This is lower than the ATP benchmark of 4% of average monthly income, which is used as the benchmark for assessing residents' financial burden.

Table 3.4.8 Affordability to Pay

ATP per Month per Household	Average Monthly Water Usage per Household (current use)	ATP
INR 269.0	4.9 m^3	INR 54.9/m^3

Source: JST

(8) Regional Analysis of Affordability to Pay (ATP)

This section analyses trends in ATP across municipalities, city corporations, town panchayats, and village panchayats. The average ATP in municipalities and city corporations are INR 274 per month per household. The amount of water used is based on current consumption level. The ATP per m^3 is calculated as follows:

52 lpcd x 30 days x 4 people/1,000 = 6.2 m^3

ATP per m^3 = INR 274 /6.2 m3 = INR 44.2/m^3

Therefore, the ATP in municipalities and city corporations is INR 44.2/m^3. The monthly ATP for the town panchayat is INR 274, which is approximately 1.7% of the average monthly household income (INR 16,125) in the Project area. This value is lower than the ATP benchmark of 4% of average monthly income, which is used as the benchmark for assessing residents' cost burden.

The average ATP in town panchayats is INR 259 per month per household. The ATP per m^3 is calculated as follows:

52 lpcd x 30 days x 4 people/1,000 = 6.2 m^3

ATP per m^3 = INR 259 /6.2 m^3 = INR 41.8/m^3

Therefore, the ATP in town panchayats is INR 41.8/m^3.

The average ATP in village panchayats is 273 per month per household. The ATP per m^3 is calculated as follows:

30 lpcd x 30 days x 4 people/1,000 = 3.6 m^3

ATP per m^3 = INR 273 /3.6 m^3 = INR 75.8/m^3

The ATP in village panchayats is INR 75.8/m^3, which is the highest in the target areas. It is around 1.8 times that of town panchayats, and 1.7 times that of municipalities and city corporations. The monthly ATP for village panchayat is INR 273, which is approximately 1.5% of the average monthly household income (INR 18,269) in the target area, and is lower than the ATP benchmark of 4% of the average monthly income, which is used as the benchmark for assessing residents' cost burden.

3.5 Financial Status of the Government of Tamil Nadu and its Water Supply Entities

3.5.1 Financial Status of the Government of Tamil Nadu

Table 3.5.1 describes the accountants of the Government of Tamil Nadu (GoTN). The state's revenue increased gradually from INR 1,745 billion in 2019-2020 to INR 2,437 billion in 2022-2023. In 2022-2023, the majority of the revenue (77.5%) was collected as tax revenue, which includes goods and services tax, taxes on income and expenditure, and taxes on property and capital transactions, among others. The tax revenue is divided into two groups, namely, state-owned tax and shared union tax. The composition of the state-owned tax, which the state government has the right to collect, is 77-81% of the total tax revenue over the last five years. Non-tax revenue takes a share of 7% in 2022-2023, which is composed of fiscal services, interest receipts, dividends and profits, and other non-tax revenues. Grant-in-aid is the subsidy given from the central government, accounted for 15.5% of total revenue in 2022-2023.

The total expenditure comprises general services, social services, economic services, and grants-in-aid and contributions. Social services include sectors such as water supply, sanitation, housing, and urban development. Social services accounted for the largest proportion of expenditures (35-38%) in 2020-2021 and 2021-2022, while general services accounted for the largest proportion (35-37%) in 2019-2020 and 2022-2023.

Table 3.5.1 Accounts of GoTN (2019 – 2023)

(Unit: INR million)

Items	2019-2020	2020-2021	2021-2022	2022-2023
Revenue Receipts	1,745,259	1,740,763	2,074,924	2,437,493
Expenditure	2,104,347	2,364,022	2,540,304	2,799,645
Surplus or Deficit on Revenue Account	**-359,088**	**-623,259**	**-465,380**	**-362,151**
Public Debt- Receipts	667,743	1,028,670	1,044,850	1,010,617
Public Debt- Repayments	178,665	162,286	197,372	271,044
Public Debt (Net)	**489,079**	**866,384**	**847,478**	**739,573**
Capital Expenditure including Loans and Advances and excluding Public Debt	**242,698**	**316,572**	**352,965**	**457,546**
Surplus or Deficit on Capital Account	**246,380**	**549,812**	**494,512**	**282,027**
I. TOTAL - CONSOLIDATED FUND (Net)	**-112,708**	**-73,447**	**29,132**	**-80,124**
II. CONTINGENCY FUND (Net)	**-103**	**0**	**0**	**0**
III. PUBLIC ACCOUNT (Net)	**126,437**	**59,541**	**-21,790**	**76,024**
TOTAL TRANSACTIONS (I + II +III)	**13,626**	**-13,906**	**7,342**	**-4,101**

Income	2019-2020	2020-2021	2021-2022	2022-2023
A. Tax revenue	1,338,547	1,310,775	1,603,249	1,889,540
B. Non-tax Revenue	128,878	104,219	121,165	170,610
C. Grants-in-aid and Contributions	277,834	325,770	350,510	377,344
Total	1,745,259	1,740,763	2,074,924	2,437,493

Expenditure	2019-2020	2020-2021	2021-2022	2022-2023
A. General services	781,374	789,929	848,935	990,967
B. Social services	739,993	898,049	887,491	889,676
C. Economic services	426,098	518,086	608,983	719,746
D. Grants-in-aid and Contributions	156,883	157,959	194,895	199,256
Total	2,104,347	2,364,022	2,540,304	2,799,645

Source: GoTN (2023) (https://financedept.tn.gov.in/en/my-documents/2020/07/Finance-Account-upto-2022_2023.pdf accessed on November 15, 2024)

3.5.2 Financial Conditions and Budget System of TWAD

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3.5.3 Financial Conditions of Local Governments

3.6 Water Tariff Setting and Collection

3-82

3.7 Necessity of the Project

In light of the Federal/State Government policies on the water supply sector and the present water supply conditions in the Project area, the necessity of the Project is explained below.

(1) Rapid Urbanization, Population Growth, and Increasing Water Demand

- Rapid urbanization has transformed the town of Hosur into an industrial city. Many industries have set up their plants in Hosur because of easy and cheap land availability and its proximity to Bangalore.
- Supplying a sufficient volume of water will benefit industries and further enhance the region's economic growth

(2) Gap Between the Present Service Level and the State's Target Service Level

Table 3.7.1 shows the present supply conditions and the State's target.

Table 3.7.1 Present Supply Conditions and State's Target

Service Level	Present Condition	India/State's Target
Per Capita Supply	Urban Area City Corporation/Municipality: 93 lpcd Town Panchayat: 64 lpcd Rural Area (Village Panchayat): 35 lpcd	Urban Area City Corporation/Municipality: 135 lpcd Town Panchayat: 70 lpcd Rural area (Village Panchayat): 55 lpcd
Service Type	Urban Area: - House service connection and public tap - Intermittent supply Rural Area: - House service connection and public tap - Intermittent supply	Urban Area: - House connection with continuous supply (24 x 7 water supply) Rural Area: - House connection to all households

Source: TWAD

Each ULB and village panchayat has a plan to install house connections under the Project. However,, none of the ULBs has a concrete plan for implementing a 24x7 water supply. Therefore, technical assistance will be required to support the implementation of 24x7 water supply.

(3) Limited Local Water Source

The Project area, comprising Dharmapuri and Krishnagiri districts, is drought-prone and has limited ground water potential. Furthermore, the fluoride levels in groundwater in many parts of the Project area are unsuitable for drinking purposes.

(4) Needs for Improved Water Supply System

The following improvements to the water supply system are needed for better and more sustainable water supply and sanitation services:

a) Ensure equitable water supply and maintain adequate water pressure throughout the system.
b) Prevent contamination in distribution systems through continuous water supply, thereby reducing the risk of water-borne diseases.
c) Achieve economic savings through avoiding undue infrastructure, such as household-level underground water storage tanks, which should be gradually phased out.

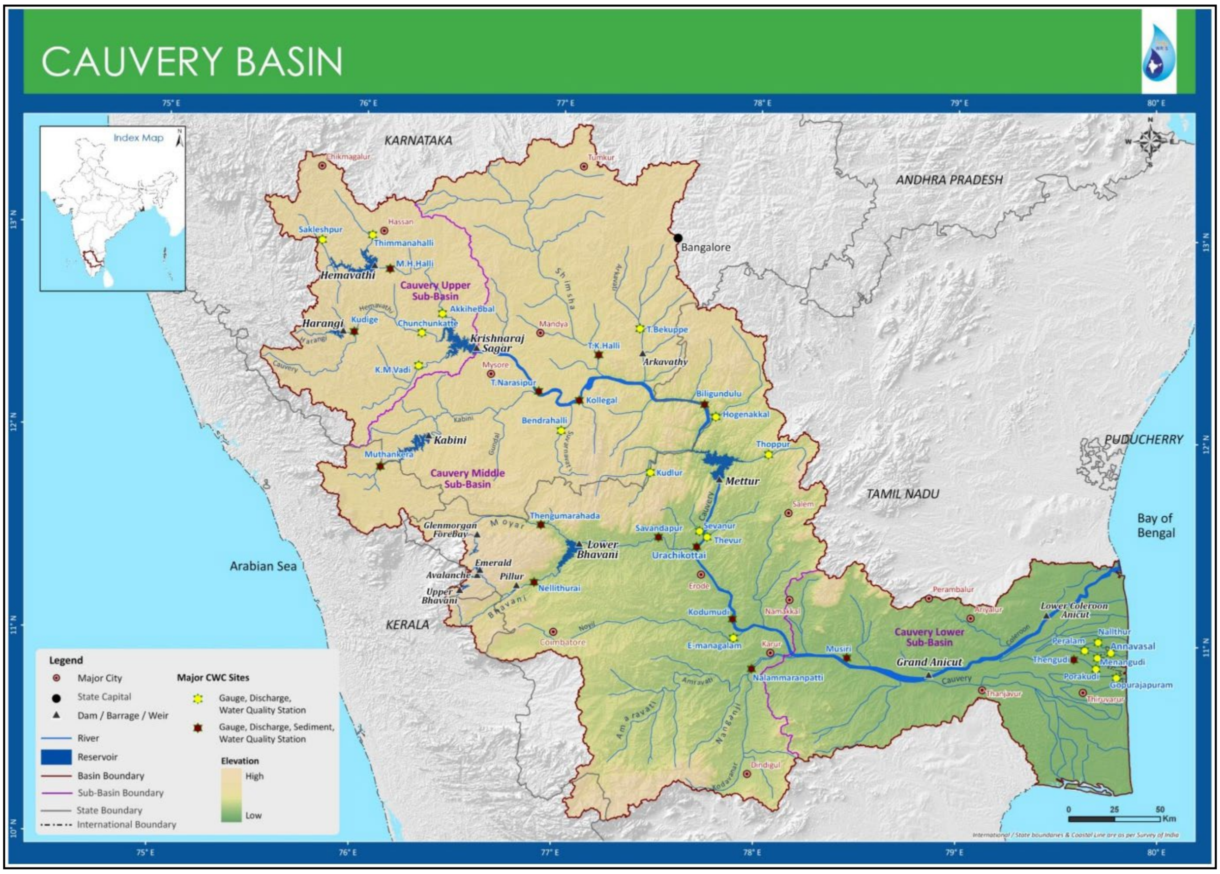
Moreover, introducing a state-of-the-art system is required to develop an economically viable and sustainable water supply system.

Chapter 4 Verification of Available Raw Water

4.1 Outline of the Cauvery River

4.1.1 Cauvery River Basin

Figure 4.1.1 shows the Cauvery River basin. The Cauvery River originates at an elevation of 1,341 m in the Kodagu District of Karnataka. The river flows for about 320 km through the Deccan Plateau in Karnataka before entering the state of Tamil Nadu. It flows further eastward in Tamil Nadu for 416 km before flowing into the Bay of Bengal near Poompuhar in the Mayiladuthurai District of Tamil Nadu. The river basin, covering an area of 81,155 km^2, spans several states: Karnataka (42.2%), Tamil Nadu (54.1%), Kerala (3.5%), and the Union Territory Puducherry (0.2%).



Source: Cauvery Basin Version 2, Central Water Commission and National Remote Sensing Centre, March 2014

Figure 4.1.1 River Basin of the Cauvery River

4.1.2 Allocation of Water Rights

Under Section 5(2) of the Inter-State River Water Disputes Act, 1956, the Cauvery Water Disputes Tribunal delivered its Final Order on February 5, 2007. Following appeals filed by the States of Karnataka, Kerala, and Tamil Nadu against the Final Order of the Tribunal, the Supreme Court delivered its judgment on February 16, 2018, detailing the allocation of water, as summarized in Table 4.1.1.

Table 4.1.1 Allocation of Water of the Cauvery River

	Annual Amount (million m^3)
Water Intake	
Karnataka State	8,063
Tamil Nadu State	11,447
Kerala State	850
Pondicherry State	198
Environmental Protection	283
Outflow to the Sea	113
Total	20,954

Source: Water Resources Department Policy Note 2024-2025

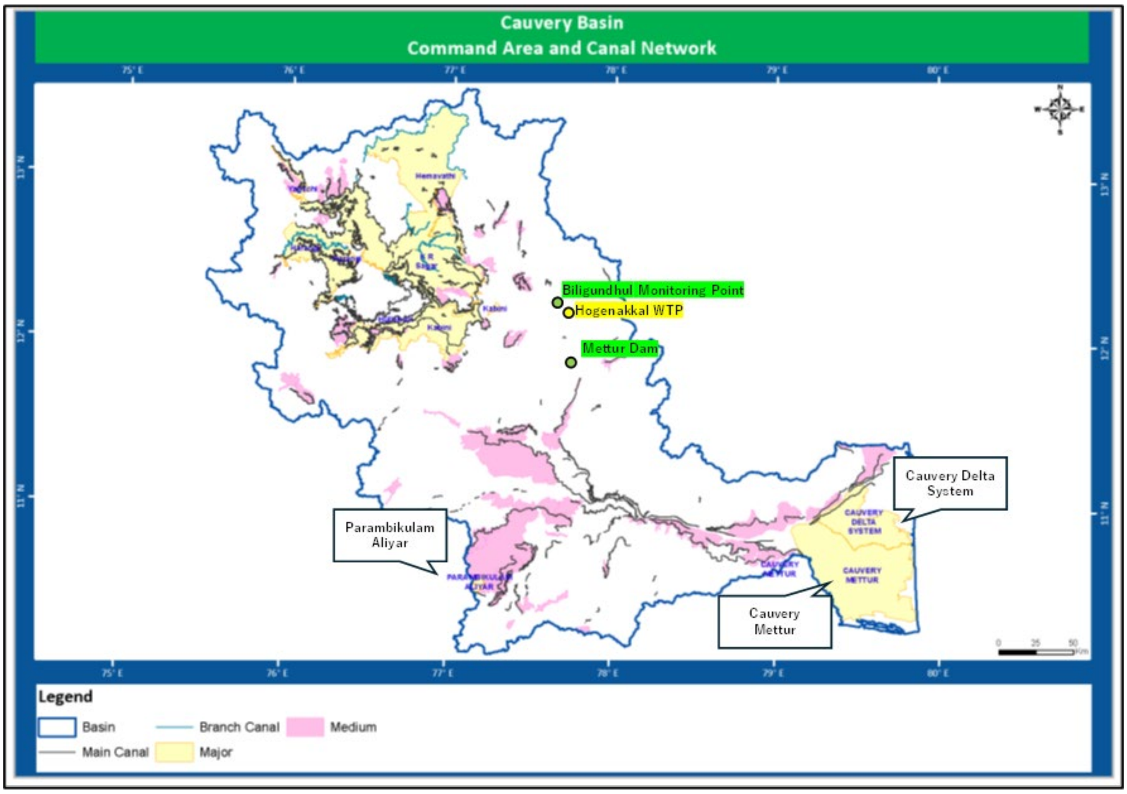
In addition, the Federal Government established the Cauvery Water Management Authority (CWMA) and the Cauvery Water Regulation Committee (CWRC) for water resource management of the Cauvery River. Under this framework, representatives from each state are discussing the following issues regarding the water resource management of the Cauvery River:

- Secured implementation of the water allocations, as presented in Table 4.1.1.
- Development of the Mekedatu Dam Project in Karnataka State.
- Operation of the Mettur Dam (Stanley Reservoir) in Tamil Nadu State.
- Return of treated sewage water from Bangalore to the Cauvery River.

4.1.3 Water Utilization Status of the Cauvery River in Tamil Nadu State

(1) Irrigation Water Use

Figure 4.1.2 illustrates the irrigation areas within the Cauvery Basin. There are three main irrigation areas in Tamil Nadu State: Parambikulam Aliyar, Cauvery Mettur, and Cauvery Delta System. Irrigation water is drawn from ten intake barrages located downstream of the Mettur Dam. A sufficient amount of water is observed to be flowing downstream at the Biligundhul River Water Level Gauging Station, which is located near the water intake point of the Project. Additionally, there are no large-scale irrigation areas or intake weirs between the Billigundhul Monitoring Point and the Mettur Dam. Therefore, the impact of the Project on irrigation water usage is considered to be minimal.



Source: Based on the map of Cauvery Basin Version 2 compiled by JST

Figure 4.1.2 Irrigation Area of the Cauvery Basin

(2) Power Generation Water Use

In Tamil Nadu State, the Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) has constructed nine hydroelectric power plants and one thermal power plant.

Hydroelectric Power Plant

Lower Mettur Hydroelectric Power Plant at the Downstream of Mettur Dam
Lower Mettur Hydroelectric Power Plant I at Chekkanur Barrage
Lower Mettur Hydroelectric Power Plant II at Nerinjipettai Barrage
Lower Mettur Hydroelectric Power Plant II at Kuthiraikkalmedu Barrage
Lower Mettur Hydroelectric Power Plant II at Urachikottai Barrage
Bhavani Kattalai Hydroelectric Power at the Downstream of Bhavani Dam
Bhavani Kattalai Hydroelectric Power I at Samayasangili Barrage
Bhavani Kattalai Hydroelectric Power II at Vendipalayam Barrage
Bhavani Kattalai Hydroelectric Power II at Solasiramani Barrage

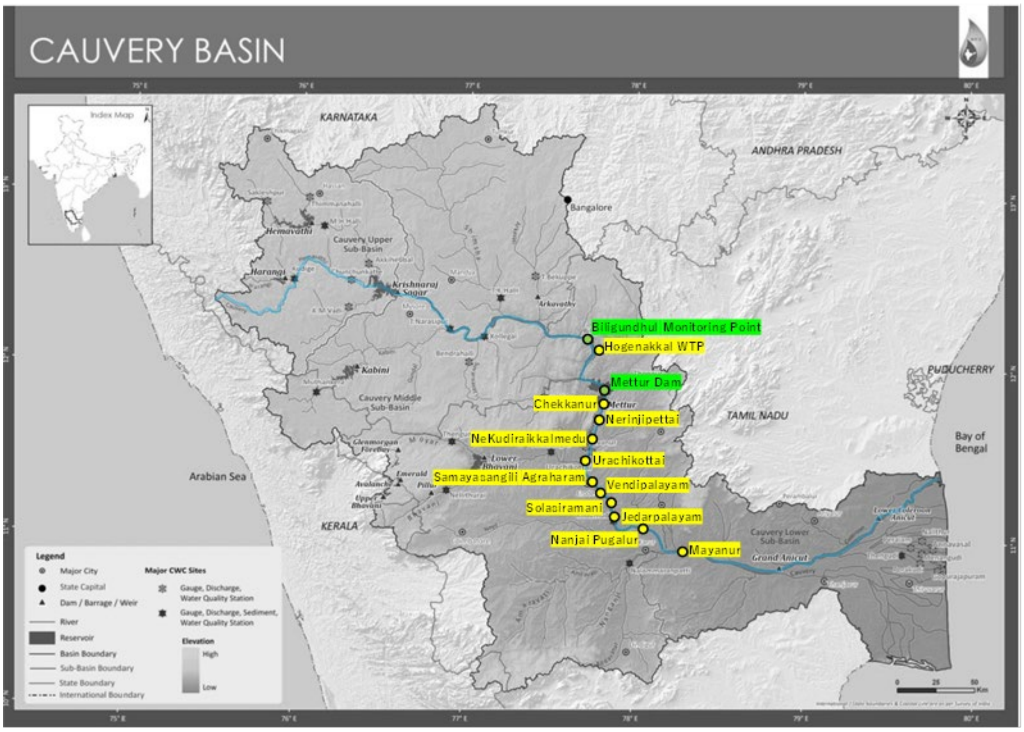
Thermal Power Plant

Mettur Thermal Power Plant

As for hydroelectric power plants, all the water used is returned to the river, resulting in zero water consumption. In contrast, the Mettur Thermal Power Plant consumes 3.6 MLD of water.

(3) Municipal Water Use

In Tamil Nadu State, on the downstream of the Mettur Dam, there are ten barrages used for the municipal water intake, as shown in Figure 4.1.3. Table 4.1.2 shows the current and proposed intake volumes for water supply, including both existing and proposed components of the Hogenakkal Project.



Source: Based on the map of Cauvery Basin Version 2 compiled by JST

Figure 4.1.3 Location of the Mettur Dam and Barrages for the Municipal Water Intake in TWAD Jurisdiction Area of the Cauvery River

Table 4.1.2 Municipal Water Intake Data from TWAD Jurisdiction Area of the Cauvery River

Sl.No.	NAME OF BARRAGE/ANICUT	TWAD - Existing		ULB - Existing		TWAD - Proposed		**Grand Total**	
		Intake No.	Permitted Qty(MLD)	Intake No.	Permitted Qty(MLD)	Intake No.	Permitted Qty(MLD)	**Intake No.**	**Permitted Qty(MLD)**
UPSTREAM OF METTUR DAM									
1	DOWNSTREAM OF BILLIGUNDULU GAUGE STATION	1	160			1	305	2	465
	Subtotal	1	160			1	305	2	465
DOWNSTREAM OF METTUR DAM									
2	UP STREAM OF CHEKKANUR BARRAGE	6	333	4	166	1	278	11	778
3	UP STREAM OF NERINGIPETTAI BARRAGE	4	109	3	11			7	120
4	UP STREAM OF KUDIRAIKKALMEDU BARRAGE	4	121	1	1	1	13	6	135
5	UP STREAM OF URACHIKOTTAI BARRAGE	6	168	2	19			8	187
6	UP STREAM OF SAMAYASANGILI AGRAHARAM BARRAGE	3	19	10	218			13	237
7	UP STREAM OF VENDIPALAYAM BARRAGE	2	11	9	75			11	86
8	UP STREAM OF SOLASIRAMANI BARRAGE	4	50			1	16	5	66
9	UP STREAM OF JEDARPALAYAM ANICUT	2	25	1	22			3	47
10	UPSTREAM OF NANJAI PUGALUR BARRAGE	3	200					3	200
11	UP STREAM OF MAYANUR BARRAGE	1	4					1	4
	Subtotal	35	1040	30	512	3	307	68	1859
	Total	**36**	**1200**	**30**	**512**	**4**	**612**	**70**	**2324**

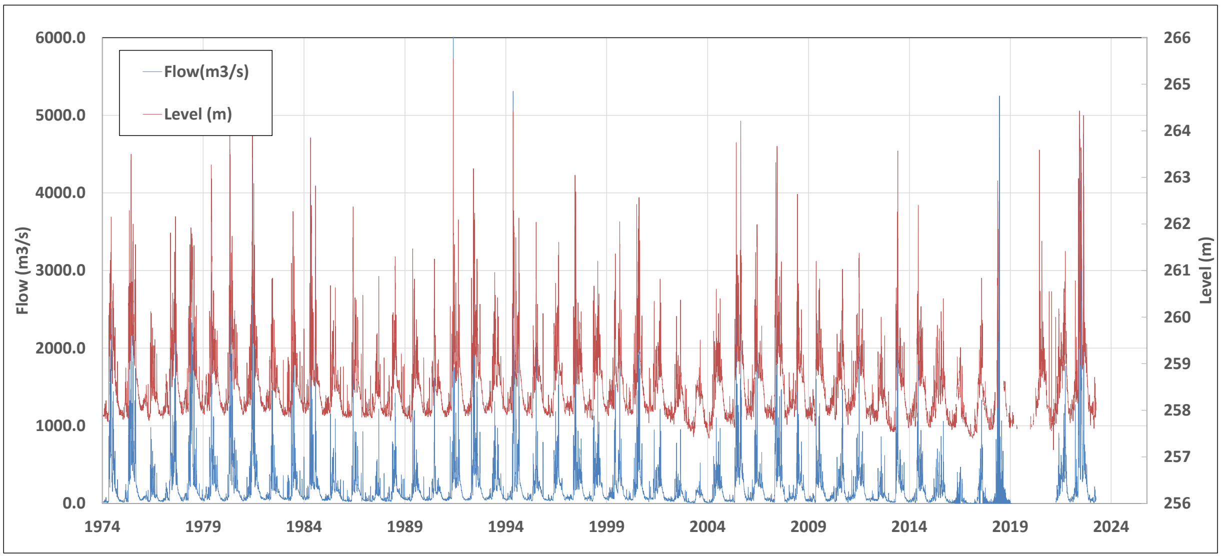
Source: TWAD

It has been confirmed that the total water intake volume for municipal water supply is 2,324 MLD, consisting of 1,200 MLD of the existing intake volume by TWAD, 512 MLD of existing intake volume by ULB, and 612 MLD of future additional intake volume by TWAD. This total represents only 7.4%

of the total annual water allocation of 11,447 million m^3/year to Tamil Nadu, as presented in Table 4.1.1. Among these, the Hogenakkal Water Treatment Plant is the only facility that will draw water upstream of the Mettur Dam, with an intake volume of 465 MLD.

4.2 Water Level and Flow Rate at the Intake Location

Figure 4.2.1 shows the monitoring data of the Cauvery River at the Biligundhul River Gauge Station for the past 50 years (1974–2023).



Note: Flow (m^3/s) is shown in blue and level (m) in red.

Source: Central Water Commission, Tamil Nadu

Figure 4.2.1 Monitoring Data of the Cauvery River at the Biligundhul River Gauge Station

During the dry season, the flow rate remains at approximately 100 m^3/s (equivalent to 8,640 MLD), with the water level maintained at 258 m. In contrast, during the rainy season, the flow rate exceeds a maximum of 4,000 m^3/s, and the water level rises above 266 m.

4.3 Confirmation of the Availability of Raw Water

Table 4.3.1 shows the drought flow rate based on the abovementioned long-term monitoring data for each year. The drought flow rate is defined as the minimum flow rate that is maintained for 355 days in a year.

Table 4.3.1 Drought Flow Rate for Each Year

Year	Drought Flow Rate (m^3/s)	Year	Drought Flow Rate (m^3/s)
1974	#N/A	1999	#N/A
1975	17.4	2000	43.1
1976	26.9	2001	46.4
1977	26.2	2002	28.3
1978	33.9	2003	8.4
1979	39.5	2004	6.3
1980	#N/A	2005	20.1
1981	37.3	2006	38.9
1982	47.5	2007	22.0

Year	Drought Flow Rate (m^3/s)	Year	Drought Flow Rate (m^3/s)
1983	42.2	2008	26.3
1984	53.2	2009	19.4
1985	39.7	2010	28.3
1986	25.2	2011	35.1
1987	25.9	2012	36.7
1988	27.7	2013	14.3
1989	37.5	2014	17.5
1990	41.6	2015	14.2
1991	41.4	2016	#N/A
1992	42.4	2017	#N/A
1993	45.8	2018	#N/A
1994	43.3	2019	#N/A
1995	36.8	2020	#N/A
1996	38.8	2021	#N/A
1997	45.8	2022	25.2
1998	32.8	2023	#N/A

Note: Years without 365 days of data due to missing monitoring data is shown as "#N/A".

Source: Central Water Commission

Based on the analysis above, the ten-year probable drought flow rate is approximately 17 m^3/s (1,468 MLD). This flow rate significantly exceeds the existing and proposed intake volume of 465 MLD—160 MLD from the Previous Hogenakkal Project and 305 MLD for the Project. Therefore, the availability of raw water for the Project has been confirmed.

4.4 Effect by Climate Change

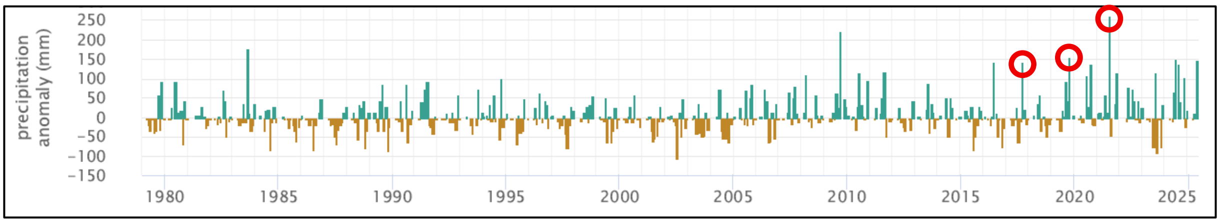
Table 4.4.1 tabulates the daily average discharge from the Mettur Dam by month. Based on the overall trend, it was observed that discharge levels are relatively low during the dry season from January to May and increase from around June when the rainy season begins.

Table 4.4.1 Daily Average Discharge from the Mettur Dam by Month

Daily Average Discharge (MLD)	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Average
January	17,008	20,450	1,061	13,008	30,453	1,133	2,111	14,096	23,789	1,444	**12,455**
February	3,491	8,080	1,162	13,054	31,426	2,647	3,675	2,962	2,454	5,226	**7,418**
March	1,937	2,320	6,022	9,886	25,225	2,642	3,677	3,678	3,044	2,528	**6,096**
April	4,498	3,366	4,780	9,075	18,607	2,936	2,822	3,677	3,670	3,994	**5,742**
May	3,134	2,922	4,679	9,824	14,424	1,770	3,152	7,392	3,670	4,270	**5,524**
June	3,287	2,990	4,246	21,314	13,148	14,469	17,226	28,592	1,674	3,904	**11,085**
July	5,512	5,746	8,659	85,511	14,960	29,006	25,851	76,900	2,657	8,084	**26,289**
August	21,895	1,865	21,474	85,438	14,062	28,239	27,988	203,015	21,102	8,426	**43,351**
September	34,347	9,511	52,683	66,532	62,568	31,994	24,230	114,212	16,644	4,346	**41,707**
October	19,937	29,224	43,130	57,900	42,784	28,350	3,836	115,470	4,385	-	**38,335**
November	1,456	3,831	35,940	65,607	20,174	16,619	55,064	38,755	784	-	**26,470**
December	6,383	1,827	25,950	44,204	12,219	2,876	27,558	21,737	618	-	**15,930**
Average	**10,240**	**7,678**	**17,482**	**40,113**	**25,004**	**13,557**	**16,432**	**52,541**	**7,041**	**4,691**	**19,478**

Source: Central Water Commission

The large discharges recorded during the rainy seasons of 2018, 2019, and 2022 can be attributed to increased river flow due to extreme rainfall events caused by the recent climate change. Figure 4.4.1 illustrates the historical trends of abnormal rainfall in Karnataka, located in the upper reaches of the Cauvery River. It can be observed that the extent and frequency of abnormal rainfall have increased since the beginning of 2000s, with major rainfall events occurring in 2018, 2019, and 2022, respectively. The frequency of extreme rainfall events has been increasing since the beginning of the 2000s.



Source: meteoblue

Figure 4.4.1 Extreme Rainfall Record in the Karnataka State (Upper Cauvery River Basin)

4.5 Alternative Water Source Other than the Cauvery River

The eastern side of the Project area falls within the Pennyaiyar River basin, as shown in Figure 4.5.1. However, extracting water from the Pennyaiyar River for the Project is not feasible in terms of either quantity or quality for the following reasons:

- The storage capacity and catchment area of the Pennaiyar Basin are limited; thus, extensive withdrawal of both surface and subsurface water from this river basin is not possible.
- Occurrence of fluoride-bearing rock formations and high levels of pollution in the upper reaches of the river further limit its suitability as a water source.

Source: ENVIS Center, Ministry of Environment and Forest

Figure 4.5.1 Tamil Nadu River Basin Map

Moreover, the Sempenai River, a small tributary of the Cauvery River that joins downstream of the Project intake point, has a limited watershed area and is not a viable source for water intake.

Chapter 5 Review of the Water Supply Plan in the DPR

This chapter presents the results of the review of the DPR water supply plan. The review covered the planning conditions, the process for establishing water demand projections and facility scale, as well as the determination of facility locations. It was confirmed that the DPR water supply plan has been adequately prepared.

The water supply plan in the DPR was prepared in accordance with the conditions specified and provided by the TWAD. The plan has been reviewed and approved by both the State and Federal governments. The water supply plan has been developed considering the following matters proposed in the Draft New National Water Policy (NWP, 2020), including the following:

- Reduce the industrial water footprint by minimizing freshwater use and shifting to recycled water.
- Mandate the use of treated wastewater for all non-potable purposes in cities, such as toilet flushing, fire protection, vehicle washing, landscaping, and horticulture.
- Shift to surface water use from groundwater use in response to declining water tables and deteriorating groundwater quality in many areas.
- Deploy pressurized closed-conveyance pipelines integrated with Supervisory Control and Data Acquisition (SCADA) systems.

5.1 Basic Conditions

The basic conditions of the water supply plan are as follows:

(1) Target year:

Base year: 2026

Intermediate year: 2041

Ultimate year: 2056

(2) Planned supply area:

Dharmapuri District: Dharmapuri Municipality, ten town panchayats, and ten rural panchayat unions

Krishnagiri District: Hosur Corporation., Krishnagiri Municipality, six town panchayats, and ten rural panchayat unions

(3) Planned per capita supply

The following per capita supply values, set by the Tamil Nadu government based on CPHEEO planning standards, were applied:

Corporation/Municipality: 135 lpcd Town Panchayat: 70 lpcd Rural Panchayat: 55 lpcd

(4) Ratio of House Service Connections

Although the current ratio of house service connections in the Project area is presented in Table 5.1.1, the Project aims to increase the ratio to 100%.

Table 5.1.1 Present Ratio of House Service Connection

	Total Household	Existing HSC	Ratio of HSC (%)
City Corporation			
Hosur	88,000	38,000	43%
Municipality			
Krishnagiri	16,566	10,057	61%
Dharmapuri	21,850	11,829	54%
Town Panchayat			
Krishnagiri District			
Denkanikottai TP	6,456	1,384	21%
Keelamangalam TP	4,109	1,008	25%
Nagojanahalli TP	2,761	1,061	38%
Bargur TP	4,287	1,721	40%
Other two TPs	NA	NA	*29%*
Dharmapuri District			
Kadathur TP	3,636	1,250	34%
B Mallapuram TP	3,213	95	3%
Marandahalli TP	5,290	3,290	62%
Karimangalam TP	5,150	2,050	40%
Other six TPs	NA	NA	*39%*
Rural Area			
Krishnagiri District	409,435	296,953	73%
Dharmapuri District	342,782	207,691	61%

Source: DPR, Website of JJM https://ejalshakti.gov.in/jjmreport/JJMBlockMapView.aspx

(5) Non-Domestic Water Demand

Non-domestic water demand has been estimated by multiplying the domestic water demand by a certain percentage. In the Project area, this percentage was set at 10%, as specified by TWAD based on local conditions. This percentage is considered relatively low for urban areas compared with other Indian cities. In Japan, the current rate is approximately 20%.

However, in addition to above, firefighting demand has been incorporated into urban areas using the formula $100\sqrt{P}$ (m^3/day), where P represents the population (in thousands) in the intermediate year. This calculation corresponds to an additional 4–10 lpcd for City Corporations and Municipalities, and approximately 20 lpcd for Town Panchayats.

Consequently, it was considered appropriate to set the non-domestic demand at 10% of domestic demand plus, abovementioned firefighting demand.

(6) Water Loss Ratio

The water loss ratio was established in accordance with the CPHEEO manual, as follows:

Treatment loss: 3%,

Loss in transmission pipeline: 2%,

Loss in distribution pipeline: 10%.

The 3% treatment loss is considered appropriate, as recycling of backwash water and supernatant of sludge is incorporated into the design of the WTP. The 2% transmission pipeline loss is also deemed appropriate, since such losses are usually repaired immediately. The water loss in existing distribution pipelines in India is generally higher than 10%. However, the target should be around at 10% and, as such, this value has been adopted for the planning of the Project. Maintaining a leakage rate of 10% will require effective leakage management measures, including establishing priority repair areas based on the leakage monitoring in each area and conducting regular maintenance to reduce losses.

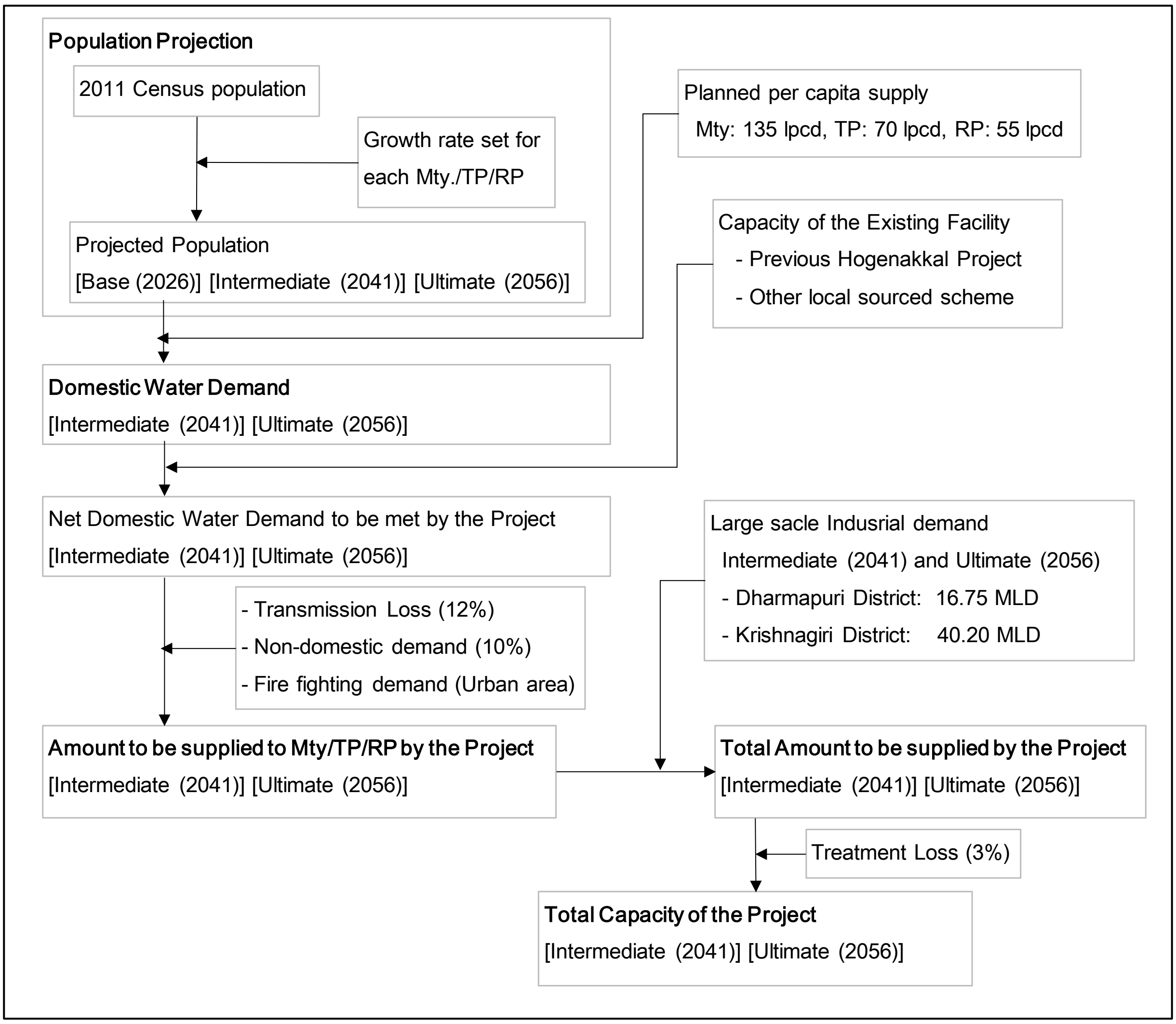
(7) Utilization of groundwater

Currently, groundwater is being used within the Project area; however, it should be regarded only as a supplementary water source. Thus, groundwater was not taken into consideration in determining the facility capacity of the Project.

5.2 Capacity Setting of the Project

5.2.1 Capacity Setting Process

Figure 5.2.1 illustrates the process for setting the water demand and required capacity of the Project.



Source: JST

Figure 5.2.1 Setting Process of Water Demand and Capacity of the Project

The water demand for each local body (Corporation, Municipality, Town Panchayat, Rural Panchayat) was calculated using the following procedure:

- Domestic water demand for each local body was calculated based on the projected population and planned per capita supply.
- Capacity of the existing facilities within each local body was then deducted from the calculated demand.
- Total water supply requirements for each local body was calculated by adding transmission losses (12%), non-domestic demand (10%), and firefighting demand in urban areas (based on population).

Subsequently, the total water supply requirement under the Project was calculated by summing the above quantities for all local bodies and adding the large-scale industrial demand separately.

Table 5.2.1 shows the large-scale industrial demand, as requested by the industrial developers and companies for industrial water supply under the Project. It was confirmed by TWAD that the demand for the intermediate year will be set equal to the demand for the ultimate year.

Table 5.2.1 Large Scale Industrial Demand

Company	Intermediate Year (2041) Ultimate Year (2056)
Dharmapuri District	
Dharmapuri SIPCOT	8.75 MLD
Dharmapuri SIPCOT (Future Expansion)	8.00 MLD
Total Dharmapuri District	**16.75 MLD**
Krishnagiri District	
Bargur SIPCOT	3.00 MLD
Bargur SIPCOT (Future Expansion for OLA Electronics Scooter Pvt. Ltd.)	9.00 MLD
Hosur SIPCOT	3.00 MLD
Hosur SIPCOT (Future Development)	13.25 MLD
Kurubarapalli SIPCOT	1.00 MLD
Shoolagiri SIPCOT	3.00 MLD
TIDCO for TATA Electronics	7.95 MLD
Total Krishnagiri District	**40.20 MLD**
Total Large Scale Industrial Demand	**56.95 MLD**

Source: TWAD

Finally, the total production capacity of the Project was determined by adding treatment loss of 3%.

5.2.2 Population Projection

The population projection was made based on the 2011 Census population data and the assumed growth rates specified by the TWAD Board for each local body. The projected population figures were approved by TWAD, as shown in Appendix 5.1, and are presented in Table 5.2.2. and Table 5.2.3.

Table 5.2.2 Population Projection of Dharmapuri District

Sl No.		2011 Census	Projected Population			Applied Population Growth Rate
			Base 2026	Inter 2041	Ulti 2056	
Dharmapuri District						
I.	**Municipality**					
1	**Dharmapuri Municipality**	**68,619**	**75,200**	**81,800**	**88,400**	Decadal Growth Rate
II.	**Town Panchayat (TP)**					
1	Pennagaram TP	17,480	21,200	24,900	28,700	Decadal Growth Rate
2	Kadathur TP	11,382	13,400	15,400	17,500	Decadal Growth Rate
3	Kambainallur TP	12,194	14,500	16,800	19,100	Decadal Growth Rate
4	B.Mallapuram TP	12,705	14,300	15,900	17,400	Decadal Growth Rate
5	Harur TP	25,469	30,200	34,900	39,600	Arithmetic Increase Method
6	Pappireddipatty TP	9,369	10,600	11,900	13,200	Incremental Increase Method
7	Papparapatti TP	12,174	13,600	15,300	17,100	Geometric Increase Method
8	Palacode TP	20,959	24,200	27,400	30,500	Arithmetic Increase Method
9	Marandahalli TP	12,451	14,400	16,300	18,200	Arithmetic Increase Method
10	Karimangalam TP	13,511	15,700	17,800	19,900	Arithmetic Increase Method
	Sub Total - II	**147,694**	**172,100**	**196,600**	**221,200**	
III.	**Panchayat Union**					
1	Dharmapuri Union	137,395	199,800	217,500	235,200	Decadal Growth Rate
2	Pennagaram Union	132,040	157,586	183,067	208,621	Decadal Growth Rate
3	Eriyur Union	73,159	87,314	101,433	115,579	Decadal Growth Rate
4	Nallampalli Union	190,535	209,100	227,700	246,200	Decadal Growth Rate
5	Kadathur Union	79,545	90,627	103,270	117,711	Geometric Increase Method
6	Morappur Union	71,950	81,973	93,430	106,489	Geometric Increase Method
7	Harur Union	165,291	181,400	197,500	213,600	Decadal Growth Rate
8	Pappireddipatty Union	96,448	105,900	115,300	124,700	Decadal Growth Rate
9	Palacode Union	156,117	181,800	207,500	233,200	Arithmetical Increase Method
10	Karimangalam Union	143,451	168,300	193,200	218,000	Decadal Growth Rate
	Sub-total - III	**1,245,931**	**1,463,800**	**1,639,900**	**1,819,300**	
Total of Dharmapuri District		**1,462,244**	**1,711,100**	**1,918,300**	**2,128,900**	

Source: DPR

Table 5.2.3 Population Projection of Krishnagiri District

Sl No.		2011 Census	Projected Population			Applied Population Growth Rate
			Base 2026	Inter 2041	Ulti 2056	
Krishnagiri District						
I.	**Corporation/Municipality**					
1	**Hosur Corporation**	**244,518**	**324,900**	**434,000**	**572,900**	Arithmetical Increase Method and Line of Best Fit Method
2	**Krishnagiri Municipality**	**71,323**	**95,100**	**122,500**	**157,900**	Semi-Log Method
	Sub-total - I	**315,841**	**420,000**	**556,500**	**730,800**	
II.	**Town Panchayat (TP)**					
1	Uthangarai TP	18,470	21,300	24,100	26,800	Arithmetic Increase Method
2	Denkanikottai TP	24,252	26,700	30,900	35,700	Line of Best Fit Method
3	Kelamangalam TP	13,321	15,500	17,500	19,500	Arithmetic Increase method
4	Kaveripattinam TP	15,006	16,000	17,000	18,000	Decadal growth rate
5	Nagojanahalli TP	9,953	11,400	12,800	14,100	Arithmetic Increase Method

Sl No.		2011 Census	Projected Population			Applied Population Growth Rate
			Base 2026	Inter 2041	Ulti 2056	
6	Bargur TP	16,366	19,400	22,400	25,400	Arithmetic Increase Method
	Sub-total - II	**97,368**	**110,300**	**124,700**	**139,500**	
III.	**Panchayat Union**					
1	Bargur Union	191,483	215,200	245,400	279,800	Line of Best Fit Method
2	Kaveripattinam Union	169,252	186,600	209,400	235,000	Line of Best Fit Method
3	Krishnagiri Union	127,329	148,200	168,900	189,700	Arithmetical Increase Method
4	Uthangarai Union	144,375	160,200	181,300	205,300	Line of Best Fit Method
5	Mathur Union	107,520	126,000	144,400	162,800	Arithmetical Increase Method
6	Hosur Union	132,214	145,100	158,000	170,900	Decadal Growth Rate
7	Thally Union	181,017	206,100	231,200	256,200	Arithmetical Increase Method
8	Veppanapalli Union	94,483	110,100	125,600	141,100	Arithmetical Increase Method
9	Kelamangalam Union	128,884	147,000	165,100	183,100	Arithmetical Increase Method
10	Shollagiri Union	177,900	195,300	212,600	229,900	Decadal Growth Rate
	Sub-total - III	**1,454,457**	**1,639,800**	**1,841,900**	**2,053,800**	
Total of Krishnagiri District		**1,867,666**	**2,170,100**	**2,523,100**	**2,924,100**	

Source: DPR

The validity of the above population projection has been verified as follows:

<u>Current Population</u>

The population in 2024, interpolated between the 2011 Census population and the 2026 projected population in the DPR, is estimated at 1,677,919 for Dharmapuri District and 2,129,775 for Krishnagiri District. Although no official data on the current population are available, the following sources provide useful references for estimating the present figures:

1) The Public Distribution System (PDS): A food distribution program implemented by the Government of Tamil Nadu, which maintains a system for registering residents, with most residents being registered.
2) The Jal Jeevan Mission (JJM): A rural water supply program under the Government of India that provides continuously updated data on the number of households in rural areas, as well as the number of households with house service connections throughout India.

Table 5.2.4 presents a comparison of the 2024 population estimates from the DPR and those estimated based on PDS data.

Table 5.2.4 Comparison of the Estimated Population Between DPR and PDS

DPR			PDS (May 2025)				
City/TP/Union	Population (2024)		Taluk	Registered population		Assumed Population (Registration ratio: 90%)	
		(A)				(B)	(A)/(B)
Dharmapuri District							
Dharmapuri Municipality	74,323	265,802	Dharmapuri Taluk	250,428	250,428	278,253	96%
Dharmapuri Union	191,479						
Nallampalli Union	206,625	206,625	Nallampalli Taluk	200,205	200,205	222,450	93%
Palacode TP	23,768	216,284	Palacode Taluk	232,118	232,118	257,909	84%
Marandahalli TP	14,140						
Palacode Union	178,376						
Karimangalam TP	15,408	180,395	Karimangalam Taluk	175,169	175,169	194,632	93%
Karimangalam Union	164,987						
Harur TP	29,569	303,650	Harur Taluk	193,849	193,849	215,388	141%
Kambainallur TP	14,193						
Morapur Union	80,637						
Harur Union	179,252						
Pappireddipatty TP	10,436	231,443	Papirediappatti Taluk	238,665	238,665	265,183	87%
Kadathur TP	13,131						
B.Mallapuram TP	14,087						
Kadathur Union	89,149						
Pappireddipatty Union	104,640						
Pennagaram TP	20,704	273,720	Pennagaram Taluk	246,693	246,693	274,103	100%
Papparapatti TP	13,410						
Pennagaram Union	154,180						
Eriyur Union	85,427						
Sub-total	1,677,919	1,677,919		Sub-total	1,537,127	1,707,919	98%
Krishnagiri District							
Hosur City Corporation	314,182	457,564	Hosur Taluk	390,204	390,204	433,560	106%
Hosur Union	143,382						
Denkanikottai TP	26,374	388,923	Denkanikottai Taluk	283,177	340,219	378,021	103%
Kelamangalam TP	15,209		Anchetty Taluk	57,042			
Kelamangalam Union	144,585						
Thally Union	202,756						
Bargur TP	18,995	365,776	Bargur Taluk	172,987	333,414	370,460	99%
Nagojanahalli TP	11,207		Pochampalli Taluk	160,427			
Bargur Union	212,038						
Mathur Union	123,536						
Krishnagiri Municipality	91,930	545,519	Krishnagiri Taluk	467,347	467,347	519,274	105%
Kaveripattinam TP	15,867						
Veppanapalli Union	108,018						
Krishnagiri Union	145,417						
Kaveripattinam Union	184,287						
Shoolagiri Union	192,980	192,980	Shooragiri Taluk	161,712	161,712	179,680	107%
Uthangarai TP	20,923	179,013	Uthangarai Taluk	214,161	214,161	237,957	75%
Uthangarai Union	158,090						
Sub-total	2,129,775	2,129,775		Sub-total	1,907,057	2,118,952	101%
	Total	**3,807,695**		**Total**	**3,444,184**	**3,826,871**	**99%**

Source: JST

The PDS enrolment rate of 90% shown in the table above is a weighted average of the PDS enrolment rates for rural and urban areas—93.1% for rural and 82.1% for urban—based on "Public Distribution System in Tamil Nadu: Implications for Household Consumption" (Anuradha G., January 2018).

[(0.931 x 0.8 + 0.821 x 0.2) ≈ 90%]

As shown in the table above, the comparison between the DPR's 2024 population estimates and those derived from PDS population estimates indicates that, although some variation exists among the Taluks (combining urban and rural districts), the DPR estimates are 98% of the PDS values for Dharmapuri and 101% for Krishnagiri, resulting in an overall ratio of 99%.

Table 5.2.5 shows a comparison of the 2024 rural population figures in the DPR with population estimates derived from the number of households recorded in the JJM dataset.

Table 5.2.5 Comparison of the Estimated Population in Rural Areas Between DPR and JJM Data

		DPR	JJM		
		2024	May, 2025		
		Population	Household	Population	
		(A)		(B)	(A)/(B)
Dharmapuri District					
1	Dharmapuri Union	191,479	55,820	223,280	86%
2	Pennagaram Union	154,180	30,927	123,708	194%
3	Eriyur Union	85,427			
4	Nallampalli Union	206,625	52,145	208,580	99%
5	Kadathur Union	89,149	24,289	97,156	92%
6	Morappur Union	80,637	18,536	74,144	109%
7	Harur Union	179,252	42,205	168,820	106%
8	Pappireddipatty Union	104,640	25,454	101,816	103%
9	Palacode Union	178,376	39,422	157,688	113%
10	Karimangalam Union	164,987	35,398	141,592	117%
	Sub Total	1,434,751		1,296,784	111%
Krishnagiri District					
1	Bargur Union	212,038	53,461	222,932	95%
2	Kaveripattinam Union	184,287	46,434	193,630	95%
3	Krishnagiri Union	145,417	46,340	193,238	75%
4	Uthangarai Union	158,090	40,019	166,879	95%
5	Mathur Union	123,536	31,911	133,069	93%
6	Hosur Union	143,382	40,888	170,503	84%
7	Thally Union	202,756	50,782	211,761	96%
8	Veppanapalli Union	108,018	24,305	101,352	107%
9	Kelamangalam Union	144,585	31,543	131,534	110%
10	Shollagiri Union	192,980	43,752	182,446	106%
	Sub Total	1,615,088		1,707,344	95%
	Total	**3,049,838**		**3,004,128**	**102%**

Population/Household: 4.0 (Dharmapuri District), 4.17 (Krishnagiri District)

Source: JST

The population per household used in the above table above—4.0 persons/household for Dharmapuri District and 4.17 persons/household for Krishnagiri District—is based on the 2011 Census.

As shown in the table, a comparison between the DPR's 2024 rural population estimates and those derived from JJM data shows a large difference in Pennagaram Union and Eriyur Union. However, overall, the DPR estimates correspond to 111% of the JJM figures for Dharmapuri District, 95% for Krishnagiri District, and 102% overall.

Based on the above, the current population estimates in the DPR are generally considered reasonable.

<u>Estimated Population Growth Rate</u>

Table 5.2.6 shows the comparison of the population growth ratios for the periods 2011 (Census)–2026, 2026–Intermediate (2041), and Intermediate Year (2041)–Ultimate Year (2056), as derived from DPR projections, Government of India (GOI, 2019) estimates, and United Nations (UN, 2024) projections.

Table 5.2.6 Comparison of Population Projection

Population Projection in DPR			National Commission on Population 2019, Ministry of Health and Family Welfare, Government of India			United Nations 2024
Dharmapuri and Krishnagiri			India			India
Year	Population	Annual Growth rate	Year	Population	Annual Growth rate	Annual Growth rate
2011	3,329,910	2011-2026	2011	1,216,147,000	2011-2026	2011-2026
2026	3,881,200	**1.03%**	2026	1,426,907,000	**1.07%**	**1.06%**
2026	3,881,200	2026-2041	2026	1,426,907,000	2026-2036	2026-2041
2041	4,441,400	**0.90%**	2036	1,521,140,000	**0.64%**	**0.66%**
2041	4,441,400	2041-2056				2041-2056
2056	5,053,000	**0.86%**				**0.27%**

Source: DPR, National Commission on Population 2019, Ministry of Health and Family Welfare, UN

According to the above analysis, the ratio of the projected population in 2056 to that in 2026 is as follows:

- Projection in DPR (Dharmapuri and Krishnagiri Districts): $1.009^{15} \times 1.0086^{15} = 1.300$ times
- Projection by UN (India): $1.0066^{15} \times 1.0027^{15} = 1.149$ times

This indicates that the projected population for Dharmapuri and Krishnagiri districts in 2056, as estimated in the DPR, is approximately 13% larger than the projected population in India in 2056 according to the UN.

Tamil Nadu State is actively developing its industry through state government subsidies and incentives. In the IT sector alone, the state accounted for 11% of India's total IT investment in 2024. The Project area, Dharmapuri and Krishnagiri districts, forms part of the state's designated industrial development region and is expected to continue to grow economically.

Moreover, the Project area lies within the Chennai-Bangalore Industrial Corridor (CBIC), a major initiative jointly promoted by the Governments of India and Japan. The development plan prepared by JICA in 2015 also predicts a high population growth rate within the Project area.[64]

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[64] Chennai-Bengaluru Industrial Corridor Comprehensive Regional Long-Term Plan (2015)

Based on the above considerations, the population projection presented in the DPR is considered to be reasonable.

5.2.3 Determined Facility Capacity

The total water demand and the corresponding supply quantity for the Project, as calculated and explained in Section 5.2.1, are presented in Table 5.2.7 and Table 5.2.8. The detailed breakdown of the rural areas by panchayat and habitation is provided in Appendix-5.2.

Table 5.2.7 Water Demand and Development Capacity of the Project in Dharmapuri District

Sl No.		Projected Populatin			Domestic Demand (MLD)			Supply capactity of existing facility (MLD)			Necessary capacity by the Project (MLD)		Transmission and distributuion loss (MLD)		Non-domestic demand (MLD)		Fire-fighting (MLD)	Development Capacity of the Project (MLD)	
		Base 2026	Inter 2041	Ulti 2056	*Base 2026*	Inter 2041	Ulti 2056	Previous PJT	Other existing	Total	Inter 2041	Ulti 2056	Inter 2041	Ulti 2056	Inter 2041	Ulti 2056		Inter 2041	Ulti 2056
I.	**City corporation/Municipality**																		
1	**Dharmapuri Municipality**	**75,200**	**81,800**	**88,400**	***6.87***	**11.04**	**11.93**	**8.12**	**2.01**	**10.13**	**0.91**	**1.80**	**0.11**	**0.22**	**0.10**	**0.20**	**0.99**	**2.12**	**3.21**
II.	**Tow Panchayat**																		
1	Pennagaram TP	21,200	24,900	28,700	*1.10*	1.74	2.01	0.95	0.52	1.47	0.27	0.54	0.03	0.06	0.03	0.06	0.55	0.88	1.21
2	Kadathur TP	13,400	15,400	17,500	*0.67*	1.08	1.23	0.56	0.37	0.93	0.15	0.30	0.02	0.04	0.02	0.03	0.43	0.62	0.80
3	Kambainallur TP	14,500	16,800	19,100	*0.75*	1.18	1.34	0.50	0.50	1.00	0.17	0.33	0.02	0.04	0.02	0.04	0.45	0.66	0.86
4	B.Mallapuram TP	14,300	15,900	17,400	*0.58*	1.11	1.22	0.47	0.51	0.99	0.13	0.23	0.02	0.03	0.01	0.03	0.44	0.60	0.72
5	Harur TP	30,200	34,900	39,600	*1.56*	2.44	2.77	1.16	0.94	2.10	0.34	0.67	0.04	0.08	0.04	0.07	0.65	1.07	1.47
6	Pappireddipatty TP	10,600	11,900	13,200	*0.55*	0.83	0.92	0.35	0.38	0.73	0.10	0.19	0.01	0.02	0.01	0.02	0.38	0.51	0.62
7	Papparapatti TP	13,600	15,300	17,100	*0.70*	1.07	1.20	0.70	0.21	0.91	0.16	0.29	0.02	0.03	0.02	0.03	0.43	0.63	0.78
8	Palacode TP	24,200	27,400	30,500	*1.25*	1.92	2.14	0.77	0.87	1.64	0.28	0.50	0.03	0.06	0.03	0.06	0.58	0.92	1.19
9	Marandahalli TP	14,400	16,300	18,200	*0.84*	1.14	1.27	0.58	0.30	0.88	0.26	0.39	0.03	0.05	0.03	0.04	0.44	0.77	0.93
10	Karimangalam TP	15,700	17,800	19,900	*0.82*	1.25	1.39	0.50	0.59	1.09	0.16	0.31	0.02	0.04	0.02	0.03	0.46	0.66	0.84
	Sub Total- II	**172,100**	**196,600**	**221,200**	***8.83***	**13.76**	**15.48**	**6.55**	**5.18**	**11.74**	**2.03**	**3.75**	**0.24**	**0.45**	**0.23**	**0.42**	**4.81**	**7.31**	**9.43**
III.	**Rural Union**																		
1	Dharmapuri Union	199,800	217,500	235,200	*9.82*	13.33	14.41	6.15	0.32	6.47	6.86	7.94	0.82	0.95	1.47	1.59		9.15	10.49
2	Pennagaram Union	157,586	183,067	208,621	*7.75*	10.07	11.47	4.70	0.00	4.70	5.37	6.77	0.64	0.81	1.16	1.32		7.17	8.90
3	Eriyur Union	87,314	101,433	115,579	*4.29*	5.58	6.36	2.77	0.00	2.77	2.81	3.59	0.34	0.43	0.63	0.72		3.78	4.74
4	Nallampalli Union	209,100	227,700	246,200	*10.28*	12.68	13.71	7.06	0.00	7.06	5.62	6.65	0.67	0.80	1.40	1.53		7.69	8.97
5	Kadathur Union	90,627	103,270	117,711	*4.45*	5.68	6.47	3.20	0.05	3.26	2.42	3.22	0.29	0.39	0.67	0.75		3.38	4.36
6	Morappur Union	81,973	93,430	106,489	*4.03*	5.14	5.86	2.60	0.31	2.91	2.23	2.95	0.27	0.35	0.61	0.67		3.11	3.98
7	Harur Union	181,400	197,500	213,600	*8.92*	10.86	11.75	6.38	0.07	6.45	4.41	5.30	0.53	0.64	1.25	1.37		6.20	7.30
8	Pappireddipatty Union	105,900	115,300	124,700	*5.20*	6.34	6.86	3.61	0.57	4.18	2.17	2.68	0.26	0.32	0.64	0.70		3.07	3.70
9	Palacode Union	181,800	207,500	233,200	*8.94*	11.41	12.83	6.01	0.00	6.01	5.40	6.81	0.65	0.82	1.44	1.60		7.49	9.24
10	Karimangalam Union	168,300	193,200	218,000	*8.27*	10.63	11.99	5.49	0.27	5.76	4.86	6.23	0.58	0.75	1.37	1.54		6.81	8.51
	Sub Total - III	**1,463,800**	**1,639,900**	**1,819,300**	***71.95***	**91.71**	**101.70**	**47.98**	**1.58**	**49.56**	**42.15**	**52.14**	**5.06**	**6.26**	**10.64**	**11.79**		**57.85**	**70.19**
IV.	**Industrial**																		
	Private Institution(Tata-500kl + Court -20kl+ GCE, Settikarai -50kl+ P.Grid - 10kl)							0.58	0.00	0.58								0.00	0.00
	SIPCOT																	16.75	16.75
	Sub Total- IV							**0.58**	**0.00**	**0.58**								**16.75**	**16.75**

Note: Domestic Demand in 2026 is estimated based on the current house connection rate and the planned lpcd (40 lpcd for unconnected household)

Non-domenstic demand in rural area includes the the individual accumulations (government offices, etc.) and the increments due to the rounding up and aggregation of demand in each village.

Source: JST based on DPR

Table 5.2.8 Water Demand and Development Capacity of the Project in Krishnagiri District

Sl No.		Projected Populatin			Domestic Demand (MLD)			Supply capactity of existing facility (MLD)			Necessary capacity by the Project (MLD)		Transmission and distributuion loss (MLD)		Non-domestic demand (MLD)		Fire-fighting (MLD)	Development Capacity of the Project (MLD)	
		Base 2026	Inter 2041	Ulti 2056	*Base 2026*	Inter 2041	Ulti 2056	Previous PJT	Other existing	Total	Inter 2041	Ulti 2056	Inter 2041	Ulti 2056	Inter 2041	Ulti 2056		Inter 2041	Ulti 2056
I.	**City corporation/Municipality**																		
1	Hosur Corporation	324,900	434,000	572,900	*26.27*	58.59	77.34	14.12	14.63	28.75	29.84	48.59	3.58	5.83	3.34	5.44	2.29	39.05	62.15
2	Krishnagiri Municipality	95,100	122,500	157,900	*9.32*	16.54	21.32	7.06	5.76	12.82	3.71	8.49	0.45	1.02	0.42	0.95	1.22	5.79	11.68
	Sub Total -I	**420,000**	**556,500**	**730,800**	**35.58**	**75.13**	**98.66**	**21.18**	**20.40**	**41.58**	**33.55**	**57.08**	**4.03**	**6.85**	**3.76**	**6.39**	**3.51**	**44.84**	**73.83**
II.	**Tow Panchayat**																		
1	Uthangarai TP	21,300	24,100	26,800	*1.04*	1.69	1.88	0.88	0.42	1.30	0.39	0.58	0.05	0.07	0.04	0.06	0.54	1.02	1.25
2	Denkanikottai TP	26,700	30,900	35,700	*1.24*	2.16	2.50	1.00	0.23	1.23	0.93	1.27	0.11	0.15	0.10	0.14	0.61	1.76	2.17
3	Kelamangalam TP	15,500	17,500	19,500	*0.74*	1.23	1.37	0.68	0.28	0.96	0.26	0.40	0.03	0.05	0.03	0.05	0.46	0.78	0.96
4	Kaveripattinam TP	16,000	17,000	18,000	*0.78*	1.19	1.26	0.59	0.23	0.83	0.36	0.43	0.04	0.05	0.04	0.05	0.45	0.90	0.98
5	Nagojanahalli TP	11,400	12,800	14,100	*0.59*	0.90	0.99	0.43	0.35	0.78	0.11	0.20	0.01	0.02	0.01	0.02	0.39	0.53	0.64
6	Bargur TP	19,400	22,400	25,400	*1.01*	1.57	1.78	0.78	0.38	1.16	0.41	0.62	0.05	0.07	0.05	0.07	0.52	1.02	1.28
	Sub Total -II	**110,300**	**124,700**	**139,500**	**5.38**	**8.73**	**9.77**	**4.38**	**1.89**	**6.27**	**2.46**	**3.50**	**0.30**	**0.42**	**0.28**	**0.39**	**2.98**	**6.01**	**7.29**
III.	**Rural Union**																		
1	Bargur Union	215,200	245,400	279,800	*10.96*	13.50	15.39	7.31	1.46	8.50	4.99	6.89	0.60	0.83	1.73	1.96		7.32	9.67
2	Kaveripattinam Union	186,600	209,400	235,000	*9.51*	11.52	12.93	6.81	0.88	7.69	3.83	5.23	0.46	0.63	1.23	1.44		5.51	7.30
3	Krishnagiri Union	148,200	168,900	189,700	*7.55*	9.29	10.43	4.85	0.34	5.19	4.10	5.24	0.49	0.63	2.41	2.70		7.00	8.57
4	Uthangarai Union	160,200	181,300	205,300	*8.16*	9.97	11.29	5.55	0.66	6.21	3.76	5.08	0.45	0.61	1.20	1.41		5.42	7.10
5	Mathur Union	126,000	144,400	162,800	*6.42*	7.94	8.95	4.11	0.29	4.40	3.54	4.55	0.43	0.55	0.95	1.07		4.92	6.17
6	Hosur Union	145,100	158,000	170,900	*7.39*	8.69	9.40	4.57	0.52	5.17	3.52	4.23	0.42	0.51	1.80	1.95		5.75	6.69
7	Thally Union	206,100	231,200	256,200	*10.50*	12.72	14.09	7.18	0.00	7.18	5.54	6.91	0.66	0.83	1.72	1.87		7.92	9.61
8	Veppanapalli Union	110,100	125,600	141,100	*5.61*	6.91	7.76	3.28	0.92	4.20	2.71	3.56	0.33	0.43	0.76	0.88		3.80	4.86
9	Kelamangalam Union	147,000	165,100	183,100	*7.49*	9.08	10.07	4.66	0.44	5.10	3.98	4.97	0.48	0.60	1.34	1.45		5.81	7.02
10	Shollagiri Union	195,300	212,600	229,900	*9.95*	11.69	12.64	7.01	0.00	7.01	4.68	5.63	0.56	0.68	1.66	1.76		6.91	8.07
	Sub Total -III	**1,639,800**	**1,841,900**	**2,053,800**	**83.55**	**101.30**	**112.96**	**55.33**	**5.51**	**60.65**	**40.66**	**52.31**	**4.88**	**6.28**	**14.81**	**16.46**		**60.35**	**75.05**
IV.	**Industrial**																		
	SIPCOT(23.25MLD) & OLA Electric (9 MLD)																	32.25	32.25
	TATA																	7.95	7.95
	Sub Total- IV																	**40.20**	**40.20**

Note: Domestic Demand in 2026 is estimated based on the current house connection rate and the planned lpcd (40 lpcd for unconnected household)
Non-domenstic demand in rural area includes the the individual accumulations (government offices, etc.) and the increments due to the rounding up and aggregation of demand in

Source: JST based on DPR

Table 5.2.9 summarizes the tables above.

Table 5.2.9 Water Demand Projection and Development Capacity of the Project

	Projected Populatin			Domestic Demand (MLD)		Supply capactity of existing facility (MLD)			Development Capacity of the Project (MLD)	
	Base 2026	Inter 2041	Ulti 2056	Inter 2041	Ulti 2056	Previous PJT	Other existing	Total	Inter 2041	Ulti 2056
Dharmapuri District										
I. Dharmapuri Mpty	75,200	81,800	88,400	11.04	11.93	8.12	2.01	10.13	2.12	3.21
II. Town Panchayat	172,100	196,600	221,200	13.76	15.48	6.55	5.18	11.74	7.31	9.43
III. Rural	1,463,800	1,639,900	1,819,300	91.71	101.70	47.98	1.58	49.56	57.85	70.19
IV. Industrial						0.58	0.00	0.58	16.75	16.75
Krishnagiri District										
I. Hosur Corp	324,900	434,000	572,900	58.59	77.34	14.12	14.63	28.75	39.05	62.15
I. Krishnagiri Mpty	95,100	122,500	157,900	16.54	21.32	7.06	5.76	12.82	5.79	11.68
II. Town Panchayat	110,300	124,700	139,500	8.73	9.77	4.38	1.89	6.27	6.01	7.29
III. Rural	1,639,800	1,841,900	2,053,800	103.19	115.04	55.33	5.51	60.65	60.35	75.05
IV. Industrial									40.20	40.20
Total Project Area										
I. City corporation/Municipalit	495,200	638,300	819,200	86.17	110.59	29.30	22.41	51.71	46.96	77.05
II. Town Panchayat	282,400	321,300	360,700	22.49	25.25	10.93	7.08	18.00	13.32	16.72
III. Ruala Uniton	3,103,600	3,481,800	3,873,100	194.90	216.74	103.31	7.09	110.20	118.20	145.24
IV. Industrial						0.58	0.00	0.58	56.95	56.95
Total	**3,881,200**	**4,441,400**	**5,053,000**	**303.56**	**352.59**	**144.12**	**36.57**	**180.50**	**235.44**	**295.96**
Treatment loss 3%									7.06	8.88
Development capacity of the Project									**242.50**	**304.84**

Source: JST based on DPR

As shown above, the development capacity of the Project has been determined to be 242.50 MLD for the Intermediate Year (2041) and 304.84 MLD for the Ultimate Year (2056).

5.3 Facility Layout Plan

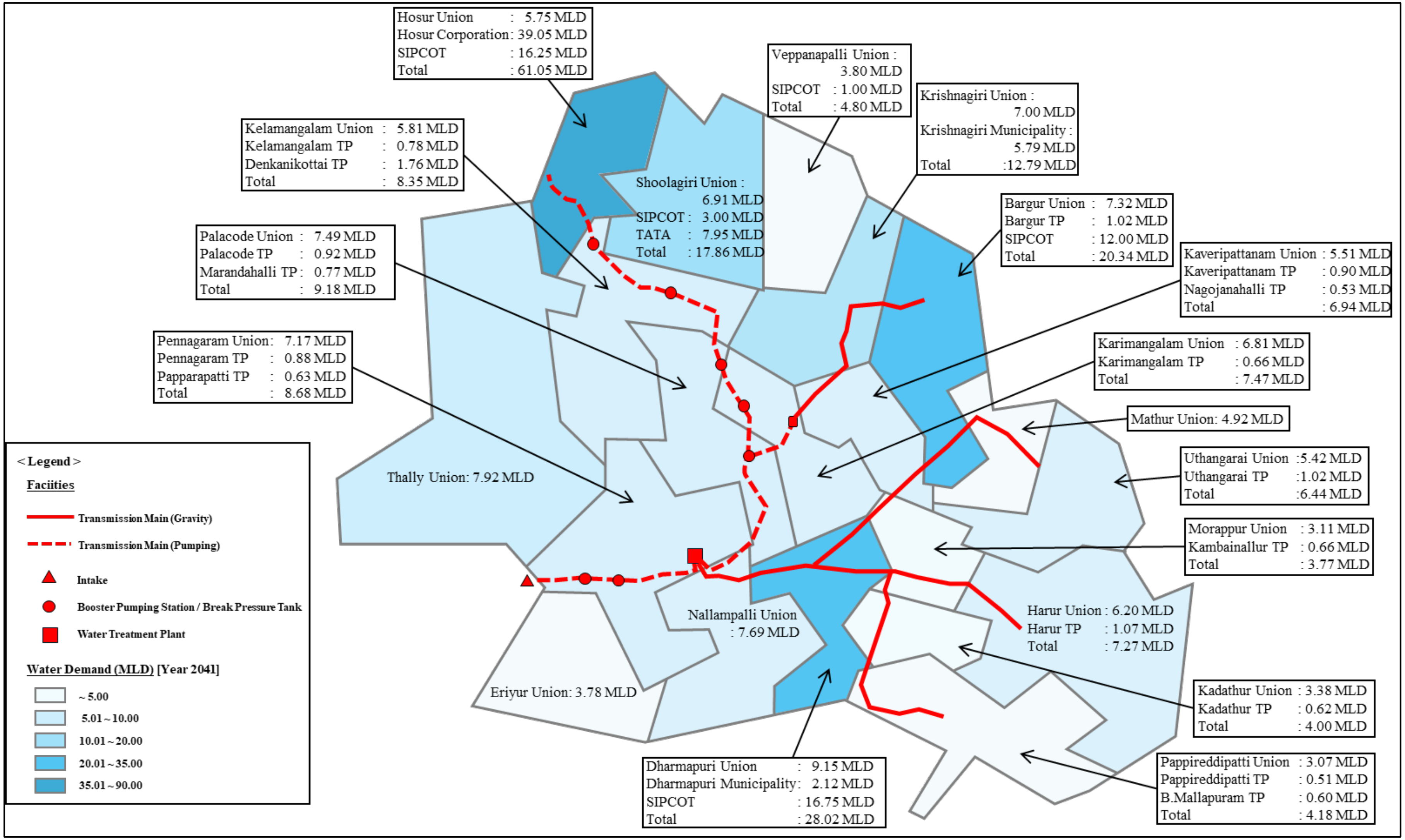
The locations and layouts of the main facilities (intake, WTP, and main transmission pipeline) have been planned in a manner similar to the Previous Hogenakkal Project. The distribution of water demand and the layouts of the main facilities are shown in Figure 5.3.1 and Figure 5.3.2, and schematically represented in Figure 5.3.3 and Figure 5.3.4.

Source: JST

Figure 5.3.1 Water Demand (2041) and Layout of the Main Facilities of the Project

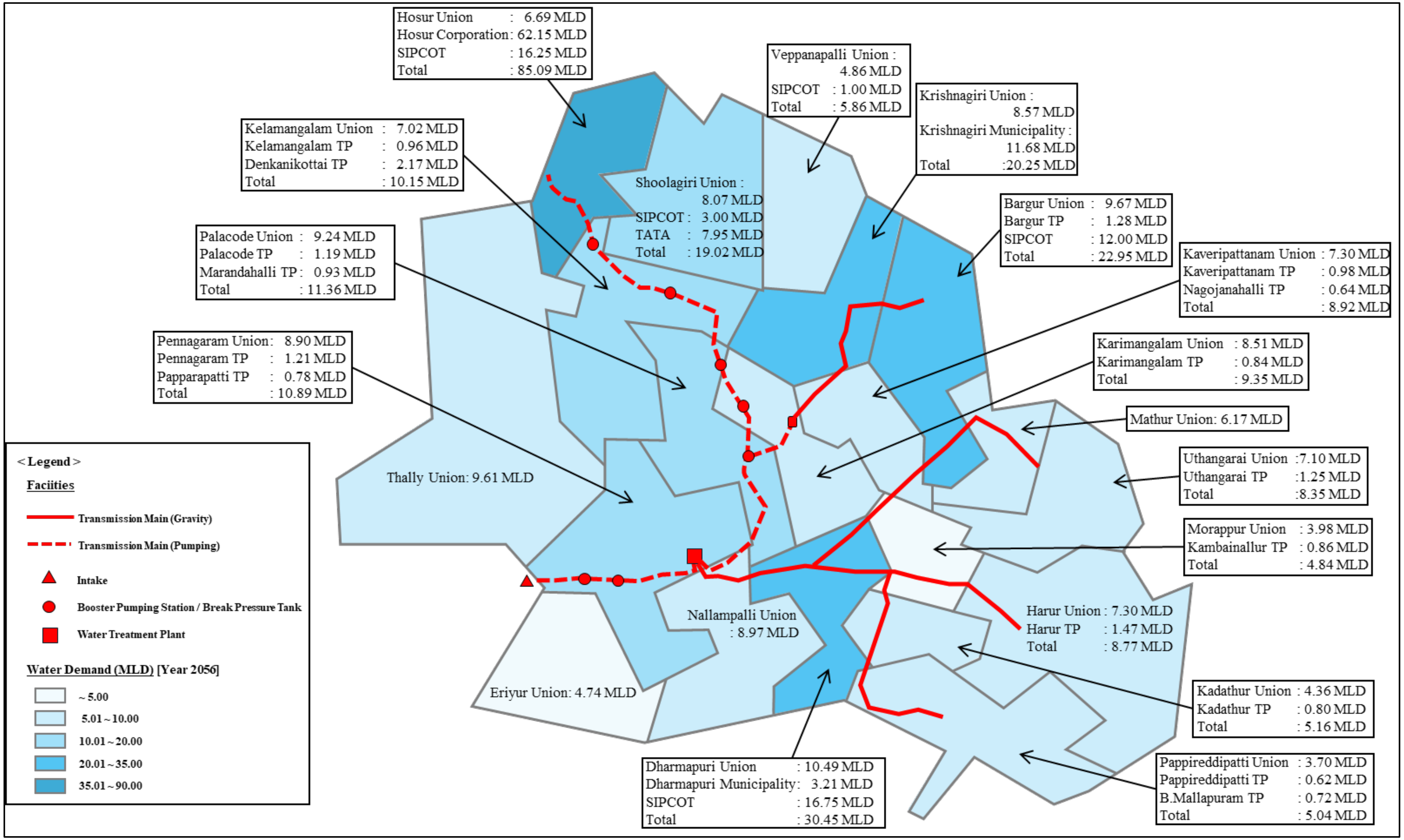
Source: JST

Figure 5.3.2 Water Demand (2056) and Layout of the Main Facilities of the Project



Source: JST

Figure 5.3.3 Schematic Layout of Water Demand (2041) and Main Facilities of the Project



Source: JST

Figure 5.3.4 Schematic Layout of Water Demand (2056) and Main Facilities of the Project

Chapter 6 Facility Plan for the Project

This chapter presents the review results of the facility plan presented in the DPR. It was confirmed that the facility design of the Project was generally appropriate and properly conducted. However, several modifications and additions are proposed, particularly with regard to the mechanical and electrical facilities. These are described in Section 6.5 to Section 6.9.

6.1 Outline of the Water Supply System

As in the Previous Hogenakkal Project, the Cauvery River is used as the water source, and the treated water will be distributed from elevated distribution reservoirs OHT in each distribution area. The raw water will be drawn from an intake facility located 600 m upstream of the existing intake facility constructed under the Previous Hogenakkal Project.

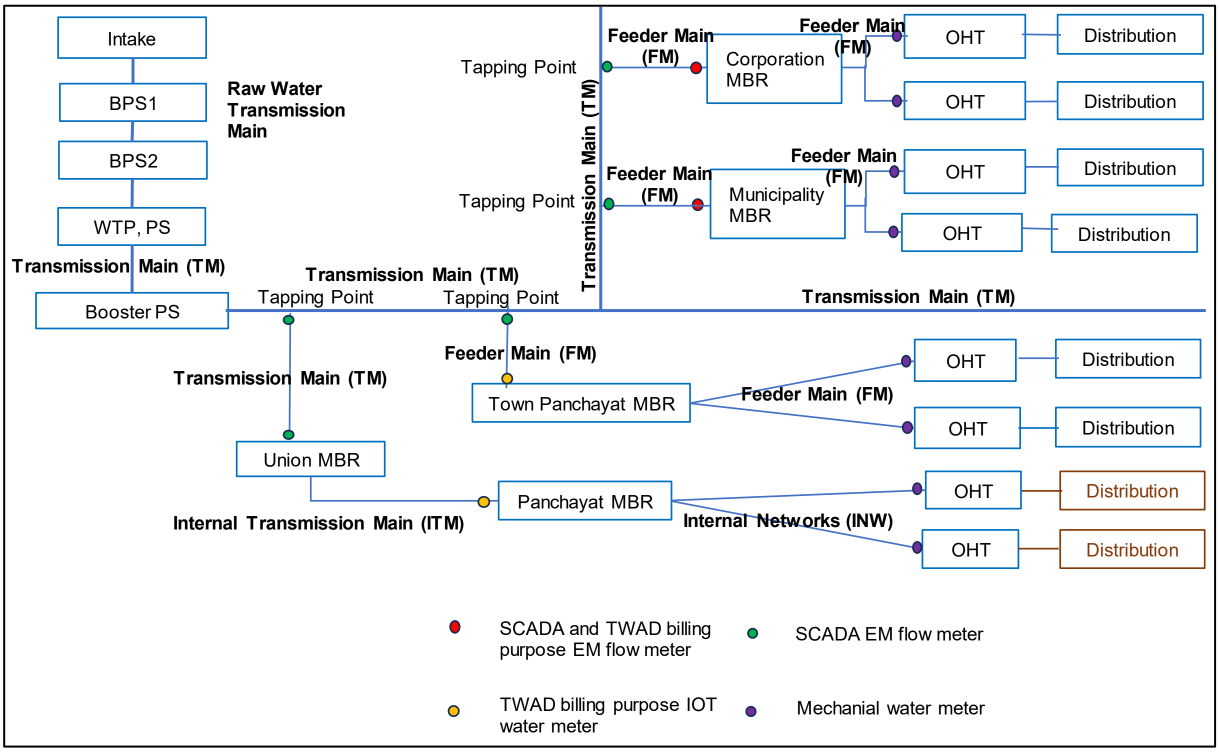
After the raw water is treated at the WTP, it is conveyed to the OHTs in each water distribution area through the water transmission system—a series of systems consisting of a water transmission pump station, water transmission pipelines, a Master Balancing Reservoir (MBR), and a sump with a pumping facility. Each household receives water through an individual service connection. All households in both urban and rural areas are provided with individual connection pipes.

The cost of household service connections in urban areas is included in the project cost. Meanwhile, the construction of distribution pipelines and household service connections in rural areas will be carried out under the Jal Jeevan Mission (JJM) scheme, which is India's village water supply program.

In urban areas, water meters will be installed at each service connection in preparation for the future introduction of metered tariffs. Within the 11 ULBs covered by the Project, all 160,000 households will be connected to the water supply system using ultrasonic AMR meters, and an automated billing system is planned for installation. There are no plans to install water meters in rural areas.

The water intake, raw water transmission facilities, WTP, and water transmission facilities will be constructed largely in parallel with the Previous Hogenakkal Project’s facilities. Collectively, these facilities are planned to meet the projected water demand up to the year 2056, in combination with the existing facility including that developed under the Previous Hogenakkal Project.

The configuration of the Project facilities follows a similar design to that of the Previous Hogenakkal Project. Figure 6.1.1 illustrates the schematic diagram of the overall water supply system.



Source: JST

Figure 6.1.1 Schematic of Water Supply System of the Project

The treated water transmission system consists of the following components:

Transmission Main (TM)	: Transmission pipeline from WTP up to the Union MBRs.
Feeder Main (FM)	: Transmission pipeline branched from the TM to the OHTs in the urban distribution areas through the Corporation/Municipality/Town Panchayat MBR.
Internal Transmission Main (ITM):	Transmission pipeline from the Union MBR to the Rural Panchayat MBRs in each union of rural panchayats.
Internal Network (INW):	Transmission pipeline from the Rural Panchayat MBRs to OHTs in the rural distribution areas.

The treated water will first be conveyed to the MBRs through pipelines branching from the tapping points of the Transmission Main. From the MBRs, the water will be transmitted to the OHTs in each distribution area and subsequently distributed to customers. In cases where a sufficient hydraulic head cannot be achieved, the Transmission Main will be connected to a sump, and the water will be pumped to the corresponding MBR or OHT.

The water flow at the tapping points will be monitored through the SCADA system. The water inflow at the MBRs will be measured using IoT-based water meters for billing purposes to local bodies (Corporation, Municipality, Town Panchayats, and Rural Panchayats). Additionally, mechanical water meters will be installed at the inlet of each OHT to monitor the supply volume to each OHT.

6.2 Design Criteria and Conditions

Table 6.2.1 shows the major design criteria adopted for the design of each facility. This is in accordance with the design guidelines of TWAD, as well as the design conditions.

Table 6.2.1 Major Design Criteria and Conditions Adopted for Facility Design

Item	Parameter
Treatment process	Rapid mechanical mixing + Clariflocculator + Rapid sand filtration
Raw water turbidity for capacity design of sludge drying bed of the WTP	220 NTU
Pump operation hours at the ultimate stage	23 hours/day
Design of water transmission pipeline	
Design formula	Modified Hazen-Williams
Hazen Williams Constant for pipes	145 (HDPE), 140 (DI), 140 (MS)
Pipe material	Diameter above 600 mm: MS Pipes 250 mm to 600 mm: Ductile Iron Up to 225 mm: HDPE
Minimum pipe diameter	OD63 (HDPE)
Minimum flow velocity	0.3 m/s
Maximum flow velocity	2.0 m/s
Residual head	At entrance of the MBR: 5 m At entrance of the OHT: 3 m
Valve installation (scour valve)	Every 3 km interval Diameter: Half of the main line plus 25 mm For transmission main: $1/5^{th}$ the pipe dia.
Valve installation (air valve)	Every 500 m interval
Capacity of OHT (Distribution Reservoir)	Urban: 1/3 the Intermediate Daily Demand Rural: 1/2 the Ultimate Daily Demand
Design of distribution pipeline network in urban areas	
Peak Factor	2.5
Minimum residual pressure	Municipality and Corporation: 17 m Town Panchayat: 12 m

Source: DPR

Regarding the pipe material, the general characteristics of each material are presented in Table 6.2.2.

Table 6.2.2 Comparison of Pipe Materials

Item	HDPE	MS	DI
Material	High-Density Polyethylene	Mild Steel	Ductile Iron
Adopted Diameters (mm)	20–600 mm	150–2000 for Enhanced Welded Steel as required	80-1000 mm
Lengths (m)	100 m in coils up to 90 mm 12 m lengths above 90 mm	5–10m for Enhanced Welded Steel as required	2.75–6 m
Weight	Light	Medium	Medium
Flexibility	Maximum	Medium	Medium
Impact Strength	Very good	Very good	Very good
Tensile Strength	2.4	40	42
Corrosion Resistance	Very Good	Good	More resistance with internal lining and outside guniting
Coefficient of Roughness	130-150	100-140	130–140
Available Working Pressure Range (kg/cm^2)	6. 2–10 Class 1–5	As required	16–25
Applicable I.S. Codes	4984, 7328, 7634	3589, 5822	8329

Source: DPR

6.3 Water Transmission System

6.3.1 Outline of the Design

The water transmission system has been designed based on the water supply plan—specifically, the water supply volume for each local body and the layout of main facilities—described in Chapter 5. The pipeline alignment has been planned to run basically in parallel with that of the Previous Hogenakkal Project. Consequently, the following information used for the pipeline design was obtained from the as-built drawings of the Previous Hogenakkal Project:

- Ground elevations along the pipeline route and at each facility location; and
- The distances of each pipeline section.

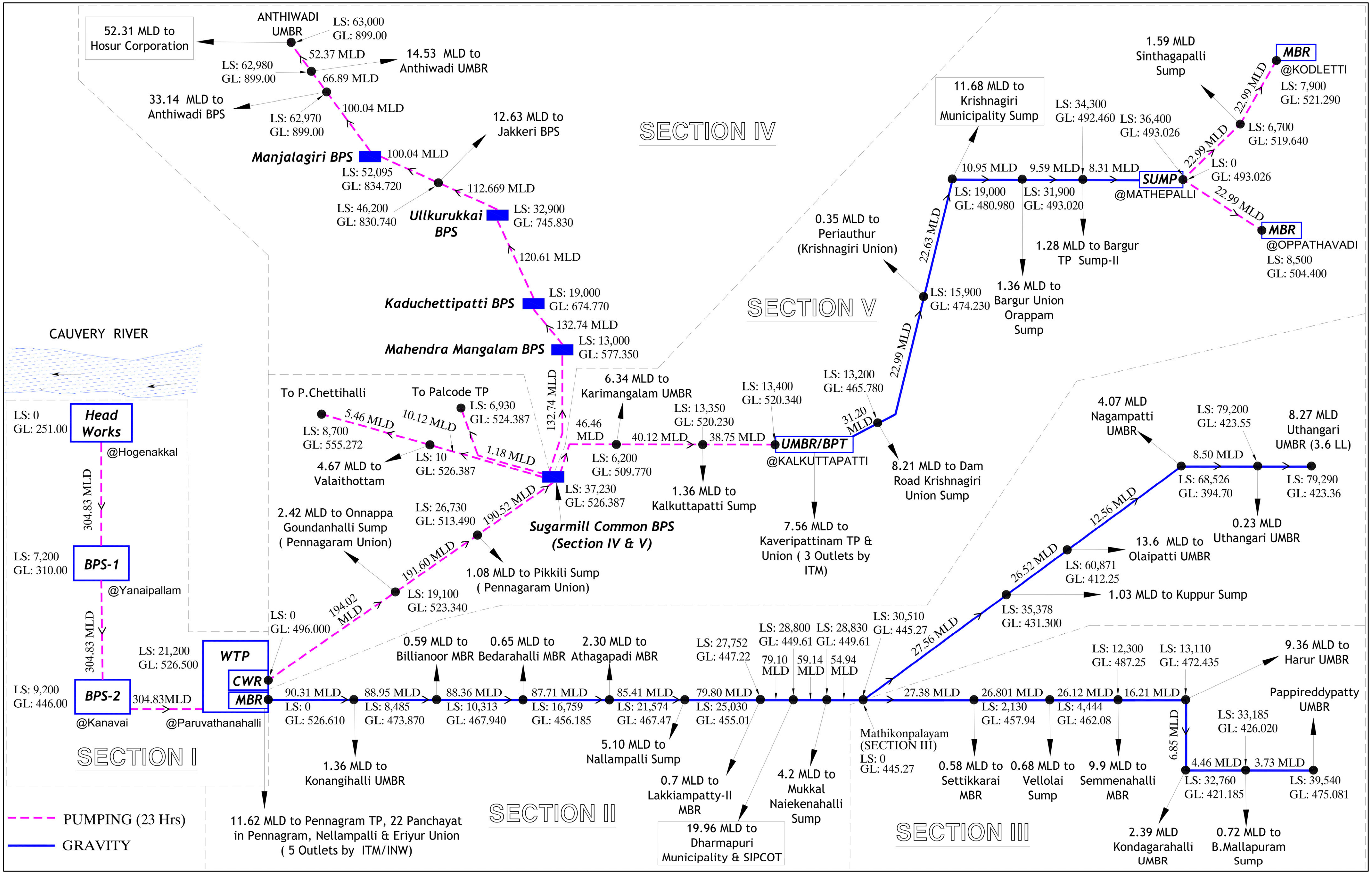
The locations of ancillary facilities such as air valves and washout valves have not yet been determined; only the tentative number of these valves has been set for cost estimation purposes. The construction drawings, showing the exact installation location of the pipeline and detailed locations of valves, will be prepared by the Contractor and submitted to TWAD for approval during the construction stage.

6.3.2 Flow Diagram of the Transmission System

Figure 6.3.1 shows the flow diagram of the trunk part of the TM. The flow diagram shows:

- The configuration of the trunk part of the Transmission Main (TM);
- The locations and ground levels of the tapping points to each MBR or sump of the Union, Town Panchayat, Municipality, or Corporation; and
- The flow through each section and from each tapping point.

The complete flow diagrams of the TM and ITM are presented in Appendix 6.1.



Source: JST

Figure 6.3.1 Flow Diagram of the Trunk Part of the Transmission Main

The transmission system consists of five sections, as outlined below:

Section I: Raw water pumping main from the Intake to the WTP at Pennagaram Union, Dharmapuri District.

Section II: Treated water gravity main from the WTP to Uthangarai Union, Krishnagiri District

Section III: Treated water gravity main branched from Section II at Mathikonpalayam Village in Dharmapuri Union to Harur and Papporeddipatti unions in Dharmapuri District.

Section IV: Treated water pumping main from the Sugar Mill Common Booster Pump Station (BPS) at Palacode Union in Dharmapuri District to Hosur Union in Krishnagiri District, via four BPSs.

Section V: Treated water pumping main from WTP to Sugar Mill Common BPS;
Treated water pumping main from the Sugar Mill Common BPS to Kalkuttapatti Union Master Balancing Reservoir (UMBR)—which also functions as a Break Pressure Tank (BPT)—in Karimangalam Union, Dharmapuri District;
Treated water gravity main from Kalkuttapatti UMBR to Bargur Union in Krishnagiri District.

At each tapping point, a sluice valve will be installed to regulate the flow.

6.3.3 Review of Hydraulic Design

The hydraulic design of the flow diagram, as shown in Figure 6.3.1, was reviewed and has been conducted in accordance with the design criteria presented in Table 6.2.1. The review results are described below. The material and wall thickness of pipes for each section were selected according to the maximum hydrostatic pressure applicable to that section.

(1) Raw Water Transmission Main (Section I)

Raw water sourced from the Cauvery River will be conveyed by pumping from the Headworks at Hogenakkal to the WTP at Paruvathanahalli. The pumping operation will run for 19 hours per day to meet the Intermediate Year (2041) demand of 242.5 MLD, and for 23 hours per day to meet the Ultimate Year (2056) demand of 304.83 MLD.

The raw water will be conveyed through a 20.2 km-long mild steel (MS) pipeline. The elevation difference between the Headworks and the WTP is approximately 275 m. To accommodate this head requirement, two raw water BPS are proposed, as outlined in Table 6.3.1 below.

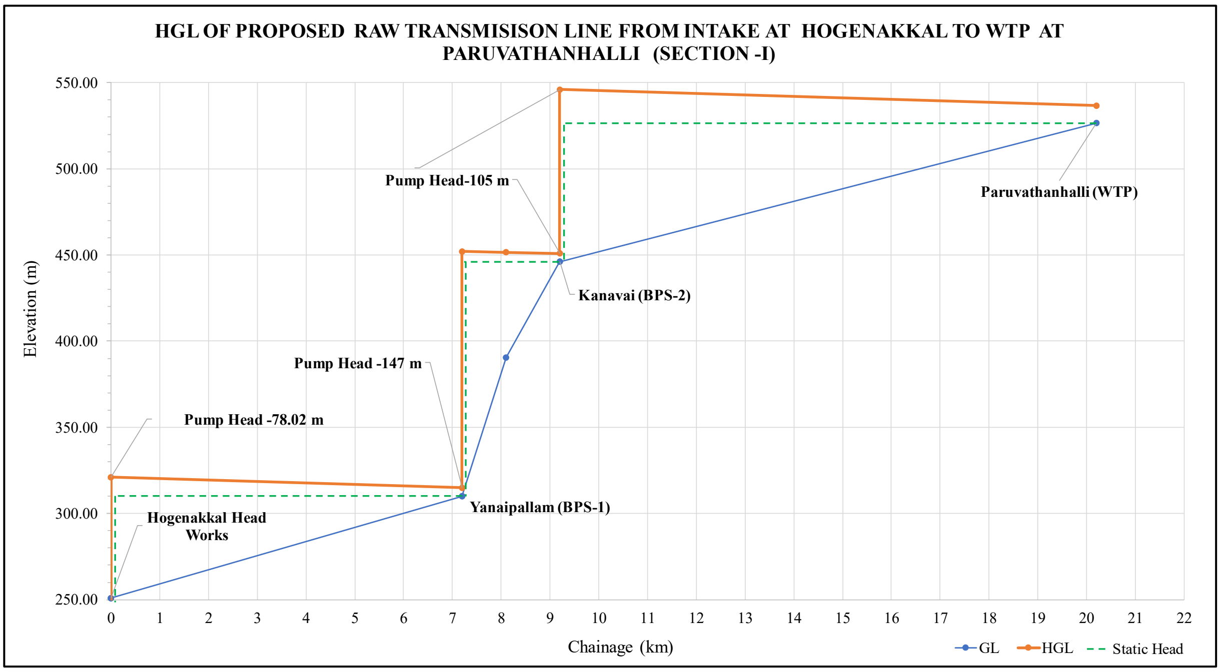
Table 6.3.1 Reach Wise Length and Pump Head of the Raw Water Pumping Main

Pump Station	Reach	Pipe Length (km)	Pipe OD and Wall Thickness (mm)	Pumping Head (m)
At Head Work (Hogenakkal) 600 m U/s of Existing Head Works	Head Work to BPS-1	7.200	1829 x 14.2	78.02
At Yanaipallam (BPS-1) beside Existing WTP	BPS-1 to BPS-2	2.000	2032 x 20 and 2032 x 14	147.00
At Kanavi (BPS-2) beside Existing BPS	BPS-2 to WTP	11.000	1829 x 14.2	105.00

Source: JST based on DPR data

The hydraulic design of the raw water pumping main was carried out in accordance with the CPHEEO guidelines, ensuring a residual head of 3 m above the maximum water level (MWL) at the terminal point. The optimum diameter of the pipeline was determined by minimising the combined cost of construction (pumping facilities and pipeline) and operation. The objective was to identify the most economical pipe diameter by comparing the total capital cost of installing the pipeline and pump sets with the operational power costs.

Figure 6.3.2 depicts the ground profile, hydraulic grade line (HGL) along the alignment of the raw water pumping main, and the required pump head (static head and head losses) at the Headworks, BPS-1, and BPS-2.



SUMMARY OF HYDRAULIC PARTICULAR OF RAW WATER PUMPING MAIN FROM HEAD WORKS @ HOGENAKKAL TO WTP AT PARUVATHANAHALLI													
Locatoin /Reach	L.S		Length (m)	Pipe ID (mm)	Type of Pipe Material & Clause	ULTIMATE STAGE-2056			H.G.L	G.L	MWL or GL of SR / SUMP	Terminal head (m)	Pumping Head Required (m)
	From	To				Q in LPM (ULT)	V in m/s	Total Loss (m)					
HEAD WORKS @ HOGENAKKAL		**0**							**321.101**	**251.000**	**252.060**	**70.101**	
HEAD WORKS TO BPS - 1	0	7200	7200	1776.6	1829 x 14.2 MS	220899	1.49	6.10	315.000	310.000	312.000	5.000	**78.02**
BPS - 1(With 110.45LL Sump) @ YANAIPALLAM									452.000	310.000	312.000		**147.00**
FROM BPS - 1 TO BPS - 2	7200	8100	900	1968.0	2032 x 20 MS	220899	1.21	0.46	451.537	390.640			
	8100	9200	1100	1976.0	2032 x 16 MS	220899	1.20	0.56	450.981	446.000	448.000	4.981	
BPS - 2(With 110.45LL Sump) @ KANAVAI									546.000	446.000	448.000		**105.00**
BPS - 2 TO WTP AT PARUVATHANAHALLI	9200	20200	11000	1776.6	1829 x 14.2 MS	220899	1.49	9.32	-9.321	526.500	532.850	-535.821	

Source: JST based on the DPR data

Figure 6.3.2 HGL of the Proposed Raw Water Transmission Line

(2) Treated Water Transmission Main

The treated water will be transmitted from the clear water reservoir (CWR) situated in the WTP premises, as indicated in Table 6.3.2.

The treated water will be conveyed through the following modes:

1. Gravity Transmission: The water pumped from the CWR to the MBR with 17,730 m^3 capacity (four hours of storage) within the WTP premises will flow by gravity to Section II and Section III.
2. Direct Pumping: Treated water will be directly pumped from the CWR to Sections IV and V.

Table 6.3.2 Section Wise Summary of Transmission Main (TM)

Section Number	Length of Trunk Part of TM (km)	Total Length of TM (km)	Pipe Material	Type of System	Flow (MLD)	Remarks
Section II	79.290	131.688	MS/DI	Gravity	90.311	Common Transmission Main from the MBR to Ch. 30.51 km (Mathikonpalyam)
Section III	39.540	67.695	MS/DI			
Section IV	63.000	63.330	MS	Pumping	194.02	Common Pumping Main from CWR to Sugar Mill Common BPS (37.23 km)
Section V	119.060	139.657	MS/DI	Pumping Gravity		
	300.890	**402.370**				

Source: JST based on DPR data

Apart from the above, 11.62 MLD of water from the MBR will be supplied directly by gravity through four separate ITMs, one INW to Pennagaram TP, as well as to 261 habitations across 22 panchayats in Pennagaram, Nellampalli, and Eriyur unions.

The hydraulic design of the transmission mains was carried out to meet the requirements for the Ultimate Year demand, following CPHEEO guidelines. The Hazen-Williams formula was applied to calculate the head loss, based on the following design criteria:

- A minimum flow velocity of 0.6 m/sec in the pipe.
- A minimum residual head of 5 m above the MWL at the terminal points (i.e., Union/Town Panchayat/Municipality/Corporation MBR or Sump). Typically, the staging height of these MBRs is 16 m above the ground level.

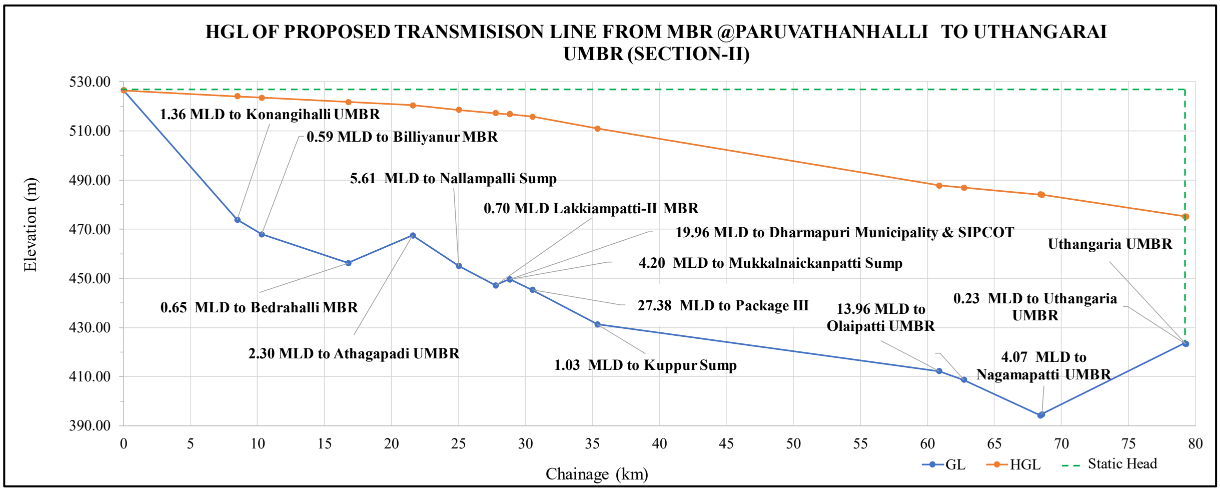
In cases where sufficient head is not achieved, the transmission main is connected to a sump from which water is pumped to the MBR. The pipe materials used for the transmission main follow the TWAD Pipe Policy, which is aligned with CPHEEO guidelines.

1) Treated Water Transmission Main (Section II)

The common gravity transmission main for Sections II and III begins from the MBR within the WTP premises. The total length of the trunk part of the TM in Section II is 79.29 km, with 14 tapping points. Notable tapping points include:

- Dharmapuri Municipality and SIPCOT at Chainage 28.0 km.
- Tapping point for Section III at Chainage 30.51 km.

Figure 6.3.3 shows the ground profile and HGL along the pipeline alignment. The data labels on the ground level represent the total flow branched at each tapping point, along with the name of the connected terminal union, town panchayat, and municipality MBR or sump.



TRANSMISSION MAIN - DESIGN OF GRAVITY MAIN FROM PARUVATHANAHALLI MBR @ WTP (147.80 LL) [P] TO UTHANGARAI UMBR (3.60 LL) [P]													
Location	L.S		Length (m)	Pipe ID (mm)	Type of Pipe Material & Clause	ULTIMATE STAGE - 2056			H.G.L	G.L	MWL or GL of SR / SUMP	Terminal head (m)	Flow to Branch (MLD)
	From	To				Q in LPM (ULT)	V in m/s	Total Loss (m)					
									526.500	526.610	531.350	-0.110	
BR. TO KONANGIHALLI UMBR - 0.60LL(P)	0	8485	8485	1373	1422 x 12.5 MS	62716	0.71	2.450	524.050	473.870		50.180	1.36
BR. MAIN TO BILLIYANUR MBR - 0.30LL(E)	8485	10313	1828	1373	1422 x 12.5 MS	61771	0.70	0.513	523.537	467.940		55.597	0.59
BR. MAIN TO BEDRAHALLI MBR - 0.30LL(E)	10313	16759	6446	1373	1422 x 12.5 MS	61361	0.69	1.787	521.749	456.185		65.564	0.65
BR. MAIN TO ATHAGAPADI UMBR - 0.80LL(P)	16759	21574	4815	1373	1422 x 12.5 MS	60910	0.69	1.317	520.432	467.470		52.962	2.30
BR. MAIN TO NALLAMPALLI SUMP - 12.35LL(P)	21574	25030	3456	1181	1219 x 10 MS	59311	0.90	1.874	518.558	455.010		63.548	5.61
BR. TO LAKKIAMPATTI - II MBR - 0.30LL(E)	25030	27752	2722	1181	1219 x 10 MS	55418	0.84	1.302	517.256	447.220		70.036	0.70
BR. TO DHARMAPURI MUNICIPALITY OHT'S & SIPCOT (2232+11632=13864)	27752	28800	1048	1181	1219 x 10 MS	54930	0.84	0.493	516.763	449.610		67.153	19.96
BR. MAIN TO MUKKALNAICKANPATTI SUMP - 2.80LL(P)	28800	28830	30	1181	1219 x 10 MS	41066	0.62	0.008	516.755	449.610		67.145	4.20
BR. TO PACKAGE - III AT MATHIKONPALAYAM	28830	30510	1680	980.4	1016 x 8.8 MS	38151	0.84	0.996	515.759	445.270		70.489	27.38
BR. TO KUPPUR USUMP- 5.20LL(P)	30510	35378	4868	680.4	711 x 6.3 MS	19136	0.88	4.766	510.992	431.300		79.692	1.03
BR. TO MATHUR NEAR OLAIPATTI UMBR - 0.90LL(P) (POCHAMPALLI TOWN)	35378	60871	25493	680.4	711 x 6.3 MS	18418	0.84	23.254	487.738	412.250		75.488	13.96
	60871	62700	1829	584.4	610 x 5.8 MS	8725	0.54	0.877	486.861	408.720		78.141	
	62700	68400	5700	583.4	610 x 6.3 MS	8725	0.54	2.757	484.104	394.260		89.844	
BR. TO NAGAMAPATTI UMBR - 1.70LL(P)	68400	68526	126	583.4	610 x 6.3 MS	8725	0.54	0.061	484.043	394.700		89.343	4.07
BR. TO UTHANGARAI UMBR - 6.00LL(E)	68526	79200	10674	450	450 DI K9	5901	0.62	8.861	475.182	423.550		51.632	0.23
TO UTHANGARAI UMBR - 3.60LL@ANTHERIPATTY	79200	79290	90	450	450 DI K9	5744	0.60	0.071	475.111	423.360	442.360	51.751	

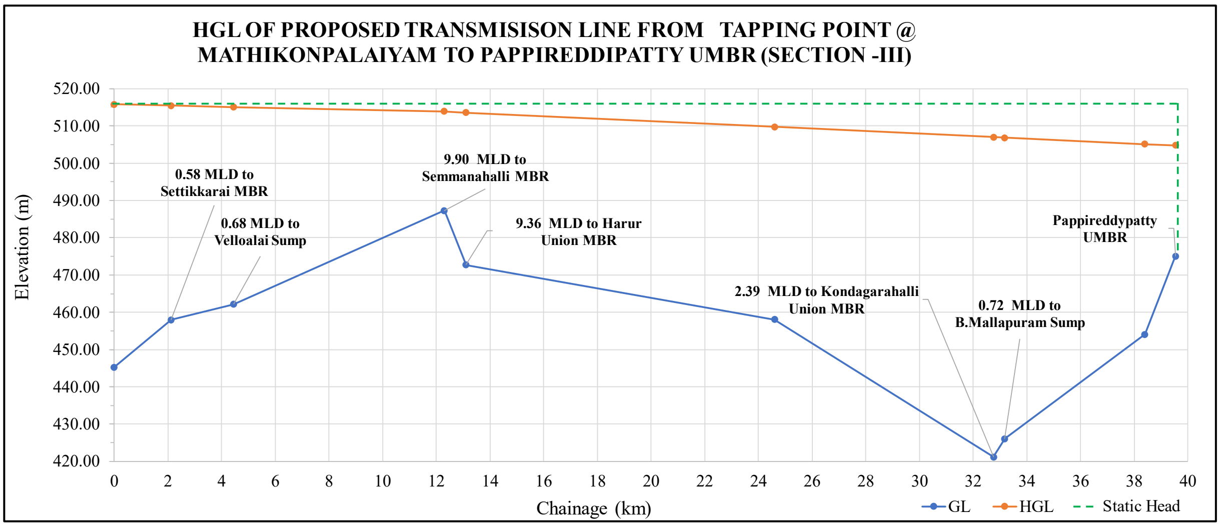
Source: JST based on DPR data

Figure 6.3.3 HGL of Transmission Main in Section II

2) Treated Water Transmission Main (Section III)

The pipeline for Section III originates at the tapping point located at Chainage 30.51 km of Section II pipeline. The total length of the Section III pipeline is 39.54 km, with nine tapping points along its route.

Figure 6.3.4. shows the ground profile and HGL along the pipeline alignment. The data labels on the ground level in the figure indicate the total flow branched at each tapping point, along with name of the connected terminal union, town panchayat, and municipality MBR or sump.



Location	L.S From	L.S To	Length (m)	Pipe ID (mm)	Type of Pipe Material & Clause	ULTIMATE STAGE - 2056: Q in LPM (ULT)	V in m/s	Total Loss (m)	H.G.L	G.L	MWL or GL of SR / SUMP	Terminal head (m)	Pumping Head Required (m)
TRANSMISSION MAIN - DESIGN OF GRAVITY MAIN FROM TAPPING POINT @ MATHIKONPALAIYAM TO PAPPIREDDIPATTY UMBR (1.60 LL) [P]													
									515.759	**445.270**	**531.350**	**70.489**	
BR. MAIN TO SETTIKKARAI MBR - 0.30LL(E)	0	2130	2130	980.4	1016 x 8.8 MS	19015	0.42	0.348	515.411	457.940		57.471	0.58
BR. TO VELLOLAI SUMP - 3.45LL(P)	2130	4444	2314	980.4	1016 x 8.8 MS	18612	0.41	0.36	515.047	462.080		52.967	0.68
BR. TO SEMMANAHALLI UMBR- 4.20LL(P)	4444	12300	7856	980.4	1016 x 8.8 MS	18139	0.40	1.18	513.871	487.250		26.621	9.90
BR. MAIN TO HARUR UNION MBR - 3.90LL(P) (RIDO)	12300	13110	810	680.4	711 x 6.3 MS	11262	0.52	0.30	513.574	472.735		40.839	9.36
	13110	24600	11490	500	500 DI K7	4762	0.40	3.84	509.736	458.014		51.722	
BR. TO KONDAGARAHALLI UNION MBR -1.00LL(P)	24600	32760	8160	500	500 DI K9	4762	0.40	2.73	507.010	421.185		85.825	2.39
BR. TO B.MALLAPURAM SUMP - 3.00LL(P)-TP	32760	33185	425	400	400 DI K9	3100	0.41	0.19	506.820	426.020		80.800	0.72
	33185	38400	5215	400	400 DI K9	2597	0.34	1.68	505.139	454.051		51.088	
TO PAPPIREDDIPATTY - UMBR - 1.60LL(P)	38400	39540	1140	400	400 DI K7	2597	0.34	0.37	504.772	475.081	**494.081**	29.691	

Source: JST based on DPR data

Figure 6.3.4 HGL of Transmission Main in Section III

3) Treated Water Transmission Main (Section IV)

The transmission pipeline for Section IV starts from the common BPS located at the Sugar Mill and ends at the Anthiwadi Union MBR. The total length of this pumped transmission main is approximately 63 km, with four BPSs positioned along the route. A summary of the Section IV transmission main, including the locations of BPSs and tapping points along the alignment, is shown in Table 6.3.3.

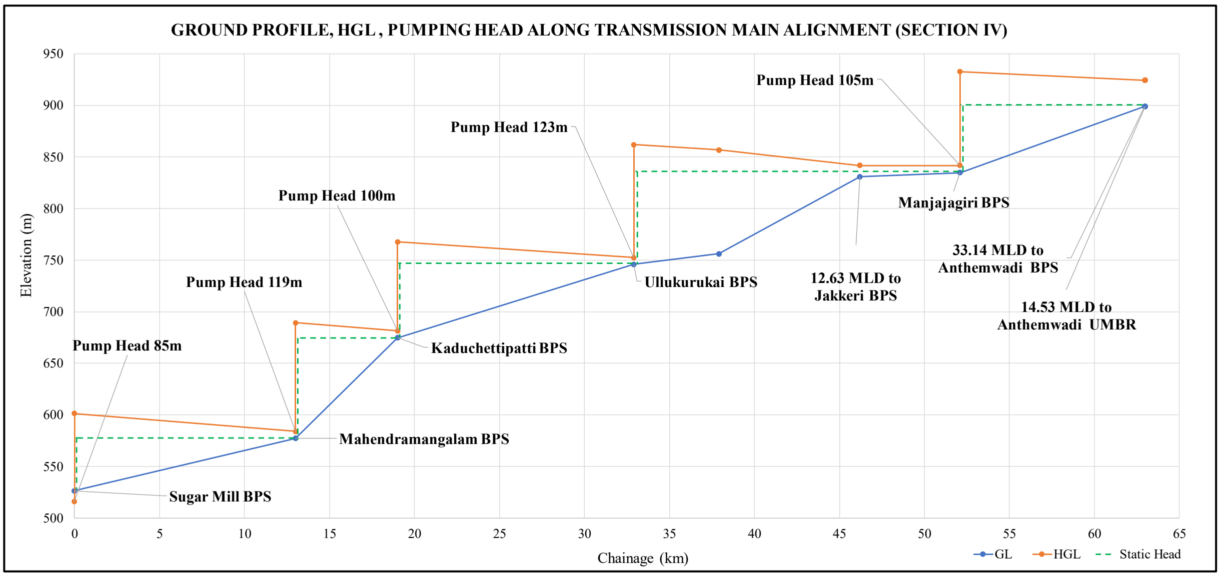
Table 6.3.3 Reach Wise Summary of Transmission Main in Section IV

From	To	Length of Pumping Main (km)	Tapping Points	Directly from BPS by Internal Transmission Main
Sugar Mill BPS (Ch. 0 km)	Mahendra Mangalam BPS (Ch. 13.0 km)	13.000		
Mahendra Mangalam BPS (Ch. 13.0 km)	Kaduchettipatti BPS (Ch. 19.0 km)	6.000		
Kaduchettipatti BPS (Ch. 19.0 km)	Ullukurukkai BPS (Ch. 32.9 km)	13.900		To Karimangalam Union To Rayakottai MBR
Ullukurukkai BPS (Ch. 32.9 km)	Manjalagiri BPS (Ch. 52.095 km)	19.195	Ch. 46.2 km	Direct Pumping line To Tata from Ullukurukkai

From	To	Length of Pumping Main (km)	Tapping Points	Directly from BPS by Internal Transmission Main
				BPS
Manjalagiri BPS (Ch. 52.095 km)	Anthawadi MPR (Ch. 63.00 km)	10.905	Ch. 62.97 km and Ch. 2.98 km	

Source: JST based on DPR data

Figure 6.3.5 shows the ground profile and the HGL along the alignment of the pipeline. The data labels on the HGL represent the pump head at each respective BPS, while the data labels on the ground level indicate the locations of the BPSs or flow branched from the main tapping point, along with name of the corresponding terminal MBR or BPS.



TRANSMISSION MAIN - DESIGN OF PUMPING MAIN FROM SUGARMILL BPS (82.85LL) [P] TO ANTHIWADI UNION MBR

Location/Reach	L.S From	L.S To	Length (m)	Pipe ID (mm)	Type of Pipe Material & Clause	ULTIMATE STAGE -2056 Q in LPM (ULT)	V in m/s	Total Loss (m)	H.G.L	G.L	MWL or GL of SR / SUMP	Terminal head (m)	Flow to Branch (MLD)	Pumping Head Required (m)
									LWL	GL	MWL			
SUGARMILL P.BPS (82.85LL)									**601.387**	**526.387**	**528.387**	**75.000**		
SUGARMILL P.BPS - TO MAHENDRAMANGALAM P.BPS	0	13000	13000	1181	1219 x 10 MS	96193	1.46	17.26	584.125	577.350	**578.350**	6.775		85.0
MAHENDRAMANGALAM P.BPS (57.75LL)									**689.350**	**577.350**		**112.000**		
MAHENDRAMANGALAM P.BPS TO KADUCHETTIPATTI P.BPS	13000	19000	6000	1181	1219 x 10 MS	96193	1.46	7.97	681.383	674.770	**675.770**	6.613	12.13	119.0
KADUCHETTIPATTI P.BPS (57.75LL)									**767.770**	**674.770**	**675.770**	**93.000**		
KADUCHETTIPATTI P.BPS TO ULLUKURUKAI P.BPS	19000	32900	13900	1181	1219 x 10 MS	87405	1.33	15.46	752.314	745.830	**746.830**	6.484	7.95	100.0
ULLUKURUKAI P.BPS (52.45LL)									**861.830**	**745.830**	**746.830**	**116.000**		
ULLUKURUKAI P.BPS (52.45LL) TO MANJALAGIRI P.BPS	32900	37900	5000	1179	1219 x 11 MS	81644	1.25	4.94	856.889	756.140	**757.140**	100.749		123.0
	37900	46200	8300	1181	1219 x 10 MS	81644	1.24	8.13	848.754	830.740	**831.740**	18.014	12.63	
	46200	52095	5895	1082.4	1118 x 8.8 MS	72493	1.31	7.09	841.666	834.720	**835.720**	6.946		
FROM MANJALAGIRI P.BPS (43.50LL)									**932.720**	**834.720**	**835.720**	**98.000**		105.0
FROM MANJALAGIRI P.BPS TO ANTHIWADI U.MBR (102.50LL) P	52095	62970	10875	1181	1219 x 10 MS	72493	1.10	8.55	924.168	899.000		25.168	33.14	
	62970	62980	10	1181	1219 x 10 MS	48476	0.74	0.00	924.164	899.000		25.164	14.53	
	62980	63000	20	1181	1219 x 10 MS	37950	0.58	0.00	924.159	899.000	**919.000**	25.159		

Source: JST based on DPR data

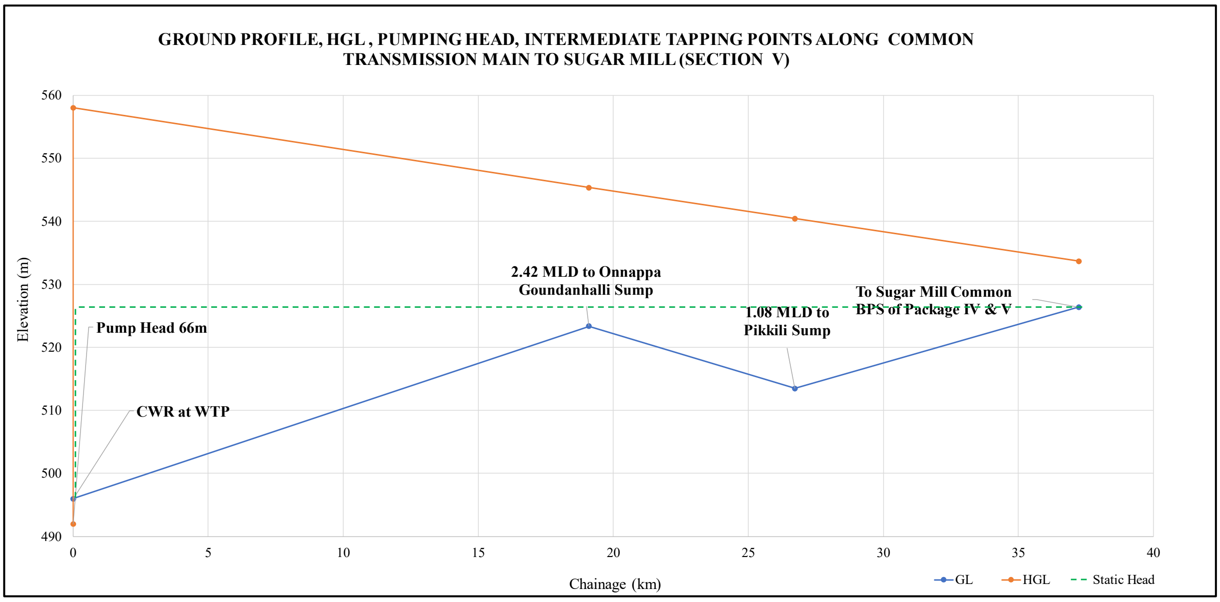
Figure 6.3.5 HGL of Transmission Main in Section IV

4) Treated Water Transmission Main (Section V)

Water from the CWR at the WTP will be pumped through the common transmission main serving Sections IV and V. This transmission main extends for a total length of 37.23 km, up to the Sugar Mill

Common BPS. Along this alignment, there are two tapping points: one at Chainage 19.1 km connected to the Goundanhalli Sump, and another at Chainage 26.73 km connected to the Pikkili Sump of Pennagaram Union.

Figure 6.3.6 shows the ground profile, HGL, and tapping points along the alignment of the common pumping main to Sugar Mill BPS. The Sugar Mill Common BPS has a total of four outlets: one outlet for Section IV and three outlets for Section V.



SUMMARY OF DESIGN OF PUMPING MAIN FROM WTP CWR (120.35LL) TO SUGARMILL P.BPS (82.85LL), KALKUTTAPATTI UMBR, P,CHETTIHALLI , PALCODE TP (SHOWING HYDRAULIC DETAILS AT TAPPING/TERMINAL LOCATIONS)														
Location/Reach	L.S		Length (m)	Pipe ID (mm)	Type of Pipe Material & Clause	ULTIMATE STAGE-2056			H.G.L	G.L	MWL or GL of SR / SUMP	Terminal head (m)	Flow to Branch (MLD)	Pumping Head Required (m)
	From	To				Q in LPM (ULT)	V in m/s	Total Loss (m)						
FROM WTP CWR (120.35LL)									**558.000**	**496.000**	**499.700**	**62.000**		**66.0**
FROM WTP CWR TO SUGARMILL P.BPS (Outlet I/IV)	0	19100	19100	1573.6	1626 x 14.2 MS	140595	1.20	12.66	545.342	523.340		22.002	2.42	
	19100	26730	7630	1573.6	1626 x 14.2 MS	138844	1.19	4.94	540.402	513.490		26.912	1.08	
	26730	37230	10500	1573.6	1626 x 14.2 MS	138058	1.18	6.73	533.674	526.387	**528.387**	7.287		

Source: JST based on DPR data

Figure 6.3.6 HGL of Common Transmission Main in Section V

Out of the three outlets, two transmission lines are connected to P. Chettihalli and Palcode Town Panchayats, respectively, while the remaining outlet serves the major portion of the Section V area through a combination of pumping and gravity flow, as shown in Table 6.3.4.

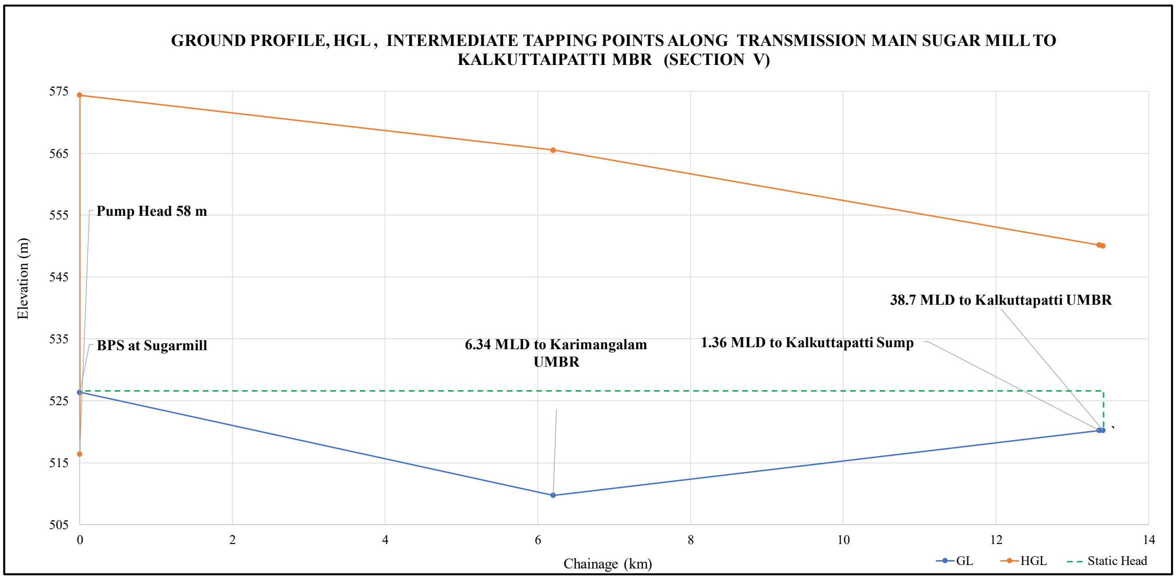
Table 6.3.4 Pumping and Gravity Transmission Mains in Section V

Type of Flow	Reach	Tapping Points
Pumping Section	The first main pumping transmission line starts from the Sugar Mill Common BPS and ends at the Kalkuttapatti UMBR, for a total length of 13.2 km. Two tapping points are provided along this alignment: one at Ch. 6.2 km connected to Karimangalam Union MBR, and another at Ch. 13.35 km connected to Kalkuttapatti Sump.	2 nos.
Gravity Section	It starts from the Kalkuttapatti UMBR and terminates at the Mathepalli Sump, covering a total length of 36.4 km. Along this alignment, there are five main tapping points.	5 nos. (Includes the Krishnagiri Municipality)

Type of Flow	Reach	Tapping Points
Pumping Section	The second main pumping transmission line starts from the Mathepalli Sump One and extends 8.5 km to the Oppathavaid MBR. The third main pumping transmission line also starts from the Mathepalli sump, running 7.9 km to the Kodletti MBR, with a tapping point at Ch. 6.7 km to the Sinthagapalli Sump.	1 No.

Source: JST based on DPR data

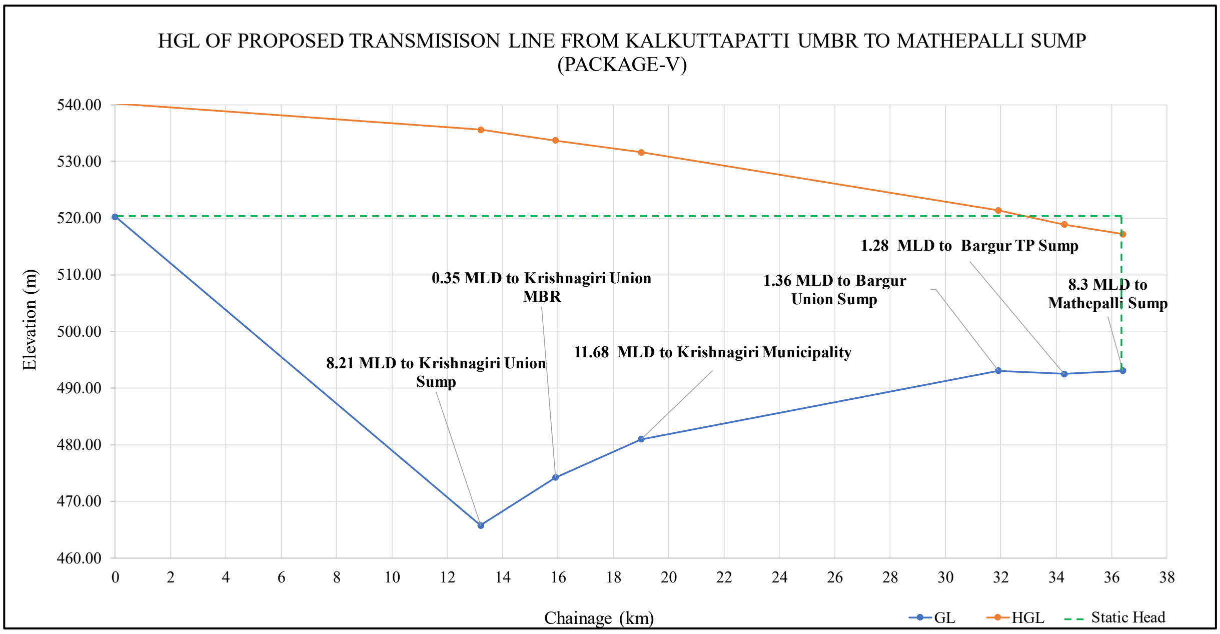
Figure 6.3.7 presents the ground profile and HGL along the alignment of the pumping section, while Figure 6.3.8 shows the corresponding profile for the gravity section.



SUMMARY OF DESIGN OF PUMPING MAIN FROM WTP CWR (120.35LL) TO SUGARMILL P.BPS (82.85LL), KALKUTTAPATTI UMBR, P,CHETTIHALLI , PALCODE TP (SHOWING HYDRAULIC DETAILS AT TAPPING/TERMINAL LOCATIONS)														
Location/Reach	L.S		Length (m)	Pipe ID (mm)	Type of Pipe Material & Clause	ULTIMATE STAGE-2056			H.G.L	G.L	MWL or GL of SR / SUMP	Terminal head (m)	Flow to Branch (MLD)	Pumping Head Required (m)
	From	To				Q in LPM (ULT)	V in m/s	Total Loss (m)						
SUGARMILL PRO.BPS (82.85LL)									**574.387**	**526.387**	**528.387**	**48.000**		**58.0**
SUGARMILL PRO.BPS TO KALKUTTAPATTI U.MBR	0	6200	6200	780.8	813 x 7.1 MS	33667	1.17	8.84	565.547	509.770		55.777	6.34	
	6200	13350	7150	678.8	711 x 7.1 MS	29075	1.34	15.37	550.181	520.230		29.951	1.36	
	13350	13400	50	678.8	711 x 7.1 MS	28086	1.29	0.10	550.080	520.230	**544.230**	**29.850**		
SUGARMILL P.BPS (82.85LL)									**568.387**	**526.387**	**528.387**	**42.000**		**40.0**
FROM SUGARMILL TO P.CHETTIHALLI (Outlet II/IV)	0	10	10	400	400 DI K7	7339	0.97	0.02	568.365	526.387			4.67	
	10	8700	8690	400	400 DI K7	3954	0.52	6.10	562.265	555.272	**556.772**	**6.993**		
SUGARMILL P.BPS									565.387	**526.387**	**528.387**	**39.000**		**41.0**
SUGARMILL P.BPS TO PALACODE TP - Outlet III/IV	0	6930	6930	150	150 DI K7	859	0.81	34.18	531.206	524.387	**525.887**	**6.819**		
MATHEPALLI U.BPS (20.80LL) [P]									**564.026**	**493.026**	**495.026**	**71.000**		**73.0**
MATHEPALLI U.BPS TO KODLETTI MBR- Outlet I/II	0	6700	6700	300	300 DI K7	3505	0.83	15.27	548.753	519.640		29.113	1.59	
	6700	7900	1200	250	250 DI K7	2353	0.80	3.18	545.575	521.290	**540.290**	24.285		
MATHEPALLI U.BPS (20.80LL) [P]									556.026	**493.026**	**495.026**	**63.000**		**65.0**
MATHEPALLI U.BPS TO OPPATHAVADI P.MBR - Outlet I/II	0	8500	8500	300	300 DI K7	4191	0.99	26.98	529.048	504.400	**523.400**	24.648		

Source: JST based DPR data

Figure 6.3.7 HGL of TM in Section V from Sugarmill BPS to Kalkuttapatti UMBR



TRANSMISSION MAIN - DESIGN OF GRAVITY MAIN FROM KALLKUTTAPATTY- UMBR TO MATHEPALLI - SUMP													
Location/Reach	L.S		Length (m)	Pipe ID (mm)	Type of Pipe Material & Clause	ULTIMATE STAGE - 2056			H.G.L	G.L	MWL or GL of SR / SUMP	Terminal head (m)	Flow to Branch (MLD)
	From	To				Q in LPM (ULT)	V in m/s	Total Loss (m)					
									540.230	520.230	544.230	20.000	
BR. TO KRISHNAGIRI UNION SUMP - 20.55LL(P)@DAM ROAD	0	13200	13200	880	914 x 8 MS	21664	0.59	4.65	535.584	465.780		69.804	8.21
BR. TO KRISHNAGIRI UNION MBR - 0.20LL(P)@PERIYAMUTHUR	13200	15900	2700	680.4	711 x 6.3 MS	15962	0.73	1.89	533.694	474.230		59.464	0.35
BR. TO KRISHNAGIRI MUNICIPALITY - SUMP - 24.35LL(P)@18HRS	15900	19000	3100	680.4	711 x 6.3 MS	15716	0.72	2.11	531.586	480.980		50.606	11.68
BR. TO ORAPPAM SUMP 6.80LL(P)@ BARGUR UNION	19000	31900	12900	500	500 DI K7	7605	0.65	10.25	521.332	493.020		28.312	1.36
BR. MAIN TO BARGUR T.P SUMP - II 2.00LL (E)	31900	34300	2400	450	450 DI K7	6662	0.70	2.49	518.837	492.460		26.377	1.28
TO MATHEPALLI - SUMP - 20.80LL(P)	34300	36400	2100	450	450 DI K7	5772	0.60	1.67	517.164	493.026	495.026	24.138	

Source: JST based DPR data

Figure 6.3.8 HGL of TM in Section V from the Kalkuttapatti UMBR to Mathepalli Sump

6.3.4 Salient Features of Water Transmission Facility

As described in Section 6.3.3, it was confirmed that the hydraulic design of the entire water transmission system has been appropriately conducted. The salient features of the water transmission facilities are presented hereunder.

(1) Salient Feature of FM, ITM, and INW

Regarding the planning of FM, ITM, and INW, the existing pipelines developed under the Previous Hogenakkal Project was taken into consideration for the design. Wherever the capacity of the existing network is sufficient to carry the additional flow, these facilities will be utilized under the Project.

Table 6.3.5 shows a summary of the existing FM, ITM, and INW to be utilized in the Project.

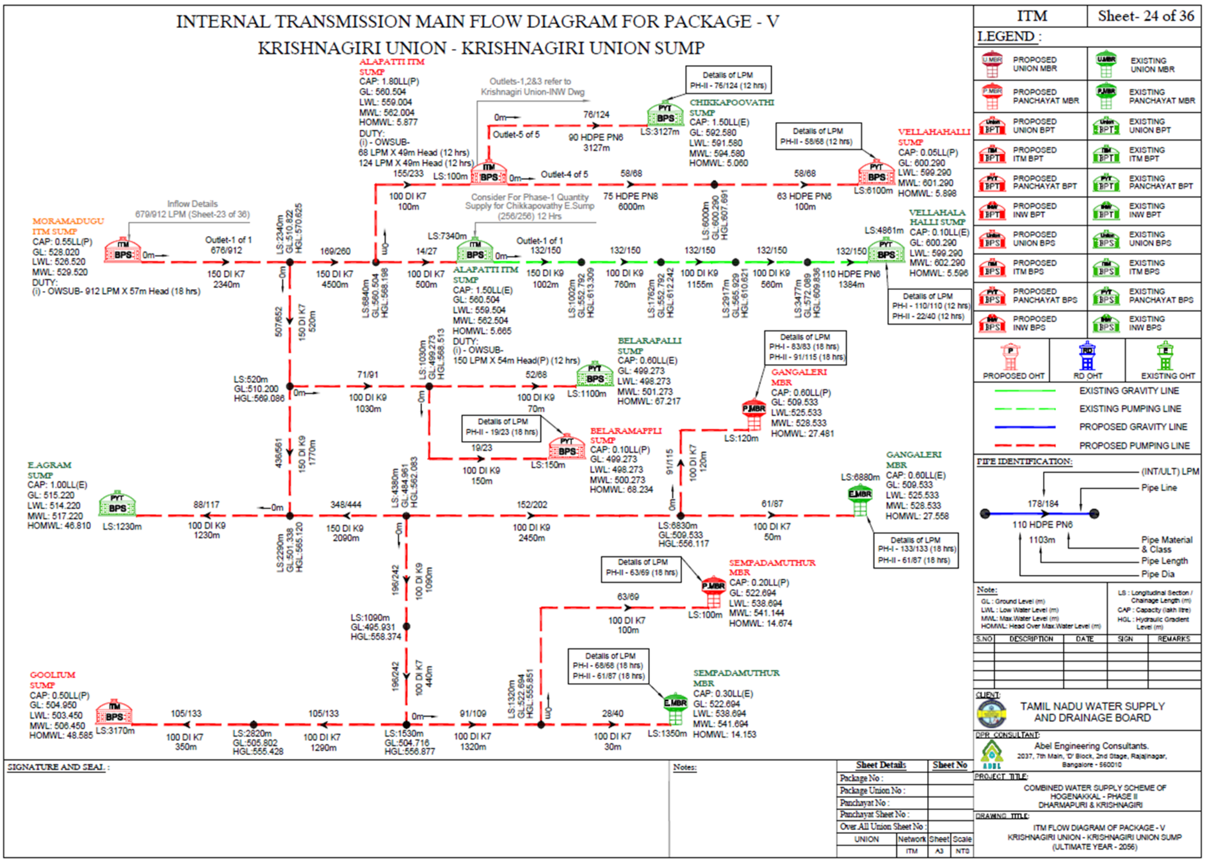
Table 6.3.5 Summary of the Existing FM, ITM, and INW to be Utilized

Description	Pipe Material	Section II	Section III	Section IV	Section V	Total (km)
Feeder Main (km)	MS	0.675				0.675
	DI	2.378			5.893	8.271

	HDPE				7.392	7.392
	Sub-total	3.053			13.285	16.338
Internal Transmission Main (km)	MS					
	DI				3.477	3.477
	HDPE				1.384	1.384
	Sub-total				4.861	4.861
Internal Network (km)	MS					
	DI	26.080	28.599	58.505	28.998	142.182
	HDPE	1,642.189	1,032.985	2,003.685	2,002.653	6,681.512
	GI		14.372			14.372
	Sub-total	1,668.269	1,075.956	2,062.190	2,031.651	6,838.066
Total Mains (km)	MS	0.675			0	0.675
	DI	28.458	28.599	58.505	38.368	153.930
	HDPE	1,642.189	1,032.985	2,003.685	2,011.429	6,690.288
	GI		14.372			14.372
Grand Total	-	1,671.322	1,075.956	2,062.190	2,049.797	6,859.265

Source: JST based on DPR data

Figure 6.3.9 presents a sample schematic drawing of the ITM, showing the existing pipelines to be used in Section V.



Source: DPR

Figure 6.3.9 Sample of Schematic Figure (ITM) Showing Existing Pipeline

A new network was proposed in areas where the existing pipelines are either unavailable or insufficient to carry the additional flows.

A summary of FM, ITM, and INW to be newly constructed under the Project is shown in Table 6.3.6.

Table 6.3.6 Summary of FM, ITM, and INW to be Constructed by the Project

Description	Pipe Material	Section II	Section III	Section IV	Section V	Total (km)
Feeder Main (km)	MS			13.976		13.976
	DI	6.136	7.820	25.121	14.511	53.588
	HDPE	31.018	39.247	19.002	57.750	147.017
	Sub-total	37.154	47.067	58.099	72.261	214.581
Internal Transmission Main (km)	DI	407.319	393.806	750.012	677.053	2,218.190
	HDPE	170.012	74.169	268.643	91.889	599.713
	Sub-total	577.331	467.975	1,018.655	768.942	2,827.903
Internal Network (km)	DI	41.384	32.425	28.749	2.190	104.748
	HDPE	1,021.267	659.243	1,158.698	1,076.260	3,915.468
	GI		6.221			6.221
	Sub-total	1,062.651	697.889	1,187.447	1,078.450	4,026.437
Total Mains (km)	MS			13.976		13.976
	DI	454.839	434.051	803.882	693.754	2,386.526
	HDPE	1,222.297	772.659	1,446.343	1,225.899	4,667.198
	GI					
Grand Total	-	1,677.136	1,212.931	2,264.201	1,919.653	7,073.921

Source: JST based on DPR data

(2) Salient Features of Pump Facilities and Storage Structures

1) Salient Features of Raw Water Pumping Station from Intake to WTP

Table 6.3.7 shows the capacity and number of pumps installed at each raw water pumping station for the conveyance of raw water from the intake to the WTP.

Table 6.3.7 Salient Feature of Raw Water Pump Station

Pump Station	Specification of each Pump Capacity (lpm) x Head (m)	Number of Pumps (Ultimate Year)	Number of Pumps (Intermediate Year)
Headworks (Intake) at Hogenakkal	Vertical Turbine 27,612 lpm x 78 m	8W + 4S	7W + 3S
Booster PS 1 at Yanalpallam	Vertical Turbine 27,612 lpm x 147 m	8W + 4S	7W + 3S
Booster PS 2 at Kanavai	Vertical Turbine 27,612 lpm x 105 m	8W + 4S	7W + 3S

Source: JST based on DPR data

2) Salient Features of Treated Water Pump Station in WTP and Major BPS

Table 6.3.8 shows the pumping destinations, capacities, and number of pumps installed at the treated water pumping stations located at the WTP site and along the transmission mains.

Table 6.3.8 Salient Feature of Treated Water Pump Station

Pump Station	Pumping Destination	Specification of each Pump Capacity (lpm) x Head (m)	Number of Pumps (Ultimate)	Number of Pumps (To be Installed under the Project)
Treated Water Pump Station at WTP	MBR in WTP Site for Sections II and III	Horizontal Double Suction 18,467 lpm x 43 m	4W + 2S	4W + 1S
	Sugar Mill Common	Horizontal Double	4W + 2S	4W + 1S

Pump Station	Pumping Destination	Specification of each Pump Capacity (lpm) x Head (m)	Number of Pumps (Ultimate)	Number of Pumps (To be Installed under the Project)
	BPS for Sections IV and V	Suction 35,149 lpm x 66 m		
Sugar Mill Common BPS	Mahendra Mangalam BPS for Section IV	Vertical Turbine 24,048 lpm x 85 m	4W + 2S	4W + 1S
	Kalkutapatti UMBR/BPT for Section V	Vertical Turbine 33,667 lpm x 58 m	1W +1S	1W +1S
	Valaithottaam UMBR and Chettihalli Sump	Vertical Turbine 7,339 lpm x 52 m	1W +1S	1W +1S
	Palacode Sump	Vertical Turbine 859 lpm x 41 m	1W +1S	1W +1S
Mahendra Mangalam BPS	Kaduchettipatti BPS for Section IV	Vertical Turbine 24,048 lpm x 112m	4W + 2S	4W + 1S
Kaduchettipatti BPS	Ullukurukkai BPS for Section IV	Vertical Turbine 21,851 lpm x 100 m	4W + 2S	4W + 1S
	Royakottai UMBR	Vertical Turbine 8,435 lpm x 111 m	1W +1S	1W +1S
	Kaduchettipatty UMBR	Vertical Turbine 2,795 lpm x 32 m	1W +1S	1W +1S
Ullukurukkai BPS	Manjalagiri BPS for Section IV and other Sumps	Vertical Turbine 20,411 lpm x 123 m	4W + 2S	4W + 1S
Manjalagiri BPS	MBR for Hosur Corporation and other MBR/Sumps	Vertical Turbine 18,123 lpm x 105 m	4W + 2S	4W + 1S

Source: JST based on DPR data

(3) Receiving Structures (MBR/Sumps), Re-chlorination, and OHTs

Treated water from the transmission mains is first sent to the Union MBR and then transmitted from the Union MBRs to the Panchayat MBRs. From each Panchayat MBR, water is transmitted to the OHTs in each water distribution zone. If there is insufficient transmission pressure along the route, the flow is redirected to a sump (ground-level tank), from which a submersible pump delivers the water to the MBR/OHT.

The capacities of the MBRs and sumps are designed to provide four to five hours of daily flow. In order to ensure that the residual chlorine does not fall below 0.2 mg/l during transmission, additional chlorine facilities are installed at booster pump stations and at MBRs/sumps located at every 30 km to 35 km along the transmission pipelines (Sugar Mill BPS: 41.5 kg/hr, Kaduhcettipatti BPS: 28.9 kg/hr, MBR/sump: 0.1–13.0 kg/hr).

OHTs are installed to distribute water within each distribution zone. The storage capacity of each OHT is determined in increments of 10 m^3, based on eight hours of water demand for the Intermediate Year (2041) in ULBs and 12 hours of water demand for the Ultimate Year (2056) in village panchayats. This is in accordance with TWAD planning and design standards.

Regarding the target year for the capacity demand, the ultimate year demand was applied for village panchayats in accordance with the JJM guidelines, while the intermediate year demand was applied at the time of CPHEEO's appraisal, in order to reduce initial investment. OHTs are of a circular shape, with staging heights of 7.5 m, 12 m, and 16 m, selected according to the topography.

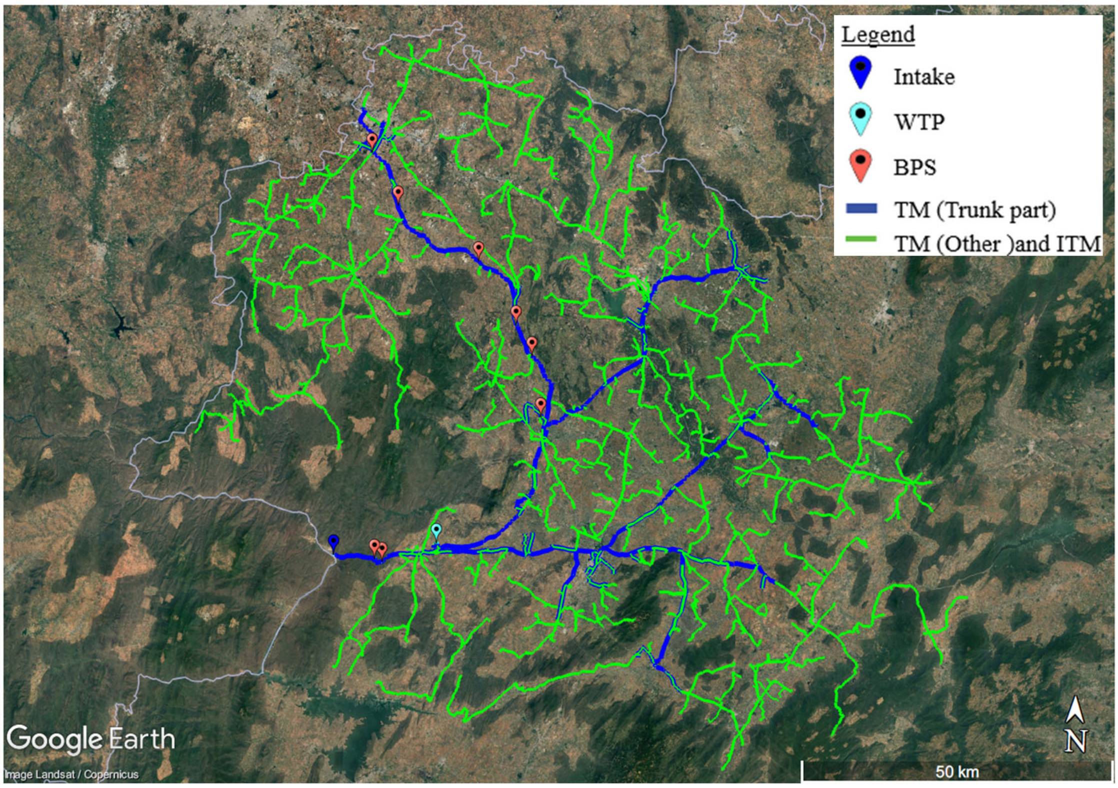
Table 6.3.9 shows the total number of these structures for each section.

Table 6.3.9 Total Number of MBRs/Sumps, Re-chlorination, OHTs

Structure	Section II	Section III	Section IV	Section V	Total
Union MBR	5	4	4	5	18
Panchayat MBR	64	40	126	76	306
Sump	148	123	153	174	598
Re-chlorination	15	12	10	20	57
OHT	468	281	522	629	1,900

Source: JST based on DPR data

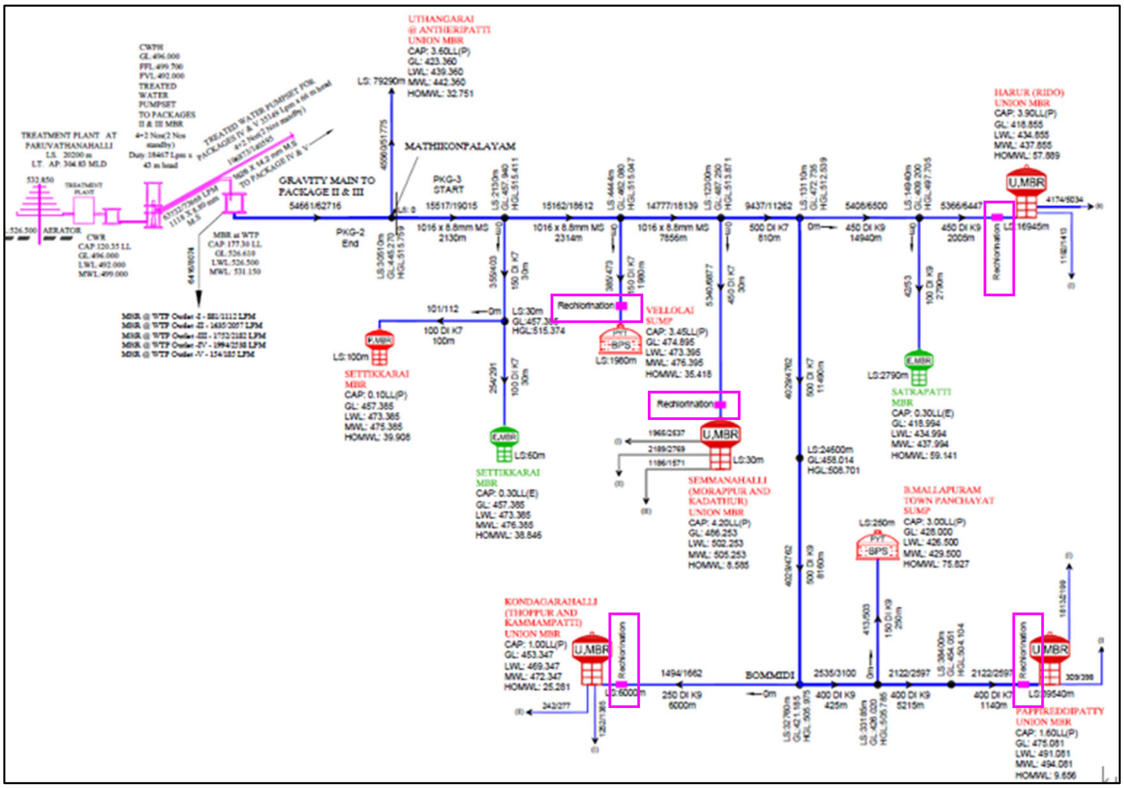
Figure 6.3.10 indicates the location of the transmission pipelines (TM and ITM). MBRs or sumps are installed at each branching point and at the end of each transmission line. The DPR deliverables do not include detailed maps of the INW routes beyond the MBRs/sumps and the 1,900 OHTs located at their terminal points. Only INW flow diagrams are included in the DPR. Approximately 1,400 INW flow diagrams have been prepared and submitted separately.



Source: JST based on DPR

Figure 6.3.10 Location of TM and ITM

Figure 6.3.11 presents a sample schematic drawing indicating the location of the re-chlorination.



Source: DPR

Figure 6.3.11 Sample of Schematic Figure indicating the Location of Re-chlorination

(4) Examination of the Application of O-PVC Pipes

JST was requested to examine the applicability of Oriented Polyvinyl Chloride (O-PVC) pipes as an alternative to DCI D250 (Class K7). Based on the review of relevant documents on O-PVC pipes, the following observations were made:

- O-PVC is a new technology for manufacturing pipes that involves controlling the circumferential and axial orientation of the molecular structure. This process results in a laminar structure in the material used for pipe construction. O-PVC pipes are light in weight, easy to handle, have excellent hydraulic capacity, and possess higher resistance against water hammers.
- The long-term testing (10,000-hour test) of compound mixes used in pipe manufacturing to ensure compliance with minimum strength requirements is not yet covered under IS 16647: 2017 (Reaffirmed 2022), due to current limitations in the available testing facilities within the country.
- In India, O-PVC pipes are available in nominal diameters of 110 mm, 160 mm, 200 mm, 250 mm, 315 mm, and 400 mm (outer diameter) with pressure ratings of PN 12.5, PN 16, PN 20, and PN 25. Their use is presently limited to small-scale projects or pilot projects in some of the states in India.
- O-PVC pipes are susceptible to strength degradation under direct sunlight; therefore, they should be stored properly with adequate cover and should not be used in above-ground installations.

- Currently, there is no Indian Standard Code for O-PVC fittings, which poses challenges in ensuring uniformity and quality. Additionally, no standard specification exists for laying O-PVC pipes in rocky terrains, highlighting a gap in guidelines for specific installation conditions.
- O-PVC pipes are recommended for use within a water temperature range of 1 °C and 45 °C. When the temperature exceeds 27 °C and approaches 45 °C, the strength of the pipe decreases; thus, the working pressure must be adjusted using the derating factor graph provided in Annexure B of IS 16647: 2017 (Reaffirmed 2022).

As a result of discussions with TWAD, and considering the above points, it was concluded that O-PVC pipes shall not be adopted for the Project.

6.4 Distribution Pipeline Network

6.4.1 Urban Area

(1) Target ULB of the Project

Table 6.4.1 shows the 11 ULBs where the distribution pipeline network will be constructed under the Project. For the remaining eight local bodies, the construction will be executed using funds from the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0 or other State-funded schemes. The AMRUT 2.0 is a national program designed to provide universal coverage of water supply through functional taps to all households in town panchayats. It was launched in October 2021 and is being implemented over five years (FY 2021-22 to 2025-26).

Table 6.4.1 List of 11 Urban Local Bodies for the Construction of Distribution Pipeline Network

Local Body	Included or Not Included in the Project	Local Body	Included or Not Included in the Project
Dharmapuri District		**Krishnagiri District**	
I. City Corporation/Municipality		I. City Corporation/Municipality	
1. Dharmapuri Municipality	**Included**	1. Hosur City Corporation	**Included**
		2. Krishnagiri Municipality	**Included**
II. Town Panchayat (TP)		II. Town Panchayat (TP)	
1. Pennagaram TP	*Not included*	1. Uthangarai TP	*Not included*
2. Kadathur TP	**Included**	2. Denkanikottai TP	**Included**
3. Kambainallur TP	*Not included*	3. Kelamangalam TP	**Included**
4. B.Mallapuram TP	**Included**	4. Kaveripattinam TP	*Not included*
5. Harur TP	*Not included*	5. Nagojanahalli TP	**Included**
6. Pappireddipatty TP	*Not included*	6. Bargur TP	**Included**
7. Papparapatti TP	*Not included*		
8. Palacode TP	*Not included*		
9. Marandahalli TP	**Included**		
10. Karimangalam TP	**Included**		

Source: DPR

(2) Hydraulic Design

The distribution pipeline network has been designed to meet the Ultimate Year (2056) water demand, taking into account existing facilities, including those developed under the Previous Hogenakkal Project.

The water distribution from the OHT is by gravity flow, assuming a 24-hour water supply. The time coefficient (ratio of peak flow rate to average daily flow rate) was set at 2.5 for the 2056 water demand .

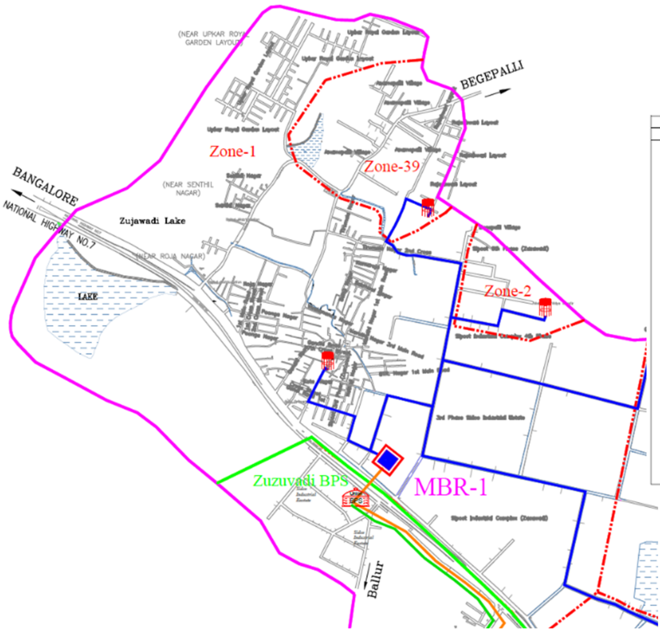
Pipe diameters were determined such that the water head at each point does not fall below 17 m (City Corporation and Municipality) and 12 m (Town Panchayat). The minimum pipe diameters are 110 mm (City Corporation and Municipality) and 90 mm (Town Panchayat).

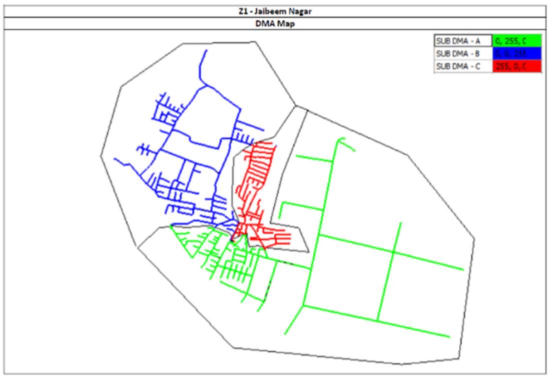
The outline of the distribution network design for Hosur City Corporation is described hereunder.

The Hosur Corporation area has been divided into 39 distribution zones, as shown in Appendix 6.X. In the DPR prepared for Hosur City Corporation, all 39 zones were previously designed with a residual head of 7 m, and an OHT with 16 m staging was planned for each zone. Out of these 39 zones, 14 zones which are in the city core area were already constructed under AMRUT 1.0 during 2015-16.

Under the current Project, the distribution system for the remaining 25 zones were designed with a residual head of 17 m. To achieve this, in-line booster pumps with variable frequency drive (VFD) will be installed to maintain the required residual head. In addition, in-line booster pumps with a 15 m head will be installed in the existing 14 zones to achieve a residual head of 17 m.

It was confirmed that the hydraulic design has been properly conducted. Figure 6.4.1 shows an example of the hydraulic design for Zone 1, while similar hydraulic designs for the other zones are outlined in Appendix 6.2.





Z1 - Jaibeem Nagar

PIPE ABSTRACT

Sum of Length (m) Row Labels	Column Labels DI	HDPE	Grand Total
SUB DMA - A	**32**	**9478**	**9510**
110		8135	8135
125		289	289
140		258	258
160		47	47
200		438	438
225		311	311
300	32		32
SUB DMA - B	**332**	**8037**	**8369**
110		7285	7285
125		225	225
160		289	289
180		238	238
250	332		332
SUB DMA - C		**4578**	**4578**
110		4340	4340
125		55	55
180		102	102
200		10	10
225		71	71
Grand Total	**364**	**22093**	**22457**

JUNCTION ABSTRACT

Row Labels	Sum of Ultimate Demand (L/day)	Sum of Peak Demand (L/day)
SUB DMA - A	1874464.05	4686160.1
SUB DMA - B	1505102.77	3762756.96
SUB DMA - C	941322.16	2353305.28
Grand Total	**4320888.98**	**10802222.34**

PRESSURE TABLE

Pressure	No. of Nodes	% of Nodes
0m to 10m	0	0%
10m to 15m	1	0%
15m to 17m	4	1%
16m to 17m	4	1%
Above 17m	359	98%
TOTAL	**368**	**100%**

VELOCITY TABLE

Velocity in m/s	Length in m	% of Tot Len
0 to 0.3	0	0%
0.3 to 0.6	0	0%
0.6 to 1.0	2415	11%
1.0 to 1.10	282	1%
Above 1.10	0	0%
Min Dia	19760	88%
TOTAL	**22457**	**100%**

Z1 - Jaibeem Nagar

Pipe Table

Label	Start Node	Stop Node	Length (m)	Flow (L/day)	Velocity (m/s)	Inner Diameter (mm)	Outer Diameter (mm)	Material	Hazen-Williams C	Headloss Gradient (m/km)	Headloss (m)	Zone	Sub DMA
Fire Pipe - 1	Z1 - Jaibeem Nagar OHT	Fire - 1	20	2,66,345	0	98.6	110	HDPE	145	1.888	0.04	Z1 - Jaibeem Nagar	SUB DMA - A
P-1	Z1 - Jaibeem Nagar OHT	J-1	27	37,62,795	1	250	250	DI	140	2.92	0.08	Z1 - Jaibeem Nagar	SUB DMA - B
P-2(1)	Z1 - Jaibeem Nagar OHT	PMP-1	17	44,19,862	1	300	300	DI	140	1.617	0.03	Z1 - Jaibeem Nagar	SUB DMA - A
P-2(2)	PMP-1	J-2	15	44,19,862	1	300	300	DI	140	1.617	0.02	Z1 - Jaibeem Nagar	SUB DMA - A
P-3	J-2	J-3	42	18,43,222	1	179.4	200	HDPE	145	3.676	0.15	Z1 - Jaibeem Nagar	SUB DMA - A
P-4	J-3	J-4	68	17,97,335	1	179.4	200	HDPE	145	3.507	0.24	Z1 - Jaibeem Nagar	SUB DMA - A
P-5	J-4	J-5	33	9,30,603	1	143.4	160	HDPE	145	3.086	0.1	Z1 - Jaibeem Nagar	SUB DMA - A
P-6	J-5	J-6	14	8,92,232	1	143.4	160	HDPE	145	2.855	0.04	Z1 - Jaibeem Nagar	SUB DMA - A
P-7	J-6	J-7	18	99,291	0	98.6	110	HDPE	145	0.304	0.01	Z1 - Jaibeem Nagar	SUB DMA - A
P-8	J-7	J-8	32	64,084	0	98.6	110	HDPE	145	0.133	0	Z1 - Jaibeem Nagar	SUB DMA - A
P-9	J-8	J-9	45	15,428	0	98.6	110	HDPE	145	0.01	0	Z1 - Jaibeem Nagar	SUB DMA - A
P-10	J-8	J-10	54	14,241	0	98.6	110	HDPE	145	0.008	0	Z1 - Jaibeem Nagar	SUB DMA - A
P-11	J-7	J-11	41	11,076	0	98.6	110	HDPE	145	0.005	0	Z1 - Jaibeem Nagar	SUB DMA - A
P-12	J-5	J-12	49	13,054	0	98.6	110	HDPE	145	0.008	0	Z1 - Jaibeem Nagar	SUB DMA - A
P-13	J-4	J-13	64	8,27,174	1	112	125	HDPE	145	8.268	0.53	Z1 - Jaibeem Nagar	SUB DMA - A
P-14	J-13	J-14	13	4,27,941	1	98.6	110	HDPE	145	4.537	0.06	Z1 - Jaibeem Nagar	SUB DMA - A
P-15	J-14	J-15	88	28,086	0	98.6	110	HDPE	145	0.03	0	Z1 - Jaibeem Nagar	SUB DMA - A
P-16	J-14	J-16	71	3,53,572	1	98.6	110	HDPE	145	3.187	0.23	Z1 - Jaibeem Nagar	SUB DMA - A
P-17	J-16	J-17	52	1,45,311	0	98.6	110	HDPE	145	0.614	0.03	Z1 - Jaibeem Nagar	SUB DMA - A
P-18	J-16	J-18	22	1,69,890	0	98.6	110	HDPE	145	0.822	0.02	Z1 - Jaibeem Nagar	SUB DMA - A
P-19	J-18	J-19	30	1,35,475	0	98.6	110	HDPE	145	0.538	0.02	Z1 - Jaibeem Nagar	SUB DMA - A

Z1 - Jaibeem Nagar

Junction Table

Label	Elevation (m)	Peak Demand (L/day)	Ultimate Demand (L/day)	Hydraulic Grade (m)	Pressure (m H2O)	Zone	Sub DMA
Fire - 1	885.925	2,66,345	1,06,538	900.802	14.85	Z1 - Jaibeem Nagar OHT	SUB DMA - A
J-1	885.326	15,032	6,013	900.76	15.4	Z1 - Jaibeem Nagar OHT	SUB DMA - B
J-2	885.925	21,361	8,545	910.788	24.81	Z1 - Jaibeem Nagar OHT	SUB DMA - A
J-3	887.584	35,602	14,241	910.633	23	Z1 - Jaibeem Nagar OHT	SUB DMA - A
J-4	890.079	39,558	15,823	910.394	20.27	Z1 - Jaibeem Nagar OHT	SUB DMA - A
J-5	890.964	25,317	10,127	910.292	19.29	Z1 - Jaibeem Nagar OHT	SUB DMA - A
J-6	891.242	20,570	8,228	910.253	18.97	Z1 - Jaibeem Nagar OHT	SUB DMA - A

Pump Table

Label	Flow (Total) (L/day)	ULT DIS (L/day)	Pump Head (m)	Downstream Pipe
PMP-1	44,19,862	17,67,945	10	P-2(2)

Source: DPR

Figure 6.4.1 Hydraulic Calculation for Distribution Zone 1 in Hosur Corporation

Table 6.4.2 shows the total quantity of distribution pipelines in the 25 zones of Hosur City Corporation.

Table 6.4.2 Planned Distribution Facility in Hosur Corporation

Zone	Pipeline (m)												Inline Pump	
	DI			HDPE								Grand Total	Head (m)	
	250	300	Total	110	125	140	160	180	200	225	Total			
Z1 - Jaibeem Nagar	332	32	364	19,760	569	258	336	340	448	382	22,093	22,457	10	
Z2 - SIPCOT Industrial				1,224	213						1,437	1,437		
Z3 - Mookandapalli	955	558	1,513	28,848	319	323	603	440	523	593	59,913	61,426	15	10 x 3 nos.
Z4 - Gandhi Nagar	673	99	772	17,971	259	440	91	164	147	283	17,318	18,090	7 x 2 nos.	
Z9 - VOC Nagar	129	194	323	14,847	411	136	158	905	131	160	16,748	17,071	10	
Z10 - Annamalai Nagar				4,380			27		33		4,440	4,440	11	
Z11 - TVS Factory Road	623	131	754	6,468				765	329	150	121,949	122,703	5	
Z12 - AVS Residency				2,045			157	108	53		2,363	2,363		
Z15 -Srimuneeswara Nagar		762	762	13,636		156	333	164	106	190	949	1,711	11	
Z16 - Kothur				2,096		46		101	151		2,394	2,394		
Z17 - Manju Sree Nagar	950		950	20,090	702	385		409	200	482	5,706	6,656	19	
Z18 - Karnur	26		26	5,157	409	150		274			255,310	255,336		
Z19 - SGK Nagar				19,039	155		455	98		1,111	20,858	20,858	4	8
Z20 - Titan Township				26,718	180	56	1,162	340	103	904	29,463	29,463		
Z23 - Ganesh Nagar	1,052	18	1,070	10,808	840	582	19	39	328		50,321	51,391		
Z24 - Brindhavan Nagar				19,034	40	24	322	256	1,603		21,279	21,279	7	
Z27 - Avalapalli HUDCO	760		760	17,096	235	296	332	111	286	246	18,602	19,362	7	
Z28 - Thottagiri Road				7,529		32			44		7,605	7,605		
Z29 - JP Nagar				11,625	377		272		153		12,427	12,427	3	
Z31 - Maruthi Nagar				6,700	217						6,917	6,917		
Z32 - Anand Nagar				11,615	26	132			128		11,901	11,901	10	
Z33 - Chinna Elasagiri	374	440	814	37,191	343	64	401	780	343	568	18,818	19,632		
Z34 - Santhapuram				2,611	289						2,900	2,900	7	
Z35 - Rajaji Nagar	450	126	576	8,652	157	178	439	95			9,521	10,097		
Z39 - Rajeswari layout				4,489	254	154					4,897	4,897	9	
Grand Total	6,324	2,360	8,684	319,629	5,995	3,412	5,107	5,389	5,109	5,069	349,710	358,394		

Source: JST based on DPR

(3) Quantity Summary of the Distribution Pipeline

The same hydraulic design approach has been applied for the ten other ULBs covered by the Project. A summary of the total pipeline quantities for the 11 ULBs where the distribution pipeline networks will be constructed under the Project is presented in Table 6.4.3.

Table 6.4.3 Quantity Summary of Distribution Pipeline by the Project

Description	Length of Pipeline (m)																									
	New																Replaced									Grand Total
	DI						HDPE										HDPE									
	250	300	350	400	450	Sub Total	90	110	125	140	160	180	200	225	Sub Total	Total	90	110	125	140	160	180	200	225	Total	
Dharmapuri Distinct																										
I. Municipality / Corporation																										
Dharmapuri Municipality (Section II＆III)	1,806	653	810	-	-	3,269	-	77,186	868	1,048	1,758	853	274	2,408	84,395	87,664	-	-	-	-	-	-	-	-	0	87,664
II. 町(Town Panchayat(TP))																										
Kadathur TP (Section III)	-	-	-	-	-	0	21,289	156	392	-	23	-	113	-	21,973	21,973	1,015	350	58	42	97	-	78	-	1,640	23,613
B. Mallapuram TP (Section III)	-	-	-	-	-	0	37,902	805	834	43	-	-	-	-	39,584	39,584	9,470	428	215	-	-	-	-	-	10,113	49,697
Marandahalli TP (Section V)	-	-	-	-	-	0	6,467	234	68	-	106	90	453	39	7,457	7,457	2,515	440	-	-	-	-	-	56	3,011	10,468
Karimangalam TP (Section V)	-	-	-	-	-	0	40,743	918	193	162	62	-	-	-	42,078	42,078	1,122	351	-	-	-	-	-	-	1,473	43,551
Krishnagiri Distinct																										
I. Municipality / Corporation																										
Hosur Corporation (Section IV)	6,324	2,360	-	-	-	8,684	-	319,629	5,995	3,412	5,107	5,389	5,109	5,069	349,710	358,394	-	-	-	-	-	-	-	-	0	358,394
Krishnagiri Municipality (Section V)	2,633	2,142	540	45	708	6,068		88,088	2,550	601	1,713	2,800	1,023	1,845	98,620	104,688	-	-	-	-	-	-	-	-	0	104,688
II. Town Panchayat(TP)																										
Denkanikottai TP (Section IV)	-	-	-	-	-	0	58,440	1,629	187	557	419	193	138	367	61,930	61,930	-	-	-	-	-	-	-	-	0	61,930
Keelamangalam TP (Section IV)	-	-	-	-	-	0	34,459	424	-	156	684	-	-	-	35,723	35,723	-	-	-	-	-	-	-	-	0	35,723
Nagojanahalli TP (Section V)	-	-	-	-	-	0	6,976	62	-	90	776	-	-	-	7,904	7,904	2,706	253	-	-	901	-	-	-	3,860	11,764
Bargur TP (Section V)	-	-	-	-	-	0	16,469	49	195	273	-	-	196	1,144	18,326	18,326	10,456	234	458	500	496	199	62		12,405	30,731

Source: DPR

(4) Outline of the Work Contents in the Eight Other ULBs

Table 6.4.4 shows the outline of the work contents for four ULBs whose funding has already been secured among the eight ULBs not covered by this Project.

Table 6.4.4 Work Contents of ULBs Not Covered by the Project

Item	Contents	Remarks
Pennagaram Town Panchayat		
Intake, Water Transmission Facility	Collecting Well (3 nos.), Pipeline (14 km), Connection Well, Transmission Pipeline to OHT (10 km)	Construction period: 12 months. Transmission pipeline is completed.
OHT	60 m^3 ～ 400 m^3 Staging 12m ～ 16m (7 nos.)	Construction period: 12 months. 6 nos. are completed.
Distribution Pipeline	47 km	Construction period: 12 months. Completed.
House Service Connection	3,041 nos.	Completed 900 nos.
Construction Cost: INR 195 million		
Palacode Town Panchayat		
Intake, Water Transmission Facility	Collecting Well 4 nos. Pipeline 2.1 km,	
House Service Connection	2,312 nos.	
Construction Cost: INR 47 million (INR 37 million by AMRUT funding)		
Kaveripattinam Town Panchayat		
Intake, Water Transmission Facility	Collecting Well (2 nos.), Pipeline (4.5 km)	
Distribution Pipeline	10.5 km	
House Service Connection	Existing Connections (replacing water meter) (1,891 nos.) New Connections (2,150 nos.)	AMR Meter
Construction Cost: INR 65 million (INR 32 million by AMRUT funding)		
Kambainallur Town Panchayat		
OHT	100 m^3 Staging 16 m (1 no.)	
Distribution Pipeline	4 km	
Construction Cost: INR 15 million		

Source: TWAD

Regarding the four remaining ULBs, the funding source is still under consideration as of June 2025.

6.4.2 Rural Area

The distribution pipeline will be constructed by the Rural Development and Panchayat Raj (RD&PR) Department, under the JJM. House service connections will be installed for all households; however, the installation of the water meters will not be conducted. Table 6.4.5 presents the list for the work quantities and construction cost.

Table 6.4.5 Distribution Pipeline and House Service Connection in Rural Area

Sl. No.	Panchayat Union	Total Household	Existing Connection	New Connection	New Pipeline (km)	Cost Including GST in INR millions
Dharmapuri District						
1	Dharmapuri	55,820	27,948	27,872	294	337
2	Eriyur	18,586	11,830	6,756	68	80
3	Harur	42,152	32,583	9,569	96	113
4	Kadathur	24,289	16,652	7,637	84	94
5	Karimangalam	35,348	24,323	11,025	110	130
6	Morappur	18,536	13,579	4,957	50	58
7	Nallampalli	52,265	23,687	28,578	286	337
8	Palacode	39,783	28,489	11,294	113	133
9	Pappireddipatti	25,393	16,481	8,912	89	105
10	Pennagaram	30,744	25,112	5,632	56	66
Subtotal		342,916	220,684	122,232	1,245	1,452
Krishnagiri District						
1	Krishnagiri	46,340	33,776	12,564	188	112
2	Kaveripattinam	46,434	32,287	14,147	212	128
3	Bargur	53,464	42,806	10,658	160	96
4	Mathur	31,911	19,369	12,542	185	112
5	Uthangarai	40,019	33,737	6,282	88	55
6	Veppanapalli	24,672	22,118	2,554	34	22
7	Shoolagiri	43,752	30,938	12,814	143	100
8	Hosur	40,888	40,888	0	0	0
9	Kelamangalam	31,543	22,266	9,277	139	84
10	Thally	50,782	29,701	21,081	422	223
Subtotal		409,805	307,886	101,919	1,572	930
Total		**752,721**	**528,570**	**224,151**	**2,817**	**2,382**

Source: TWAD

The construction work aims to provide house service connections to households that are currently unconnected. Funding for additional house service connections after the Project will be sourced from a combination of Central Finance Commission Grants and other available sources. The implementation will be undertaken in accordance with the JJM guidelines. The planned expenditure of construction funds is distributed as follows: 30% in FY 2026, 30% in FY 2027, and 40% in FY 2028, with completion targeted by FY 2029.

6.5 House Service Connection

House service connections are planned to be installed in the 11 target ULBs where the distribution pipeline will be constructed under the Project. These service connections will be equipped with water meters. In accordance with the Indian Government's policy, all households in both urban and rural areas will be equipped with house service connections, and their costs are included in the Project cost.

The proposed type of water meter is an ultrasonic meter with automatic meter reading (AMR) using LoRaWAN, based on the recommendations of the CPHEEO Technical Appraisal Report for the Project. The main advantages of this type of water meter are as follows:

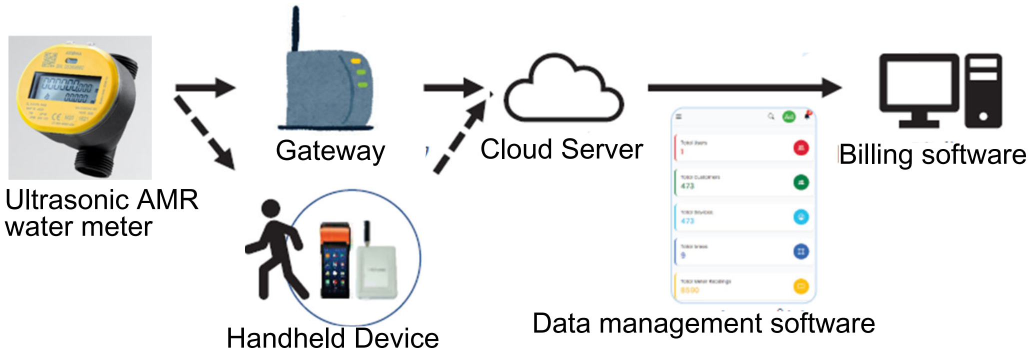
Main advantages of ultrasonic meters over conventional mechanical types:

- Both horizontal and vertical mounting are possible.
- Air flow when the water supply is resumed is not recorded.

Main advantages of AMR Systems:

- Negligible manpower required for meter reading.
- Accurate measurement and billing.
- No disputes, as consumers can monitor daily consumption.
- Automatic bill generation.

Figure 6.5.1 shows an image of the AMR system.



Source: JST

Figure 6.5.1 Image of the AMR System

Moreover, if an AMR system is implemented, the data could be used to:

- Assess the amount of non-revenue water and monitor water distribution data from reservoir runoff.
- Analyze the time variability in water consumption and forecast water demand fluctuations.

However, the following issues should be addressed prior to the introduction of AMR meters:

- Human resource development for AMR operation and maintenance.
- Consideration of legal measures for handling personal information.
- Development of measures to prevent AMR device theft.

Table 6.5.1 outlines the number of house service connections to be installed under the Project. In addition to the new house service connections, it is proposed that existing mechanical water meters be replaced with ultrasonic AMR water meters.

Table 6.5.1 Number of New House Service Connections and Existing House Service Connections

Local Body	Number of Connections		
	New Connection with Ultrasonic AMR Water Meter	Existing Connections (to be replaced with Ultrasonic AMR Water Meters where mechanical meters are installed)	Total
Dharmapuri District			
I. City Corporation/Municipality			
Dharmapuri Municipality	10,021	11,829	21,850
II. Town Panchayat (TP)			
Kadathur TP	2,386	1,250	3,636
B. Mallapuram TP	3,118	95	3,213
Marandahalli TP	2,000	3,290	5,290
Karimangalam TP	3,100	2,050	5,150
Krishnagiri District			
I. City Corporation/Municipality			
Hosur City Corporation	50,000	38,000	88,000
Krishnagiri Municipality	6,509	10,057	16,566
II. Town Panchayat (TP)			
Denkanikottai TP	5,072	1,384	6,456
Kelamangalam TP	3,101	1,008	4,109
Nagojanahalli TP	1,700	1,061	2,761
Bargur TP	2,566	1,721	4,287
Total	89,573	71,745	161,318

Source: DPR

As mentioned above, the Project plans to install house service connections with ultrasonic AMR meters to all 160,000 households across the 11 target ULBs. It should be noted that the number of new connections was determined at the time of DPR preparation (2023), and additional connections may be required by the time of Project completion (FY 2029). Furthermore, after the Project, the distribution pipeline network will need to be expanded, and additional connections will need to be installed as necessary.

To fully utilise the AMR system and to introduce a metered water tariff system, it is necessary to include the following equipment and software in the cost estimate of the Project:

- Gateway for data collection,
- Handheld devices for data collection,
- Data management software, and
- Billing software.

Thus, it is proposed to include these items in the cost estimate for the House Service Connections under the Project.

6.6 Pump Facilities

The JST recommended the following proposals regarding mechanical works, which were agreed upon by TWAD.

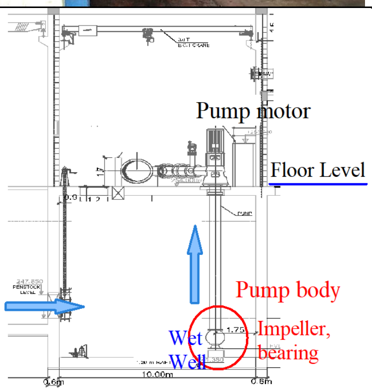
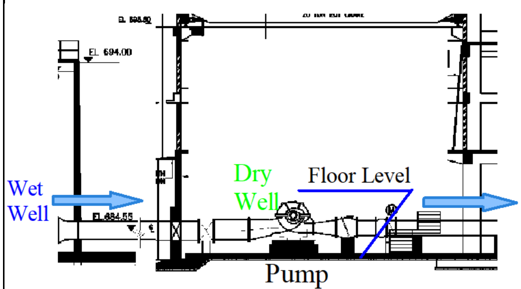
(1) Major Pump Type

In the Previous Hogenakkal Project, almost all intake pumps, transmission pumps at the WTP, and booster pumps (both main and distribution BSPs) adopted vertical turbine pumps. This is because the 2023 updated CPHEEO Manual of the Government of India stipulates the use of vertical turbine pumps for large-scale systems.

TWAD are familiar with the maintenance of vertical turbine pumps for many years. However, they accepted to change the type of the transmission pump (12 pumps) at the water treatment plant to the horizontal split casing type for the following reasons.

- In Bangalore, the horizontal split casing type pumps have been in operation for more than 20 years with minimal maintenance requirements. In comparison to certain Indian-made pumps that experience frequent breakdowns, the horizontal split casing type have maintained optimal efficiency and have garnered a strong reputation among clients.
- Their efficiency is 1-2% higher than that of vertical turbine pumps, potentially reducing electricity costs for the WTP by up to INR 7 million per year.
- They are easier to maintain than vertical turbine pumps.

Table 6.6.1 Comparison of Major Pump Type

	Vertical Turbine	**Horizontal Split Casing**
Photo		
Structure		
Features	Pump body and multi-impellers are submerged in the water tank.	A direct suction pipe-in connection can be achieved and is very easy to maintain since all parts are above the floor level.
Advantages	Pump efficiency is relatively high. Saves installation space.	Superior for maintenance since the casing is axially split, allowing the rotating element to be easily removed by only opening the upper casing. Pump efficiency is 1-2% higher than the left type, therefore, it offers potential for power saving.

	Vertical Turbine	Horizontal Split Casing
Disadvantages	Maintenance work is more costly than other types, and reinstallation requires more time, resulting in longer down time.	Suction piping space is required.
Equipment Cost (ratio) (Indian Manufacturer)	100	95
Reference Record	There are many records in India. This pump type, designed for large-capacity systems, is defined by the CPHEEO manual.	Applied in the Bangalore Water Supply Expansion Project Stage IV Phase 1 (2002) and Stage V (2022). In Stage IV Phase 1 (JICA Loan Project), Japanese-made pumps were installed for maintenance-free operation and sustained high performance Over 20 years of operation, no spare parts replacement was required, and over 87% efficiency was maintained as of 2023.
TWAD Preference	Electro-mechanical technicians are well familiar with this type, having maintained it for over 15 years; hence, TWAD prefers to continue using it.	If a new ground tank is constructed, this type may be preferable as it offers easier maintenance access.

Source: JST

(2) Pump Capacity and Working Number

The DPR stipulates that the intake facility and the two BPS will each be equipped with eight operating and four standby pumps, designed to meet a total daily water demand of 304,000 m^3/d. This configuration aligns with the design of the Previous Hogenakkal Project, which employed four operating pumps and two standby pumps for a total daily capacity of 160 MLD (160,000 m^3/d). Although JST suggested an alternative proposal—doubling the capacity of each pump and halving the number of pumps—TWAD concluded that the pump numbers specified in the DPR are appropriate for the following reasons:

- The lifting load of each pump would become excessively large.
- There is insufficient time for re-examination of the vortex prevention system, pump well design, and other related civil structures (such as water channel width and load).
- Regardless of the pump size, the pump efficiency remains unchanged at about 85%.

In addition, the number of standby pumps shall be based on 50% of the duty capacity, in accordance with the provisions of the CPHEEO Manual.

(3) Introduction of Variable Speed Control

Although the DPR initially specified fixed-speed operation, due to the absence of operational issues in existing facilities and the higher electricity costs associated with variable-speed control, variable-speed control is now considered desirable, especially for the section between the water intake facility and the WTP, for the following reasons:

- In the Previous Hogenakkal Project, water was directly transferred from the intake facilities to the WTP. In this project, however, water is planned to be transferred to the WTP via two BPS because the WTP elevation has risen due to land restrictions. Since the hydraulic retention time of the water receiving tanks at each BPS is only about one hour, there is a possibility of overflow in the event of an instrumentation malfunction or unexpected conditions.

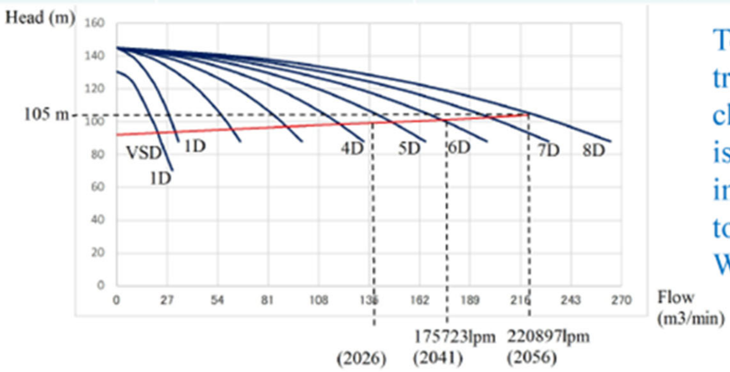
- Adopting variable-speed control will ensure a constant inflow rate regardless of variations in the suction water level at each pumping station or in the river, thereby contributing to the stable operation of the WTP, including the chemical injection system.
- Variable-speed control is a common approach to control the amount of water inflow rates in order to ensure stable water treatment conditions.
- It contributes to slight energy savings, as constant flow rate control under fluctuating suction water levels is possible.

Following the discussions held in December, it was determined that two pumps at BPS-2 (feeding the WTP) and six pumps at the WTP (supplying the Sugar Mill Common Pump Station) will employ variable-speed control. This decision is driven by economic factors and the need to accommodate projected increases in water demand up to the mid-stage year 2041.

1) Pumps at BPS-2

Given the high operating heads of most pumping stations, such as BPS-2, the transmission losses relative to the pump head are relatively small. Consequently, operation based on pump unit control is standard practice. However, owing to the nature of the inflow to the WTP, constant flow rate control is feasible. Therefore, considering the initial water volume and the projected increase in water volume demand by the mid-stage year 2041, two pumps, including one standby, will be converted to variable-speed control.

Item	DPR	Proposal-1	Proposal-2
VSD	None (Fixed speed)	None (Fixed speed)	2 VSDs including 1 standby
Approx. Operation period/day			
Initial 2026	15 hours/d (8 duties)	less 23 hours/d (5 duties)	23 to 24 hours/d (5 duties)
Intermediate 2041	19 hours/d (8 duties)	less 23 hours/d (7 duties)	23 to 24 hours d (7 duties)
Ultimate 2056	23 hours/d (8 duties)	23 hours/d (8 duties)	23 to 24 hours (8 duties)



To ensure stable water treatment including chemical injection control, it is recommendable to introduce minimum 2 VSDs to achieve constant flow to WTP.

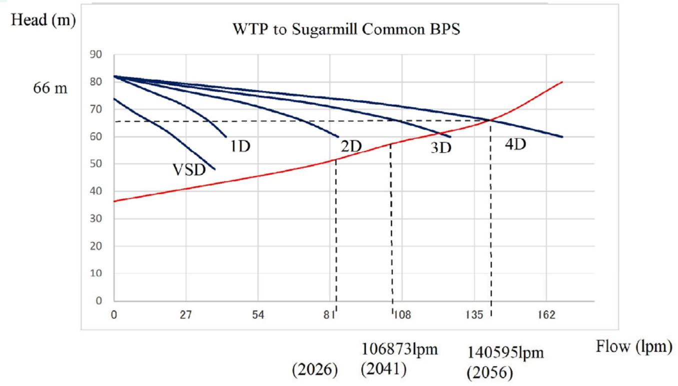
Source: JST

Figure 6.6.1 Performance Curve of Pumps at BPS-2

2) Pumps at the WTP for the Sugar Mill BPS

Although the water volume will increase by the intermediate year of 2041, operating two pumps at a fixed speed for several years from the initial operation will be difficult due to the significant transmission losses relative to the actual head. Therefore, intermittent operation with three pumps will be necessary. Supplying 1.5 times the demand for about ten hours during the initial operation is less efficient in terms of operation management and energy consumption compared with supplying the average water volume for 23 hours. To improve efficiency, six pumps—including standby—will be converted to variable speed control, enabling two-pump operation from the start.

Item	DPR	Proposal-1	Proposal-2
VSD	None (Fixed speed)	None (Fixed speed)	6 VSDs including 2 standby
Approx. Operation period/day			
Initial 2026	15 hours/d (4 duties)	16 hours/d (3 duties)	23 to 24 hours (3 duties)
Intermediate 2041	19 hours/d (4 duties)	21 hours/d (3 duties)	23 to 24 hours (4 duties)
Ultimate 2056	23 hours/d (4 duties)	23 hours/d (4 duties)	23 to 24 hours (4 duties)



To consider initial and intermediate stage, it is required to introduce VSDs. They could be energy saving potential. ※it is impossible to run by only 2 fixed speed pumps

Source: JST

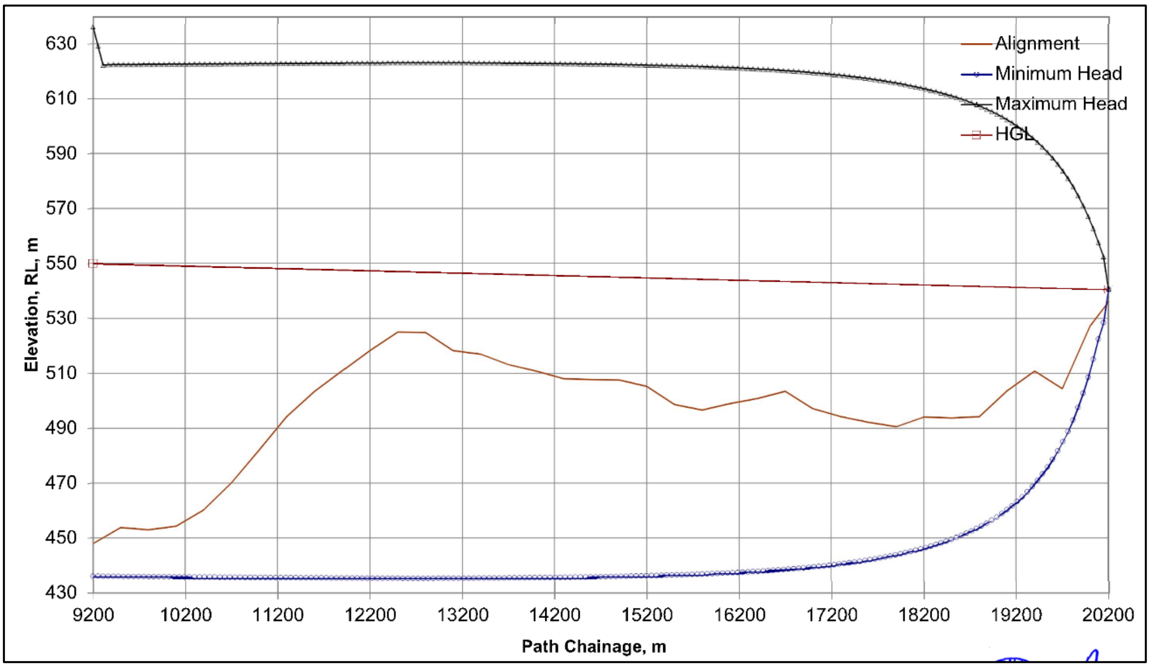
Figure 6.6.2 Performance Curve of Pumps at the WTP for Sugar Mill BPS

(4) C Value for Pump Head Calculation

In accordance with the CPHEEO Manuals, a C-value of 140 is applied to newly installed large-diameter steel pipes.

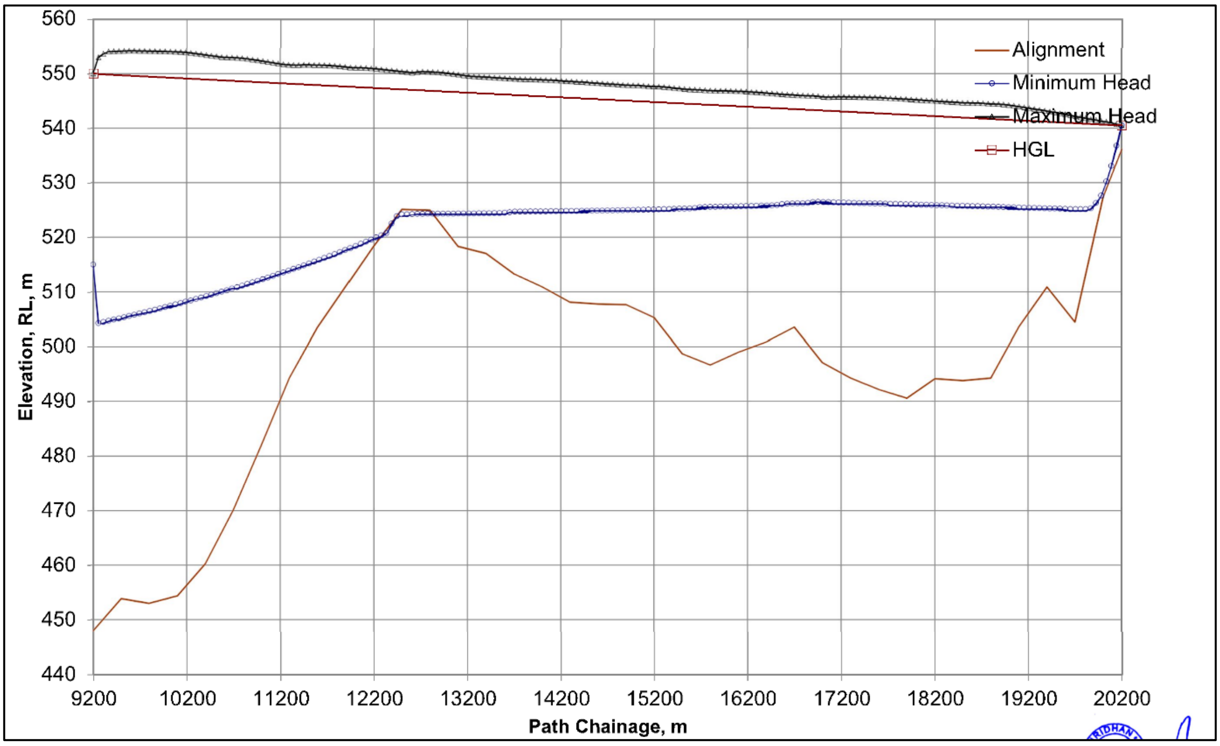
(5) Examination of Water Hammer Countermeasure

In the DPR, water hammer countermeasures were appropriately studied. Figures 6.6.3 and 6.6.4 present the surge analysis results for BPS-2, which is representative of pump stations supplying the transmission main featuring significant elevation changes. To mitigate the surge pressure, three sets of 60 m³ pressure-type surge tanks will be installed on the pump discharge side, and 300 mm diameter air valves will be placed at the highest points of the pipeline—specifically at 12,500 m, 16,700 m, and 19,400 m. As shown in Table 6.6.2, it has been concluded that adequate surge protection can be achieved by installing a pressure-type surge tank near the pump discharge side and an air valve at the highest points of the water transmission pipeline in most pumping stations. The validity of these surge countermeasures has been confirmed. In addition, the contractor shall conduct a final review of the surge analysis based on the approved pipeline profile during design-build stage.



Source: DPR

Figure 6.6.3 Pressure Curve Without Surge Countermeasure



Source: DPR

Figure 6.6.4 Pressure Curve With Surge Countermeasure

Table 6.6.2 List of Surge Countermeasures for Pump Stations

Hogenakkal CWSS Ph II							
Summary of Surge protection works							
Sl No.	Location	Tranmission Main	Capacity of Vessel	No. of Working Tanks	No. of Standby Tanks	Total No. of Tanks	Other Items
1	Intake	From Intake to BPS 1	50 m3	2	1	3	- Air Valve 300mm x 1 No at Chainage 6600mtr - Stand Pipe 400mm Dia x 15 Mtrs Long x 5mm thick
2	BPS 1	From BPS 1 to BPS 2	7 m3	2	1	3	- Elevated Air Valve 300mm x 2 Nos at Chainage 8400mtr & 9000mtr
3	WTP	From CWR at WTP to MBR at WTP	-	-	-	-	- Provide Air Valves at all peak location to control down surge (Minimum 4 Nos)
4	WTP	From CWR at WTP to Common BPS at Sugarmill	100 m3	4	2	6	- Elevated Air Valve 300mm x 1 No at Chainage 20,000mtr
5	Common BPS at Sugarmill	From Common BPS at Sugarmill to Kalkuttapatti MBR	11.5 m3	2	1	3	-
6	Common BPS at Sugarmill	From Common BPS at Sugarmill to Mahendramangalam BPS	36 m3	2	1	3	- Air Valve 300mm x 2 Nos at Chainage 7,200mtrs & 9,900mtrs
7	BPS at Mahendramangalam	From BPS at Mahendramangalam to BPS at Kaduchettipatti	22.5 m3	2	1	3	- Air Valve 300mm x 3 Nos at Chainage.17,900mtrs & 18,800mtrs
8	BPS at Kaduchettipatti	BPS at Kaduchettipatti to BPS at Ullukurkkai	33 m3	2	1	3	- Air Valve 300mm x 3 Nos at Chainage 23,800mtrs, 26,200mtrs & 31,900mtrs
9	BPS at Ullukurkkai	BPS at Ullukurkkai to BPS at Manjalagiri	22.5 m3	2	1	3	- Air Valve 300mm x 3 Nos at Chainage.45,500mtrs, 46,100mtrs & 51,200mtrs
10	BPS at Manjalagiri	BPS at Manjalagiri to Anthiwadi	21 m3	2	1	3	- Air Valve 300mm x 3 Nos at Chainage. 56,895Mtr, 59,295Mtr & 60,195Mtr

Source: DPR

6.7 Intake and WTP

6.7.1 Intake and Water Treatment Facilities

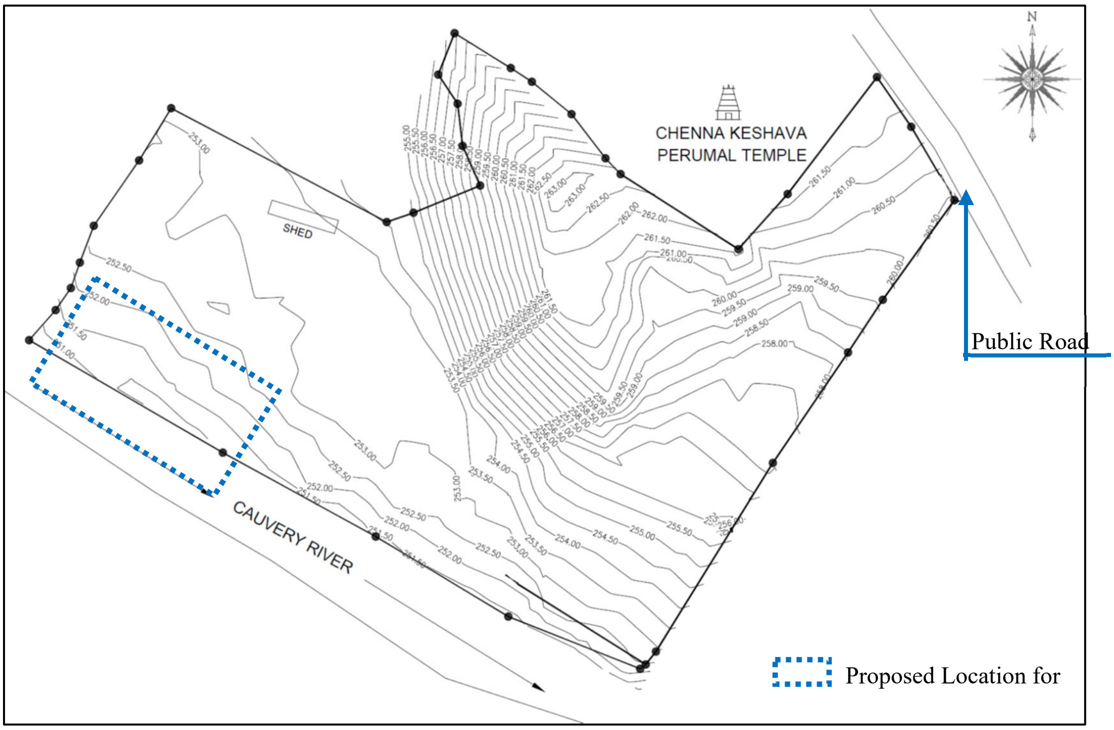
(1) Intake Facilities

1) Topography and Soil Conditions at the Intake Point

The intake facility proposed in the DPR is located 600 m upstream of the intake facility constructed under the Previous Hogenakkal Project. It is planned to be constructed on a site of approximately 20,000 m^2 along the Cauvery River, as shown in Figure 6.7.1.

TWAD selected this site as the preferred location for the intake facility for the following reasons:

1. Relatively deep water depth near the intake point.
2. The river channel has a shape suitable for water intake.
3. Low risk of intake disruption due to sedimentation or scouring.
4. Convenient access from public roads.
5. Being state-owned land, the transfer of ownership can be easily arranged.
6. Currently unused land and no existing structures require demolition.

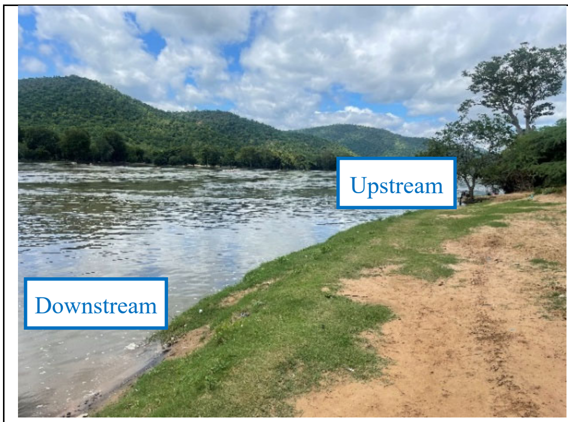


Source: JST

Figure 6.7.1 Topographic Survey Drawing for the Proposed Location for Intake

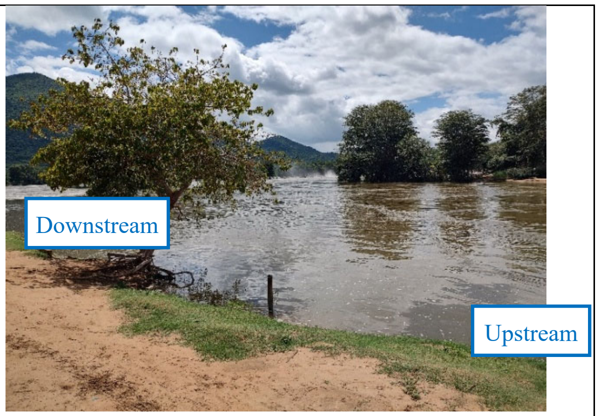
The candidate site for the intake facility is located immediately adjacent to a public road approximately 8 m wide. With no overhead power lines, no anticipated issues for construction machinery access or material transportation. Although there is a continuous slope from the public road (elevation approximately 260 m) down to the intake facility candidate site (elevation approximately 240 m), the gradient is about 3%, making it possible for construction machinery to safely ascend and descend.

To verify the soil conditions at the intake facility site, reference was made to the results of a soil investigation bore conducted at the transmission pump station under the Previous Hogenakkal Project Phase I, as shown in Figure 6.7.5.



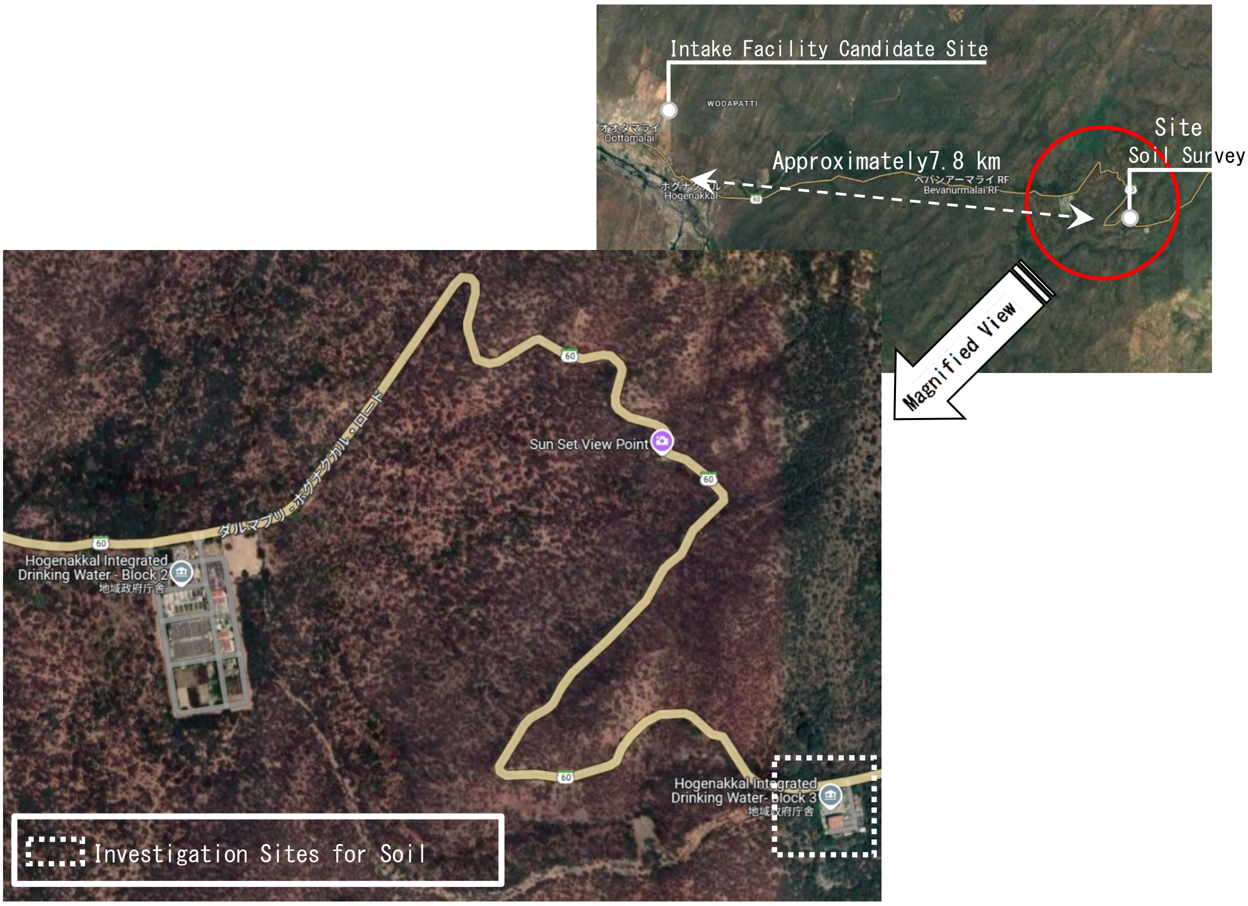
Source: JST

Figure 6.7.2 Intake Facility Candidate Site (1/2)



Source: JST

Figure 6.7.3 Intake Facility Candidate Site (2/2)



Source: JST

Figure 6.7.4 Investigation Site for Soil Survey

At the transmission pump station constructed under the Previous Hogenakkal Project Phase I, three boring surveys were conducted. Among these, two boring logs (BH-01 and BH-02) indicated exposed rock, while BH-03 revealed soft rock at depths greater than 4.5 m below ground level. From these findings, it can be concluded that the ground in the surrounding area primarily consists of bedrock. Therefore, it is presumed that the ground at the candidate site for the intake facility also consists of solid bedrock.

Project : Proposed Construction of Booster Station at Hogenakkal
Location: BH-01
Started On : 13/05/2010; Ended On : 13/05/2010

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	Depth of SPT below E.G.L (m)	SPT - Details 0-15 cm	15-30 cm	30-45 cm	N-Value	Graphical Representation of SPT 0 10 20 30 40 50 60 70 80 90	Relative Density/Consistency
1.00			Weathered Rock	1.00	SPT Hammer Rebounded					V.Dense
2.00			Hard Rock	2.00	Rock Core Recovery : 53%					V.Dense

Bore Hole Terminated at R.L of -2.00m below the existing ground level

Fig. 2.1 Soil Profile BH-01 Location

Project : Proposed Construction of Booster Station at Hogenakkal
Location: BH-02
Started On : 14/05/2010; Ended On : 14/05/2010

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	Depth of SPT below E.G.L (m)	SPT - Details 0-15 cm	15-30 cm	30-45 cm	N-Value	Graphical Representation of SPT 0 10 20 30 40 50 60 70 80 90	Relative Density/Consistency
1.00			Weathered Rock	1.00	SPT Hammer Rebounded					V.Dense
2.00			Hard Rock	2.00	Rock Core Recovery : 60%					V.Dense

Bore Hole Terminated at R.L of -2.00m below the existing ground level

Fig. 2.2 Soil Profile BH-02 Location

Project : Proposed Construction of Booster Station at Hogenakkal
Location: BH-03
Started On : 11/05/2010; Ended On : 11/05/2010

R.L of Layer (m)	G.W.T. (m)	Soil Profile	Engineering Description of Soil	Depth of SPT below E.G.L (m)	SPT - Details 0-15 cm	15-30 cm	30-45 cm	N-Value	Graphical Representation of SPT 0 10 20 30 40 50 60 70 80 90	Relative Density/Consistency	Type of Sample
			Reddish Loose Silty Sandy Gravels	1.50	4	6	8	14		Loose	SS
3.00				3.00	10	15	20	35		Dense	SS
4.50			Reddish Dense Silty Clayey Sandy Gravels	4.50	SPT Hammer Rebounded					V.Dense	SS
6.00			Soft Rock	6.00	Rock Core Recovery : 32%					V.Dense	CS

Bore Hole Terminated at R.L of -6.00m below the existing ground level

Fig. 2.3 Soil Profile BH-03 Location

Source: As-built documents of Previous Hogenakkal Project

Figure 6.7.5 Borehole Log (Pump Station in Hogenakkal Project Phase I)

2) Validation of DPR Intake Facility Design and Review of Intake Facility for this Project

According to the DPR, as shown in Figure 6.7.6, the intake facility is designed to meet the projected water demand until 2056. The facility will be equipped with a total of 12 intake pumps—comprising eight duty pumps and four standby pumps—arranged across six pump wells, to provide a total water intake volume of 304,000 m³/day. The riverbed elevation is 246.65 m, and the low-water level is 247.50 m. The floor height of the pump room at the intake facility is set at 254.00 m—which is approximately 2 m higher than the high-water level of the Cauvery River (252.06 m)—and the hydraulic calculations were appropriate. The overall design follows the intake facility under the Previous Hogenakkal Project, and since adequate space has been secured for pumps and electrical equipment, no particular improvements were deemed necessary.

For the ultimate year of operation, the raw water will be drawn by eight intake pumps after debris removal by fine screens, and conveyed through a single 1,800 mm-diameter pipeline to the BPS located approximately 7.2 km away, with an elevation difference of about 69 m.

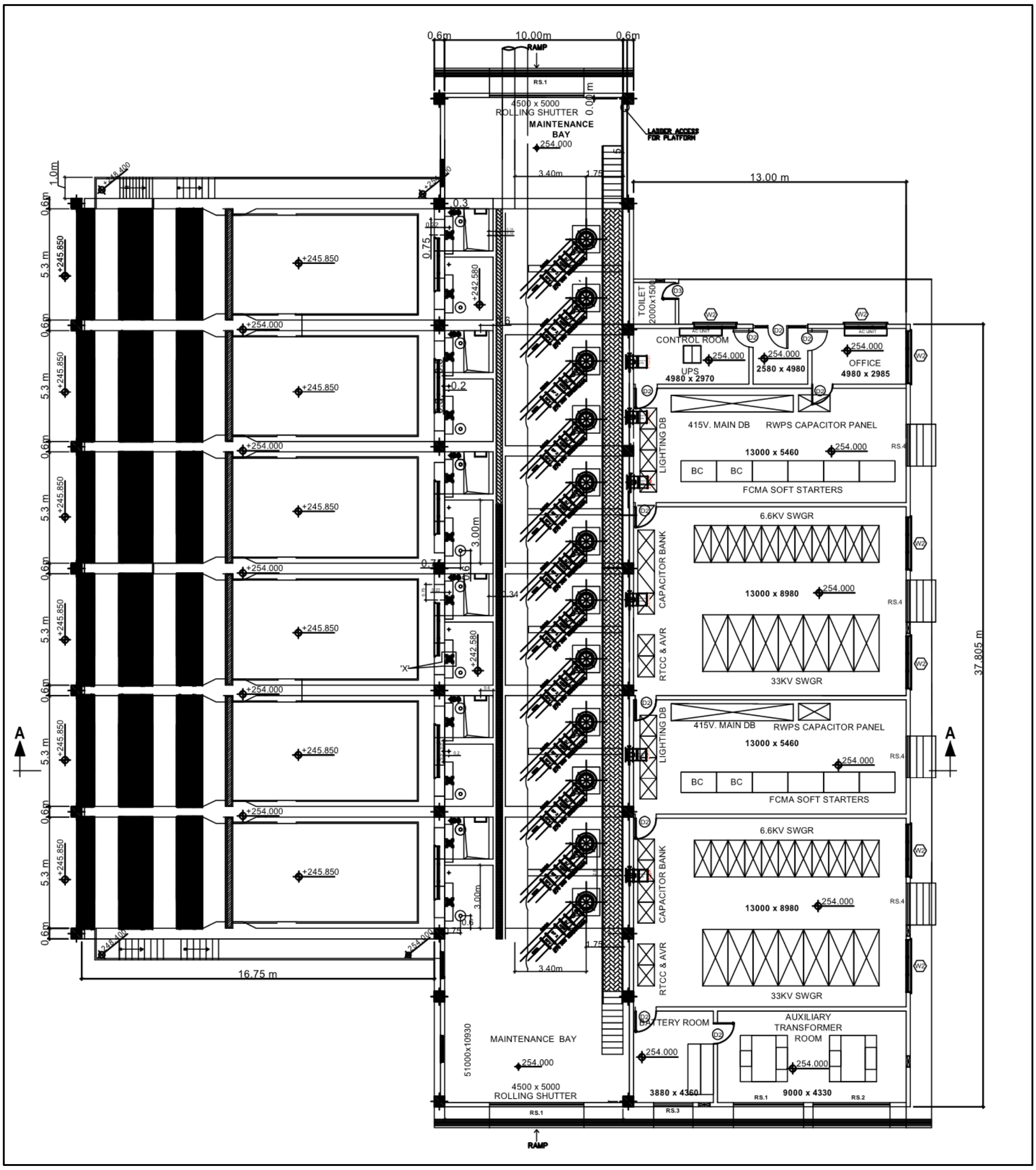
The section between the intake point to the pump well is divided into six channels by partition walls. Normally, four channels are used, with the remaining two channels serving as backups for sequential switching operation. The main mechanical equipment consists of bar screens (three stages), stop logs, inflow gates, two vertical turbine pumps for each channel, and surge tanks.

Furthermore, in this project, while the civil structures will be constructed to accommodate the ultimate year's water demand, only ten intake pumps (seven duty and three standby) corresponding to the intermediate year 2041 demand will be installed, along with the associated electrical equipment. The SCADA system, installed in the electrical room, will enable pump operation and status monitoring. It will also be compatible with remote control from the WTP. Table 6.7.1 shows the specifications of the major facilities.

Table 6.7.1 Major Specifications of the Proposed Intake Facility

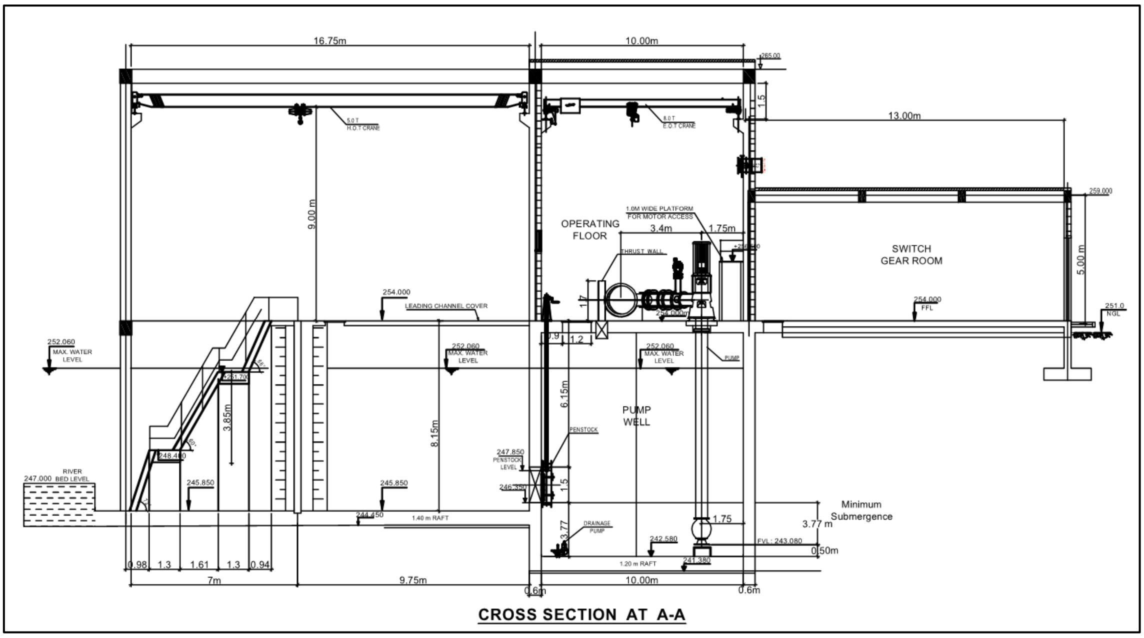
Item	Specification	Ultimate No.	Intermediate No.
Civil and Architecture			
Intake Channel	16.6 m x 5.3 m	6	6
Pump House	10.4 m x 45.8 m	1	1
Electrical Room	13.4 m x 38.3 m	1	1
Equipment			
Bar Screen	Bar Screen Opening 20 mm	6	6
Stop Log	Steel	6	6
Inlet Gate	Rectangular Sluice Gate	12	10
Drainage Pump	Submersible Pump	12	10
Intake Pump	Vertical Turbine 27,612 L/min x 78 m	8 Duty + 4 Standby	7 Duty + 3 Standby
Surge Tank	Horizontal Steel Tank	2 Duty + 1 Standby	2 Duty + 1 Standby

Source: JST based on DPR



Source: DPR

Figure 6.7.6 Plan View of Water Intake (DPR)



Source: DPR

Figure 6.7.7 Cross Section of Water Intake (DPR)

(2) Water Treatment Plant (WTP)

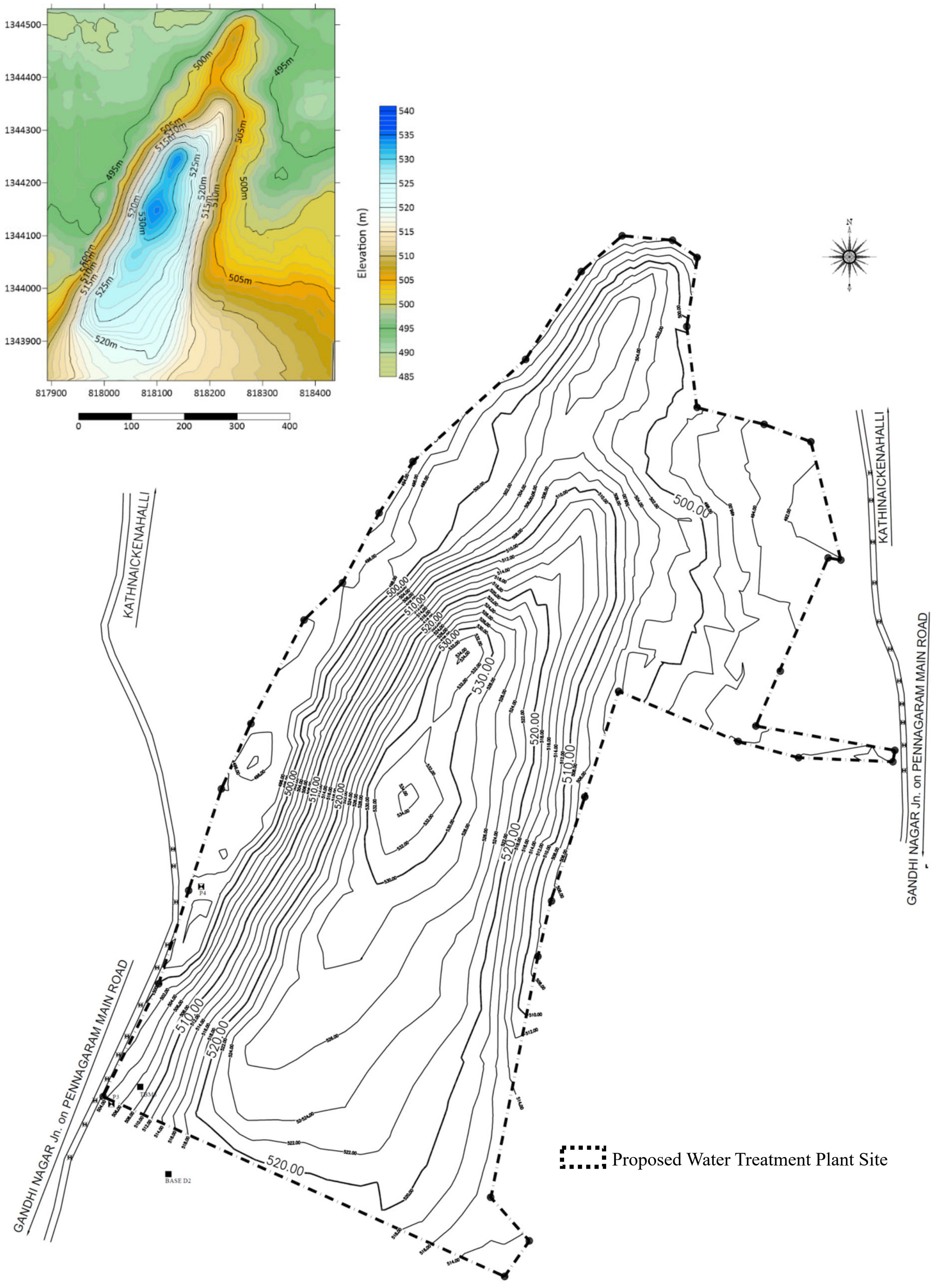
1) Topography and Soil Conditions of the Proposed WTP Site

The WTP, as proposed in the DPR, is planned to be constructed on a small hill, as shown in Figures 6.7.8. and 6.7.9. Initially, TWAD was seeking flat land; however, this location was the only state-owned land near the intake point with sufficient area for constructing a new WTP and could be promptly transferred to TWAD. Consequently, TWAD selected this location as the candidate site for the WTP. The proposed WTP site is located approximately 20.2 km from the intake facility, with an elevation difference of about 250 m. Raw water will be pumped to the treatment plant through two relay pumping stations.

Source: JST

Figure 6.7.8 Location Map of the Proposed Water Treatment Plant Site

As there are no residential houses or factories within the proposed WTP site, it is assumed that there are no existing underground utilities or overhead lines that would obstruct construction work. The topographical survey map of the proposed WTP site is shown in Figure 6.7.9. As evident from the survey map, the proposed WTP site is situated at a higher elevation compared to the surrounding area. The ground elevation within the site ranges from approximately 492 m at its lowest point to about 534 m at its highest point, resulting in an elevation difference of about 42 m. Therefore, the facility layout plan needs to consider the water level differences between facilities, the effective utilization of the potential energy, and the operational costs of water transmission pumps.



Source: JST

Figure 6.7.9 Survey Map of the Proposed Water Treatment Plant Site

Source: JST

Figure 6.7.10 Candidate Site of WTP (1/2)

Source: JST

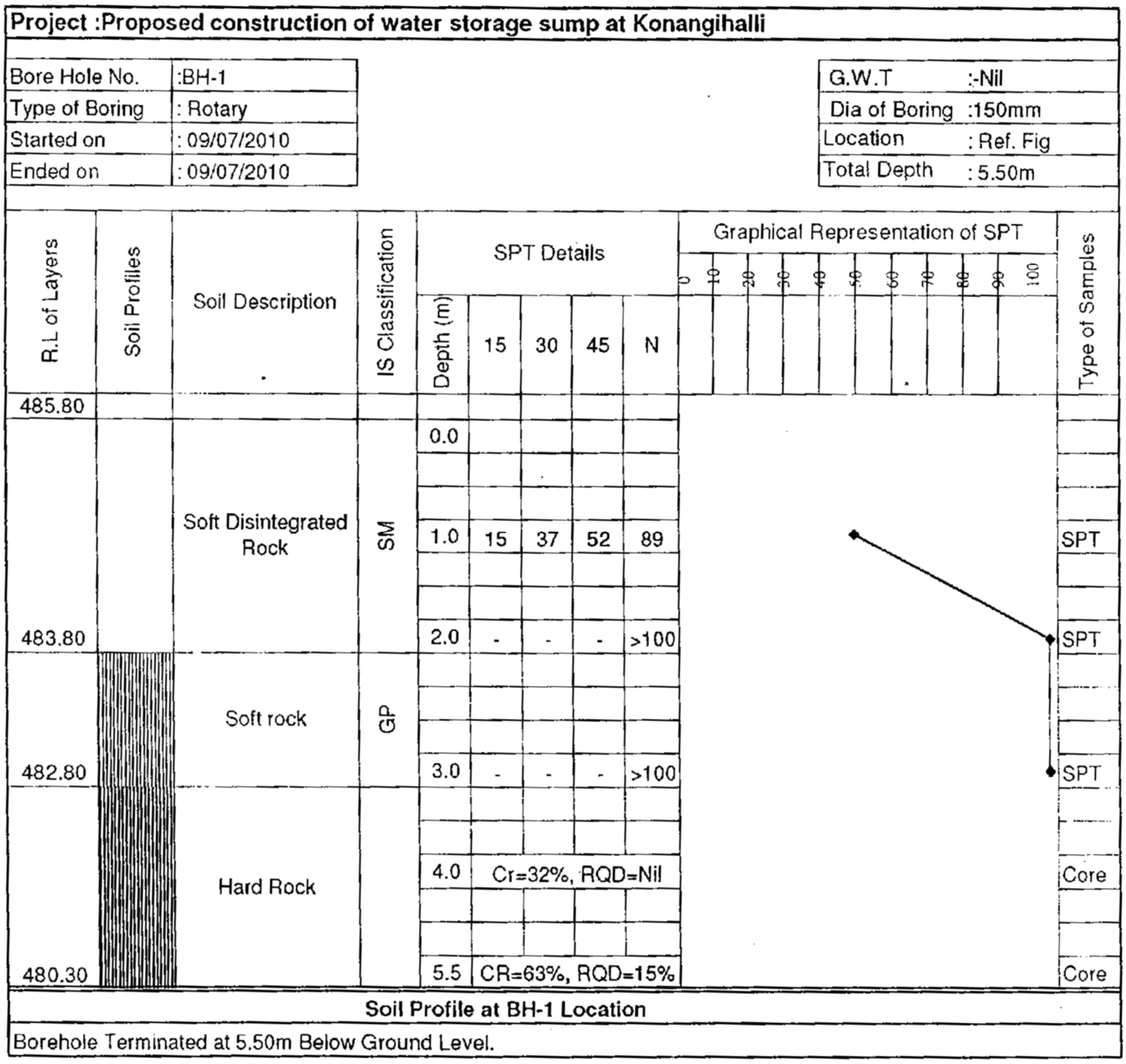
Figure 6.7.11 Candidate Site of WTP (2/2)

To confirm the soil conditions at the proposed WTP site, both a review of existing documents and an on-site inspection were conducted. Reference was made to the soil survey results from the overhead tank constructed as part of the Previous Hogenakkal Project Phase I, located approximately 7 km southeast of the proposed site along the Dharmapuri-Hogenakkal Road, as provided by TWAD. The location is illustrated in Figure 6.7.12.

Source: JST

Figure 6.7.12 Soil Survey Location Map (Overhead Tank in Hogenakkal Project Phase I)

In the Previous Hogenakkal Project Phase I, a borehole investigation was conducted, and the borehole log is shown in Figure 6.7.13. The borehole log indicates that clastic rocks are exposed at the ground surface, while the deeper portions consist of soft and hard rock. During the site reconnaissance, rock outcrops were observed, as shown in the above photographs, suggesting that the ground in the surrounding area is predominantly composed of bedrock. Therefore, it is presumed that the ground at the proposed WTP site similarly consists of solid bedrock.



Project :Proposed construction of water storage sump at Konangihalli

Bore Hole No.	:BH-1	G.W.T	:-Nil
Type of Boring	: Rotary	Dia of Boring	:150mm
Started on	: 09/07/2010	Location	: Ref. Fig
Ended on	: 09/07/2010	Total Depth	: 5.50m

R.L of Layers	Soil Profiles	Soil Description	IS Classification	Depth (m)	SPT Details 15	30	45	N	Type of Samples
485.80									
		Soft Disintegrated Rock	SM	0.0					
				1.0	15	37	52	89	SPT
483.80				2.0	-	-	-	>100	SPT
		Soft rock	GP						
482.80				3.0	-	-	-	>100	SPT
		Hard Rock		4.0	Cr=32%, RQD=Nil				Core
480.30				5.5	CR=63%, RQD=15%				Core

Soil Profile at BH-1 Location

Borehole Terminated at 5.50m Below Ground Level.

Source: TWAD

Figure 6.7.13 Borehole Log (Overhead Tank in Hogenakkal Project Phase I)

2) Design and Review of the Water Treatment Plant in the DPR

i) Raw Water Quality

The raw water quality analysis results of the Cauvery River at the proposed water intake facility site, conducted by both TWAD and the JST, are summarized in Table 6.7.2 along with the Indian Surface Water Quality Standards (IS 2296). According to TWAD, there are no factories or industrial activities in the upstream area of the Cauvery River that could discharge substances such as oils and fats, copper, phenols, anionic detergents, or radioactive materials (including alpha and beta radiation) into the water. Therefore, it was determined that the presence of these substances in the river water is unlikely, and neither TWAD nor JST conducted tests for these water quality parameters.

As shown in the table, the raw water quality complies with the Indian surface water quality standards. Regarding the turbidity of the raw water, as indicated in Table 3.3.7 and Figure 3.3.13, except during flood periods, the average turbidity of the Cauvery River generally ranges from 10 to 30 NTU, and the water quality analysis conducted by the JST recorded a turbidity of 25 NTU.

Table 6.7.2 Raw Water Quality and the Requirements

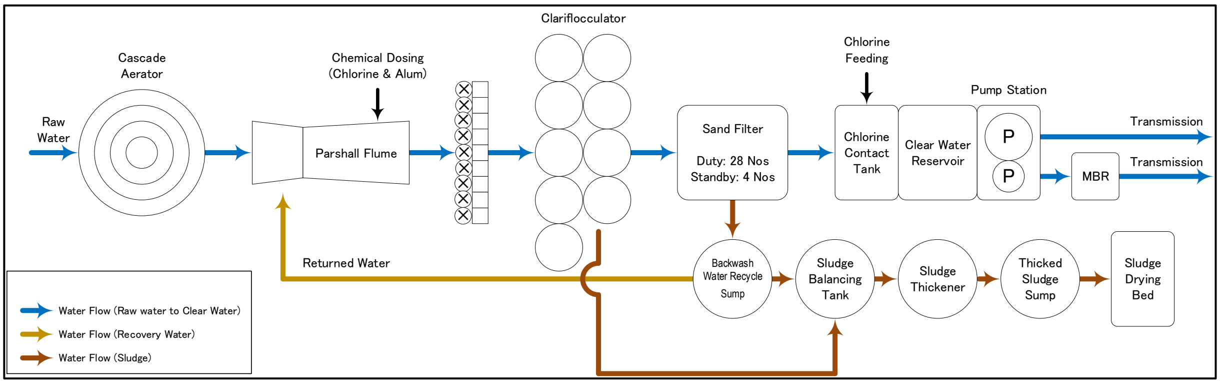
No.	Characteristic	Requirement	March 2023 By TWAD	December 2024 By JST
1	Taste	None	-	
2	Odor	Unobj.	-	Agreeable
3	Color	10	-	<10
4	pH	6.5 - 8.5	7.02	7.60
5	Conductivity（EC）, µS/cm		593	
6	Dissolved Oxygen（DO） min, mg/L	6	7.1	
7	BOD, mg/L	2	1.4	
8	Total Coliforms, MPN/100 mL	50	20	
9	TDS, mg/L	500	362	354
10	Oil and Grease, mg/L	-		
11	Mineral Oil, mg/L	0.01		
12	Total Hardness（$CaCO_3$）, mg/L	300	97	222
13	Chlorides（Cl）, mg/L	250	55.3	43.0
14	Sulfates（SO_4）, mg/L	400	26.1	24.1
15	Nitrates（NO_3）, mg/L	20	0.28	7.6
16	Free CO_2, mg/L	-		
17	Free NH_3, mg/L	-		
18	Fluorides（F）, mg/L	1.5	0.29	0.79
19	Calcium（Ca）, mg/L	80.10	26.8	43.6
20	Magnesium（Mg）, mg/L	24.28	7.3	27.6
21	Copper（Cu）, mg/L	1.5		
22	Iron（Fe）, mg/L	0.3		0.21
23	Manganese（Mn）, mg/L	0.5	BLQ 0.05	
24	Zinc（Zn）, mg/L	15	BLQ 0.1	
25	Boron（B）, mg/L	-		
26	Barium（Ba）, mg/L	1		
27	Silver（Ag）, mg/L	0.05		
28	Arsenic（As）, mg/L	0.05	BLQ 0.005	
29	Mercury（Hg）, mg/L	0.001	BLQ 0.0005	
30	Lead（Pb）, mg/L	0.1	BLQ 0.005	
31	Cadmium（Cd）, mg/L	0.01	BLQ 0.001	
32	Chromium（Cr）, mg/L	0.05	BLQ 0.01	
33	Selenium（Se）, mg/L	0.01	BLQ 0.005	
34	Cyanide（CN）, mg/L	0.05	BLQ 0.01	
35	Phenols（C_6H_5OH）, mg/L	0.002		
36	Anionic Detergents（MBAS）, mg/L	0.2		
37	PAH, mg/L	0.2		
38	Pesticides, µg/L	0		
39	Insecticides, µg/L	-		
40	Alpha Emitters, 10^{-6} µC/mL	0.001		
41	Beta Emitters, 10^{-6} µC/mL	0.01		
42	Percent Sodium (%)	-		
43	Sodium Absorption Ratio	-		
-	Turbidity, NTU			2.5

BLQ: Below the Lower Limit of Quantification

Source: JST based on data provided by TWAD and water quality surveys conducted by JST.

ii) Water Treatment Flow and Overview

The treatment process flow of the proposed WTP in the DPR is shown in Figure 6.7.14, and the overview is summarised in Table 6.7.3. Additionally, the layout plan is presented in Figure 6.7.15.



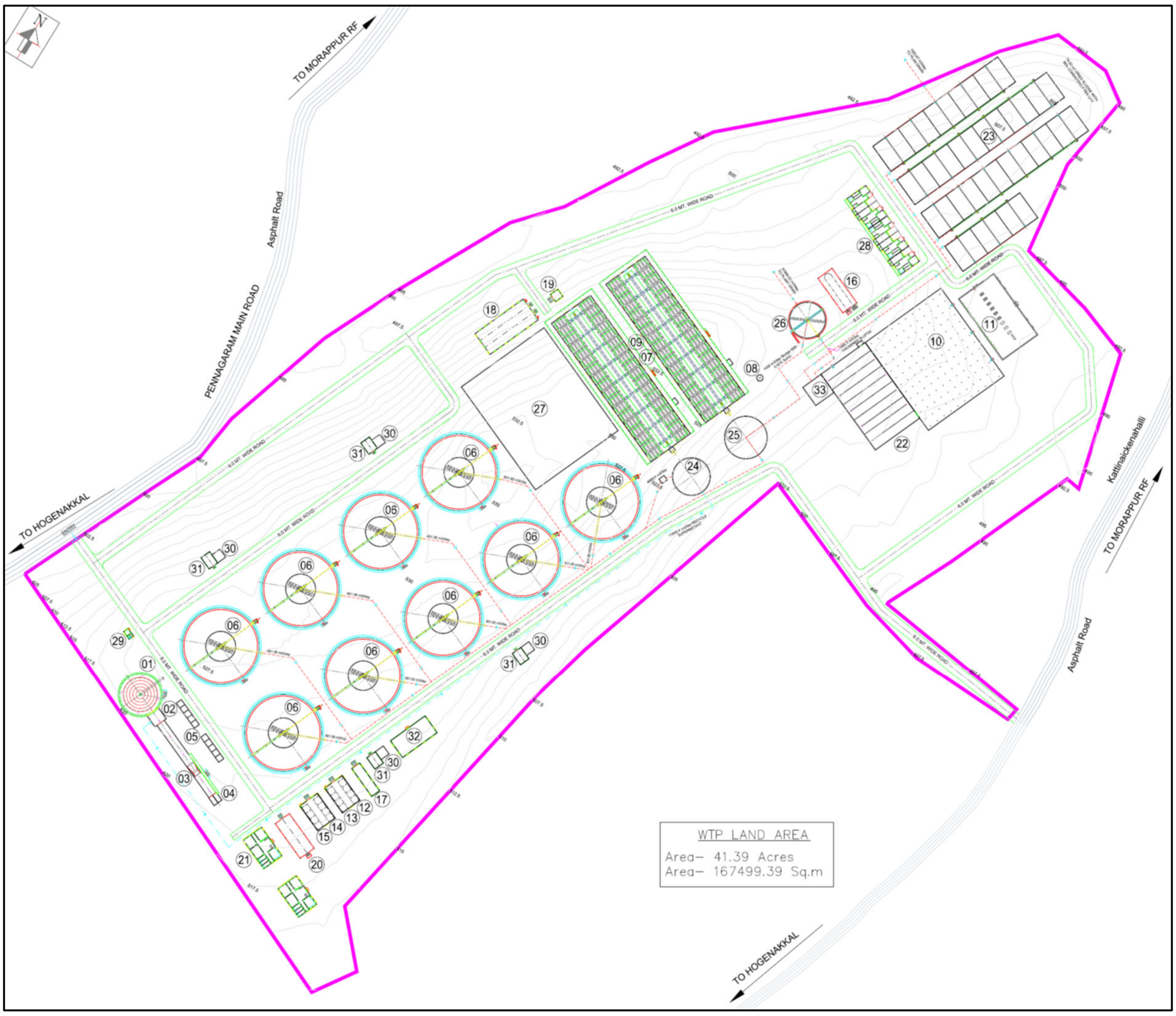
Source: JST

Figure 6.7.14 Water Treatment Process Flow of the Proposed Water Treatment Plant in the DPR

Table 6.7.3 Overview of the Proposed Water Treatment Plant in the DPR

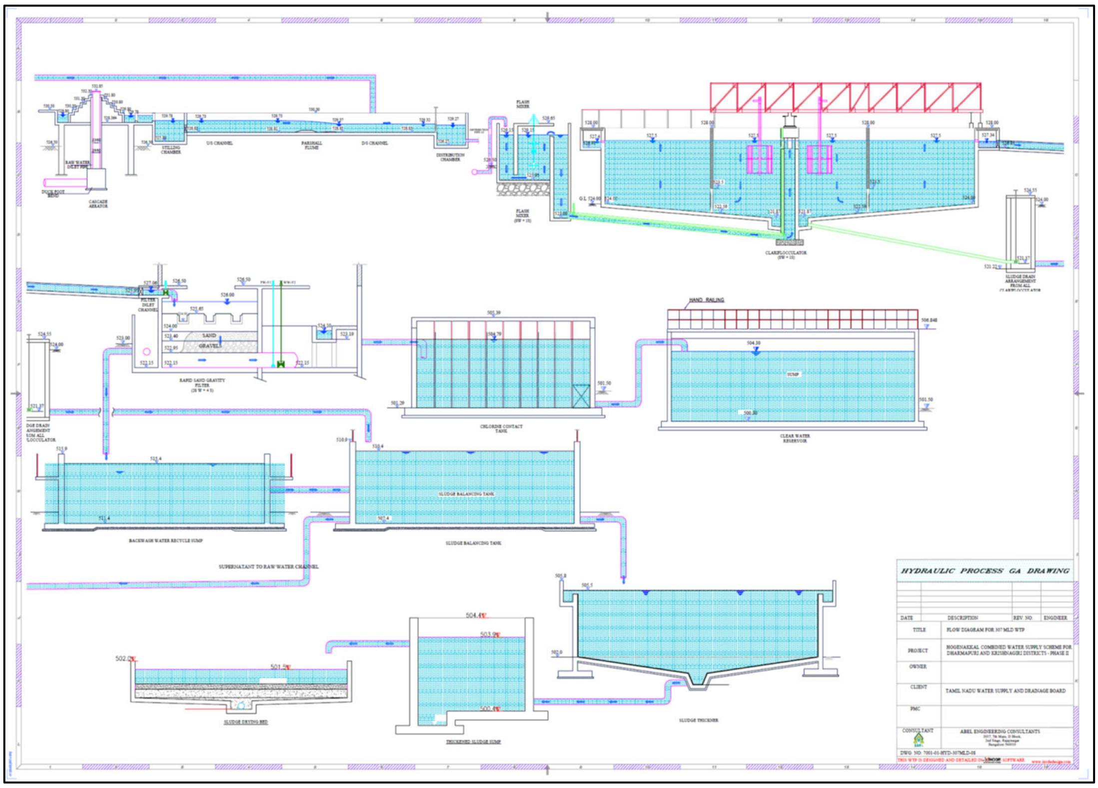
Item	Specification	No.
Main Facility		
Cascade Aerator	Dia 25.035 m	1
Parshall Flume	7.8 m x 7.8 m x 4.0 m	1
Mixing Well	3.2 m x 3.2 m x 3.2 m	8 Duty + 1 Standby
Clariflocculator	45.6 m dia x 4.68 m	8 Duty + 1 Standby
Rapid Sand Filter	9.0 m x 5.5 m	28 Duty + 4 Standby
Backwash Tank	3.5 m Dia. x 2.5 m	1
Chlorine Contact Tank	55.0 m x 32.0 m x 4.0 m	1
Clear Water Reservoir	55.0 m x 64.0 m x 4.0 m	1
Pump House	44.0 m x 25.0 m x 10.0 m	1
Backwash Water Recycle Sump	22.0 m dia x 4.0 m	1
Sludge Balancing Tank	25.0 m dia x 3.0 m	1
Sludge Thickener	21.0 m dia x 3.5 m	1
Alum Dosing Tank	3.8 m x 3.8 m x 3.0 m	2 Duty + 1 Standby
Lime Dosing Tank	3.8 m x 3.8 m x 3.0 m	2 Duty + 1 Standby
Chemical House	20.0 m x 5.5 m x 5.0 m	1
Chlorine Building	25.0 m x 10.0 m x 5.0 m	2
Sludge Drying Beds	18.0 m x 18.0 m x 0.5 m	20
Office, Laboratory Building	20.5 m x 13.0 m x 4.0 m	1

Source: JST



Source: DPR

Figure 6.7.15 Layout Plan of the Proposed Water Treatment Plant in the DPR



Source: DPR

Figure 6.7.16 Hydraulic Profile of the Proposed Water Treatment Plant in the DPR

At the proposed construction site for the new WTP, the hill will be levelled at approximately GL +524.0 m, and the water treatment facilities—from the cascade aerator to the rapid sand filters—will be arranged according to the water treatment flow. The CWR and sludge treatment facilities will be located in the topographically lower areas.

iii) Water Treatment Process

Since there is no time-series data on raw water turbidity at the candidate water intake facility site, turbidity samples collected at the intake facility of the Previous Hogenakkal Project, located approximately 550 m downstream, will be organized to check the characteristics of raw water turbidity. The raw water turbidity from 2021 to 2024 has been summarized in Table 6.7.4

Table 6.7.4 Raw Water Turbidity (2021 - 2024)

	2021		2022		2023		2024	
	Max	Ave.	Max	Ave.	Max	Ave.	Max	Ave.
JAN	12	8	15	13	18	17	15	14
FEB	10	8	14	14	19	17	16	15
MAR	9	8	17	14	21	18	16	15
APR	9	8	22	15	22	21	16	15
MAY	12	9	66	21	65	29	120	25
JUN	17	10	42	17	23	15	98	34
JUL	40	17	130	40	45	15	152	68
AUG	18	11	190	84	29	17	130	59
SEP	22	14	400	69	72	22	35	25
OCT	96	30	145	46	40	18	126	36
NOV	180	40	29	25	36	18	30	23
DEC	24	17	34	23	16	15	80	30

Source: JST based on data provided by TWAD Unit: NTU

The choice between rapid sand filtration and slow sand filtration methods primarily depends on the quality of raw water. For raw water with turbidity of 10 NTU or higher, slow filtration is difficult to apply, so rapid filtration methods are generally adopted. The trend of raw water turbidity, when applied to the Water Treatment Technology Guidelines (Japan Water Research Center, 2010), falls into the "High" category (greater than 5 FTU [Formazin Turbidity Unit] and up to 800 FTU). Additionally, according to the turbidity removal process selection table in the same guidelines, the recommended process consists of coagulation, sedimentation, and rapid filtration. The water treatment method proposed in the DPR is "coagulation/sedimentation + rapid sand filtration", which is a standard method widely utilized in India, Japan, and other countries.

Considering WTP performance, construction costs, and the following factors, the adoption of rapid sand filtration as proposed in the DPR is deemed appropriate:

- TWAD has sufficient experience in operating rapid sand filtration systems under the Previous Hogenakkal Project, enabling proper and sustainable operation and maintenance compared with slow sand filtration.
- During the monsoon season, raw water turbidity can reach approximately 400 NTU, making slow sand filtration unsuitable for proper water treatment.
- Slow sand filtration requires skilled technicians to properly the scrape sand without destroying the biological layer. TWAD has limited experience in operating and maintaining slow sand filtration processes.

iv) Basic Design Conditions and Validity of the WTP Design in DPR

The preliminary design of the WTP in the DPR is based on the design standards specified in the CPHEEO Manual (Ministry of Urban Development, December 2023, 4th Edition – Revised and Updated). With regard to water treatment, the design ensures compliance with the water quality standards shown in Tables 6.7.5 and 6.7.6. Additionally, as the manual specifies provisional standard values as acceptable limits for water quality parameters when alternative water sources are unavailable, these values are also included in the tables.

Table 6.7.5 Organoleptic and Physical Parameters

No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source
1	Color, Hazen Units	5	15
2	Odor	Agreeable	Agreeable
3	pH Value	6.5-8.5	No Relaxation
4	Taste	Agreeable	Agreeable
5	Turbidity, NTU	1	5
6	Total Dissolved Solids, mg/L	500	2000

Source: CPHEEO 2023, page 346

Table 6.7.6 General Parameters Concerning Substances Undesirable in Excessive Amounts

No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source
1	Aluminum (as Al), mg/L	0.03	0.2
2	Ammonia (as total ammonia N), mg/L	0.5	No relaxation
3	Anionic detergents (as MBAS) mg/L	0.2	*1*
4	Barium (as Ba), mg/L	0.7	No relaxation
5	Boron (as B, mg/L	0.5	2.4**
6	Calcium (as Ca), mg/L	*75*	*200*
7	Chloramines (as Cl2), mg/L	4	No relaxation
8	Chloride (as Cl), mg/L	250	1000
9	Copper (as Cu), mg/L	0.05	1.5
10	Fluoride (as F), mg/L	1	1.5
11	Free residual chlorine, mg/L	0.2	1
12	Iron (as Fe), mg/L	1**	No relaxation
13	Magnesium (as Mg), mg/L	30	100
14	Manganese (as Mn), mg/L	0.1	0.3
15	Mineral oil, mg/L	1**	No relaxation
16	Nitrate (as No3), mg/L	45	No relaxation
17	Phenolic compounds (as C6H5OH), mg/L	0.001	0.002
18	Selenium (as Se), mg/L	0.01	No relaxation
19	Silver (as Ag), mg/L	0.1	No relaxation
20	Sulphate (as SO4), mg/L	200	400
21	Sulfide (as H2S), mg/L	0.05	No relaxation
22	Total alkalinity as calcium carbonate, mg/L	200	600
23	Total hardness (as CaCO3), mg/L	200	600
24	Zinc (as Zn), mg/L	5	15

Source: CPHEEO 2023, page 347

In this evaluation, the design values of each facility were compared with the CPHEEO Manual and relevant Japanese design standards to verify their appropriateness. The validity of the design for each major facility in the DPR is evaluated as follows:

- Cascade Aerator

The proposed cascade aerator consists of five steps with a surface contact area of 0.03 m^2/m^3/hour. This falls within the design standards specified in the CPHEEO Manual (4-6 steps, 0.015-0.045 m^2/m^3/hour; CPHEEO, 2003, p. 378). Although cascade aerators are not commonly used in Japan, the design of the cascade aerator presented in the DPR complies with the CPHEEO design standards and is considered appropriate.

- Parshall Flume

The Parshall flume is a flow-measurement device used in water treatment facilities to measure water flow in open channels. This device consists of a specially shaped flume through which the water flow accelerates through a constricted section. The flow rate is determined by measuring the water level at the narrow section based on empirical formulas. In the DPR, the Parshall flume design complies with IS 14371:2016 standard Parshall flume No. 14, and is therefore considered appropriate.

- Flash Mixer

Mixing methods can be categorized into mechanical mixing and gravity mixing. While gravity mixing is susceptible to fluctuations in water flow velocity and temperature effects—often resulting in uneven mixing—mechanical mixing allows more uniform dispersion of coagulants and floc formation through adjustments to the mixer's rotational speed and blade configuration.

Furthermore, mechanical mixing provides superior control over mixing intensity (G-value) by appropriately regulating mixing energy using motors and inverters, thereby, enabling optimal mixing conditions to be maintained in response to variations in raw water quality. In contrast, gravity mixing relies on natural changes in water flow, making precise adjustments difficult.

Based on these considerations, the selection of mechanical mixing using a flash mixer is deemed appropriate.

- ➢ Detention Time

The flash mixer in the DPR is designed with a detention time of 60 seconds, which corresponds to the standard value specified in the CPHEEO Manual (30-60 seconds; CPHEEO, 2003, p. 383). Japanese design standards also indicate that a detention time of 60 seconds is sufficient, provided that proper mixing can be ensured. Therefore, the designed detention time is appropriate.

- ➢ Other Parameters

The flash mixer's depth, impeller-to-tank diameter ratio, and the tank height-to-diameter ratio all correspond to the values specified in the CPHEEO Manual. In the DPR, the plan includes the installation of nine units of flash mixers; however, to improve maintainability, a proposal regarding the number of units will be presented later.

- Clariflocculator

The clariflocculator, as shown in Figure 6.7.17, is characterized by the effective integration of flocculation and sedimentation processes in a single unit. It consists of a double-tank structure made of reinforced concrete with inner and outer circular tanks, where flocculation and sedimentation are processed in the inner "flocculation zone" and outer "sedimentation zone", respectively.

The clariflocculator is characterized by its high processing efficiency, as it performs coagulation and sedimentation processes within one integrated unit. In conventional methods where these processes are conducted separately, the equipment for each stage operates independently, leading to complex coordination and control between units. In contrast, the clariflocculator's integrated design enables both process to proceed continuously and efficiently, allowing for smooth progression from floc formation to sedimentation.

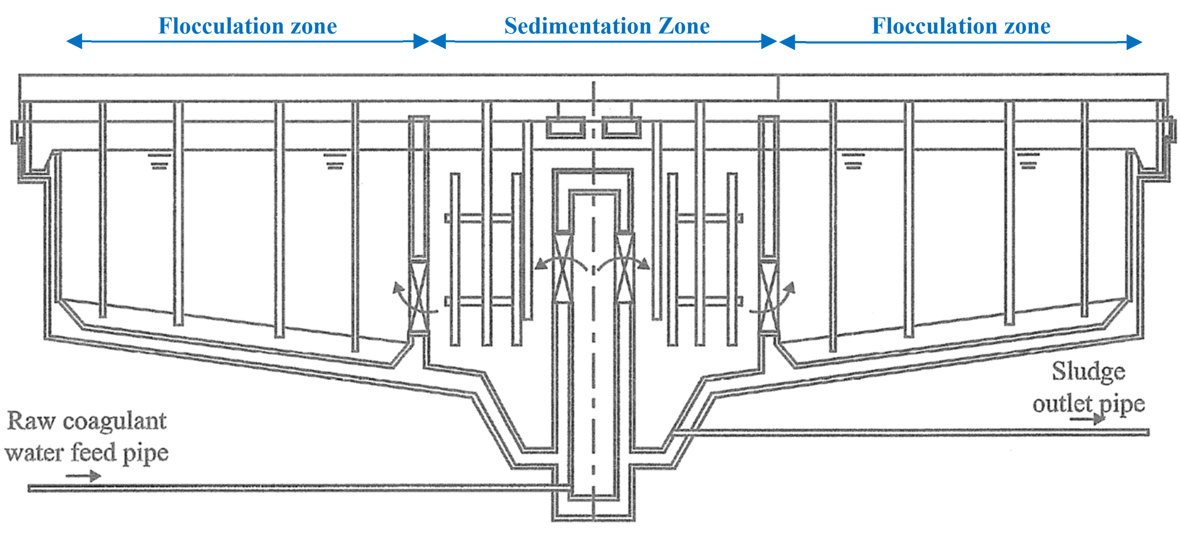
Another significant advantage is space efficiency. Conventional methods require separate flocculation and sedimentation basins, which demand an extensive land area. While the area of sedimentation basins can be reduced through incorporating inclined tubes or plates, the area required for flocculation basins remains unchanged. By comparison, the clariflocculator method can complete both processes within single tank, thereby reducing the installation footprint.

Another benefit of the clariflocculator is the reduction in water retention time due to its streamlined processing. The integrated design also contributes to reduced energy consumption.

By ensuring appropriate flow and mixing conditions within the clariflocculator, it becomes possible to form larger and heavier flocs more efficiently than with conventional methods, thereby improving sedimentation separation performance. Furthermore, the design can flexibly respond to fluctuations in raw water quality, making it easier to consistently achieve target water quality under various conditions.

As mentioned in the CPHEEO Manual (p. 394), clariflocculators are already widely used across India, with substantial track records and presenting no significant issues with maintenance and inspection.

From these considerations, the clariflocculator demonstrates overall superiority compared with conventional methods that use separate flocculation and sedimentation basins, or flocculation basins combined with sedimentation basins incorporating inclined tubes (plates). It offers advantages in processing efficiency, space utilization, reduced retention time, energy efficiency, optimized floc formation, and maintainability. Therefore, the selection of a clariflocculator is considered appropriate.



Source: LEXICON water and wastewater engineering

Figure 6.7.17 Section of a Typical Clariflocculator

- Depth

In the DPR, the flocculator is designed as an integral circular structure combined with the sedimentation basin. The depth is designed at 4.0 m, which falls within the range specified in the CPHEEO Manual (2.5-5.0 m; CPHEEO, 2003, p. 396). Although Japanese design standards for clariflocculators specify only rectangular structures, the proposed flocculator depth in the DPR complies with the CPHEEO Manual's standard values. Therefore, the structural depth is appropriate.

➢ Detention Time

The detention time is designed for 2.5 hours, which falls within the CPHEEO Manual's design range (2.0-2.5 hours; CPHEEO, 2003, p. 397). Accordingly, making the detention time appropriate.

➢ Surface Loading

The design surface loading rate for the sedimentation basin in the DPR is 30 m^3/m^2/day., which falls within the CPHEEO Manual's design range (30-40 m^3/m^2/day; CPHEEO, 2003, p. 397).Therefore, making the surface loading rate appropriate.

➢ Other Parameters

The clariflocculator's detention time—G value of 30, and Gt value of 5.4×10^4—fall within the CPHEEO Manual's standard values (G value: 20 s^{-1} to 75 s^{-1}; Gt value: 2 to 6×10^4; CPHEEO, 2003, p. 389) and also comply Japanese design standards, making them appropriate. In the DPR, the plan includes the installation of nine clariflocculator units; however, to achieve a systematic water treatment process, a proposal regarding the number of units will be presented later.

- Rapid Sand Filters

Rapid filtration is an critical process for ensuring the reliability of water treatment systems. Generally, there are "single-layer filtration", which uses a single filter medium, and "multi-layer filtration", which uses different types or sizes of filter media stacked together. As mentioned earlier, the average turbidity of the Cauvery River is relatively low at approximately 10–30 NTU, except during flood conditions. Therefore, single-layer filtration is considered sufficient. Additionally, single-layer filtration allows easy backwashing and requires simpler equipment, which helps reduce initial costs. Furthermore, the straightforward structure of the filter medium simplifies operational management, and since filter medium replacement and filtration rate adjustments can be done with only a single type of medium, maintenance is also more efficient. Based on these considerations, the selection of single-layer filtration, which is simple in design and easy to manage consistently, is appropriate.

➢ Filter Beds

The rapid sand filter design in the DPR consists of 32 beds in total, with 28 operational units and four standby units. The length-to-width ratio of each filter bed is 1.22 (9.0 m × 11.0 m), which is based on the CPHEEO Manual. Japanese design standards recommend that this ratio should not exceed five (Water Supply Facilities Design Guidelines, 2012, p. 213), as higher ratios can impede uniform water distribution within the filter bed. Therefore, the designed length-to-width ratio is considered appropriate.

➢ Filtration Rate

The rapid sand filter's filtration rate is designed at 5.0 m^3/m^2/hour (120 m/day), which falls within the CPHEEO Manual's standard range (4.8-6 m^3/m^2/hour; CPHEEO, 2003, p. 409). Although the design filtration rate indicates relatively low-load operation, it is considered appropriate when considering treatment stability.

- Filter Media

In the DPR, the sand and gravel layer depths are 600 mm and 450 mm, respectively. The filter sand's uniformity coefficient of 1.5 and effective size of 0.6 mm are based on the CPHEEO Manual specifications. These values also comply with the Japanese design standards and are therefore appropriate.

- Backwashing

The filter backwashing system combines air scouring and water washing, utilizing compressed air at 45 $m^3/m^2/hour$ and backwash water at 36 $m^3/m^2/hour$. Although both parameters are slightly lower than Japanese design standards, they fall within the CPHEEO Manual's standard range (air: 36–45 $m^3/m^2/hour$; water: 24-40 $m^3/m^2/hour$; CPHEEO, 2003, p. 414). The backwash wastewater is planned to be properly treated at the wastewater treatment facility.

In the DPR, structural calculations for each facility have been performed considering dead loads, live loads, wind loads, water pressure, earth pressure, and equipment load of the structures. Additionally, in accordance with Indian guidelines, seismic design has been incorporated by considering horizontal forces based on the seismic coefficients for each region. Therefore, it can be evaluated that these structures have been appropriately planned from a structural perspective.

In conclusion, the various design parameters used in the water treatment plant design in the DPR are based on design standards specified in the CPHEEO Manual, and appropriate values have been adopted. These parameters are also technically appropriate when compared with Japanese design standards.

3) Proposed Design Modifications for Water Treatment Plant

The functions and layout of each facility in the DPR are examined and reviewed below, and improvement proposals are presented where necessary.

i) Consolidation of Flash Mixers and Rapid Mixing Basins

The DPR envisions the installation of nine flash mixers and nine rapid mixing basins to correspond with the nine clariflocculators. For this project, it is proposed to consolidate these into three flash mixers and three rapid mixing basins, considering the following advantages:

- ✓ Improved maintainability,
- ✓ Enhanced mixing efficiency,
- ✓ Reduced initial costs.

ii) Serialization of Clariflocculators

While the DPR designs nine clariflocculators, this project proposes a design of ten units arranged in two series of five units each, considering the following maintenance advantages:

- ✓ Improved cleaning efficiency,
- ✓ Ensured operational continuity during inspection and repairs, and
- ✓ Enabled series-based maintenance management.

iii) Elimination of Chlorine Contact Tank

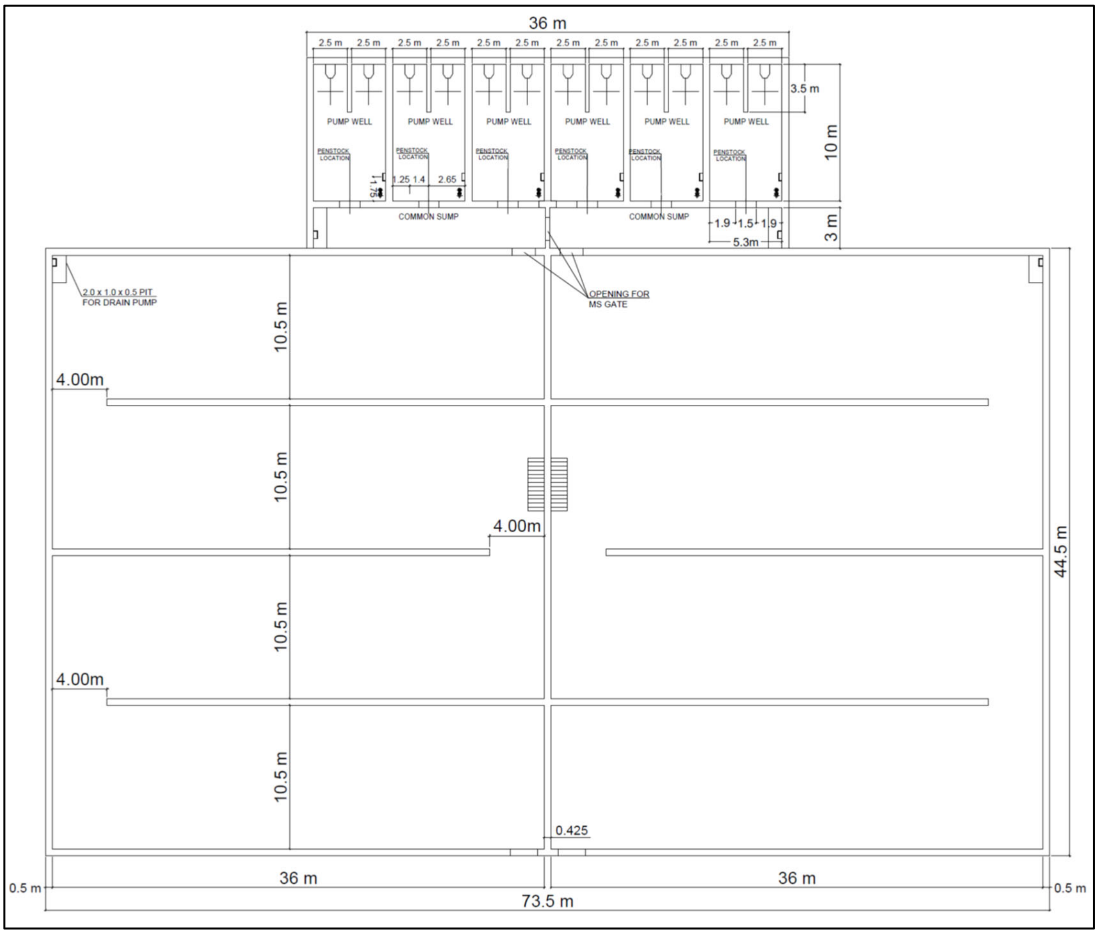
The DPR includes a chlorine contact tank with a capacity of 7,040 m³ (55.0 m × 32.0 m × 4.0 m), located between the rapid sand filters and the CWR, providing approximately 33 minutes of retention time. Since this facility's sole purpose is to ensure uniform contact between the injected chlorine and treated water, this project proposes eliminating the chlorine contact tank and integrating its function into the CWR, thereby reduce construction costs.

iv) Clear Water Reservoir

The DPR includes a CWR with a capacity of 12,460 m³ (65.3 m × 47.7 m × 4.0 m), providing 60 minutes of retention time. However, the absence of baffle walls could lead to water stagnation. Therefore, this project proposes the following improvements:

- ✓ Installing baffle walls to prevent water stagnation;
- ✓ Increasing retention time to 75 minutes (15,625 m³) to compensate for the buffer reduction resulting from the elimination of the chlorine contact tank; and
- ✓ Adjusting the reservoir capacity to 15,725 m³, considering the layout of other facilities within the WTP.

Figure 6.7.18 shows the plan view of the proposed CWR for this project.



Source: JST

Figure 6.7.18 Proposed Plan View of the Clear Water Reservoir

v) Relocation of the MBR

In the DPR, the gravity-flow MBR is positioned at ground level GL +526.61 m, as shown in Figure 6.7.15. However, the proposed expansion of clariflocculators in this project necessitates a revision of the MBR layout plan.

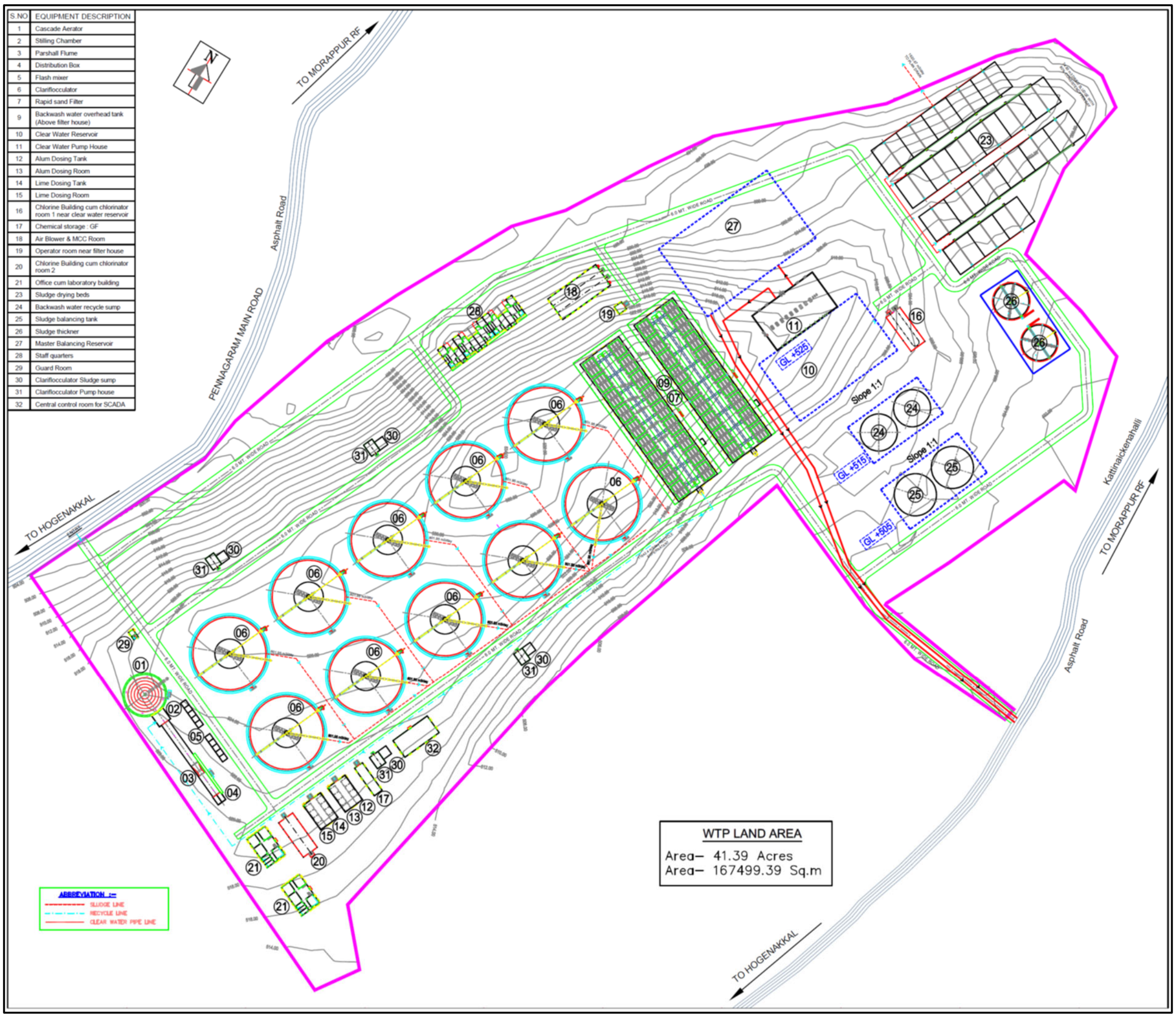
This project proposes the following:

- ✓ Developing the slope north of the rapid sand filters to create a planned ground level of GL +525.0 m.
- ✓ Locating the CWR and transmission pump station at this ground level.
- ✓ Setting the planned ground level near the MBR at GL +526.5 m to maintain the required high-water level of HWL +531.15 m for gravity-flow transmission.

Figure 6.7.19 shows the overall layout plan proposed by the JST for this project, while Figure 6.7.20 illustrates the elevation relationships among the three facilities: CWR, transmission pump station, and MBR.

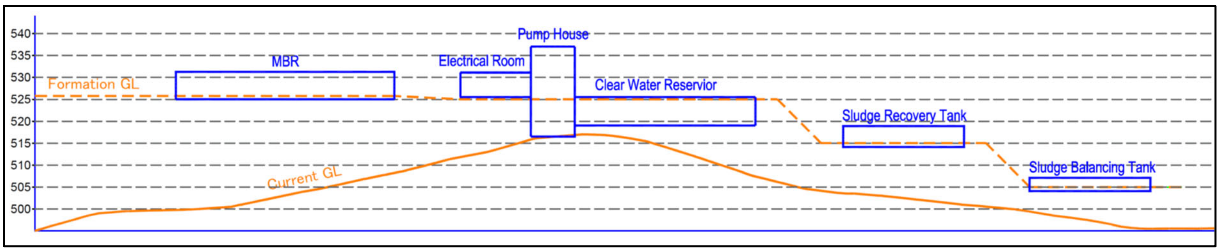
This modification reduces the pump head from the CWR to the MBR from 43 m to 15 m, achieving a significant head reduction of approximately 28 m. This is expected to result in cost savings through:

- ✓ Reduced initial costs for transmission pumps.
- ✓ Lower running costs due to decreased electricity consumption.



Source: JST

Figure 6.7.19 Overall Layout Plan of the Proposed Water Treatment Plant



Source: JST

Figure 6.7.20 Height Relationship Among the MBR, Pumping Station, and Clear Water Reservoir

vi) Drain Sump, Sludge Sump, and Thickener

While the DPR plans single units of the drain sump, sludge sump, and thickener, this project proposes duplicating all these facilities (two units each) to:

- ✓ Improve cleaning efficiency;
- ✓ Ensure operational continuity during maintenance and inspections; and
- ✓ Provide backup functionality during repairs.

vii) Thickened Sludge Storage Tank

The DPR includes a thickened sludge storage tank. However, this facility is only necessary for WTPs using dewatering machines, as its purpose is to mix chemicals with thickened sludge for homogenisation. The DPR adopts the same approach as the Previous Hogenakkal Project Phase I, using sludge drying beds to remove supernatant water and filter the sludge to reduce moisture content and produce sludge cake. Therefore, the thickened sludge storage tank is unnecessary for this project.

Table 6.7.7 summarises the proposals and their technical justifications for this project, and Figure 6.7.21 shows the water treatment flow diagram.

Table 6.7.7 Proposals and their Technical Justifications for the Project

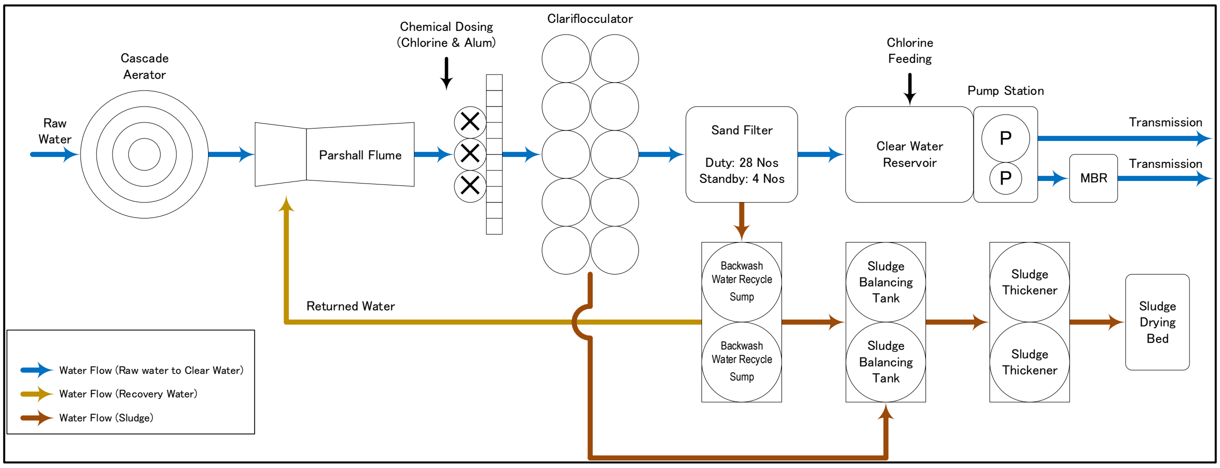
Item		DPR	Proposed Reason
1	Flash Mixers and Mixing Wells	Flash Mixers (9 units) and Mixing Wells (9 units)	The proposal is to reduce the number to three flash mixers and three rapid mixing basins to improve mixing efficiency and reduce initial costs.
2	Clariflocculator	9 units	To create two series, the system will consist of ten units.
3	Chlorine Contact Tank	1 unit (Detention Time 30 min)	The chlorine contact tank will be eliminated, and its function will be integrated into the CWR to reduce initial construction costs.
4	Clear Water Reservoir	1 unit (Retention Time: 60 min) Due to the absence of baffle walls, water stagnation may occur. 65.28 m x 47.7 m x 4.0 m	The reservoir will be located on the east side of the rapid sand filters and set at the same ground level, allowing for smaller pumps to transfer water to the MBR. Baffle walls will be introduced to prevent water stagnation. Considering the reduction in buffer capacity due to the elimination of the chlorine contact tank, the retention time will be increased to 75 minutes (15,725 m^3). 72.0 m x 42.0 m x 5.2 m
5	MBR	GL +526.61 m, HWL +531.15 m, LWL +526.5 m	By locating it on the east side of the rapid sand filters, water distribution costs will be reduced.
6	Backwash Water Recycle Sump, Sludge Balancing Tank, and Sludge Thickener	1 unit each	To enhance maintainability, the system will include two units.
7	Thickened Sludge Sump	1 unit	Since concentrated sludge is sent to sludge drying beds instead of undergoing mechanical dewatering, the dewatering machine will be omitted.

Source: JST

Table 6.7.8 Overview of the Proposed Water Treatment Plant Suggested by the JST

Item	Specification	Ultimate No.	Intermediate No.
Main Facility			
Cascade Aerator	25.035 m dia.	1	1
Parshall Flume	7.8 m x 7.8 m x 4.0 m	1	1
Mixing Well	3.2 m x 3.2 m x 3.2 m	2 Duty + 1 Standby	2 Duty + 1 Standby
Clariflocculator	45.6 m dia. x 4.68 m	8 Duty + 2 Standby	7 Duty + 2 Standby
Rapid Sand Filter	9.0 m x 5.5 m	28 Duty + 4 Standby	23 Duty + 3 Standby
Backwash Tank	3.5 m dia. x 2.5 m	1	1
Chlorine Contact Tank	80 m x 50 m x 5.5 m	1	1
Clear Water Reservoir	72 m x 42 m x 5.2 m	1	1
Pump House	44.0 m x 25.0 m x 10.0 m	1	1
Backwash Water Recycle Sump	22.0 m dia. x 4.0 m	2	2
Sludge Balancing Tank	25.0 m dia. x 3.0 m	2	2
Sludge Thickener	21.0 m dia. x 3.5 m	2	2
Alum Dosing Tank	3.8 m x 3.8 m x 3.0 m	2 Duty + 1 Standby	2 Duty + 1 Standby
Lime Dosing Tank	3.8 m x 3.8 m x 3.0 m	2 Duty + 1 Standby	2 Duty + 1 Standby
Chemical House	20.0 m x 5.5 m x 5.0 m	1	1
Chlorine Building	25.0 m x 10.0 m x 5.0 m	2	2
Sludge Drying Beds	18.0 m x 18.0 m x 0.5 m	20	17
Office, Laboratory Building	20.5 m x 13.0 m x 4.0 m	1	1

Source: JST



Source: JST

Figure 6.7.21 Proposed Water Treatment Process Flow for the Water Treatment Plant

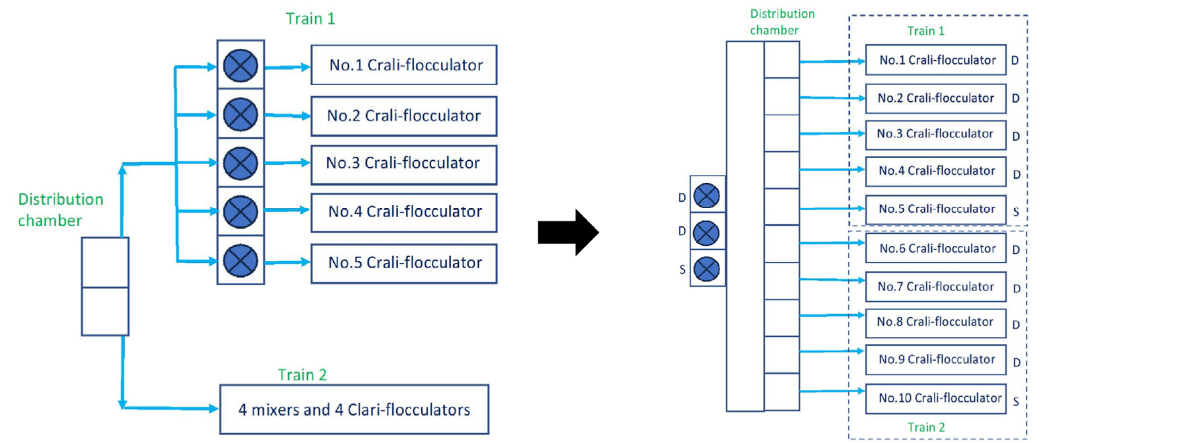
6.7.2 Mechanical Works

JST recommended the following proposals regarding the mechanical works, which TWAD has agreed to.

(1) Mechanical Rapid Mixer

The Previous Hogenakkal Project adopted a stirring system using water level differences without a mechanical mixer. However, since the DPR specifies a maximum raw water turbidity of 200 NTU, mechanical mixers are required to ensure efficient mixing. While the DPR plans for a total of nine clariflocculators—one mixer for each unit—JST recommends consolidating the mixers upstream, reducing the number of mixer units from nine to three, including one standby unit, to facilitate easier maintenance. The raw water reacts well with the chemicals in the rapid mixing basin and then flow into each clariflocculator through the distribution chamber.

Item	DPR	Proposal
Rapid mixer	8 duties and 1 standby	2 duties and 1 standby (50 kw/each) or 4 duties and 2 standby (2 duties in series/ train, 22kW/each)



Source: JST

Figure 6.7.22 Revised Flow for Mechanical Rapid Mixer

(2) Mechanical Clariflocculator

According to the DPR, a total of nine clariflocculator units, including one standby unit, are planned. However, it is difficult to perform sludge removal or divert water flow if one unit fails. Therefore, considering operation and maintenance efficiency, JST recommends installing a total of ten units, with five units per train.

(3) Backwash System for Rapid Sand Filter

The DPR specifies only one backwash system, as in the Previous Hogenakkal Project. However, considering the importance of the backwash system and the larger scale of this project, two independent backwash systems will be implemented to enhance operational safety. JST recommends increasing the number of backwash blowers and backwash pumps from two to four each.

(4) Chemical Facility

Regarding the coagulant dosing system, the DPR specifies eight chemical dissolution tanks and a total of twelve injection pumps, including three standby pumps. Based on the revised rapid-mixing layout, JST recommends reducing the number of dissolution tanks to four and the total number of injection pumps to six, including two standby pumps, to improve maintainability. Given the poor quality of aluminium sulphate blocks, JST also proposes the necessity of separating the stock and dissolution tanks, as implemented in the Previous Hogenakkal Project. A coarse-bubble diffuser membrane grid system and air blower shall be designed to aerate both the alum solution tanks and dosing tanks. The coagulant preparation and dosing system shall be capable of functioning reliably with locally produced alum containing up to 20% insoluble material. For emergency situations, JST proposes a dual dosing system with injection lines to the rapid-mixing basin.

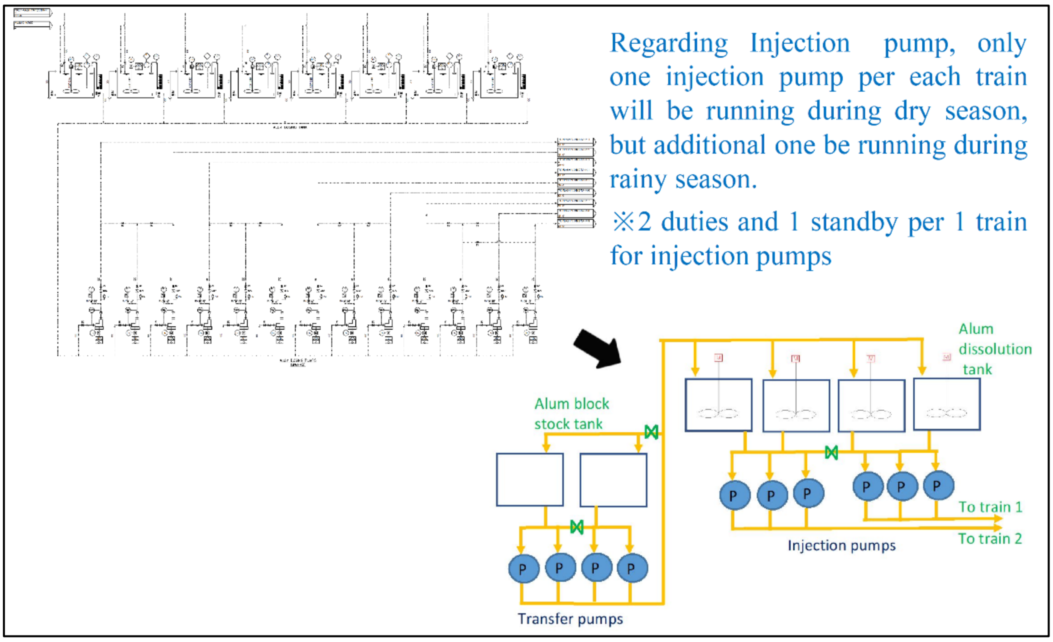
For the lime dosing system, the DPR specifies eight chemical dissolution tanks. To improve maintainability, JST recommends reducing the number of storage tanks to three. Following the same concept as the coagulant injection pumps, a dual dosing system with injection lines to the rapid-mixing basin is proposed, with one pump operating per system during low turbidity and two pumps operating per system during high turbidity, for a total of six pumps, including standby units.

While the lime facility in the Previous Hogenakkal Project was initially utilized, its operation was later discontinued due to the relatively high pH of the raw water. In this project, installing a lime facility is considered appropriate, given the potential alkalinity consumption during high-turbidity operation. However, it is recommended to re-evaluate whether to retain this facility as an option during the detailed design stage. Although lime saturators were installed in the Previous Hogenakkal Project, TWAD has reported no issues such as pipe clogging, indicating that they may not be necessary for this facility.

Table 6.7.9 Revised List for Chemical Facilities

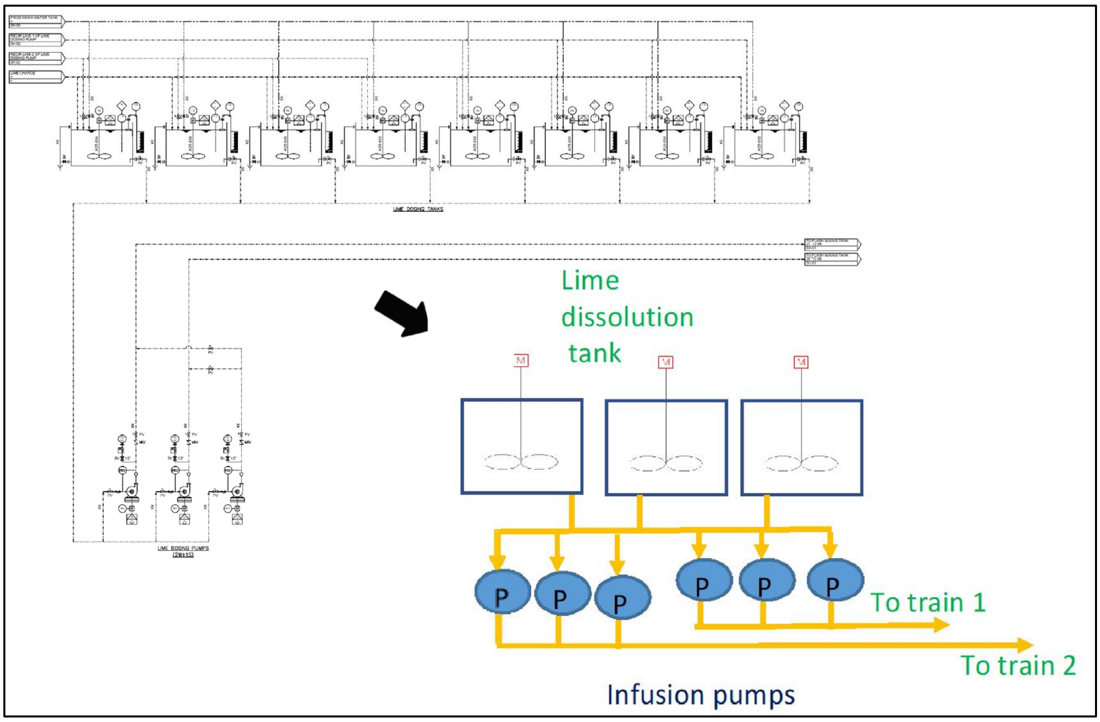
Item	DPR	Proposal
Coagulant storage tank	previous project: 2 tanks DPR: none	2 tanks
Coagulant transfer pump	previous project: 2 units, DPR: none	4 units (2 of which are standby)
Coagulant dissolution tank	previous project: 1 tank DPR: 8tanks	4 tanks
Coagulant injection pump	12 units (of which 4 units are standby)	6 units (2 of which are standby)
Lime dissolution tank	8 tanks	3 tanks
Lime infusion pump	3 units (one of which is standby)	6 units (2 of which are standby)
Lime saturator	previous project: 2 units, DPR: none	Not required

Source: JST



Source: JST

Figure 6.7.23 Revised Flow for Coagulant Facilities



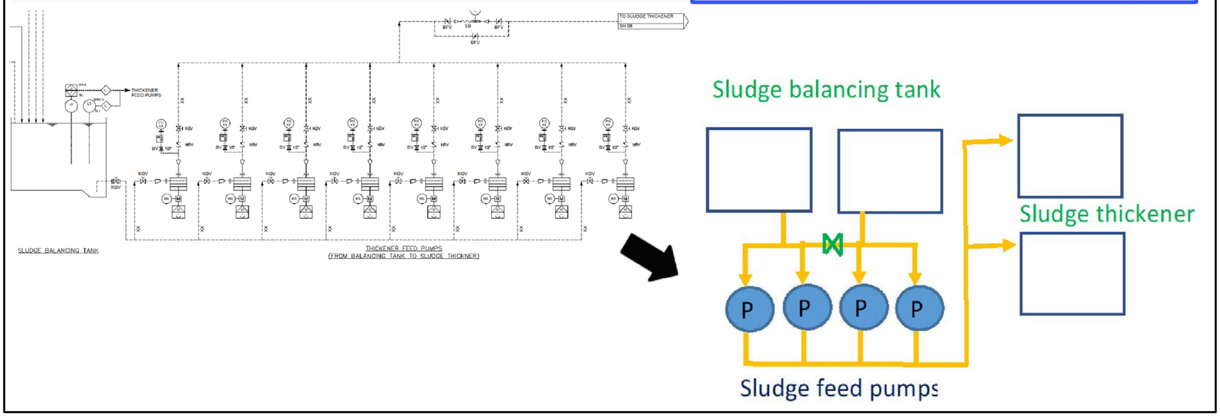
Source: JST

Figure 6.7.24 Revised Flow for Lime Facilities

(5) Sludge Balancing Facility

The DPR does not include a standby sludge balancing tank and specifies eight sludge feed pumps. However, considering maintainability, it is recommended to provide two sludge balancing tanks and a total of four sludge feed pumps.

Item	DPR	Proposal
Sludge balancing tank	1 tank	2 tanks
Sludge feed pump	8 units	4 units (2 of which are standby)



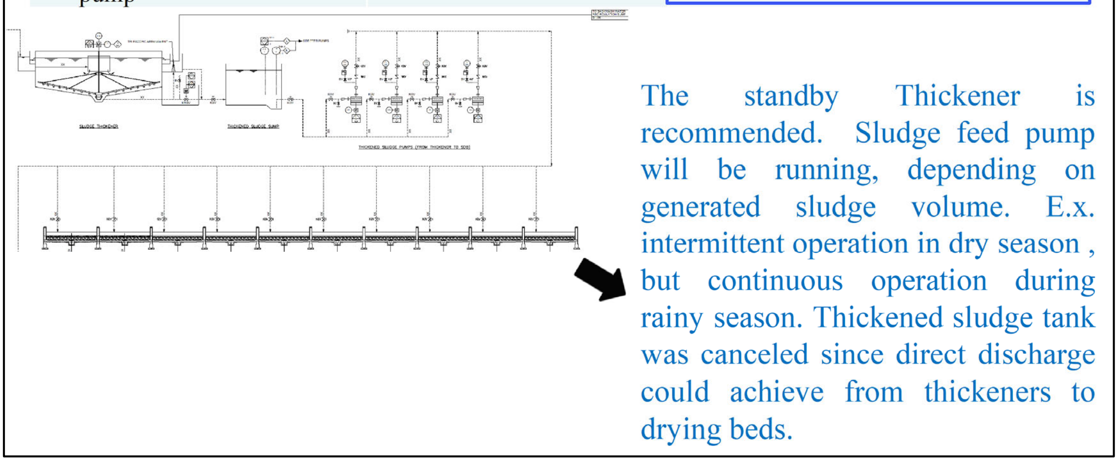
Source: JST

Figure 6.7.25 Revised Flow for Sediment Sludge Feed Facilities

(6) Thickened Sludge Facility

The DPR specifies four sludge feed pumps and does not include a standby sludge balancing tank. However, considering operational maintainability, it is recommended to provide two sludge balancing tanks and reduce the number of pumps to four.

Item	DPR	Proposal
Sludge Thickener	1	2
Thickened sludge tank	1 tank	**Canceled**
Thickened sludge feed pump	4 units	4 units (2 of which are standby)

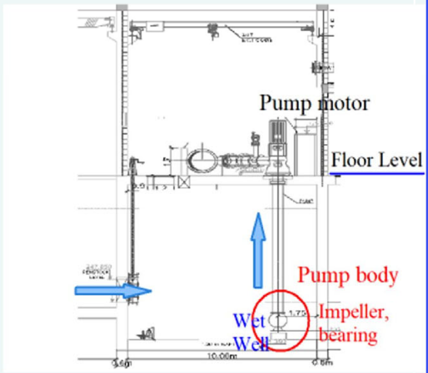
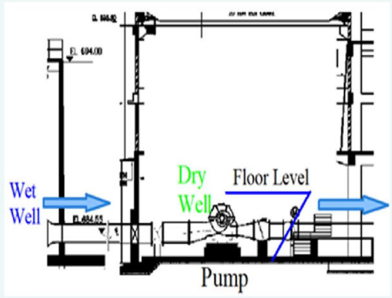


Source: JST

Figure 6.7.26 Revised Flow for Thickened Sludge Facilities

(7) Transmission Pump

As discussed in Section 6.6, the transmission pump type at the WTP will be changed from a vertical turbine pump to a horizontal split-case pump.

Item	DPR	Proposal
Structure		
Pump efficiency	85 %	87 % (for 35,149 lpm) 85 % (for 18,467 lpm)
Specifications	35,149 lpm x 66 m x 520 kW 18,467 lpm x 43 m x 200 kW	35,149 lpm x 66 m x 490 kW 18,467 lpm x 43 m x 190 kW
Unit Price (IDR) Japanese supplier	N/A	12,000,000 (for 35,149 lpm) 5,300,000 (for 18,467 lpm)
Unit Price (IDR) Indian supplier	11,200,000 (for 35,149 lpm) 4,100,000 (for 18,467 lpm)	9,700,000 (for 35,149 lpm) 3,100,000 (for 18,467 lpm)

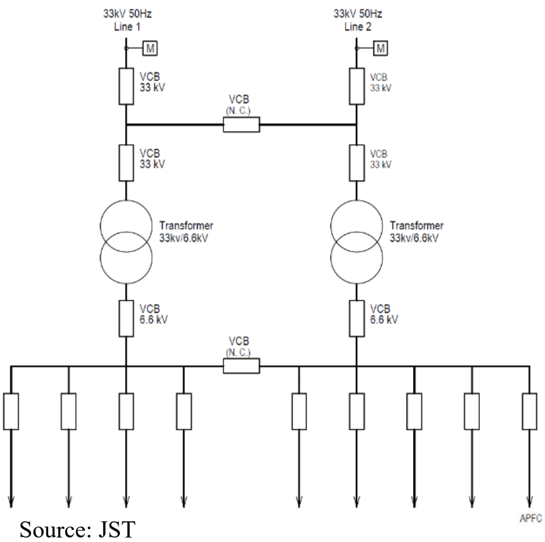
Source: JST

Figure 6.7.27 Comparison of Transmission Pump for Sugar Mill

6.8 Review of Electrical Works

6.8.1 Power Receiving and Transforming Facilities

The power receiving and transforming facilities for large-scale sites, such as the Intake Pump Station, are planned in 33 kV with a dual (two-line) power receiving system, similar to the existing project. Each line will operate as a continuously charged duty-standby line, with each expected to have 100% of the total power demand up to the transformer. The secondary voltage of the transformer will remain 6.6 kV, consistent with the existing project, to match the requirements of large motors. A schematic single-line diagram is shown in Figure 6.8.1.



Source: JST

Figure 6.8.1 Typical Single-Line Diagram

The high-voltage electrical room is installed within the pump station. This configuration is acceptable, since most of the power demand is accounted for by large pumps. However, in WTPs, where low-voltage loads are dispersed over several hundred meters from the pump stations, it is desirable to distribute 6 kV power to the blower building and administration building and to install distributed electrical rooms to minimize voltage drop and simplify construction. In addition, it is recommended that PLCs be installed in each electrical room in a distributed manner.

6.8.2 Confirmation of Power Availability

The Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO) is an electrical power generation and distribution public sector undertaking owned by the Government of Tamil Nadu (formerly the Tamil Nadu Electricity Board). The project will also receive power from TANGEDCO; however, due to the relatively large capacity and multiple facility locations, it is necessary to confirm in advance that the required power supply can be received in time for the construction work. Table 6.8.1 shows the facilities that will require 33kV dual (two-line) power supply for this project.

Table 6.8.1 Electricity Requirements per Site

Site	Required Cap. (Tentative)
1. Intake Pump Station	7.5 MVA
2. Booster Pump Station -1	10 MVA
3. Booster Pump Station -2	10 MVA
4. Water Treatment Plant	5 MVA
5. Sugar Mill Common BPS	5 MVA
6. Mahendar Mangalam BPS	5 MVA
7. Kadu Chetti Patti BPS	4 MVA
8. Ullu Kurukkai BPS	4 MVA
9. Manjalagiri BPS	3 MVA
10. Mathepalli Sump	0.5 MVA

Source: JST based on DPR

According to a consultation letter dated August 2022 between the Dharmapuri Electricity Distribution Circle (DEDC)—a sub-organization of TANGEDCO—and TWAD, a new 110/33 kV substation will be constructed. Power will then be distributed to the four project facilities—Intake, BPS-1, BPS-2, and WTP—via 33 kV underground cable (dual supply). A copy of the discussion memo with DEDC is attached to the Appendix for reference.

TANGEDCO, like TWAD, is a government organization, and the project is expected to be carried out in a coordinated manner. However, since specific construction plans for the substation construction and transmission line extension have not yet been presented, the construction period, capacity to receive power, and construction work classification should be confirmed again before the tender. In addition, while it is assumed that the consultation letter confirms the four facilities—Intake PS, BPS-1, BPS-2, and WTP—the same confirmation should also be required for the other six facilities in the city. Some facilities, such as the WTP, do not show outdoor substations in their layout drawings; therefore, for all ten facilities listed in the table, coordination with TANGEDCO—including layout plans—will be necessary before the tender is issued.

It should be noted that, in principle, the distribution of electricity to each facility, including budgetary measures, is within TANGEDCO's scope of work and is not covered by the JICA loan. Accordingly, matters such as consultations and coordination with TANGEDCO, payment of of any required contributions, provision of land necessary for receiving electricity, and execution of contracts for receiving electricity will be the responsibility of TWAD.

Furthermore, as mentioned in Section 3.2.7 Power Outage Records, while there is a risk of water supply interruptions due to power outages, there are no countermeasures planned using backup generators, as was the case in existing facilities. Considering that generators are very expensive and the fact that the operational record of generators in India is limited, it is not practical to install generators at all facilities.

However, measures to improve the reliability of power supply will be required in consultation with TANGEDCO, particularly for major facilities with dual-line power connections.

For example, the following measures could be taken to minimize damage from power outages:

(1) Separate the power transmission lines from the existing facilities to prevent simultaneous power outages caused by transmission accidents.

(2) Reduce the risk of concurrent power outages by receiving dual power lines from separate grids.

(3) Ensure that ageing power facilities are properly maintained, including its renewal as needed.

(4) Ensure adequate lightning protection and related safeguards.

In pilot areas where 24-hour continuous water supply is planned, it is advisable to consider installing generators for the targeted distribution pumps or, as a future plan, provide space for installing generators and feeders for switching power sources.

6.8.3 Introduction of VFDs

In order to improve controllability and reduce power consumption, it is recommended to adopt Variable Frequency Drives (VFDs) as the starting method for large pumps. The advantages and disadvantages of using VFD are listed below.

Table 6.8.2 Advantages and Disadvantages of Introducing VFD

Advantages	
24-hour constant flow control	The amount of water intake can be pumped up at a constant rate for 24 hours a day according to the amount of water required, thereby reducing pipeline losses and allowing the water treatment process to continue without stopping.
Proper operation according to river level	Depending on the range of water level fluctuations, automatic operation is possible in response to these variations. Pump efficiency is improved because valve throttling can be minimized at high water levels. **This method is more effective when the total water level fluctuation between the suction and discharge sides is 10 m or more, or accounts for 20% or more of the total head.**
Linked pump-up to WTP	In this project, unlike the existing system, pumping up to the WTP is done in two stages. However, the three pumping stations must operate in coordination to ensure equal flow rates, preventing pump well overflow and improving efficiency compared to valve-based flow adjustments.
No power factor correction required	VFD does not require power factor correction due to the inverter start-up (always around 98%).
Other	**Effective as an initial solution when the initial water volume is low.**
Disadvantages	
High price	About ten times more than the current reactor startup.
Difficult to repair	Indian manufacturers are limited and tend to have slow response time for repairs and related issues. However, no special maintenance is generally required.
Limited life span	Shorter equipment life than current reactor startup due to electronics (about 15 years or more).
Harmonics	Countermeasures are required because harmonics are generated.
Other	**Energy savings are less effective in systems with short pipelines and large elevation differences.**

Source: JST

For reference, the following table shows the estimated reduction in electricity costs resulting from decreased electricity consumption. It also shows the capacity and power requirements of the large pumps from the Intake PS to the WTP. The annual electricity cost for the main pumps up to the WTP estimated to be approximately INR 1 billion, representing a large portion of the maintenance cost (based on 7.5 INR/kWh as of 2024 actuals).

Table 6.8.3 Power Consumption and Rates for Each Facility by Pumps

Site	Motor capacity (Assumed)	Total	Required kWh/day	Required kWh/year	Annual Electricity Costs [INR]
Intake PS	500 kW	4000 kW	77,737	28,374,005	212,805,038
Booster PS-1	900 kW	7200 kW	144,650	52,797,250	395,979,375
Booster PS-2	630 kW	5040 kW	103,321	37,712,165	282,841,238
WTP PS-1	180 kW	720 kW	14,934	5,450,910	40,881,825
WTP PS-2	500 kW	2000 kW	41,334	15,086,910	113,151,825
total			381,976	139,421,240	1,045,659,300

19% reduction saves 13,280,000 INR per year in first 15 years

Source: JST based on DPR

As a simplified economic comparison, Table 6.8.4 presents an example for WTP PS-2. According to the DPR, water demand will increase in stages from 66% to 80% of the final planned water demand between 2026 (base year) and 2041 (intermediate year).

Table 6.8.4 Simplified Economic Comparison (e.g. WTP PS-2)

	unit price	Qty	DPR [INR]	Qty	VFD [INR]
500kW FCMA	1,000,000	5	5,000,000	0	0
500kW VFD	10,000,000	0	0	5	50,000,000
total			5,000,000		50,000,000
				Difference →	-45,000,000

Source: JST based on DPR

The DPR states that this water volume adjustment is to be made by changing pump operating hours; however, a simplified economic comparison is provided for a case in which this adjustment is achieved through the use of a VFD.

Assuming that 72% of the facility capacity [planned water volume in 2041: 80% of the total planned water volume) x (90% of the average from the start of operation to 2041) = 72%] will be required to supply water for 15 years until 2041, a fixed-speed pump will need to operate for 16.5 hr/day. In contrast, if a VFD is used to adjust the water volume and deliver water at 24 hr/day, the total head can be reduced by about 14.6 m (based on a simplified calculation). This will reduce the amount of electricity by about 19%, which can be converted into an annual electricity savings of about 13,280,000 INR.

For initial costs, the estimated costs of the current reactor starting panel (500 kW FCMA) and VFD (500 kW VFD) were compared. As shown in the table, the price difference in the initial cost of five pumps can be estimated to be 45,000,000 INR. Comparing the electricity savings to the initial investment in equipment costs, the additional price can be recovered in about four years, and the economic benefits of VFD are expected to be substantial.

The introduction of VFDs should be considered not only from an economic standpoint but also comprehensively, considering improved controllability through automatic operation and reduced of CO_2 emissions from lower power consumption. Specifically, as described in the Mechanical Facilities chapter, VFDs are proposed to be installed in BPS-2 intake pumps to enable constant intake flow control (2 out of 12 pumps) and in the WTP water pumps (6 out of 6 pumps), as described in the economic comparison above.

The project will be partially tendered using the Design-Build-Operate (DBO) method, and the bidding requirements may include proposals for reducing power consumption through the use of energy-saving equipment (such as VFDs) and renewable energy sources (such as solar power generation). It is necessary to consider evaluation criteria that encourage bidders to propose solutions from the perspective of greenhouse gas reduction and overall cost-effectiveness, including operation and maintenance costs.

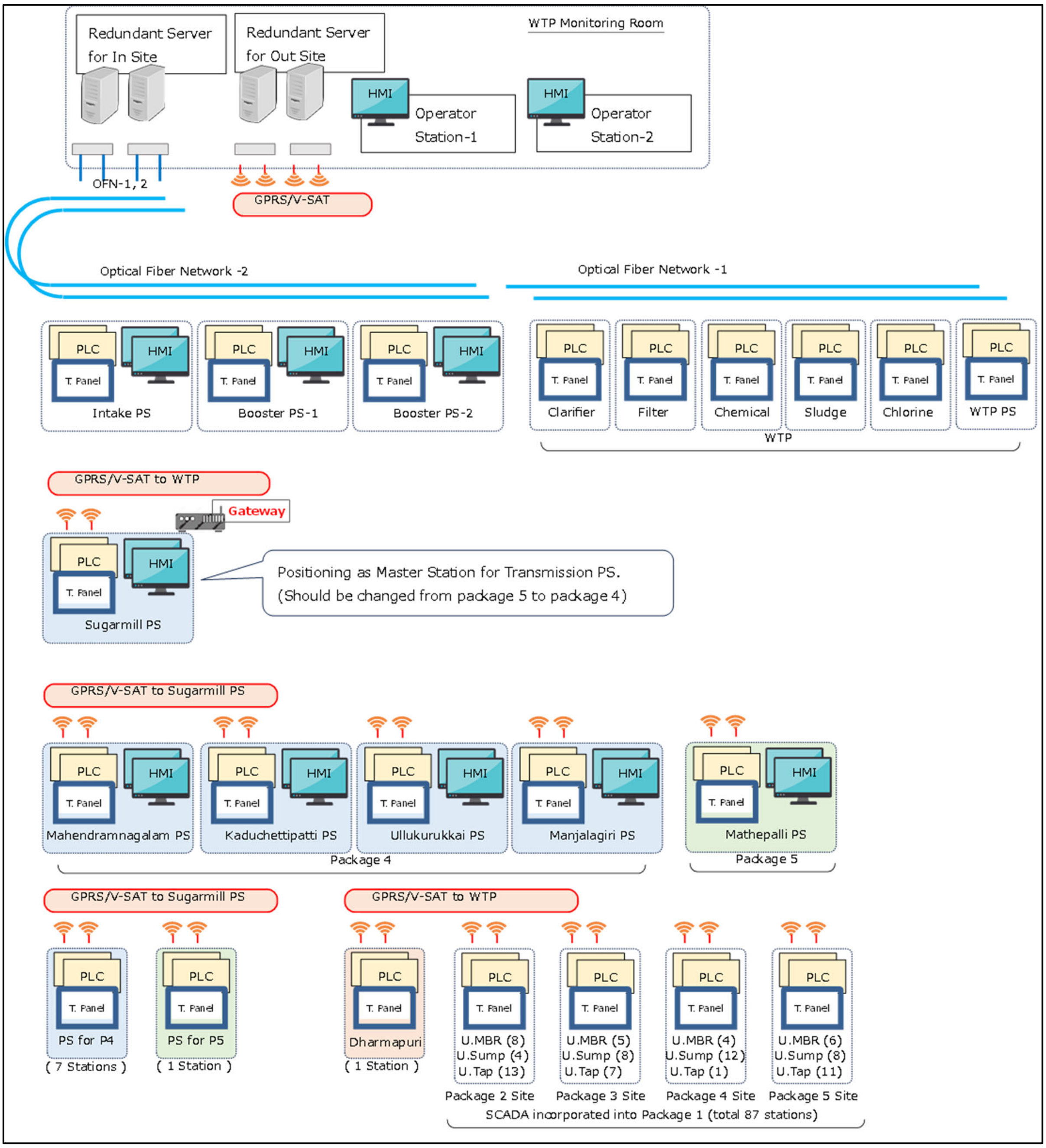
6.9 Review of Instrumentation and SCADA

6.9.1 SCADA System Diagram for the Project

Suggestions for SCADA system configurations in the DPR are shown. These have been agreed upon by TWAD; however, the details should be discussed at the time of preparation of the tender document to confirm tender requirements.

1) PLCs in the WTP should be installed in a decentralized configuration, providing an electrical room for each facility, as in the existing project. Since the site of the WTP is larger in this project than in existing, distributed PLC installation will not only improve reliability but will also benefit construction and economics since cable connections can be greatly reduced.
2) The optical cable network should be separated between the WTP on-site and off-site, as monitoring and control functions differ in role, level of importance, and risk tolerance (e.g., for wire breakage).
3) It is recommended that all signals from pumping stations downstream of Sugar Mill should be integrated at the Sugar Mill PS, making it the base for monitoring for pumping stations.
4) Signal collection from each pumping station to the WTP SCADA should be conducted via the Sugar Mill PS, defined under the scope of Package 1. This means that there is only one interface for signal collection in Package 1, making it easier to understand the construction scope and responsibility allocations.
5) To reduce the burden on servers, it is recommended that WTP servers be separated into a water production system (connected via optical cable) and a water transmission system (connected via GPRS). This will also improve maintainability.
6) Since instrumentation and SCADA facilities are highly specialized and unique compared to other civil works, it is recommended to have specified subcontractors nominated based on their performance and other factors with PQ conditions.

The overall recommended SCADA system configuration is shown in the figure below (Figure 6.9.1).



Source: JST

Figure 6.9.1 Overall SCADA System Configuration

6.9.2 Signal Acquisition from Other Facilities

(1) Signal acquisition from existing SCADA

Regarding the import of signals from the existing SCADA, it is recommended—considering the viewpoint of dividing up the responsibilities for operation and maintenance—that only the signals necessary for water supply management be imported, rather than integrating the entire SCADA into the new project. A specific method for importing signals is to import them through a gateway from the OPC port of the existing server, which is a low-cost and straightforward approach. By going through the OPC port, it becomes possible to import signals into a system different from the existing one. While OPC ports are standard on Windows servers, it is necessary to verify whether they are available or not.

Signal transmission will be via LAN; however, since the number of signals are large and real-time connection is required, it is recommended to use optical cable communication between the existing WTP and the new WTP.

(2) Signal acquisition from other packages

As mentioned earlier, if the Sugar Mill PS serves as the base of the water transmission system and collects signals from other pumping stations, only the Sugar Mill PS is required to provide the interface for signal acquisition in Package 1. As stated above, the use of gateways for signal import is recommended. It is also preferable to communicate with WTP via optical cable.

Other signal acquisitions, such as those from Union MBR, will be communicated by GPRS and V-SAT as per the DPR. However, the procurement and installation of valves and actuators should be excluded from the SCADA Works in Package 1 due to the difficulty of interfacing with other packages and because the work type is different from SCADA Work.

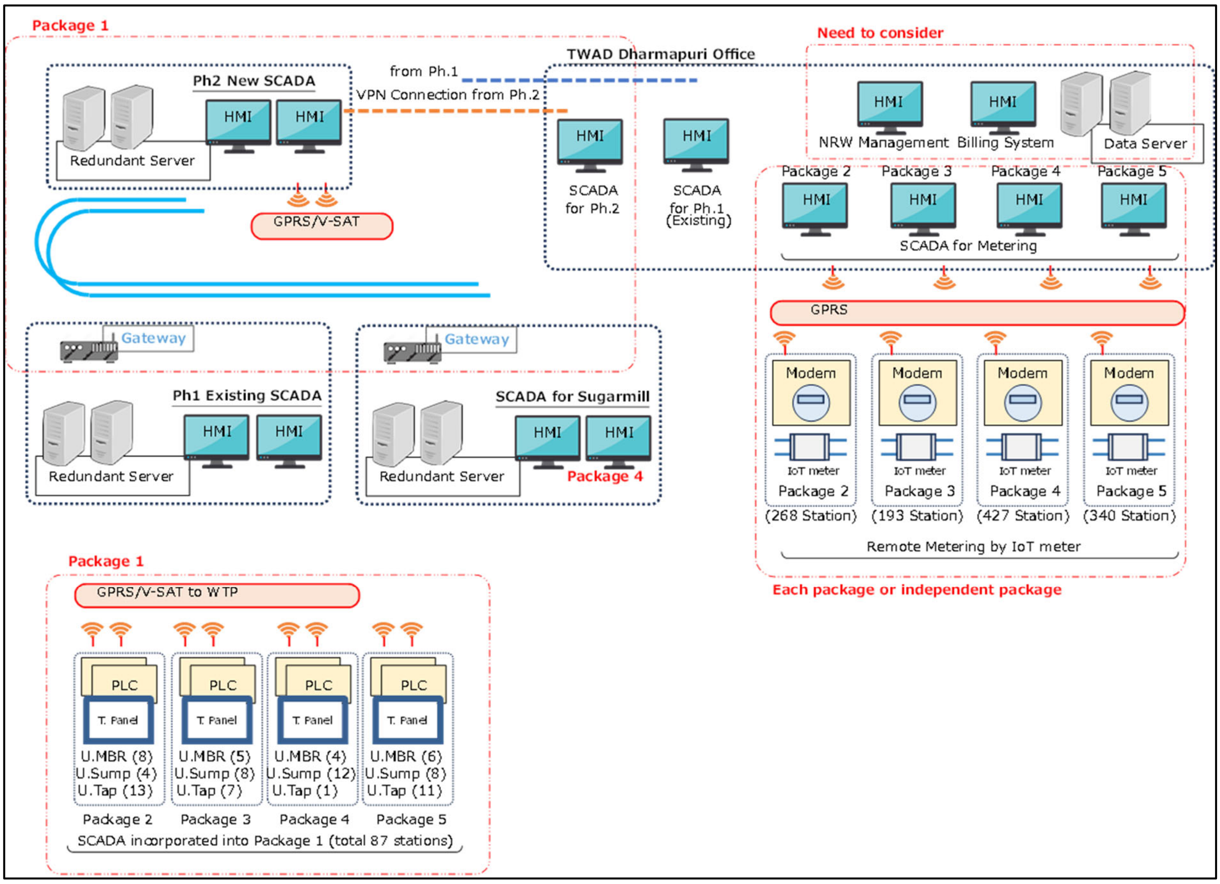
(3) Signal acquisition from IoT meters

Package 2 plans to utilize IoT meters for water fee collection, however, the DPR does not specify the signal acquisition methods. Since the acquisition and recording of flow signals will be an important function directly related to fee collection, it is advisable to make each package take responsibility for this function as part of a meter reading system, along with the installation of flow meters.

It is suggested that the meter reading system be installed at the TWAD Dharmapuri Office, separate from the operation and maintenance of facilities. It is proposed that the meter reading system installed in each package be further integrated into a unified billing system to promote digitalization and enhance management of fee collection.

In addition, consideration may be given to incorporating the meter reading systems for Packages 2 to 5—including the installation of IoT meters—into separate and independent packages. This approach would enable system unification and advanced digitization, including billing; however, on-site coordination and division of responsibilities during construction will be an issue. Furthermore, by integrating, comparing, and analyzing the flow signals collected under Package 1 with those collected by the IoT meters, it will be possible to enhance water transmission management—such as leakage management—can be possible.

Figure 6.9.2 below shows the proposed SCADA integrations with other packages.



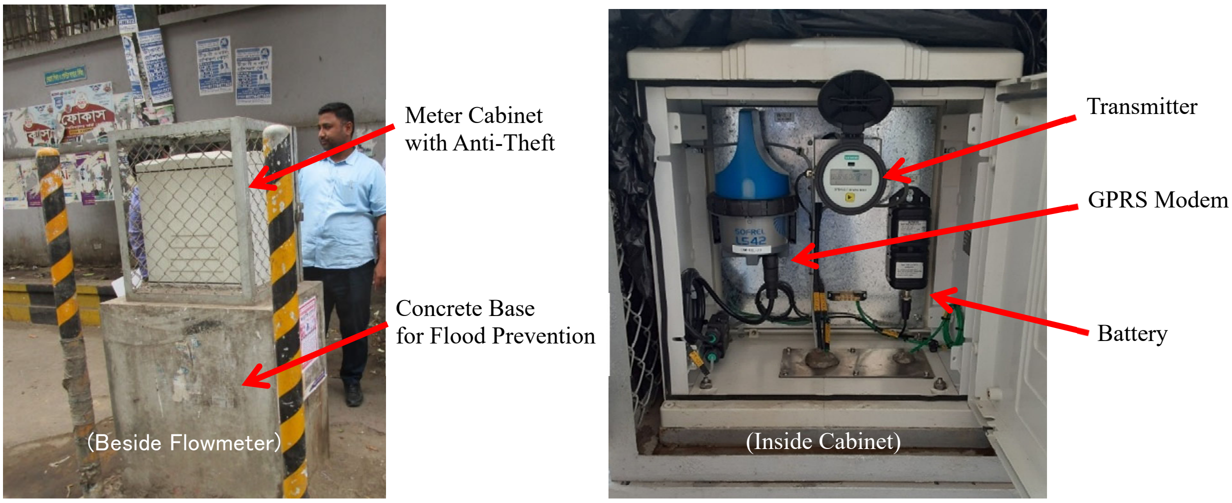
Source: JST

Figure 6.9.2 SCADA Integrations with Other Packages

6.9.3 Specifications and Configuration of the IoT Meters

Small-diameter IoT meters used for house service connections generally have a transmitter, communication device, and battery all into single unit. However, when the meter has a relatively large diameter and is installed in an outdoor pit, a separately mounted transmitter and communication device is recommended. This is particularly important when the flowmeter pit is likely to be submerged in water. Moreover, depending on the frequency of communication, a battery may be added if the expected battery life is set to be approximately ten years. The specifications of the IoT meter and details of the device configuration should be considered during detailed design and included in the bidding documents.

In addition, it is necessary to clarify the communication method for signal acquisition, the data recording method, the need for a billing system, and the need for connection to the existing billing system.



Source: JST

Figure 6.9.3 Examples of IoT Meter Installations

6.10 Summary of Project Facility Plan

6.10.1 Recommended Improvement and Modification from the DPR

Table 6.10.1 shows the recommended improvements and modifications from the DPR. These were discussed with TWAD officials during the survey period and were accepted accordingly. The approved modifications have been incorporated into the cost estimate.

Table 6.10.1 Recommended Improvements and Modifications from the DPR

Category	Facility	Recommended Improvement/Modification	
		Item	Description
Raw Water Transmission	BPS-2	Pump Control	Introduction of Variable Speed Drive (VSD) for 2 out of total 12 pumps.
Water Treatment	Clariflocculator	Number of Units	DPR: 9 units Proposed modification: 10 units: 2 x (4W+1S).
	Filtration Facility	Backwash System	DPR: One backwash system Proposed modification: Two independent backwash systems.
	Sludge Treatment	Treatment System	Addition of one standby sludge balancing tank. Addition of one standby sludge thickener. Deletion of thickened sludge pump.
	Clear Water Reservoir	Chlorine Contact	Chlorine contact tank shall be combined with the CWR.
Treated Water Transmission	Transmission Pump in WTP - Pumping from CWR to MBR in WTP - Pumping from CWR to Sugar Mill BPS	Type of Pump	Change of pump type: Vertical Turbine type => Horizontal Suction Centrifugal type
	Transmission Pump in WTP - Pumping from CWR to Sugar Mill BPS	Pump Control	Introduction of Variable Speed Drive (VSD) for 6 pumps.
Instrumentation /SCADA	- Decentralization of PLC panel at WTP. - Separation OFC network at WTP on-site and off-site.		

<table>
<tr><th rowspan="2">Category</th><th rowspan="2">Facility</th><th colspan="2">Recommended Improvement/Modification</th></tr>
<tr><th>Item</th><th>Description</th></tr>
<tr><td></td><td colspan="3">- Signal collection from Sugar Mill BPS to WTP.
- Additional Server for Water Transmission System connected with GPRS.
- Installation of OFC cable from WTP to Sugar Mill PS.
- Signal Collection from the existing SCADA.
- Additional cost for:
/ Signal collection from IoT meter installed at Panchayat MBRs,
/ Billing system for bulk supply to local bodies,
/ Non-revenue water management system,
/ SCADA connection to SE office in Dharmapuri.</td></tr>
<tr><td>House Service Connection</td><td>AMR system</td><td colspan="2">Addition of the following to the cost:
- Gateway for data collection from AMR water meters,
- Handheld device for data collection from AMR water meter,
- Data management software,
- Billing system software.</td></tr>
</table>

Source: JST

6.10.2 Salient Features of the Project Facility

Table 6.10.2 shows the salient features of the Project Facility.

Table 6.10.2 Salient Features of the Project Facility

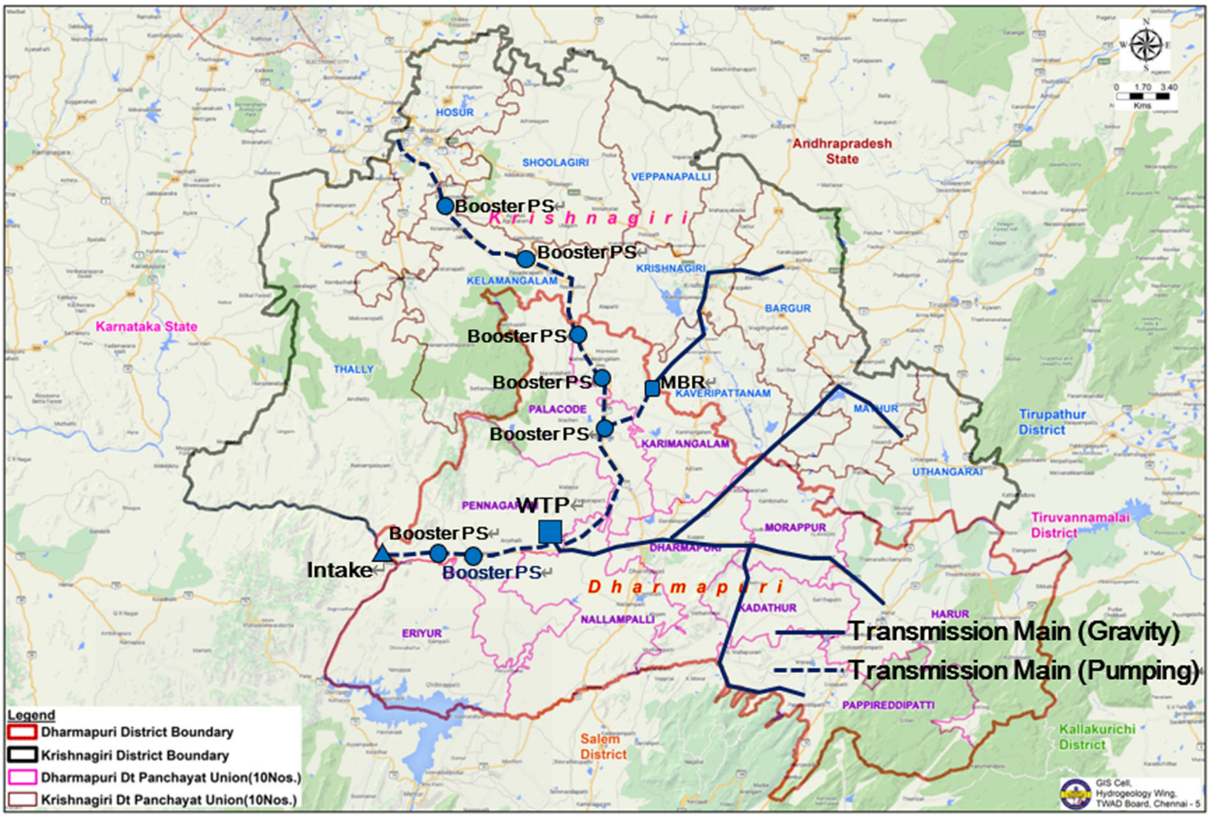
<table>
<tr><th colspan="2">Section I: Intake, Raw Water Transmission System, Water Treatment Plant with Treated Water Pump Station, and SCADA System</th></tr>
<tr><td>Intake</td><td>Source: Cauvery River, Location: Hogenakkal (GL = 251.0 m), Design Capacity: 304.83 MLD
Main Structures: Intake Channel, Pump Well, Pump House, Switch Gear Building, Compressor Room, and Transformer Yard.
Intake Pump: 27,612 lpm x 78 m Head (7W +3S)</td></tr>
<tr><td>Transmission Pipeline</td><td>From Intake to BPS-1.
MS Pipe: 1,829 mm x 14.20 mm, L = 7.20 km</td></tr>
<tr><td>BPS-1</td><td>Location: Yanaipallam, beside the existing WTP site (GL=310.0 m).
Sump: 13,255 m³, Transmission Pump: 27,612 lpm x 147 m Head (7W+3S)</td></tr>
<tr><td>Transmission Pipeline</td><td>From BPS-1 to BPS-2
MS Pipe: 2,032 mm x 20.0 mm, L = 0.9 km, MS Pipe: 2,032 mm x 16.0 mm, L = 1.10 km</td></tr>
<tr><td>BPS-2</td><td>Location: Kanavai, beside the existing BPS site (GL = 446.0 m).
Sump: 13,255 m³, Transmission Pump: 27,612 lpm x 105 m Head (7W+3S)</td></tr>
<tr><td>Transmission Pipeline</td><td>From BPS-2 to WTP
MS Pipe: 1,829 mm x 14.20 mm, L = 11.0 km</td></tr>
<tr><td>WTP</td><td>Location: Paruvathanahalli (GL = 496.0 m – 526.61 m), Design Capacity: 304.83 MLD (250 MLD by the Project).
Major Components: Cascade Aerator, Parshall Flume, Flash Mixer and Mixing Well (2W+1S), Clariflocculator (7W+2S), Rapid Sand Filter (23W+3S), Backwash Water Recycle Sump (2), Sludge Balancing Tank (2), Sludge Thickener (2), Sludge Drying Bed, Chemical Dosing Facilities (Alum, Lime, Chlorination).</td></tr>
<tr><td>Clear Water Main Pipeline</td><td>From CWR to MBR
MS Pipe: 1,118 mm x 8.80 mm, L = 0.5 km</td></tr>
<tr><td>Treated Water Pump Station and MBR in</td><td>Sump (CWR): 12,870 m³, MBR for Section II & III: 17,730 m³
Transmission Pump:</td></tr>
</table>

WTP	- Pumping to MBR for Section II & III: 18,467 lpm x 43 m Head (4W+1S), - Pumping to Sugar Mill BPS for Section IV & V: 35,149 lpm x 66 m Head (4W+1S).
SCADA	Headworks (Intake) and BPS: Pressure Transmitter, Pressure Gauge, EM Flowmeter, Level Transmitter, Motorized Valve, RTU based PLC-HMI, and UPS. WTP: Pressure Transmitter, Pressure Gauge, EM Flowmeter, Level Transmitter, Level Switch, Motorized Valve, Water Quality Analyzer (Turbidity, pH, Chlorine), RTU based PLC-HMI, and UPS. Transmission System (Tapping point, Sump, MBR): Pressure Transmitter, Pressure Gauge, EM Flowmeter, Level Transmitter, Motorized Valve, RTU based PLC-HMI, and UPS.
Section II: Treated Water Transmission System, Distribution System, and House Service Connection	
Coverage	Corporation/Municipality: Dharmapuri Municipality. Town Panchayats: Pennagaram TP and Uthangarai TP. Rural Unions: Dharmapuri (Part), Nallampalli (Part), Mathur, Uthangarai, Pennagaram (Part), and Eriyur. Industries: Bulk Quantity provision for SIPCOT, Athagapadi, Dharmapuri and Bargur.
Transmission Pipeline	Transmission Main (TM): D100-D1400, L = 146.10 km, Feeder Main (FM): D63-D350, L = 37.20 km, Internal Transmission Main (ITM): D63-D400 L = 590.30 km, Internal Network (INW): D63-D150 L = 1,166.70 km
MBR, Sump (BPS) and OHT	MBR (10 m^3 - 390 m^3): 69 nos. SumpwithPumps: (5 m^3 - 1,235 m^3): 148 nos. BPT (5 m^3 - 85 m^3): 12 nos. Rechlorination: 15 locations, OHT (10 m^3 - 170 m^3): 468 nos.
Distribution	Distribution Pipeline: 87.70 km Installation of House Service Connection: 10,021 nos. Replacement of Existing Water Meters: 11,829 nos.
Section III: Treated Water Transmission System, Distribution System, and House Service Connection	
Coverage	Town Panchayats: Kadathur TP, B.Mallapuram TP, Kambainallur TP, Pappireddipatty TP, and Harur TP Rural Unions: Dharmapuri (Part), Kadathur, Morappur, Harur, Pappireddipatty, and Nallampalli Union (Part)
Transmission Pipeline	Transmission Main (TM): D100-D1016, L = 53.30 km, Feeder Main (FM): D63-D180, L = 47.10 km, Internal Transmission Main (ITM): D63-D350 L = 455.00 km, Internal Network (INW): D50-D150 L = 593.90 km
MBR, Sump (BPS) and OHT	MBR (10 m^3-10,250 m^3): 44 nos. Sump with Pumps: (5 m^3 - 2,080 m^3): 123 nos. BPT: (5 m^3-70 m^3): 4 nos. Rechlorination: 12 locations, OHT (10 m^3-360 m^3): 281 nos.
Distribution	Distribution Pipeline: 73.30 km Installation of House Service Connection: 5,504 nos. Replacement of Existing Water Meter: 1,345 nos.
Section IV: Treated Water Transmission System, Distribution System, House Service Connection	
Coverage	Corporation or Municipality: Hosur Corporation Town Panchayats: Denkanikottai TP and Kelamangalam TP Rural Unions: Veppanahalli, Shoolagiri, Hosur, Kelamangalam, Karimangalam (Part), and Thally Industries: Bulk Quantity provision for TIDCO, SIPCOT, and Hosur.

Transmission Pipeline	Transmission Main (TM): D150-D1219, L = 63.30 km, Feeder Main (FM): D63-D711, L = 58.10 km, Internal Transmission Main (ITM): D63-D500 L = 1,018.70 km, Internal Network (INW): D63-D160 L = 1,187.40 km
MBR, Sump (BPS) and OHT	MBR (10 m^3-2,280 m^3): 130 nos. Sump with Pumps: (5 m^3-395 m^3): 153 nos. BPT: (5 m^3-1,795 m^3) : 15 nos. Major BPS: (2,805 m^3-5,775 m^3) : 4 nos. Rechlorination: 10 locations, OHT (10 m^3-1,560 m^3): 522 nos.
Distribution	Distribution Pipeline: 456.0 km, Installation of House Service Connection: 58,173 nos. Replacement of Existing Water Meter: 40,392 nos.
Section V: Treated Water Transmission System, Distribution System, House Service Connection	
Coverage	Corporation or Municipality: Krishnagiri Municipality Town Panchayats: Papparapatty TP, Palacode TP, Karimangalam TP, Marandahalli TP, Kaveripattinam TP, Nagojanahalli TP, and Bargur TP Rural Unions: Pennagaram (Part), Palacode, Karimangalam (Part), Kaveripattinam, Krishnagiri, and Bargur
Transmission Pipeline	Transmission Main (TM): D100-D1626, L = 139.70 km, Feeder Main (FM): D63-D500, L = 72.30 km, Internal Transmission Main (ITM): D63-D350 L = 768.90 km, Internal Network (INW): D63-D150 L = 1,078.50 km
MBR, Sump (BPS) and OHT	MBR (10 m^3-7,590 m^3): 81 nos. Sump with Pumps: (5 m^3-2,055 m^3): 174 nos. BPT: (5 m^3-120 m^3): 1 no. Major BPS: (8,285 m^3): 1 no. Rechlorination: 20 locations, OHT (10 m^3-800 m^3): 629 nos.
Distribution	Distribution Pipeline: 201.20 km, Installation of House Service Connection: 15,875 nos. Replacement of Existing Water Meter: 18,179 nos.

Note: The above table reflects the 11 packages as mentioned in Section 7.2.1, when some part of Section III in the original DPR has been shifted to Section II.
Source: JST

Figure 6.1.1 illustrates the location of the main facilities such as the Intake, WTP, Main Water Transmission Pipeline, and Major Booster PS.



Source: JST

Figure 6.10.1 Location of Major Facilities of the Project

6.10.3 Consideration for Utilization of Japanese Technology

When applying Japanese technologies, it is necessary to examine them from the viewpoints of economic efficiency, including improved workability, operating costs, maintenance management, and energy conservation, and to obtain TWAD's approval. It should be noted that, since materials and equipment required for waterworks facilities are manufactured in India and are relatively inexpensive and easy to procure, the use of Japanese products will be limited. Nonetheless, technologies in which Japanese companies have advantages and the possibilities for utilization are shown in Table 6.10.3.

Table 6.10.3 Consideration for Utilization of Japanese Technologies

Item	Equipment /Technology	Advantage of Japanese Technology/Company	Possibility for Adoption
Pipes	PVC, HDPE, Fittings	Japanese-made joints offer high workability and safety, with a proven track record overseas. They contribute to faster installation and cost reduction.	Low; Existing material will be used.
Electrical Items	Top Runner System	The efficiency of motors, transformers, and other equipment is regulated by the Top Runner Method, which is also one of the standards of the Energy Conservation Law in Japan. Higher efficiency contributes to energy savings.	Low; Existing system will be used.
Horizontal Pump	High-efficiency Pump + High-voltage Inverter	Highly efficient large pumps combined with motor, with a high-voltage inverter, enable appropriate flow and pressure control through automatic operation, thereby contributing to energy conservation. Intake pumps and water supply pumps are assumed.	Japanese products may be utilized.

Item	Equipment /Technology	Advantage of Japanese Technology/Company	Possibility for Adoption
Surge Countermeasures	Flywheel System	A pump with a flywheel as a measure against surge (water hammer) is a technology unique to Japanese manufacturers. It saves space compared to surge tanks. There are many opportunities to adopt this technology in this project where there are large differences in elevation.	Low; Existing system will be used.
Monitoring Control	Instruments	Although not exclusively Japanese technology, the product has been developed worldwide as a comprehensive brand of flowmeters and other measuring instruments. The product has an established reputation for accuracy and durability.	Japanese products may be utilized.
	SCADA	SCADA systems, including PLCs, are world-class in terms of track record and reliability. The product also has a strong track record in water distribution management, including leakage management, using SCADA, both in Japan and overseas.	Japanese products may be utilized.

Source: JST

As a result of discussions with TWAD, it was agreed to change the type of the water transmission pumps at the WTP from the vertical-shaft turbine pumps proposed in DPR to horizontal double-suction pumps, which offer superior pump efficiency and maintenance management, and in which Japanese companies have a competitive advantage.

Regarding the pump starters, it was agreed to install inverters for the pumps at the Intake Pump Station to control a constant flow rate, and for the pumps at the Treated Water Transmission Pump Station at the WTP to achieve energy savings corresponding to the initial flow rate. Details are described in Section 6.6 Pumping Equipment and Section 6.8.3 Introduction of VFD.

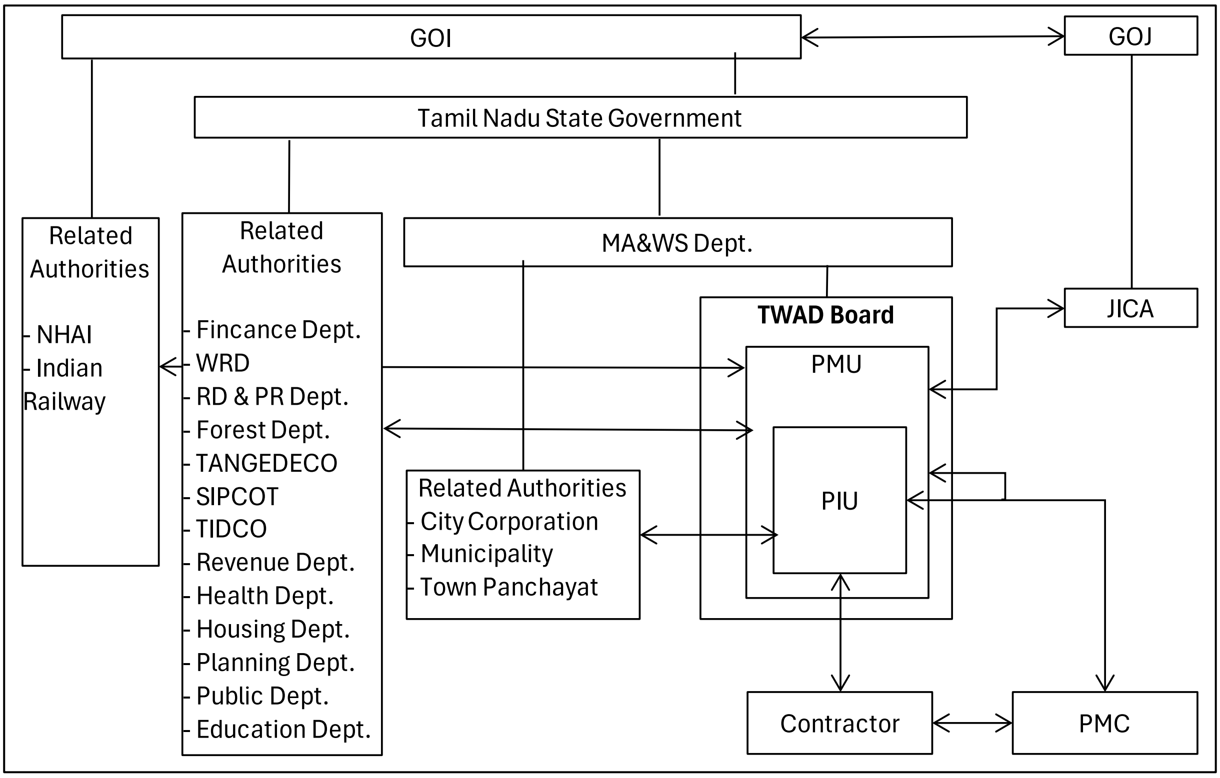
In order for Japanese products to be actually adopted, it is necessary to include the specification settings, actual performance, and the estimations of energy conservation effects and life cycle costs as evaluation items in the technical evaluation during bidding. In addition, since there are Japanese engineering manufacturers of plants and SCADA systems in India, as well as Japanese companies that undertake maintenance and management, establishing technical conditions that encourage these companies to participate in bidding would also be effective for the utilization of Japanese technology.

Chapter 7 Project Implementation Plan

7.1 Project Implementation System

7.1.1 Overall Framework

Figure 7.1.1 illustrates the overall implementation framework of the Project.



Source: JST

Figure 7.1.1 Overall Implementation Framework of the Project

The Tamil Nadu Water Supply and Drainage Board (TWAD) Board, executing agency of the Project, will establish the Project Management Unit (PMU) and Project Implementation Unit (PIU). The PMU will manage the project implementation and maintain liaison with the Japan International Cooperation Agency (JICA). TWAD will appoint a PMC to assist the PMU and PIU in the implementation of the Project.

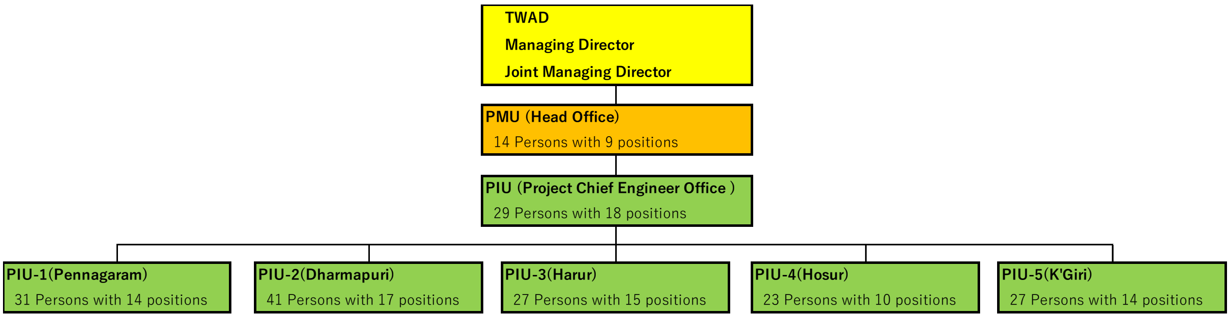
7.1.2 Project Implementation System of TWAD

For the Previous Hogenakkal Project, the TWAD Board, as the executing agency of the Project, established a PMU at the Head Office to ensure streamlined project implementation and to maintain liaison with JICA. The PIU was established under this PMU at the Project Chief Engineer Office in Dharmapuri. The construction at field-level was managed by five PIUs headed by five Executive Engineers at Pennagaram, Dharmapuri, Harur, Hosur, and Krishnagiri, under PIU (Project Chief Engineer Office Dharmapuri).

At the peak of the project, the PMU (Head Office) will comprise 14 staff with nine positions. The PIU (Project Chief Engineer Office Dharmapuri) will consist of 29 staff with 18 positions. The Fluoride Task

Force Cell (FTF) will comprise four staff with three positions. The five PIUs established in the aforementioned areas had a combined total of 149 staff with 23 positions.

Figure 7.1.2 shows the organization and staffing structure of the PMU and PIU for the Previous Hogenakkal Project.



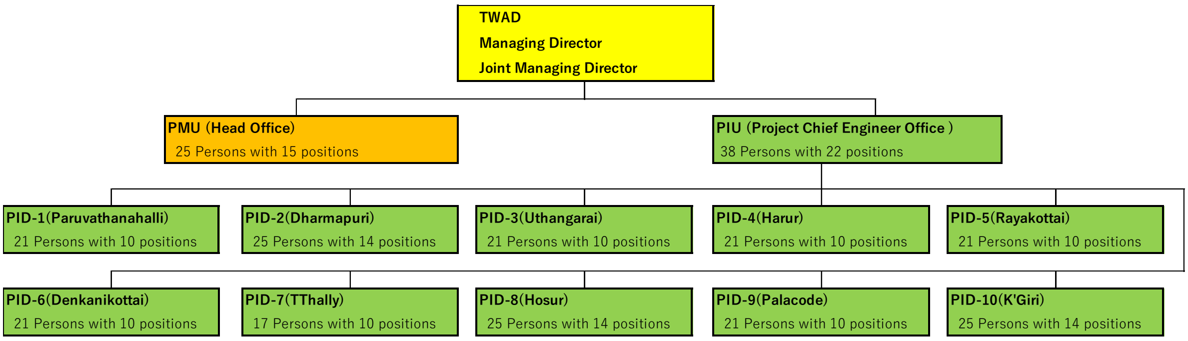
Source: JST based on the information from TWAD

Figure 7.1.2 Organization and Staffing of PMU and PIU for the Previous Hogenakkal Project

For the Project, TWAD, as the executing agency, is considering the formation of a new and strengthened organization structure, drawing on the experience of the Previous Hogenakkal Project. A PMU (Head Office) and a PIU (Project Chief Engineer Office Dharmapuri) will be established directly under the Managing Director and Joint Managing Director of TWAD. Field-level construction activities will be managed by ten Project Implementation Divisions (PIDs) operating under the PIU.

Figure 7.1.3 outlines the proposed organization and staffing structure of the PMU, PIU, and PID for the Project. The PMU (Head Office) will consist of 25 people in 15 positions. The PIU (Project Chief Engineer Office Dharmapuri) will consist of 38 people in 22 positions. In addition, taking into consideration the regional characteristics of the construction sites and the construction packages, the construction at field-level will be managed by ten PIDs headed by ten Executive Engineers at Paruvathanahalli, Dharmapuri, Uthangarai, Harur, Rayakottai, Denkanikottai, Thally, Hosur, Palacode, and Krishnagiri, consisting of 14 positions and a total of 218 staff.

For the Project, TWAD plans to enhance direct project involvement in the PMU and PIU by appointing two directors, establishing PIDs based on the number of construction packages, and increasing the number of staff assigned.



Source: JST based on the information from TWAD

Figure 7.1.3 Organization and Staffing Structure of the PMU, PIU, and PID for the Project

Table 7.1.1 presents the roles of PMU, PIU, and PID for the implementation of the Project.

Table 7.1.1 Roles of Each TWAD Organization in the Project Implementation

	PMU	PIU	PID
(1) Reporting to JICA	✓		
(2) Consultation with Relevant Organizations and Obtaining Permits	✓	✓	
(3) Selection of Consultant and Contractor	✓	✓	
(4) Supervision of Project (Design, Construction, and Commissioning) and Financial Management	✓	✓	✓
(5) Land Acquisition and Environment Monitoring		✓	✓
(6) Public Relations and Awareness Activities,		✓	✓

Source: JST

The positions and number of staff of PMU, PIU, and PID are presented in Table 7.1.2.

Table 7.1.2 Number of Staff for PMU, PIU, and PID for the Project

Sl. No.	Name of Position	PMU	PIU												Grand Total
			PIU	PID-1	PID-2	PID-3	PID-4	PID-5	PID-6	PID-7	PID-8	PID-9	PID-10	PIU-Total	
1	Project Director	**1**												**0**	**1**
2	Chief Engineer	**0**	1											**1**	**1**
3	Supt. Engr/JCE	**1**	2											**2**	**3**
4	Exec. Engr./DSE/DCE	**1**	2	1	1	1	1	1	1	1	1	1	1	**12**	**13**
5	Asst. Exec. Engr.	**3**	3	3	3	3	3	3	3	2	3	3	3	**32**	**35**
6	Asst. Engr./Junior Engr.	**6**	5	9	9	9	9	9	9	6	9	9	9	**92**	**98**
7	Chief Head Drafting Officer		1											**1**	**1**
8	Spl. Gr. Drafting Officer	**1**	1											**1**	**2**
9	Sr. Drafting Officer		1											**1**	**1**
10	Drafting Officer	**1**	1	1	1	1	1	1	1	1	1	1	1	**11**	**12**
11	Junior Drafting Officer	**1**	1	1	1	1	1	1	1	1	1	1	1	**11**	**12**
12	Administrative Officer		1											**1**	**1**
13	Accounts Officer		1											**1**	**1**
14	Asst. Accounts Officer	**1**	2		1						1		1	**5**	**6**
15	Superintendent		1		1						1		1	**4**	**4**
16	Assistant		3	1	1	1	1	1	1	1	1	1	1	**13**	**13**
17	Junior Assistant	**1**	2		1						1		1	**5**	**6**
18	Steno Typist	**1**	1											**1**	**2**
19	Typist/Data Entry Operator	**3**	1	2	2	2	2	2	2	2	2	2	2	**21**	**24**
20	Record Clerk	**1**	1		1						1		1	**4**	**5**
21	Office Assistant	**2**	3	1	1	1	1	1	1	1	1	1	1	**13**	**15**
22	Watchman		1	1	1	1	1	1	1	1	1	1	1	**11**	**11**
23	Driver	**1**	3	1	1	1	1	1	1	1	1	1	1	**13**	**14**
	Total	**25**	**38**	**21**	**25**	**21**	**21**	**21**	**21**	**17**	**25**	**21**	**25**	**256**	**281**

Source: Information from TWAD

7.1.3 Monitoring/Coordination Committee by the State Government

For seamless and proper implementation of the Project, the State Government will establish the Monitoring Committee and Coordination Committee for the Project, as outlined in Table 7.1.3.

Table 7.1.3 Monitoring and Coordination Committee for the Project

Name	**District-wise Monitoring Committee**
Purpose	1) Overall project monitoring. 2) Coordination among relevant local-level organizations on pending issues.
Members	· District Collectors of Dharmapuri and Krishnagiri · Project Director of the Project · Chief Engineer/Superintending Engineer of the TWAD Board · District Revenue Officer (related to land acquisition) · Deputy Director of Medical and Rural Health Services under the Directorate of Medical and Rural Health Services (DMRHS) · Chief Educational Officer, Tamil Nadu Education Department · Superintending Engineer, Electricity Board · District Forest Officer · District Environmental Engineer, Pollution Control Board · Project Director, District Rural Development Agency (DRDA) · Assistant Director, Panchayat · Assistant Director, Town Panchayat · Municipal/Corporation Commissioner · Divisional Engineer of Highway · Divisional Engineer of National Highway · Project Director, National Highways Authority of India · Project Officer, SIPCOT · Executive Engineer, Public Works Department · Executive Engineer, Water Resources Department · Deputy General Manager, Gas Authority of India Ltd. · Deputy General Manager, Hindustan Petroleum Corporation Ltd. · Deputy General Manager, Bharat Petroleum Corporation Ltd. · Divisional Railway Manager · Divisional Engineer, Bharat Sanchar Nigam Ltd. · Assistant Commissioner, Hindu Religious & Charitable Endowment
Frequency	Once a month or as necessary.
Name	**Component-wise Coordination Committee**
Purpose	1) Monitoring overall project component, including physical and financial progress of each package. 2) Review of performance of the contractors.
Member	· Managing Director, TWAD Board (Chairman) · Commissioner for Land Administration, Department of Revenue and Disaster Management · Managing Director, TANGEDCO · Director of Municipal Administration · Director of Town Panchayats · Director of Rural Development and Panchayat Raj · Director General, Highways Department · Director, Directorate of Medical and Rural Health Services (DMRHS) · Project Director and Joint Managing Director, TWAD Board · Director, Tamil Nadu School Education Department · Principal Chief Conservator of Forests, Chennai · Member Secretary, Tamil Nadu Pollution Control Board · Joint Commissioner, Hindu Religious and Charitable Endowments Department · Regional Officer, NHAI, Chennai · Chief Engineer (Tamil Nadu i/c), Ministry of Road Transport and Highways, Engineer-in-Chief, Water Resources Department · Engineer-in-Chief, Public Works Department · Managing Director, State Industries Promotion Corporation of TN · General Manager, Railways · Chief Engineer/Superintending Engineer of TWAD Board
Frequency	Once a month or as necessary.

Name	State-Level Executive Committee
Purpose	1) Overall project monitoring. 2) Decision-making on policy matters. 3) Coordination among relevant organisations on pending issues that cannot be addressed at district-level forums.
Member	· Chief Secretary (Chairman) · Secretary, Municipal Administration and Water Supply · Secretary, Highways and Minor Ports · Secretary, Health and Family Welfare Department · Secretary, School Education Department · Secretary, Environment, Forest, and Climate Change · Secretary, Rural Development Department · Secretary, Hindu Religious and Charitable Endowments Department · Secretary, Public Works Department · Secretary, Water Resources Department · Secretary, Revenue and Disaster Management · Secretary, Industries Department · Managing Director of TWAD Board · District Collectors of Dharmapuri and Krishnagiri · Project Director for the Project as Member Secretary
Frequency	Once every three months or as necessary.

Source: TWAD

7.2 Procurement Plan

7.2.1 Contract Packaging

7.2.2 Contract Type

7.2.3 Consideration of Staged Development

(1) Prioritized Distribution Area

It was envisaged by JST that, in the first stage of the Project, construction of the distribution facility will be limited to the prioritized area (Hosur City Corporation, municipalities, several town panchayats, and rural unions), while all main facilities (intake facility, raw water transmission facility, WTP, and treated water transmission main) will be constructed during this stage. The JST inquired the feasibility of this approach with TWAD. TWAD responded that it was not possible because the contents of the Project have been already approved by the State Government following the appraisal by the Central Public Health & Environmental Engineering Organization (CPHEEO). Thus, it was concluded that the prioritization of the distribution area will not be implemented.

(2) Number of Mechanical and Electrical Equipment

The water demand in the intermediate year is approximately 80% of the ultimate year. Therefore, it was proposed that the number of facilities to be installed under the Project shall be reduced, as listed below:

- Pump Number: 8W + 4S => 7W + 3S in Table 6.3.7; 4W + 2S => 4W + 1S in Table 6.3.8
- Clari-flocculator (including ancillary civil structure) in WTP: 8W + 2S => 7W + 2S
- Rapid Sand Filter (including ancillary civil structure) in WTP: 28W + 3S => 23W + 3S

As a result, the WTP capacity to be developed under the Project will be approximately 250 MLD (calculated as 305 MLD x (23 units/28 units) = 250 MLD) out of the total planned capacity of 305 MLD.

- Reduction in electrical control equipment associated with the above adjustments.

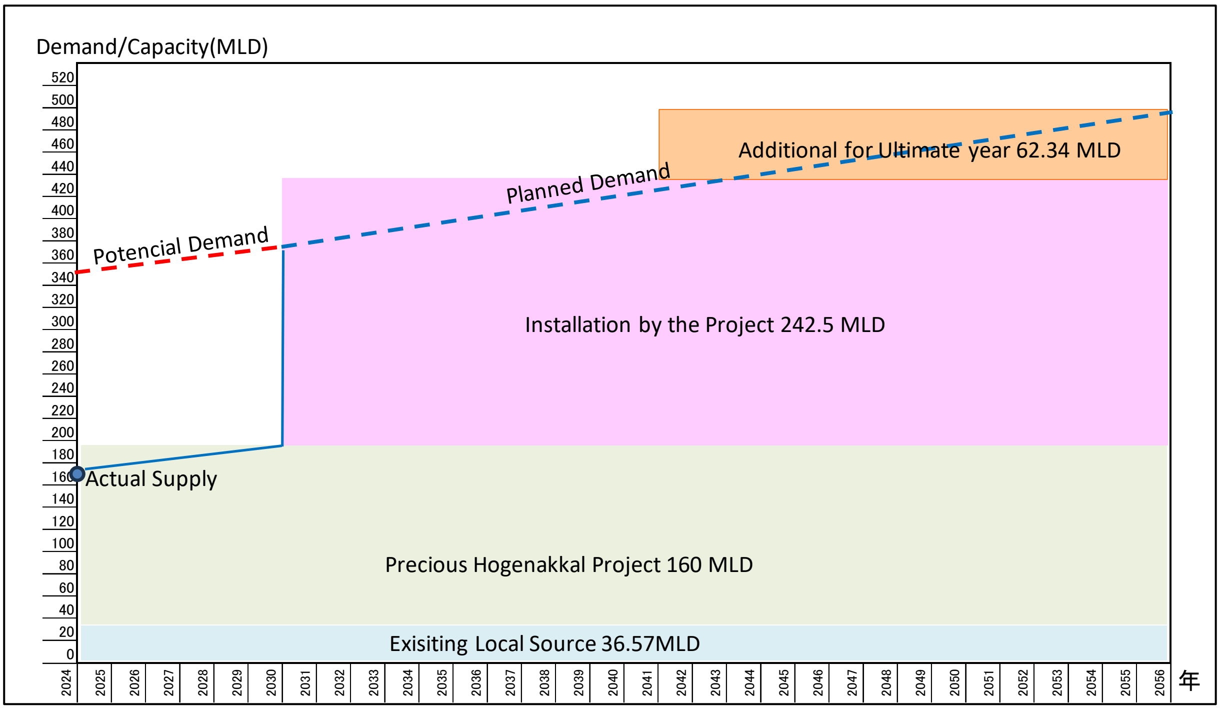
These reductions have no impact on operations until the intermediate year (i.e., machine renewal period) and it will improve the financial viability of the Project through initial cost reductions. Thus, the cost estimate has been prepared based on the above adjustments, with TWAD's approval.

Table 7.2.6 and Figure 7.2.2 show the changes in overall water demand and total facility capacity within the Project area.

Table 7.2.6 Change in Overall Water Demand and Overall Capacity

Item		2024 (Actual Supply)	2024 (Potencial Demand)	2030 (Planned Demand)	2041 (Planned Demand)	2056 (Planned Demand)
Total Water Demand (MLD)	Hosur City Corporation	27.63	41.62	50.86	67.80	90.90
	Krushnagiri Municipality	9.77	11.94	14.29	18.61	24.50
	Dharmapuri Municipality	7.20	11.00	11.44	12.25	13.34
	Other panchayats	125.29	225.25	237.42	259.74	290.18
	Total (incl, Industry)	169.89	352.34	377.28	423.00	485.34
Total Capacity (MLD)	Existing local source	36.57				
	Previous Hogenakkal Pjt.	160.00				
	The Project			242.50		
	Additional for Ultimate year					62.34
	Total	196.57		439.07		501.41

Source: JST



Source: JST

Figure 7.2.2 Change in Overall Water Demand and Overall Capacity

7.3 Permissions

Prior to the start of construction work, the necessary permissions from related authorities need to be obtained. Table 7.3.1 outlines these required permissions, the responsible authorities in charge, and the estimated timeframes for obtaining these permissions.

Table 7.3.1 Permissions for Construction Work

Permission	Approved and Authorized by	Period for Getting Approval
1. Forest Clearance	PCCF, and Chennai	1 year
2. Road Occupancy and Crossing (National Highway)	Regional Office, NHAI, and Chennai	6 months
3. Road Occupancy/Crossing (State Highway)	Divisional Engineer, Dharmapuri and Krishnagiri	2 months
4. Railways	Divisional Railway Manager, Bangalore and Divisional Railway Manager, and Salem	1 year
5. Water Intake Permission	WRD	Already Obtained
6. Land Acquisition of Government Land	District Collector of Revenue Department	6 months
7. Power Receiving	Superintending Engineer, Dharmapuri and Superintending Engineer, Krishnagiri of TANGEDECO	2 months

Note: PCCF: Principal Chief Conservator of Forest, NHAI: National Highway Authority of India, WRD: Water Resources Department.
Source: TWAD

Among these, the procedure for “6. Land Acquisition of Government Land” is currently in progress and expected to be completed prior to the construction contract. Regarding Items 1 2, 3, 4, and 7, the procedures will be carried out after the facility design has been completed. The PMU is required to complete these procedures in a timely manner to ensure smooth implementation of the Project.

7.4 Tax

Value Added Tax (VAT) will be imposed on both the consultant and construction contracts under the Project. Materials and equipment procured from overseas are subject to customs duties. In addition, consultants and contractors are liable for corporate income tax, and their salaries are subject to personal income tax.

7.5 Implementation Schedule

Chapter 8 Project Cost Estimates

Chapter 9 Operation and Maintenance Plan

9.1 Operation and Maintenance of Intake, Raw Water Conveyance, WTP, and Treated Water Transmission Facility

Similar to the Previous Hogenakkal Project, the bulk supply—coming from the intake facility through the water treatment plant then to the overhead tanks (OHTs) in each distribution area—will be conducted by the O&M contractor under a contract with the TWAD. The tasks of the O&M contractor include:

1) Operation of the facility
2) Inspection and maintenance of the facility
3) Control of the water quality to be supplied to the customers
4) Procurement management
5) Document management
6) Emergency support

The O&M contractor is obligated to properly operate and maintain the facility while ensuring that the prescribed amount of water is delivered to each OHT as directed by TWAD. Payments from TWAD to the O&M contractors are made based on the following documents:

- Daily water delivery record approved by each local body's official
- Actual facility maintenance and repair records

Payments will be made based on the above documents and the unit price agreed upon in advance. In addition, penalties will be imposed for the following cases:

- Water leakage from a water tank due to operational errors
- Failure to carry out specified periodic repairs
- Failure to detect residual chlorine at the inlet of each OHT

9.2 Operation and Maintenance of Water Distribution Facility

O&M of water distribution facilities from OHTs to each house service connection in the water distribution area will be carried out by the respective local body. O&M will be conducted under the same system as the Previous Hogenakkal Project. The O&M situation of each local body is described hereunder.

9.2.1 Operation and Maintenance by the City Corporation/Municipality

(1) Hosur City Corporation

1) Organization

The O&M of the water supply facilities is conducted by the staff listed in Table 9.2.1.

Table 9.2.1 Staffing for O&M of Water Supply Facilities in Hosur City Corporation

Type	Number
Staff of Engineering Section Executive Engineer Assistant Executive Engineer Assistant Engineer/Junior Engineer Tap Inspector Electrician	11
Operator/Worker Employed by City Corporation	46
Operator/Worker Employed by NGO	72

Source: TWAD

2) Operation and Maintenance Situation

The present O&M situation and maintenance record in 2024 is presented in Table 9.2.2.

Table 9.2.2 2024 O&M Situation and Maintenance Record in Hosur City Corporation

Item	Outline
Water Supply Volume	From Existing Local Source: 14.63 MLD From Previous Hogenakkal Project: 13.00 MLD
Distribution Facility	Main OHT: 14 nos. Branch OHT: Approx. 80 nos. Distribution pipeline: 525 km
Service Facility	Service Connection (Domestic): 38,000 nos. Service Connection (Commercial): 199 nos. Public Tap: 161 nos.
Maintenance Record （2024）	Installation of New House Service Connection: 920 nos. Repair of Distribution Pipeline: 3,200 nos. Repair of House Service Connection: 245 nos.

Source: Hosur City Corporation, TWAD

The distribution area is divided into different distribution zones, each having one OHT. An earmarked volume of water is transmitted daily to the main OHT by TWAD's O&M contractor. The water distribution pipelines and facilities connected to the main OHT are operated and managed by the Engineering Section, while operators are employed in each zone to open and close the valves at set times each day. To avoid water distribution issues caused by supplying water to the entire zone simultaneously, each zone is further divided into subzones. Water is then supplied to each subzone by opening and closing the corresponding valves. In practice, while water is transmitted to each zone every day distribution to each subzone occurs once every other day for one to two hours at a time.

The primary cause of water distribution failure is the flow rate in the distribution pipeline exceeds the design flow rate. Specifically, when distributing water, every household opens their taps at the same time to store enough water for two days. Because this exceeds the design flow rate of the distribution pipeline, water cannot be distributed uniformly throughout the zone.

3) Water Tariff Collection and TWAD Bulk Charge Payment

Each house service connection is registered in a customer ledger. The residents pay the water tariff at a flat-rate and it can be paid in cash at the City Corporation's office or through a web portal. While bulk charges paid by the City Corporation to the TWAD are based on billed amounts and are paid via online bank transfer by the Accounts Section.

(2) Krishnagiri Municipality

1) Organization

The O&M of the water supply facility is conducted by the staff as listed in Table 9.2.3.

Table 9.2.3 Staffing of the Water Supply Facility O&M in Krishnagiri Municipality

Type	Number
Staff of Engineering Section Executive Engineer (Nonexclusive) Assistant Executive Engineer Assistant Engineer Tap Inspector	4 (Nonexclusive 1)
Operator/Worker Employed by Municipality	12

Source: TWAD

2) O&M Situation

The present O&M situation and maintenance record in 2024 is presented in Table 9.2.4.

Table 9.2.4 O&M Situation and Maintenance Record in 2024 in Krishnagiri Municipality

Item	Outline
Water Supply Volume	From Existing Local Source: 6.02 MLD From Previous Hogenakkal Project: 2.70 MLD
Distribution Facility	OHT: 6 nos. Distribution pipeline: 53 km
Service Facility	Service Connection (Domestic): 10,057 nos. Public Tap: 64 nos.
Maintenance Record (2024)	Installation of New House Service Connection: 126 nos. Repair of Distribution Pipeline: 350 nos. Repair of House Service Connection: 70 nos.

Source: Krishnagiri Municipality, TWAD

The distribution area is divided into different distribution zones, each having one OHT. A designated volume of water is transmitted daily to the main OHT by TWAD's O&M contractor. The water distribution pipelines and facilities connected to the main OHT are operated and managed by the Engineering Section, while operators employed in each zone open and close the valves at set times daily. To avoid water distribution issues caused by supplying water to the entire zone simultaneously, each zone is further divided into subzones. Water is then supplied to each subzone by opening and closing the corresponding valves. In practice, while water is transmitted to each zone daily, distribution to each subzone occurs once every other day for one to two hours at a time. The primary cause of poor water distribution is the same as in the city of Hosur.

3) Collection of Water Tariff from Residents and Payment of Bulk Charge to TWAD

Each house service connection is registered in the customer ledger. The residents pay the water tariff at a flat-rate and it can be paid in cash at the Municipality's office or through a web portal. While bulk charges paid by the Municipality to the TWAD are based on billed amounts and are paid via online bank transfer by the General Section of the Municipality.

(3) Dharmapuri Municipality

1) Organization

The O&M of the water supply facility is conducted by the staff as listed in Table 9.2.5.

Table 9.2.5 Staffing of the Water Supply Facility O&M in Dharmapuri Municipality

Type	Number
Staff of Engineering Section Executive Engineer (Nonexclusive) Assistant Engineer/Junior Engineer Tap Inspector Electrician	15 (Nonexclusive: 2)
Operator/Worker Employed by Municipality	13

Source: TWAD

2) O&M Situation

The 2024 O&M situation and maintenance record is presented in Table 9.2.6.

Table 9.2.6 O&M Situation and Maintenance Record in 2024 in Dharmapuri Municipality

Item	Outline
Water Supply Volume	From Existing Local Source: 1.75 MLD From Previous Hogenakkal Project: 6.50 MLD
Distribution Facility	OHT: 6 nos. Distribution Pipeline: 77 km
Service Facility	Service connection (Domestic): 11,829 nos. Service connection (Commercial): 631 nos. Public tap: 168 nos.
Maintenance Record (2024)	Installation of New House Service Connection: 119 nos. Demolition of House Service Connection: 18 nos. Repair of Distribution Pipeline: 73 nos. Repair of House Service Connection: 10 nos.

Source: Krishnagiri Municipality, TWAD

The distribution area is divided into distribution zones, each having one OHT. A designated volume of water is transmitted daily to the main OHT by TWAD's O&M contractor. The water distribution pipelines and facilities connected to the main OHT are operated and managed by the Engineering Section, while operators are employed by each zone open and close the valves at set times daily. To avoid water distribution issues caused by supplying water to the entire zone simultaneously, each zone is further divided into subzones. Water is then supplied to each subzone by opening and closing the corresponding valves. In practice, while water is transmitted to each zone daily, distribution to each subzone occurs once every other day for one to two hours at a time. The main cause of water distribution failure is the same as in the city of Hosur.

3) Collection of Water Tariff from Residents and Payment of Bulk Charge to TWAD

Each house service connection is registered in the customer ledger. The residents pay the water tariff at a flat rate, and it can be paid in cash at the Municipality's office or through a web portal. While bulk charges paid by the Municipality to the TWAD are based on billed amounts and are paid via online bank transfer by the General Section of the Municipality.

9.2.2 Operation and Maintenance by Town Panchayats

(1) Outline of the Water Supply Facilities in Town Panchayat

The TP is an organization under the management of each district's Town Panchayat Department (Director of Town Panchayat) of each district, which is a branch organization of the Municipalities and Water Supply Department of the State Government. There are ten TPs in Dharmapuri District and six TPs in Krishnagiri District, with population sizes ranging from 10,000 to 26,000. There are one to five OHTs in each TP, with each OHT is assigned to one distribution zone. The distribution pipeline in each TP ranges from 10 km to 30 km, servicing approximately 100 to 3,000 house connections, with house service connection rates ranging from 3% to 60%.

(2) Distribution Situation

A designated volume of water is transmitted daily by TWAD's O&M contractor to each OHT. Valve operations for each distribution zone are outsourced to an NGO and are managed by the engineering staff of the Districts' Town Panchayat Department. Specifically, the NGO employs valve operators who are responsible for conducting the valve operations.

Since simultaneous distribution of water to the entire zone may cause water distribution problems, each zone is further divided into subzones. Water is then distributed to each subzone by opening and closing the corresponding valves. In practice, while water is transmitted to each zone daily, distribution to each subzone occurs once every other day for one to two hours at a time. The primary causes of water distribution failures are the same as those in the city of Hosur.

(3) Water Tariff Collection from Residents and Bulk Charge Payment to the TWAD

Each house service connection is registered in the customer ledger. The residents pay the water tariff at a flat-rate and it can be paid in cash at the town panchayat's office or through a web portal. While bulk charges paid by the Town Panchayat to TWAD are based on amounts billed by TWAD and are paid via online bank transfer by the accounting staff of the Town Panchayat.

9.2.3 Operation and Maintenance by Village Panchayats

(1) Outline of the Water Supply Facilities in Village Panchayat

A village panchayat is the smallest administrative unit in rural areas under the jurisdiction of the RD&PR Department, which functions as a state-level branch of the Rural Development and Panchayat Raj Department of the state government. There are 247 village panchayats in Dharmapuri District and 338 village panchayats in Krishnagiri District, with an average population of approximately 5,300 per village panchayat. Each of the two districts also comprises 10 panchayat unions (blocks), with each union consisting of 10 to 30 village panchayats. However, administrative functions are primarily carried out at the village panchayat level.

Each village panchayats governs an average of 11 habitations, with each habitation having a population of approximately 400 to 500 (around 100 households). Accordingly, one OHT with a capacity of 10 to 15 m^3— calculated as [(450 persons x 55 l/c/d) / 2≒ 12 m^3]—is to be installed for every habitation. Each distribution zone typically includes 1 to 2 km of distribution pipeline and 60 to 70 house service connections, with connection rates ranging from 3% to 60%.

(2) Water Distribution Situation

Each village panchayat has a panchayat MBR, which receives a designated volume of water as distributed by TWAD's O&M contractor. A specified amount of water is then transferred daily from the Panchayat MBR to the OHT in each village, which is also managed by TWAD’s O&M contractor. The distribution of water from the OHT to the individual household service connection is managed by the respective village panchayat.

The valve operation after the OHT is conducted by local residents employed under each village panchayat, under the supervision of the Engineering Officer of the Rural Development and Panchayat Raj Department of the district. The valves are opened and closed at fixed times every day.

Since distributing water to an entire zone simultaneously may cause water distribution problems, each zone is further divided into subzones. Water is distributed to each subzone by opening and closing the respective valves. In practice, water is transmitted to each zone daily, but water is distributed to each subzone every other day for one to two hours at a time. The main cause of the water distribution failure is that, in addition to the above-mentioned factors for each city and town, villages manage the flow rate to each OHT based on the water level in the tanks. Consequently, water cannot be distributed when pumping water into the OHT.

In several village panchayats, a Village Water and Sanitation Committee (VWSC) is organized under the village panchayat in accordance with the guidelines. The VWSC is responsible for the management of the facilities within the village panchayat, while the JJM guidelines prescribe the following as the main roles of the VWSC:

- Receiving and processing applications for house service connections.
- Operating and maintaining the village’s water distribution facilities.
- Establishing and managing an accounting system for facility operations, including the collection of operation and maintenance fees from residents.
- Conducting awareness activities for residents on the proper use of water supply facilities, and receiving and handling complaints.

(3) Collection of Water Tariff from Residents and Payment of Bulk Charge to the TWAD

Each house service connection is registered in the customer ledger. Residents pay the water tariff at a flat-rate in the village panchayat's office. In the village panchayat where the VWSC is organized, the VWSC collects the tariff from residents and pays them to the village panchayat.

The bulk charge paid by the village panchayat to the TWAD will be paid by each panchayat through the Tamil Nadu Simplified Panchayat Accounting System (TN Pass) website operated by the Tamil Nadu State Government. Funds are allocated to each panchayat's TN Pass account by the Rural Development and Panchayat Raj Department of the State Government. The amount billed by TWAD to each panchayat is reflected in the TN Pass and the payment is executed online.

9.3 Current Operation and Maintenance Issues

9.3.1 Current Issues in the Financial Aspect

9.3.2 Current Issue on Technical Aspects

(1) Issue in the O&M System of Water Distribution Facilities by the Local Bodies

The Project will increase the volume of water delivered to each local body. With the goal of achieving a 100% house service connection rate, the water distribution pipeline network and house service connection work will be carried out.

Currently, the Engineering Section is both in charge of operation and maintenance of water distribution facilities from the OHT and serves as an organization that handles road drainage and streetlight maintenance. It does not have a dedicated system for the operation and maintenance of the water distribution facilities and house service connections to be developed under the Project. In particular, it is essential for the City Corporation/Municipality to establish an organization specifically responsible for water supply management. This will increase the number of house service connections and improve tariff revenue, ensuring the sustainable growth of house service connections even after the implementation of the Project.

(2) Issues of Continuous Water Supply

Currently, water distribution in both the urban and rural area is being undertaken once every other day for one to two hours. The objective of the Project includes, achieving continuous water supply systems for all the urban areas, as mentioned in the CPHEEO Technical Appraisal Report. The Manual on Water Supply and Treatment System revised by CPHEEO in 2023 includes the vision of a gradual shift to a 24-hour water supply by 2047. To achieve this, in addition to developing the water supply facilities—such as the intake, WTP, water transmission and distribution facilities—it is necessary to introduce the metered water tariff system. That is, instead of water always being available for customers, the water must be metered, and customers must pay the tariff based on the metered water volume. The manual also raises the introduction of a metered tariff system as one of the requirements for an adequate water supply system.

Although the TWAD primarily functions as a bulk water supply entity and is not directly responsible for water distribution, the DPR was prepared for appraisal by CPHEEO, which adheres to the above-mentioned policy. In the process of CPHEEO's appraisal of the DPR, CPHEEO commented that the water meters to be installed in the Project should be ultrasonic AMR meters.

Moreover, awareness and understanding of a continuous water supply within the TWAD remains limited, and sufficient discussions have not been held between TWAD and local governments. Therefore, as part of the Project's soft component, pilot areas of about 100 households each will be set up in three cities and municipalities to test 24-hour water supply and volumetric tariff systems, aiming to establish a basis for achieving continuous water supply in urban and rural areas in the future.

To realise a continuous water supply, coordinated effort is necessary from both the supplier and the consumers. On the supplier's side, it is essential to secure a sufficient and stable water supply and to keep the distribution valves open at all times. On the consumers' side, behavioural adjustments are needed—especially only using water as required rather than opening the valves simultaneously to store water for the whole day, with the latter requiring building confidence in the water supply system among consumers.

(3) Hygiene Education

The number of fluorosis cases increased in 2015 to 2016, 2020, and 2023, but decreased after the relevant years. In 2024, the rate significantly decreased to 14.2 %, compared with that in 2010. There are 592 patients in Dharmapuri District and 649 patients in Krishnagiri District, as of 2024. Dental fluorosis happens when a child consistently ingests too much fluoride while their permanent teeth are still forming under their gums. This includes drinking heavily fluoridated water or formula or swallowing large amounts of fluoride toothpaste. Additionally, skeletal and non-skeletal fluorosis happens when a person ingests large amounts of fluoride over the course of several years. This includes drinking heavily fluoridated water, or brewed beverages made from heavily fluoridated water.[67]

In addition, the majority of the water-related diseases in the target areas is that of acute diarrhea disease (ADD), accounting for 75 % in Dharmapuri and 84 % in Krishnagiri in 2024. The causes of ADD include pathogens such as viruses, bacteria and parasites, as well as food poisoning, medication side effects and other factors.[68] All schools that cooperated in social condition surveys are equipped with handwashing facilities, but 21 % of them did not have soaps available at the facilities.

The school approach, hospital approach, and community approach, as mentioned in Section 3.4.1, in the Previous Hogenakkal Project, were successful based from the aforementioned results. However, these were conducted 13 to 14 years ago. Therefore, certain measures can be implemented under the Project to reduce the number of patients.

In addition to the above, joint research on fluorosis between the following Japanese universities and local medical universities is proposed. The following are the candidates for Japanese universities:

- National Institute of Public Health (website: https://www.niph.go.jp/soshiki/suido/suidotop.html)
- Laboratory of Water Environment Studies, Azabu University (website: https://lab-navi.azabu-u.ac.jp/le-02/)
- Osaka Medical and Pharmaceutical University (website: https://www.ompu.ac.jp/education/g_pharm/index.html)

9.4 Need for Technical Assistance

9.4.1 Issues and Needs for Urban Municipal Water Supply Operations

The issues and support needs for urban municipal water supply operations are shown below. It is proposed that support be provided first to Hosur, Krishnagiri, and Dharmapuri. After obtaining the understanding of the Tamil Nadu government regarding the results and lessons learned, support may be extended to the town municipalities (town panchayat).

Table 9.4.1 Issues and Need for support in Implementing Water Supply Projects

	Issues	Need for support
1. Water Supply Business Management		
(1)	Water supply operations are part of the responsibilities of the Engineering Section, which also handles road and drainage maintenance. As there is no organization solely dedicated to water supply, it is difficult to improve organizational and employee capabilities.	To improve management capabilities in the water supply sector, a department dedicated to water supply should be established within the Engineering Section. Alternatively, a section dedicated to water supply should be set up, and support for this should be provided.
(2)	As water supply is managed by the general accounting of local governments, it is difficult to grasp the financial situation of water supply	Support is needed to establish an accounting system for the clarification of the expenditure status of water-related expenses, as well as for measures to improve

[67] Cleveland Clinic (Fluorosis: Symptoms, Causes & Treatment accessed on February 19, 2025)
[68] Cleveland Clinic (Diarrhea: Causes, Symptoms & Treatment accessed on February 19, 2025)

	Issues	Need for support
	operations. Furthermore, there is no incentive to improve financial conditions or increase fee collection rates.	fee collection rates. The establishment of a special water supply account should also be considered and recommendations made.
(3)	Since the fee is fixed, residents in areas with good water distribution conditions (water pressure and water volume) do not have awareness on water conservation, thus, the unequal water distribution situation does not improve.	For this project, water meters (AMR meters) are installed at each household connection. However, support will be needed to develop a fee structure to introduce a pay-as-you-go system. Ultimately, permission from the state government is required and assistance in obtaining this is needed.
2. Facility Operation and Maintenance		
(1)	Facility information, operation and repair procedures, and operation and repair records remain implicit knowledge among staff. This makes it difficult to plan and implement improvement measures, even when there are issues such as inappropriate facility conditions or unequal water distribution conditions. Although an inadequately designed water distribution pipeline network and insufficient water volume are thought to be the causes of the intermittent water supply, developing effective remedial measures is difficult.	There is a need for support in building and operating information management systems that include facility registers, O&M manuals, and operation and repair records to turn these systems into shareable explicit knowledge.
(2)	The customer ledger is not organized into a database, creating difficulty in managing and updating it.	Support is needed for the creation of a GIS-based customer ledger database, as well as for establishing a system to update the database in response to new service connections or terminations.
(3)	Under this project, AMR meters will be installed for each house connection. However, there is no operational experience in the area. In addition, because the fee is fixed, there is no experience of billing based on meter readings.	Assistance is required for the implementation of software for the AMR meter data management system and billing system. Additionally, in areas with poor communication, meter reading data must be collected using mobile devices, but meter readers need to be trained to do this.
(4)	The amount of water leakage cannot be determined because the amount of water supplied to each customer and the amount of water flowing out from the elevated water reservoir are not measured.	In this Project, AMR meters are installed at each household connection. However, support is needed to utilize the measured values for facility management (leakage management). In addition, to manage leakage, water meters (IOT meters) will be installed at the outlets of elevated water reservoirs (both existing and those to be constructed under this project), and support for managing the measured values will also be required.
3. 24-hour Water Supply		
(1)	A 24-hour water supply is expected to be provided by the urban municipalities in the Project areas. To start, a pilot area needs to be selected for the trial.	It is necessary to assist in the selection of areas suitable for a 24-hour water supply trial by conducting customer surveys, actual water usage surveys, and inspection of facility conditions.
(2)	To provide a 24-hour water supply, it will be necessary to curb the concentrated opening of water taps, which is based on the assumption of the current intermittent water supply.	There is a need to support the implementation of a 24-hour water supply campaign in pilot areas.
(3)	To implement a 24-hour water supply, it is necessary to prevent excessive water consumption by implementing a pay-per-use system.	Support needs to be provided for the pay-per-use operations. (Same as 1. (3) above)

	Issues	Need for support
4. Town Panchayat Project Implementation Structure		
(1)	Each city/municipal corporation has an Engineering Section, but the Town Panchayats do not. Instead, NGOs manage the facilities in each town under the management of the state government's local offices in each district (Town Panchayat Bureau). This makes it difficult to respond to each town individually.	It is necessary to provide the above-mentioned support, from 1. to 3., for the cities/municipalities, and to obtain the understanding of the Tamil Nadu state government regarding the results and lessons learned. After that, it is necessary to provide support for improvements in the town panchayats.

Source: JST

9.4.2 Issues and Other Needs Regarding Water Supply and Sanitation in the Project Area

The issues and needs for water supply and sanitation in the entire Project area are shown in Table 9.4.2.

Table 9.4.2 Issues and Other Needs regarding Water Supply and Sanitation in the Project Area

	Issues	Need for support
1. Operation and Maintenance of Water Distribution Facilities		
(1)	The operation and maintenance of water supply facilities in each village is managed by operators employed in each village under the management of the provincial government's local branch office (the Rural Development and Self-Government Bureau), thus, information on facility and operations remains tacitly known to the operators.	Support is needed for officials in each prefecture's rural development and self-governance bureau to build and operate facility information management systems that ensures appropriate and fair water supply, thereby turning them into shareable explicit knowledge. In addition, guidance on the formulation of appropriate water distribution plans is necessary.
(2)	The management skills of operators vary from village to village, in some places water is not being distributed appropriately or fairly.	It is necessary to prepare an O&M manual for and provide training to the operators in each village.
2. Raising Awareness on Proper Water Use and Sanitation		
(1)	The number of fluorosis patients has decreased due to fluorosis prevention activities under the Previous Hogenakkal Project. However, these were carried out 13 to 14 years ago.	Training is needed for teachers who have not participated in the school approach under the Previous Hogenakkal Project.
(2)	The most common water-related disease in the target area is acute diarrhea (ADD), many of which are caused by unsanitary water use. All schools that participated in the social conditions survey had handwashing facilities, but 21% did not have soap.	Education on proper water use and handwashing is needed. Additionally, support is needed for the installation of handwashing facilities in each school.
3. Gender Sensitivity		
(1)	Gender mainstreaming is underway in Tamil Nadu. This project will increase household water connections, reducing the need to fetch water, which is currently mainly carried out by women. There is a need to encourage women to participate in society through this.	It is necessary to encourage women to participate in supporting the above points, and to raise awareness among men about women's participation.
4. Japan-India Collaborative Research in the Field of Health		
(1)	During the implementation of the Previous Hogenakkal Project, cooperation with a Japanese university was provided for the fluorosis control component. This project also proposes joint research with local medical institutions.	If joint research is to be carried out, the following support will be required to ensure the smooth conduct of the joint research: 1) supporting communication between Indian medical institutions and TWAD; and 2) providing local information to Japanese research and educational institutions.

Source: JST

9.5 Proposed Technical Assistance by the Project (Soft Component)

To address the aforementioned issues and ensure the effectiveness of the Project, it is proposed that the soft components described below be implemented to: i) improve the water service operation capacity of the three urban local bodies (Hosur City Corporation, Dharmapuri and Krishnagiri municipalities) that distribute water received from the Project to their residents, and ii) support the operation and maintenance of water distribution facilities and sanitation activities in the Project area.

9.5.1 Objectives and Expected Output

The objectives and expected outputs shall be as follows:

Objective-I: Improvement of Water Supply Operation in the Three ULBs (Hosur City Corporation, Dharmapuri and Krishnagiri Municipalities)

Output for Objective-I:

- Output-I-1: Improvement of water supply management capacity
- Output-I-2: Improvement of facility operation and maintenance capacity
- Output-I-3: Implementation of a 24-hour water supply trial
- Output-I-4: Dissemination of the results to each town panchayat

Objective-II: Enhancement of Water Distribution and Hygiene Activities in the Entire Project Area

Output for Objective-II:

- Output-II-1: Strengthen the operation and maintenance capacity of town panchayat
- Output-II-2: Awareness raising on hygienic behavior, including proper water use and handwashing
- Output-II-3: Awareness raising on gender consideration
- Output-II-4: Support for the India-Japan collaboration research in the field of health

9.5.2 Framework of Soft Component

(1) Implementation System

It is proposed that the following organizations be established for the implementation of the soft component, as shown in Table 9.5.1.

Table 9.5.1 Organization for Implementation of the Soft Component

Name	JCC: Joint Coordination Committee
Purpose	・To discuss and approve the activity plan of the soft component ・To coordinate and have a consensus with the concerned parties ・To monitor the progress of the activities ・To discuss the arising problems and to propose the solutions
Member	<u>TWAD</u> ・Project Director of PMU ・Executive Engineer of PMU ・Chief Engineer of PIU JICA ・Representative of JICA India Office ・Staff of the JICA Headquarters (to be confirmed)

	Member of WG-I Member of WG-II Consultant Team
Name	**Working Group-I (WG-I)**
Purpose	To plan and implement the activities for Objective-I
Member	TWAD ・Executive Engineer of the PIU ・Assistant Executive Engineers of the PIU ・Assistant Executive Engineers of the PID ULBs (Hosur City Corporation, Krishnagiri Municipality, Dharmapuri Municipality) ・Members of the General Section ・Members of the Engineering Section ・Members of the IT Section Consultant Team
Name	**Working Group-II (WG-II)**
Purpose	To plan and implement the activities for Objective-II
Member	TWAD ・Executive Engineer of PIU ・Assistant Executive Engineers of PIU ・Assistant Executive Engineers of PID ULBs (Hosur City Corporation, Krishnagiri Municipality, Dharmapuri Municipality) ・Members of the public health section Director Office of Town Panchayat in Dharmapuri and Krishnagiri District, Municipal Administration and Water Supply Dept. ・Members of the engineering section ・Members of the public health section Director Office of Village Panchayat in Dharmapuri and Krishnagiri District, Rural Development and Panchayat Raj Dept. ・Members of the engineering section ・Members of the public health section Consultant Team

Source: JST

(2) Staging of the Implementation

Survey and Planning Stage

- Set up of the JCC and WGs.
- The current conditions will be surveyed by the WGs.
- Based on the survey results, the activity plan (output, activity contents, input resources) shall be prepared.
- The survey results and activity plan shall be presented in the JCC.
- The activity plan shall be agreed upon with each ULB and JCC.

Implementation Stage

- The WGs shall conduct the approved activities.

- The progress of activities shall be reported to the JCC twice a year and the necessary amendments to the activity plan, if any, shall be discussed in the JCC.

9.5.3 Proposed Activities

The following activities are proposed, while the detailed plans shall be prepared and proposed at the "Survey and Planning Stage" as mentioned above.

Activities 1 to 3 will be implemented in three cities—Hosur, Krishnagiri, and Dharmapuri. The outcomes and lessons learned from these activities will be compiled and reported at the JCC to gain the understanding of the State Government. Following this, Activity 4 will be expanded to the town panchayat.

(1) Output-I-1: Improvement of Water Supply Management Capacity

The capacity of ULB and municipalities to manage water supply services is strengthened, the service level is improved, and the implementation of sustainable water supply operations is ensured.

I-1-1: Development of water supply management organization
I-1-2: Confirmation of water utility financial status and introduction of independent accounting system
I-1-3: Consideration of introducing a metered tariff system

(2) Output-I-2: Improvement of Facility Operation and Maintenance Capacity

The facility operation and maintenance capacity of ULB and municipalities is strengthened by the Consultant through the following activities.

I-2-1: Establishment of an information management system for customer ledgers, O&M manuals, and operation and repair records
I-2-2: Creation of a GIS database for customer records and establishment of a system for updating
I-2-3: Support the introduction of an AMR meter data management system, billing system software, and meter reader training
I-2-4: Support for establishing a water distribution management system

(3) Output-I-3: Implementation of a Trial-basis 24-hour Water Supply

To improve the water supply service level of the ULB, introduce the metered tariff system, and to aim for 24x7 water supply service, it is necessary to strengthen the O&M system of the ULB. The Consultant shall assist ULBs in the following activities:

I-3-1: Customer survey, water usage survey, and selection of pilot areas
I-3-2: Campaign to provide 24-hour water supply
I-3-3: Implementation of a 24-hour water supply by metered tariff system
I-3-4: Monitoring of water supply status in pilot areas implementing 24-hour water supply

(4) Output-I-4: Dissemination of Results to Each Town Panchayat

The results and lessons learned from the above activities in ULBs to town panchayat will be expanded through the following activities.

I-4-1: Holding a workshop on the results and lessons learned from activities in town panchayats

I-4-2: Developing an action plan to carry out activities in the respective town panchayat

(5) Output-II-1: Strengthening the Operation and Maintenance Capacity of Town Panchayat

The ability of operation and maintenance capacity of the town panchayat and village panchayat is strengthened by the Consultant through the following activities:

II-1-1: Support for the establishment of a facility information management system and guidance for the formulation of appropriate water distribution plan.

II-1-2: Preparation of O&M manuals and holding workshops for operators

(6) Output-II-2: Awareness Raising of Hygienic Behavior Including Proper Water Use and Handwashing

The Consultant shall organize and facilitate the following activities to be conducted by local bodies in the Project area:

II-2-1: One day training of schoolteachers on fluorosis prevention

II-2-2: Providing sanitation facilities, including handwashing facilities for each school

II-2-3: Creation of educational pamphlets on proper water use and handwashing for use

(7) Output-II-3: Awareness Raising on Gender Consideration

The Consultant shall promote women's participation in the O&M of water supply facilities and hygiene activities through the following activities:

II-3-1: Promoting women's participation in the above activities for Output II-2

II-3-2: Supporting the implementation of TWAD's ongoing Gender Action Plan

(8) Output-II-4: Support for India-Japan Research Collaboration in the Field of Health

The Consultant shall support the India-Japan research collaboration in the field of health through the following activities:

II-4-1: Supporting communication between Indian medical institutions and TWAD

II-4-2: Providing local information to Japanese research and educational institutions

9.5.4 Implementation Schedule

Chapter 10 Environmental and Social Consideration

10.1 Initial Environmental and Social Considerations

10.1.1 Project Components Causing Environmental and Social Impact

Water supply facilities—from intake and raw water pumping station (PS) to house connections—are being constructed in Dharmapuri District and Krishnagiri District. The outline of the facilities is shown in Figure 6.1.1 and Table 6.10.2 in Chapter 6. In Dharmapuri District, facilities from the transfer, pumping station, to the house connections will be constructed for one municipality, ten town panchayats and ten panchayat unions. In Krishnagiri District, facilities will be constructed from the intake to the house connections for one municipality and one corporation, six town panchayats, and ten panchayat unions. The intake and raw water PS will be constructed along with some facilities in the forest area, while the pipelines will be constructed along existing roads.

10.1.2 Environmental and Social Conditions

(1) Living Conditions

1) Air Quality and Noise Level

The baseline air quality and noise levels were measured at the locations where new intake points and WTPs are planned to be constructed. The survey locations are shown in Figure 10.1.1, Figure 10.1.2, and Figure 10.1.3, while the results of the air quality and noise level surveys are shown in Table 10.1.1 and Table 10.1.2.

The overall mean of the 24-hourly average values of PM 10 and PM 2.5 at the intake points were 51.3 μg/m^3 and 19.7 μg/m^3, respectively, while the mean WTP values are 47.5 μg/m^3 and 17.4 μg/m^3, respectively. Both stations had no observed specific pollution sources, and the ambient air quality levels were found to be within the Central Pollution Control Board (CPCB) standards.

At the intake point, noise levels 67.2 dB Leq. was observed in the daytime and 53.6 dB in the nighttime, while at the WTP, it was measured to be 57.6 dB in the daytime and 49.4 dB in the nighttime. Noise levels during the daytime were found to be in the range of 57.6 - 67.2 dB(A). The monitored locations during the daytime exceed the prescribed limit, while the noise levels during nighttime were found to be within the range of 49.4 - 53.6 dB(A). At the intake point, the observed nighttime noise level was within the CPCB standard limit. Moreover, in the WTP, noise levels in the intake point during daytime and nighttime exceed the prescribed limits.

Table 10.1.1 Air Quality Survey Results of the Intake Point and WTP

Location Name	Geotag Location	Parameter	Observed Value	CPCB Standard*
Intake point	12° 7’24.51”N	PM_{10}	51.3 μg/m^3	100 μg/m^3 (24 hours)
	77° 46’25.57”E	$PM_{2.5}$	19.7 μg/m^3	60 μg/m^3 (24 hours)
WTP	12° 8’43.92”N	PM_{10}	47.5 μg/m^3	100 μg/m^3 (24 hours)
	77° 55’25.36”E	$PM_{2.5}$	17.4 μg/m^3	60 μg/m^3 (24 hours)
Pipeline 1		PM_{10}	89.1 μg/m^3	100 μg/m^3 (24 hours)

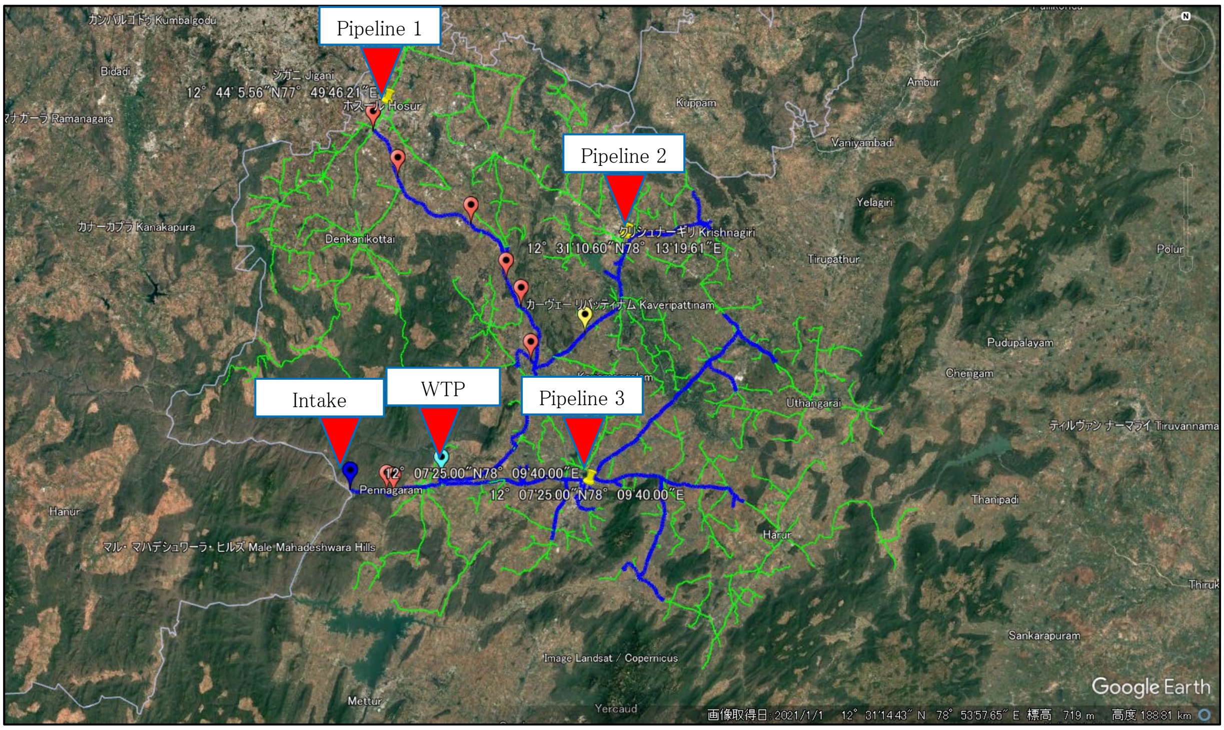
Location Name	Geotag Location	Parameter	Observed Value	CPCB Standard*
(Hosur)	12° 44' 5.56"N 77° 49'46.21"E	PM 2.5	42.6 μg/m³	60 μg/m³ (24 hours)
Pipeline 2 (Krishnagiri)	12° 31'10.60"N 78° 13'19.61"E	PM 10	66.4 μg/m³	100 μg/m³ (24 hours)
		PM 2.5	28.1 μg/m³	60 μg/m³ (24 hours)
Pipeline 3 (Dharmapuri)	12° 07'25.00"N 78° 09'40.00"E	PM 10	70.3 μg/m³	100 μg/m³ (24 hours)
		PM 2.5	35.6 μg/m³	60 μg/m³ (24 hours)

*Ambient Air Quality Monitoring Guidelines 2009
Source: JST

Table 10.1.2 Noise Level Results of the Intake Point and WTP

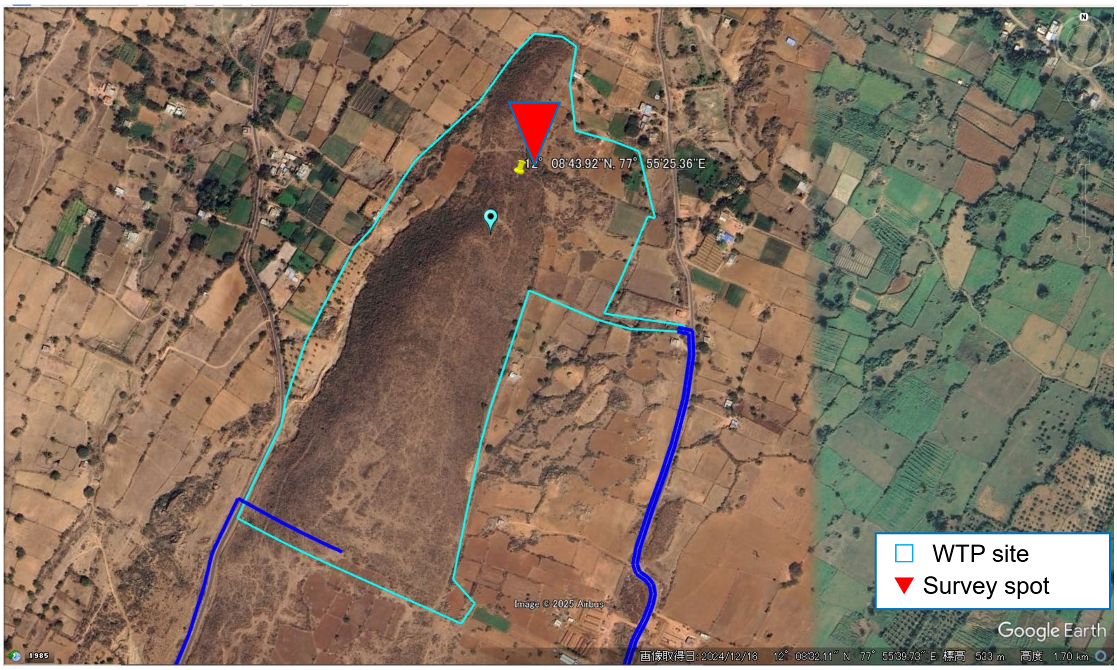
Location		Category of Area	Daytime Noise Level (dB)			Nighttime Noise Level (dB)		
Name	Coordinate		Max.	Min.	Leq.	Max.	Min.	Leq.
Intake point	12° 7'24.36"N 77° 46'25.80"E	Commercial	68.0	64.4	67.2	54.1	52.2	53.6
WTP	12° 8'40.87"N 77° 55'25.05"E	Residential	58.4	54.9	57.6	49.9	48.0	49.4
Pipeline 1 (Hosur)	12°44'5.56"N 77°49'46.21"E	Industrial	78.6	75.3	77.8	68.6	66.7	68.1
Pipeline 2 (Krishnagiri)	12°31'10.60"N 78°13'19.61"E	Industrial	70.4	66.8	69.6	59.1	57.2	58.4
Pipeline 3 (Dharmapuri)	12° 8'11.52"N 78° 9'42.36"E	Industrial	73.2	69.6	72.4	64.8	62.9	64.3
CPCB Standards*		Commercial Residential	- -	- -	65 55	- -	- -	55 45

*The Noise Pollution (Regulation and Control) Rules, 2000
Source: JST



Source: JST

Figure 10.1.1 Survey Locations for Air Quality and Noise



Source: JST

Figure 10.1.2 Survey Location for Air Quality

Source: JST

Figure 10.1.3 Survey Location for Noise Survey

2) Water Quality

Water samples were collected from a nearby location of the proposed intake point. One surface water sample was collected and analyzed. Color, odor, pH, turbidity, total dissolved solids, total alkalinity (as $CaCO_3$), total hardness (as $CaCO_3$), calcium (Ca), magnesium (Mg), chloride (Cl), sulphate (SO_4), iron (Fe), chlorine (Cl_2), silica, nitrate (NO_3), fluoride, calcium hardness (as $CaCO_3$), appearance, and carbonate hardness in surface water were detected. Details of the sampling location, test methods, test results, and map showing the surface water monitoring, are given in Table 10.1.3, Table 10.1.4, Table 10.1.5, and Figure 10.1.4.

Table 10.1.3 Survey Location for Water Quality Survey

Sample Type	Source	Location
Surface Water	Cauvery River	12° 7'22.14''N 77° 46'24.22''E

Source: JST

Table 10.1.4 Test Methods for Water Quality

No.	Parameters	Test Method
1	Color	IS 3025 PART 04
2	Odor	IS 3025 PART 05
3	pH @ 25 ℃	IS 3025 PART 11
4	Turbidity	IS 3025 PART 10
5	Total Dissolved Solids	IS 3025 PART 16
6	Total Alkalinity ($CaCO_3$)	IS 3025 PART 23
7	Total Hardness ($CaCo_3$)	IS 3025 PART 21
8	Calcium (Ca)	IS 3025 PART 40
9	Magnesium (Mg)	IS 3025 PART 46
10	Chloride (Cl)	IS 3025 PART 32
11	Sulphate (SO_4)	IS 3025 PART 24
12	Iron (Fe)	IS 3025 PART 53
13	Free Residual Chlorine (Cl_2)	IS 3025 PART 26
14	Silica	IS 3025 PART 35
15	Nitrate (NO_3)	IS 3025 PART 34 Sec 1
16	Fluoride	IS 3025 PART 60: 2005
17	Calcium hardness ($CaCO_3$)	IS 3025 PART 40
18	Magnesium hardness ($CaCO_3$)	IS 3025 PART 46
19	Appearance	SOP/W/001
20	Carbonate Hardness	IS 3025 PART 21

Source: JST

Table 10.1.5 Results of the Surface Water Quality Survey

No.	Parameters	Unit	Results	DW Standards (IS10500:2012) Acceptable Limit
1	Color	Hazen	<10	5
2	Odor	-	Agreeable	Agreeable
3	pH @ 25 ℃	-	7.60	6.5 to 8.5
4	Turbidity	NTU	2.5	1.0
5	Total Dissolved Solids	mg/l	354	500
6	Total Alkalinity ($CaCO_3$)	mg/l	184	200
7	Total Hardness ($CaCo_3$)	mg/l	222	200
8	Calcium (Ca)	mg/l	43.6	75
9	Magnesium (Mg)	mg/l	27.6	30
10	Chloride (Cl)	mg/l	43.0	250
11	Sulphate (SO_4)	mg/l	24.1	200
12	Iron (Fe)	mg/l	0.21	0.3
13	Free Residual Chlorine (Cl_2)	mg/l	BDL(DL:1.0)	0.2
14	Silica	mg/l	8.4	-
15	Nitrate (NO_3)	mg/l	7.6	45
16	Fluoride	mg/l	0.79	1.0
17	Calcium Hardness ($CaCO_3$)	mg/l	108	-
18	Magnesium Hardness ($CaCO_3$)	mg/l	113	-
19	Appearance	-	Light Turbid	-
20	Carbonate Hardness	mg/l	184	-

Source: JST

Source: JST

Figure 10.1.4 Map of the Surface Water Monitoring Locations

(2) Natural Environment

1) Ecology

There are no surrounding areas in the proposed project site that qualify as biologically important habitats, such as Important Bird Areas (IBAs) or Key Biodiversity Areas (KBAs).

In the proposed Project area and its 10-km buffer zone, the existing flora comprises 47 tree species, 18 shrub species, 16 climber species, 57 herb and sedge species, 11 grass species, and 16 aquatic floras. One tree species, teak (*Tectona grandis*), is listed as Endangered.

The recorded fauna includes 5 species of mammals, 43 species of birds, 6 species of reptiles, 39 species of butterfly, 8 species of aquatic birds, 5 species of fishes. Among these, one species of mammals—Indian hare (*Lepus nigricollis*)—is listed as Near Threatened, and another—Bonnet macaque (*Macaca radiata*)—as Vulnerable.

2) Wildlife Sanctuary and Forest Area

The wildlife habitats and forested areas within 15-km radius of the proposed Project boundary are listed in Table 10.1.6. There are no protected areas or sites designated for nature conservation—such as Ramsar Wetlands—where development is prohibited under Indian national laws. According to Forest Service Notification No. 193, dated July 11, 2022, roads and village areas passing through the Cauvery South Wildlife Sanctuary (WLS) are excluded from the WLS boundary. In Cauvery North WLS, the road passing through the sanctuary is not considered as part of the WLS, as the applicable regulations do not extend to it. Accordingly, the legal treatment under Indian Domestic Law is the same as the road passing through the Cauvery South WLS, and the laying of water distribution pipelines along these routes is permitted. TWAD has confirmed with the State Forest Department, which has jurisdiction over both WLSs, and has submitted an official letter confirming the above. The relevant minutes, notification letters, and letters from the Forest Department and TWAD are shown in Appendix-10.1. Furthermore, although Reserved Forests do not fall under the protected areas specified in the JICA Environmental and Social Considerations Guidelines, they have been designated under the Indian Forest Act. While farming and grazing of livestock are not permitted, construction work—including the laying water pipes as planned in the Project—is not prohibited.

Table 10.1.6 List of Environmentally Sensitive Areas within a 15 km Vicinity

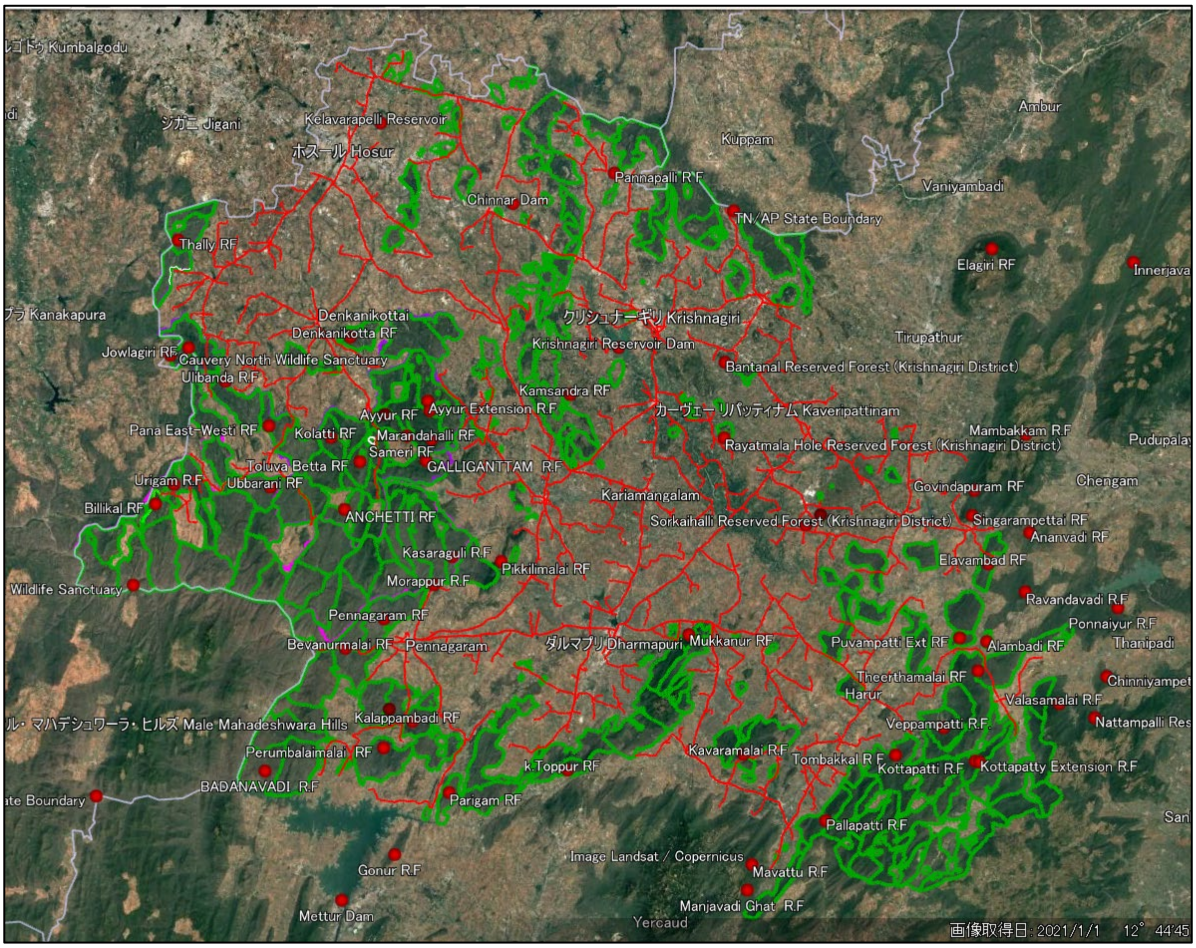
No.	Area	Distance from the Project Boundary (km)
1	Javalagiri RF	Pipeline Crossing RF
2	Panai West RF	Pipeline Crossing RF
3	Panai East RF	Pipeline Crossing RF
4	Bevanurmalai RF	Pipeline Crossing RF
5	Kalappambadi RF	Pipeline Crossing RF
6	Toppur RF	Pipeline Crossing RF
7	Tirthamalai RF	Pipeline Crossing RF
8	Aiyur Ext RF	Pipeline Crossing RF
9	Aiyur RF	Pipeline Crossing RF
10	Sameri RF	Pipeline Crossing RF
11	Toluvabetta RF	Pipeline Crossing RF
12	Anchetti RF	Pipeline Crossing RF
13	Ubbarani RF	Pipeline Crossing RF
14	Ulibanda RF	Pipeline Crossing RF
15	Urigam RF	Pipeline Crossing RF
16	Bilikal RF	Pipeline Crossing RF
17	Nayanasandiram RF	Pipeline Crossing RF
18	Galliganttam RF	Pipeline Crossing RF
19	Elagiri RF	Pipeline Crossing RF
20	Kavaramalai RF	Pipeline Crossing RF
21	Elavambadi RF	Pipeline Crossing RF
22	Kottapatti Ext RF	Pipeline Crossing RF
23	Sanatkumar Nadi or Chinnar R	Pipeline Crossing River
24	Palar or Nagavati R	Pipeline Crossing River
25	Ponnaiyar R	Pipeline Crossing River
26	Markanda Nadi R	Pipeline Crossing River
27	Veppanapalli Nadi R	Pipeline Crossing River
28	Pambar R	Pipeline Crossing River
29	Muttur R	Pipeline Crossing River
30	Bargur Ar	Pipeline Crossing River
31	Dakshina Pinakini R	Pipeline Crossing River
32	Dodda Halla/Mirre Vanka/Kittilimarattu Pallam R	Pipeline Crossing River
33	Maddala Pallam R	Pipeline Crossing River
34	Vaniyar R	Pipeline Crossing River
35	Cauvery North Wildlife Sanctuary Core/ESZ	Pipeline Crossing Road (Classified outside of WLS)
36	Cauvery South Wildlife Sanctuary	Pipeline Crossing Road (Classified outside of WLS)
37	Kolatti RF	Adjacent to Pipeline
38	Manjavadi Ghat RF	Adjacent to Pipeline
39	Krishnagiri Resevoir	0.01
40	Masakkallu RF	0.01
41	Kaveri (Cauvery) R	0.02
42	Pennagaram RF	0.02

No.	Area	Distance from the Project Boundary (km)
43	Denkanikota RF	0.02
44	Singarampettai RF	0.02
45	Govindapuram RF	0.02
46	TN/KA State Boundary	0.03
47	Marandahalli RF	0.04
48	Kalappambadi RF	0.06
49	Perumbalaimalai RF	0.07
50	Kasaraguli RF	0.10
51	Tali RF	0.11
52	Parigam RF	0.20
53	Cauvery Wildlife Sanctuary Core/ESZ	0.20
54	Mavuttu RF	0.22
55	Morappur RF	0.25
56	Tombakkal Ext RF	0.25
57	Nachikuppam Ar	0.35
58	Puvampatti Ext RF	0.36
59	Pallippatti RF	0.39
60	Veppampatti RF	0.41
61	Innerjavadi RF	0.44
62	Mukkanur RF	0.46
63	Ananvadi RF	0.78
64	Alambadi RF	0.78
65	Badanavad RF	0.81
66	Mettur Dam/Stanley Reservoir	0.86
67	Pikkilimalai RF	0.87
68	Ravandavadi RF	0.88
69	Kamsandra RF	0.96
70	Mambakkam RF	1.12
71	Kottapatti RF	1.40
72	Bantanal RF	1.65
73	Kelavarapelli Reservoir	1.83
74	Ponnaiyar RF	1.85
75	Bilikal RF	1.98
76	Chinnar dam	2.38
77	Gonur RF	2.64
78	Valasamali RF	3.27
79	Rayatmala Hole	6.73
80	Nattampalli RF	7.35
81	Chinniyampettai RF	7.40
82	Sorkailhalli SF	8.93

Note: R = River, RF = Reserve Forest, SF = Social Forest, WLS = Wildlife Sanctuary

Source: TWAD, Environmental Impact Assessment Report for Proposed Hogenakkal Combined Water Supply Scheme for Dharmapuri and Krishnagiri Districts – Phase 2, November 2024

The pipelines of the Project and Reserve Forest are shown in Figure 10.1.5.



Note: ── Pipeline ── Reserve Forest
Source: JST

Figure 10.1.5 Reserve Forest in the Project Site

Cauvery South WLS and Cauvery North WLS are shown in Figure 10.1.6. As listed below, the following are the roads and villages, from ① to ⑪, where the regulations for WLS do not apply (not considered as WLS).

① Road: (12.33885°N, 77.69095°E) ～ (12.32298°N, 77.65866°E)

② Road: (12.33399°N, 77.63988°E) ～ (12.32241°N, 77.62232°E)

③ Road: (12.33841°N, 77.62584°E) ～ (12.30591°N, 77.63878°E)

④ Road: (12.31993°N, 77.59418°E) ～ (12.32519°N, 77.59404°E)

⑤ Road: (12.28276°N, 77.55996°E) ～ (12.31750°N, 77.58387°E)

⑥ Village: Urigam Village

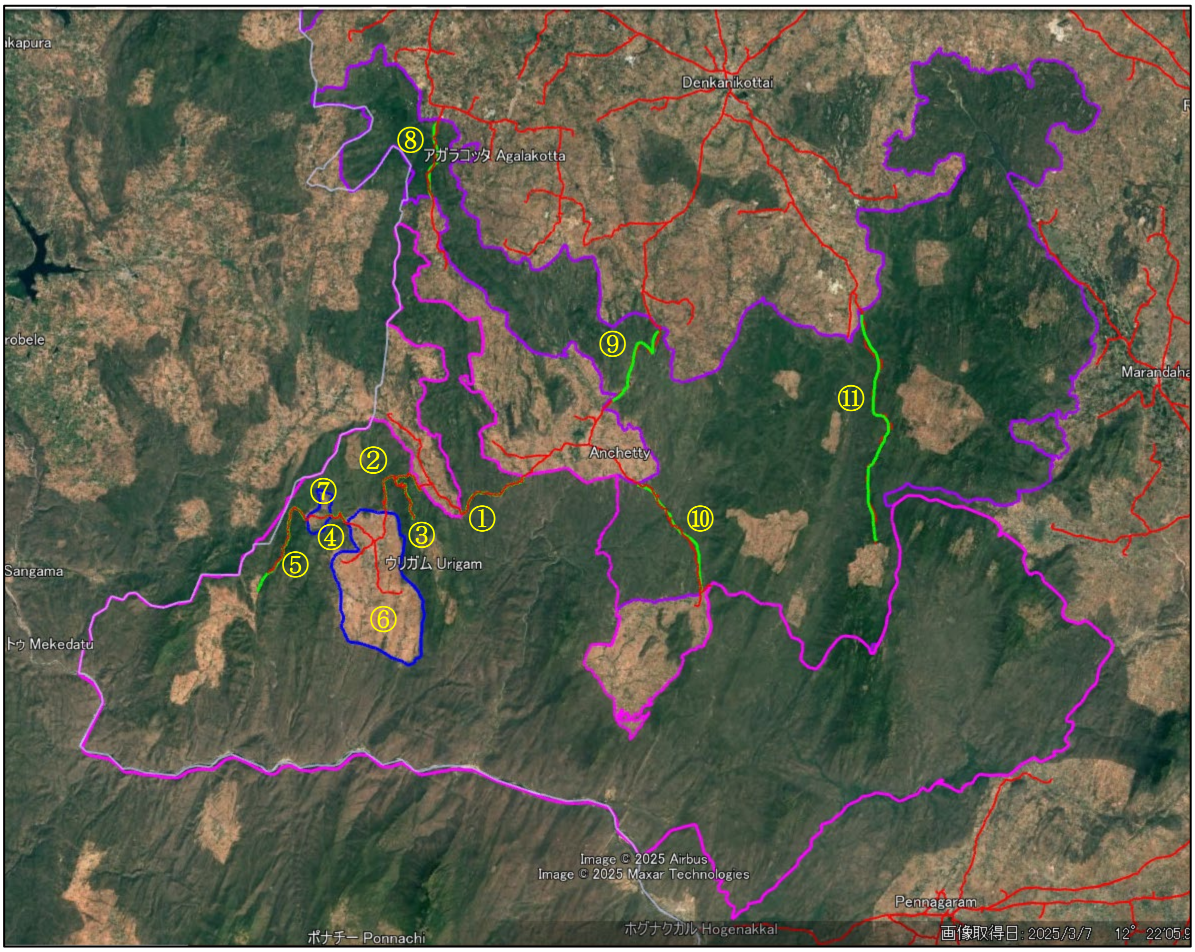
⑦ Village: Bilikal Village

⑧ Road (Although the coordinates of the starting and ending points are not shown in the notification, the roads and paths in North WLS are not subject to the regulation for WLS (not considered as WLS).

⑨ Road

⑩ Road

⑪ Road



Note: Cauvery South WLS　Cauvery North WLS　Pipeline
Pipeline under the roads crossing WLS (not considered as WLS)　Village

Source: JST

Figure 10.1.6 Map of WLS

The map of Cauvery South WLS is shown in Figure 10.1.7. The following roads and villages as shown below, from ① to ⑦, are where the regulations for WLS do not apply (not considered as WLS).

① Road: (12.33885°N, 77.69095°E) ~ (12.32298°N, 77.65866°E)

② Road: (12.33399°N, 77.63988°E) ~ (12.32241°N, 77.62232°E)

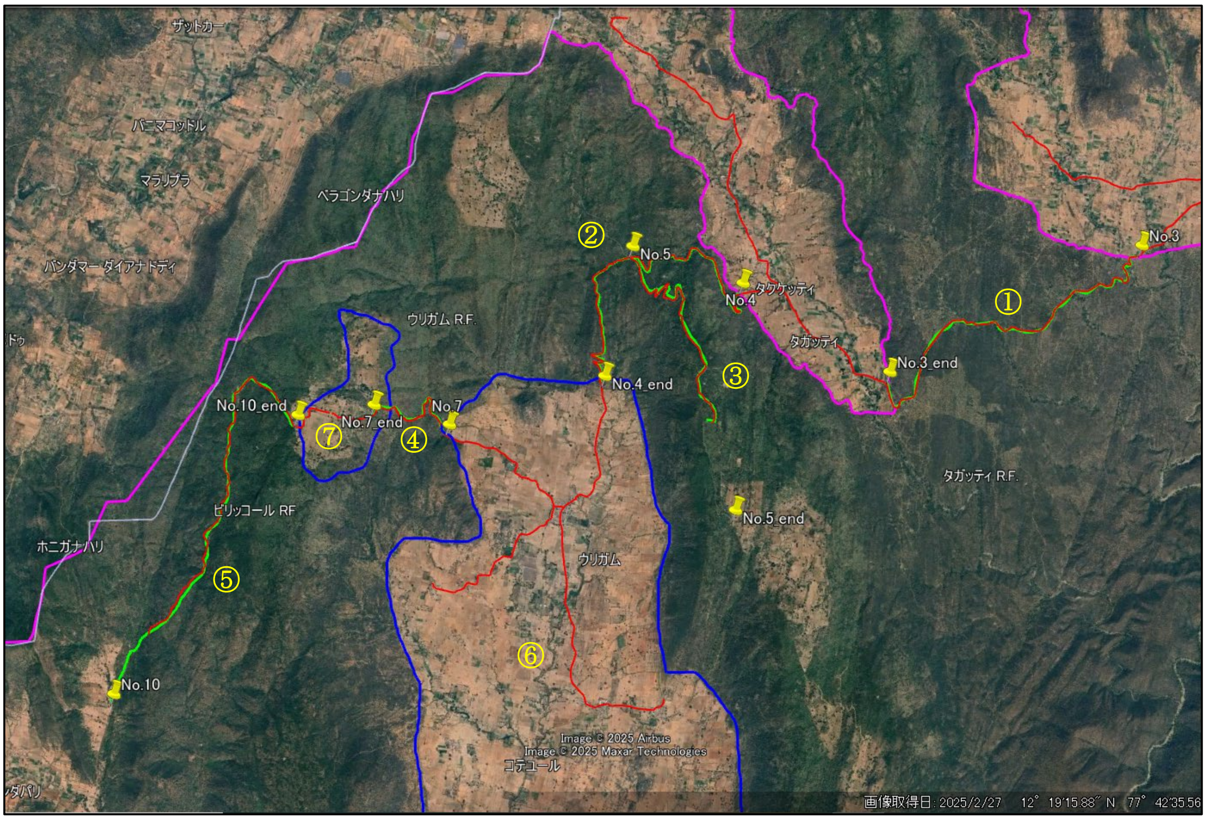
③ Road: (12.33841°N, 77.62584°E) ~ (12.30591°N, 77.63878°E)

④ Road: (12.31993°N, 77.59418°E) ~ (12.32519°N, 77.59404°E)

⑤ Road: (12.28276°N, 77.55996°E) ~ (12.31750°N, 77.58387°E)

⑥ Village: Urigam Village

⑦ Village: Bilikal Village



Note: Cauvery South WLS   Cauvery North WLS   Pipeline
Pipeline under the roads crossing WLS (not considered as WLS)   Village

Source: JST

Figure 10.1.7 Cauvery South WLS (Pipeline Crossing Area)

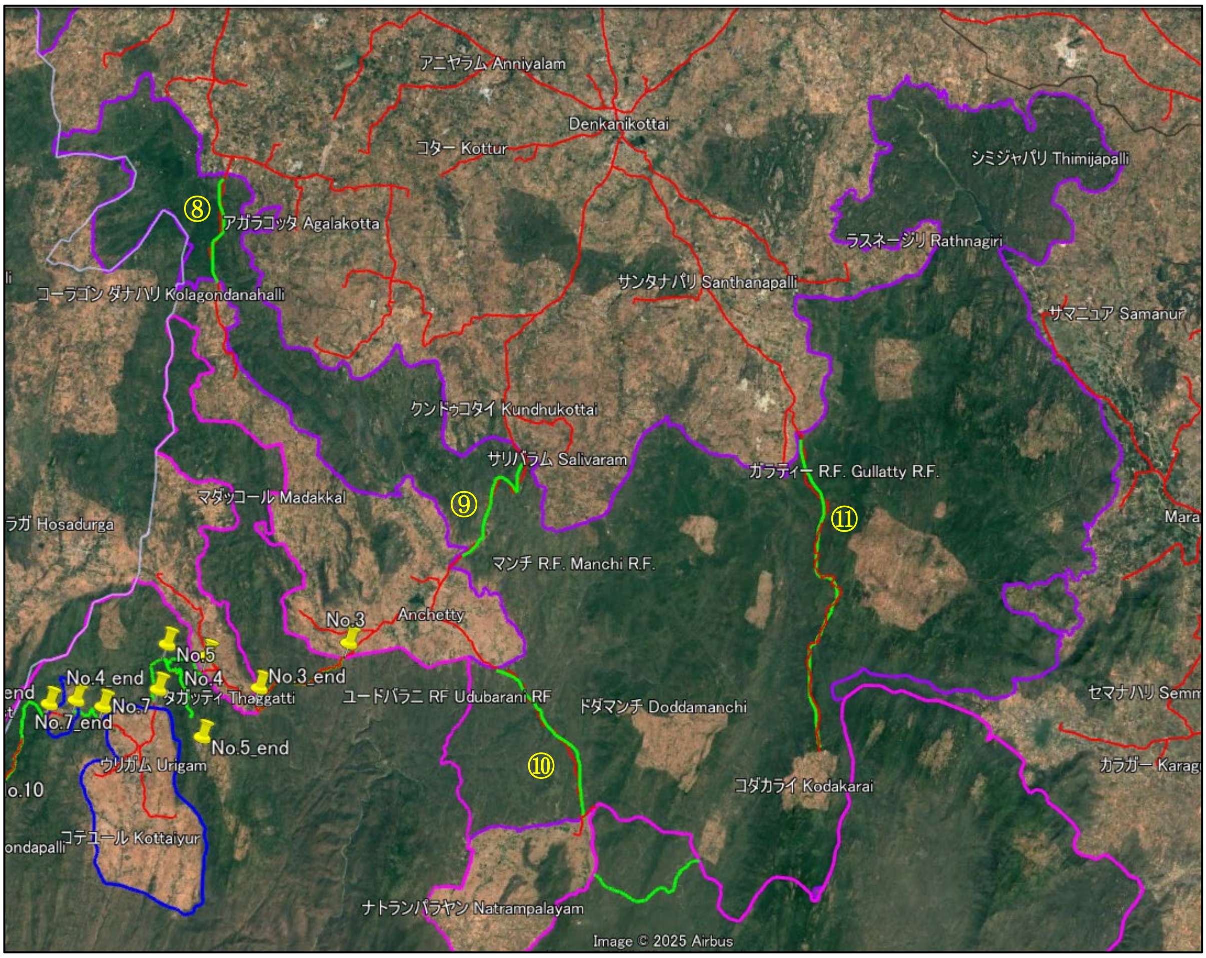
The map of Cauvery North WLS is shown in Figure 10.1.8. The regulations for WLS do not apply (not considered as WLS) in the following roads and villages from ⑧ to ⑪ are.

⑧ Road (Although the coordinates of the starting and ending points are not indicated in the Notification, the roads and paths within the Cauvery North WLS are not subject to the WLS regulations and are therefore not considered as part of the WLS.)

⑨ Road

⑩ Road

⑪ Road



Note: Cauvery South WLS — Cauvery North WLS — Pipeline
— Pipeline under the roads crossing WLS (not considered as WLS) — Village

Source: JST

Figure 10.1.8 Cauvery North WLS (Pipeline Crossing Area)

(3) Social Environment

1) Population and Density of the Indigenous People

The population information for Dharmapuri District and Krishnagiri District are shown in Table 10.1.7 and Table 10.1.8.

Table 10.1.7 Population Information of Dharmapuri District

	Total	Rural	Urban
Population	1,506,843	1,245,931	260,912
Male population	774,303	643,215	131,088
Female population	732,540	602,716	129,824
Children (0-6 years)	167,940	140,903	27,037
Literacy	68.54%	65.86%	81.21%
Sex Ratio	946	937	990

Source: Census 2011

Table 10.1.8 Population Information of Krishnagiri District

	Total	Rural	Urban
Population	1,879,809	1,451,446	428,363
Male population	960,232	742,444	217,788
Female population	919,577	709,002	210,575
Children (0-6 years)	217,323	166,231	51,092
Literacy	71.46 %	67.32 %	85.54 %
Sex Ratio	958	955	967

Source: Census 2011

The populations of Scheduled Castes and Scheduled Tribes in Dharmapuri District and Krishnagiri District are shown in Table 10.1.9. Scheduled Castes are designated by Presidential Decree on a state-by-state basis under Article 341 of the Constitution and are historically referred to as “untouchables”—a group that has been socially disadvantaged. Scheduled Tribes, on the other hand, are a generic term for tribes designated by Presidential Decree on a state-by-state basis under Article 342 of the Constitution, and are recognized on the basis of cultural uniqueness, socioeconomic backwardness, and highly segregated residence.

In Dharmapuri District, Scheduled Castes constitute 16.29%, while the Scheduled Tribe represents 4.18% of the total population. In Krishnagiri District, Scheduled Caste constitutes 14.22%, while Scheduled Tribe represents 1.19 % of the total population. The Scheduled Tribes in the Project area do not exhibit geographically distinct settlements, separate economic, social, and cultural practices that differ from mainstream society and culture, nor do they possess unique languages that differ from the official language of the region. Therefore, they are not considered Indigenous Peoples requiring special measures under the Project.

Table 10.1.9 Population of Scheduled Caste and Scheduled Tribute

Population	Dharmapuri District			Krishnagiri District		
	Total (% for total population of the district)	Male	Female	Total (% for total population of the district)	Male	Female
Scheduled Caste	245,392 (16.29%)	124,706	120,686	267,386 (14.22%)	135,474	131,912
Scheduled Tribe	63,044 (4.18%)	32,130	30,914	22,388 (1.19%)	11,419	10,969

Source: Census 2011

2) Gender

In 2011, the total population of Dharmapuri District was 1,506,843, comprising 774,303 males and 732,540 females. The sex ratio was 937 in rural areas and 990 in urban areas. The male and female literacy rates were 76.85% and 59.8%, respectively, with an average literacy rate of 68.54%. In Krishnagiri District, the total population was 1,879,809, comprising 960,232 males and 919,577 females. The sex ratio was 955 in rural and 967 in urban area. With a literacy rate was 71.46%, for which the male literacy rate was 78.75% and the female literacy rate was 63.91%.

3) Economy and Industry

Information regarding economy and industry is stated in Section 2.2.

4) Historical and Cultural Heritage

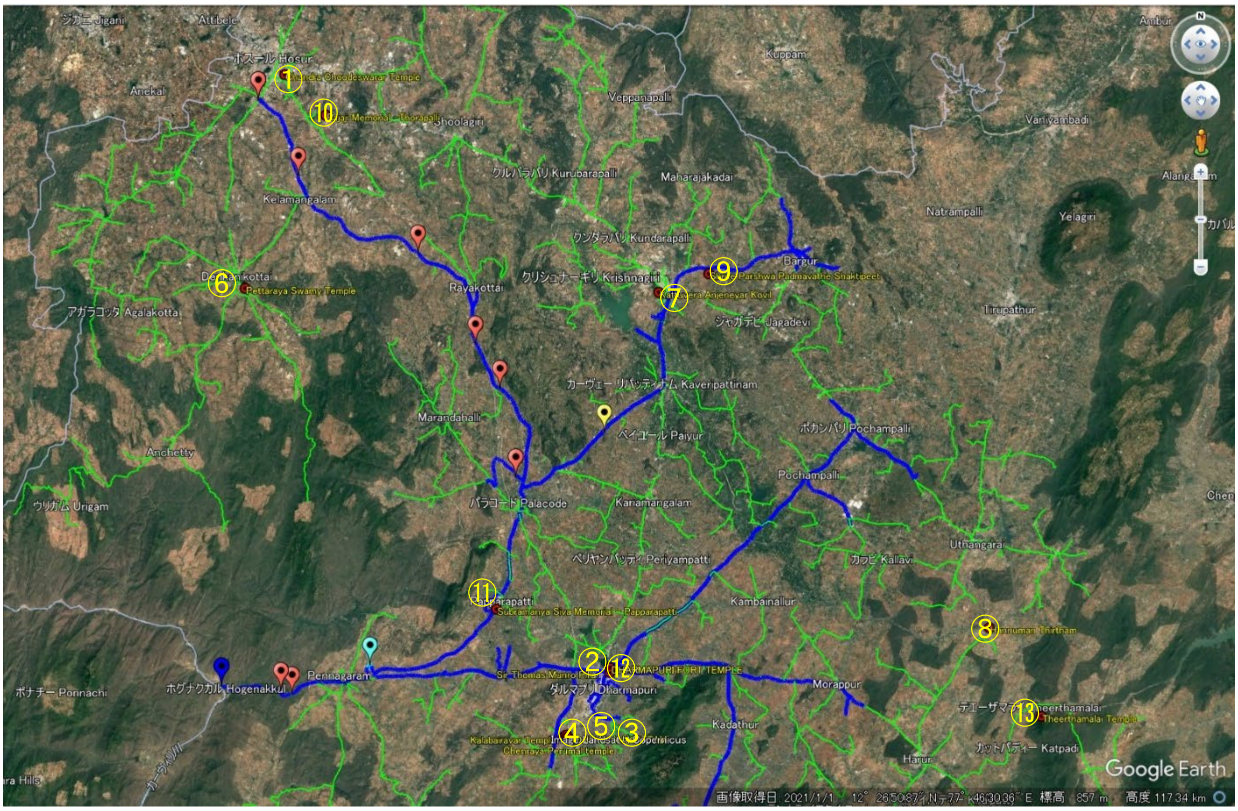
The historical and cultural heritage sites in Dharmapuri and Krishnagiri districts are listed in Table 10.1.10. However, none these sites are considered as World Heritage Sites by UNESCO or Monuments of National Importance under the Ancient Monuments and Archaeological Sites and Remains Act, 1958, etc., of India. Historical and cultural heritage sites subject to this Act are protected and managed by the Central Government, and the area within 100 m of such sites is defined as a “Prohibited Area,” while the area within another 200 m is classified as a “Regulated Area” where construction and development activities are restricted. The historical and cultural heritage sites located within the Project area are not subject to these restrictions. The pipeline will be constructed in the vicinity of these temples (1.7 m to 20 km). The construction work next to ⑬, which is at a distance of 20 m to the project site in Table 10.1.10, involves laying a small-diameter pipe of about 300 mm diameter in a trench of a width of approximately 1 m. However, the potential impact is expected to be minimized through the mitigation measures, such as using construction equipment that has undergone maintenance inspections to reduce excessive noise and vibration, limiting the area of construction where traffic will be restricted, and informing the surrounding community of the restrictions prior to construction.

Table 10.1.10 Historical and Cultural Heritage Sites

District	No.	Historical and Cultural Heritage	Distance from the Project Area
Dharmapuri	①	Chenraya Perumal Temple	Approximately 1.3 km
	②	Theerthamalai Temple	Approximately 1.2 km
	③	Kalabairavar Temple	Approximately 1.3 km
	④	Dharmapuri Fort Temple	Approximately 0.3 km
	⑤	Subramanya Siva Memorial - Papparapatti	Approximately 0.1 km
	⑥	Sir Thomas Munro Pillar	Approximately 0.3 km
	⑦	Adhiyaman Kottam	Approximately 1.3 km
Krishnagiri	⑧	Rajaji Memorial - Thorapalli	Approximately 1.3 km
	⑨	Chandra Choodeswarar Temple	Approximately 0.2 km
	⑩	Shree Parshwa Padmavathe Shaktipeet	Approximately 0.5 km
	⑪	Hannuman Thirtham	Approximately 1.7 km
	⑫	Kattuvera Anjeneyar Kovil	Approximately 0.2 km
	⑬	Pettaraya Swamy Temple	Approximately 20 m

Source: JST

The location of each historical and cultural heritage site is shown in Figure 10.1.9.



Note: Project area (pipeline)

Source: JST

Figure 10.1.9 Historical and Cultural Heritage Site

10.1.3 Institution and Organization for Environmental and Social Considerations in India

(1) Regulations Related to the Project

The summary of environmental regulations applicable to the project is presented in Table 10.1.11.

Table 10.1.11 List of Environmental Regulations

Regulation
Constitutional Provisions
Environmental Protection Act 1986 and CPCB Environmental Standards
EIA Notification 2006
The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013
Forest (Conservation) Act 1980 as Amended in 1988
Wildlife Protection Act 1972 as Amended in 2003 and 2006
Biological Diversity Act 2002
Water (Prevention and Control of Pollution) Act of 1974 and Tamil Nadu Water (Prevention and Control of Pollution) Rules 1975
Air (Prevention and Control of Pollution) Act 1981 as Amended in 1987 and Tamil Nadu Air (Prevention and Control of Pollution) Rules 1983
The Treasure Trove Act 1878
Manufacture, Storage and Import of Hazardous Chemicals Rules 1989
Noise Pollution (Regulation and Control) Rules 2000, Amended in 2010
Construction and Demolition Waste Management Rules 2016
Hazardous and Other Waste (Management and Transboundary Movement) Rules 2016

Source: JST

1) Constitutional Provisions

The Constitution of India, under Article 48, provides for the protection and preservation of the environment. It states that “the State will endeavor to protect and improve the environment and to safeguard forests and wildlife of the country.” Furthermore, Article 51-A(g) is focused on fundamental duties emphasizing that “it will be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.”

2) Environmental Protection

The Environmental Protection Act of 1986 articulates a policy for environmental protection covering air, water, and land. It provides a framework for the Central Government to coordinate with Central and State Authorities established under various laws, including the Water Act and Air Act. Under this umbrella legislation, the Central Government is mandated to set National Ambient and Emissions Standards, establish procedures for managing hazardous substances, regulate industrial sites, conduct investigation and research on pollution issues, establish laboratories, and collect and disseminate information.

Among other relevant legislation, the Public Insurance Act (PLIA) of 1991 mandates that business owners operating with hazardous substances obtain insurance policies to cover potential liabilities from accidents, and to establish the Environmental Relief Funds to address accidents involving hazardous substances. The National Environmental Appellate Authority Act of 1997 requires the Central

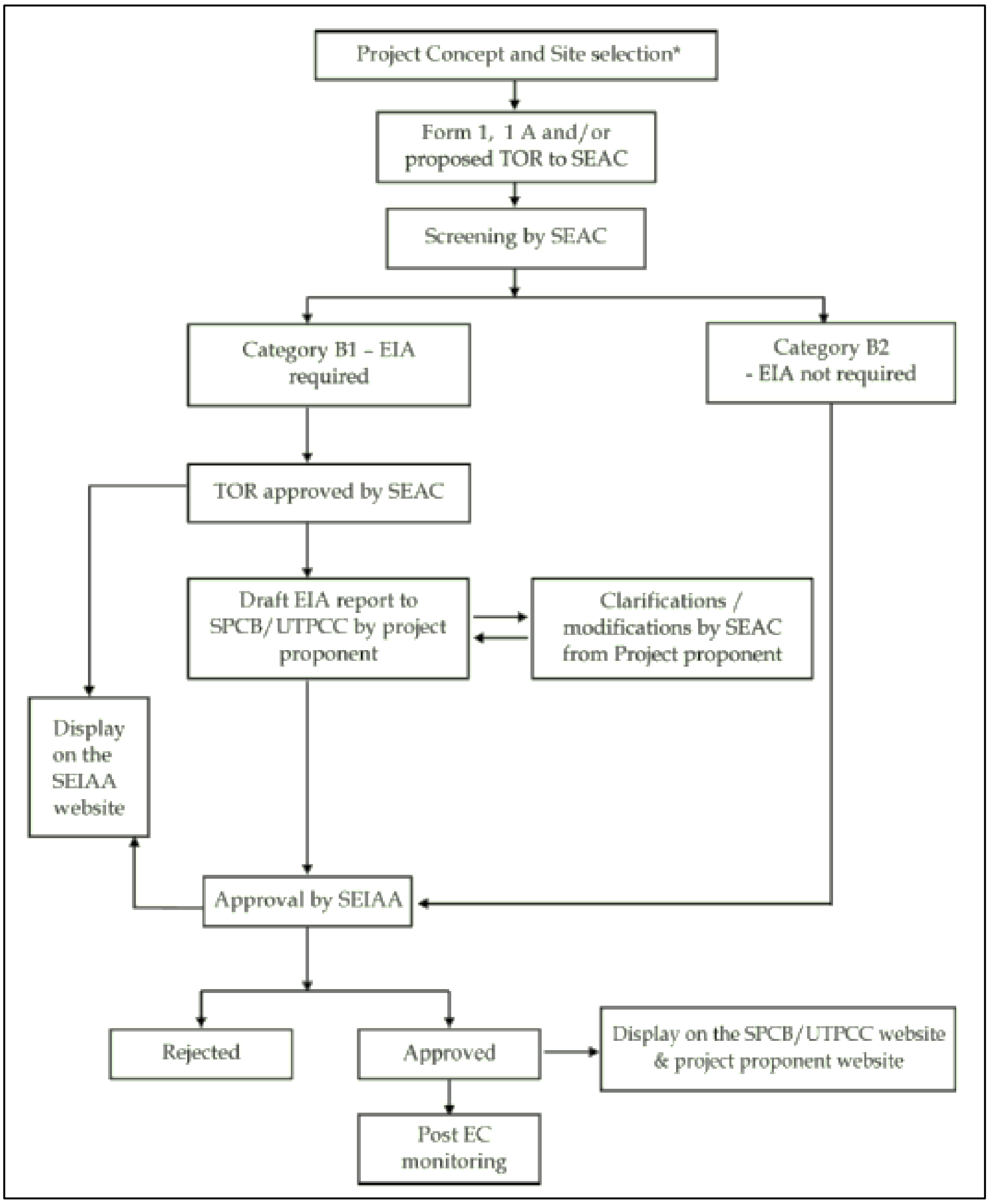
Government to establish an authority to hear appeals concerning area restrictions, where certain operations may be prohibited or permitted under safeguard measures.

3) Environmental Impact Assessment (EIA)

The requirement for conducting an EIA is stipulated in the Environment (Protection) Act and EIA Notification 2006.

The water supply project is not listed in the Schedule of the EIA Notification 2006; thus, EIA approval is not necessary in accordance with provisions of the Notification for implementation of the project.

The EIA procedure is shown in Figure 10.1.10.



Source: EIA Guidance Manual, Ministry of Environment and Forests (2010)

Figure 10.1.10 EIA Procedure

4) Forest Land Use

If forest land is used for non-forest purposes, the Forest (Conservation) Act of 1980 mandates that prior permission is required. To obtain such permission, compensatory afforestation is requested to compensate for the loss of 'land by land' and loss of 'trees by trees.'

Normally, compensatory afforestation must be raised on suitable non-forest land equivalent to the area proposed for diversion, and the cost is borne by the user agency. The amount of compensatory afforestation cost is informed by the Divisional Forest Officer as a demand note in the procedure of approval.

5) Protection of Flora and Fauna

The Wildlife Protection Act of 1972 stipulates that specified species of flora and fauna are to be protected and activities in the sanctuary require permission. The requirement regarding permission to use biological resources is stipulated in the Biodiversity Act of 2002.

6) Waste

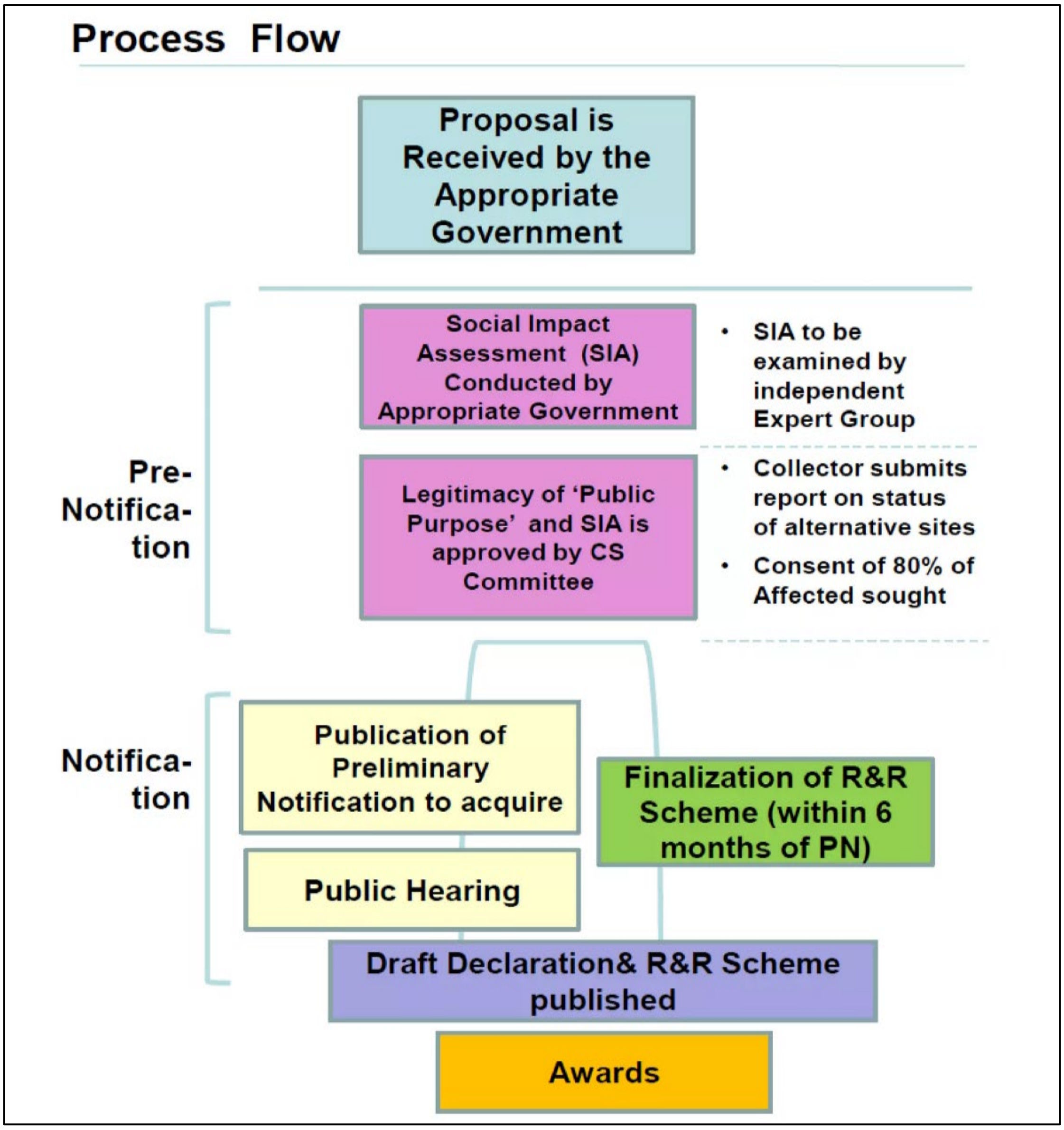
The Construction and Demolition Waste Management Rule of 2016 states that every waste generator shall be responsible for the collection, segregation of concrete, soil, and other debris, storage of construction and demolition waste generated separately, deposit at collection center of the local body or handover to the authorized processing facilities, and ensure that there is no littering/deposition to prevent traffic, drainage, and public obstruction. Waste generators who generate more than 20 tons in one day or 300 tons per project in a month shall submit a waste management plan and get appropriate approvals from the local authority before starting construction, demolition, or remodeling work. Waste must be segregated into five streams such as concrete, soil, steel, wood and plastics, bricks and mortar, while keeping the concerned authorities informed regarding relevant activities from the planning stage to the implementation stage. These shall be applied on a project-to-project basis.

7) Information Disclosure

The nation of India has the right to access information from the government as stipulated in the Right to Information Act of 2005. This also requires all public authorities to computerize their records for wide dissemination and to proactively publish certain categories of information, minimizing the recourse needed by citizens to formally request for information.

8) Land Acquisition

The land acquisition procedure is stipulated in the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation, and Resettlement Act. Land is acquired with a social impact assessment study, and compensation is calculated based on the guideline value of the land. The land acquisition procedure flow is detailed in Figure 10.1.11.



Source: Right to Fair Compensation and Transparency in the Land Acquisition, Rehabilitation, and Resettlement Act ("Indian Economy towards a Pragmatic Land Acquisition Policy for Industrial Use" by Ministry of Rural Development)

Figure 10.1.11 Land Acquisition Procedure

(2) Gap Analysis between the National Laws and JICA Guidelines

The gap analysis between the JICA Guidelines and Indian Law is presented in Table 10.1.12.

Table 10.1.12 Gap Analysis between the Indian Regulation and the JICA Guideline on EIA Study

JICA Guidelines for Environmental and Social Considerations	Relevant Law in India	Gap between JICA Guidelines and Government Law/Actions to be Taken
Principles		
Environmental impacts that may be caused by projects must be assessed and examined at the earliest possible planning stage. Alternative options or mitigation measures to avoid or minimize adverse impacts must be examined and incorporated into the project plan.	<u>Environment (Protection) Act 1986 and EIA Notification 2006</u> Subject to the provisions of this Act, the Central Government has the power to take all necessary measures deemed necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling, and abating environmental pollution.	There is no major gap between the JICA Guidelines and Indian Law. The water supply project is not listed in the Schedule of the EIA Notification 2006.
Information Disclosure		
- EIA reports (which may be referred to differently under different systems) must be written in the official language or in a language widely used in the country in which the project is to be implemented. When explaining the projects to local residents, written materials must be provided in a language and form understandable to them. - EIA reports are required to be made available to the residents of the country in which the project is to be implemented. The reports must always be available for perusal by project stakeholders, such as residents., and duplication of the reports must be permitted.	<u>EIA Notification 2006</u> For public hearings, Summary EIA Reports are prepared in English in the local language and are disclosed in selected offices, public libraries, panchayats, and other accessible locations.	There is no major gap between the JICA Guidelines and Indian Law. However, EIA for the project is not requested in EIA Notification 20006.
Social Acceptability		
- For projects with a potentially large environmental impact, adequate consultations with local stakeholders, such as local residents, must be conducted via the disclosure of information at an early stage, when alternatives for project plans can still be examined. The outcomes of these consultations must be incorporated into the contents of project plans. - In preparing EIA reports, consultations with stakeholders, such as residents, must take place after sufficient information has been	<u>EIA Notification 2006</u> - Public Consultation refers to the process where the concerns of local affected persons and those who have a plausible stake in the environmental impacts of the project or activity are ascertained with a view to consider all the material concerns in the project or activity design as appropriate. All Category A and Category B1 projects or activities shall undertake Public Consultation. - After completion of the public consultation, the applicant shall address all material	There is no major gap between the JICA Guidelines and Indian Law. The EIA for the project is not requested in EIA Notification 2006. It is necessary that the project authorities shall arrange the public consultation at the block level with local stakeholders, such as the residents, which must be conducted via disclosure of information at an early stage, at which time, alternatives for project plans may be examined. The summary of the project will be made available after the consultation with locals, where enough information was collected from the locals. After public

disclosed. Records of such consultations must be prepared. - Consultations with relevant stakeholders, such as residents, should also be conducted, as necessary, throughout both the preparation and implementation stages of a project. Holding consultations is highly desirable, especially when the items to be considered in the EIA are being selected and when the draft report is being prepared.	environmental concerns expressed during the process and make appropriate changes to the draft EIA and EMP. - A public hearing shall be conducted at or near the project site(s) by the State Pollution Control Board (SPCB) or the Union territory Pollution Control Committee (UTPCC) concerned in the specified manner. The proceedings should then be forwarded to the regulatory authority concerned within 45 days or a request to the effect from the applicant.	consultations, the record of consultation is prepared.
Scope of Impacts to be Assessed		
- The impacts to be assessed on environmental and social considerations include impacts on human health and safety, as well as the natural environment (transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora) in trans-boundary or global scale impacts. - These also include social impacts, including population migration and involuntary resettlement; effects on the local economy, such as employment and livelihoods; utilization of land and local resources; impacts on social institutions, such as social capital and local decision-making institutions existing social infrastructure and services; vulnerable social groups, such as the poor and indigenous peoples; equality in the distribution of benefits and losses, and equality in the development process; gender and children's rights; cultural heritage; local conflicts of interest; infectious diseases such as HIV/AIDS; and working conditions, including occupational safety. - In addition to direct and immediate impacts of projects, derivative, secondary, and cumulative impacts, as well as impacts of projects that are indivisible from the project,	EIA Notification 2006 The following items are required to be assessed in EIA: - Land Environment (including soil and waste) - Water Environment - Vegetation - Fauna - Air Environment - Aesthetics - Socio-economic Aspects - Building Materials - Energy Conservation	Regarding social aspects, a detailed point of view is not described in the EIA Notification 2016. Derivative, secondary, and cumulative impacts, as well as indivisible projects, are also not described. Since the EIA for this project is not requested under the EIA Notification 2006, the impact assessed has been conducted with reference to the JICA Guidelines.

must also be examined and assessed to a reasonable extent. It is also desirable to consider impacts that may occur at any stage of the project cycle, throughout the life cycle of the project.		
Monitoring and Grievances		
- Project proponents should make efforts to make the results of the monitoring process available to local project stakeholders. - When third parties point out that environmental and social considerations are not being fully undertaken, forums for discussion and examination of countermeasures are established based on sufficient information disclosure, including stakeholders' participation in relevant projects. Project proponents should make efforts to reach an agreement on procedures to be adopted for addressing problems.	<u>EIA Notification 2006</u> - It shall be mandatory for the project management to submit semi-annual compliance reports on the stipulated environmental clearance terms and conditions, both in hard and soft copies, to the concerned regulatory authority by June 1st and December 1st of each calendar year. - All compliance reports and documents submitted by project management shall be made available to the public. Copies of the these shall be given to concerned regulatory authorities. The latest version of the compliance report shall be displayed on the website of the concerned regulatory authority.	Detailed procedures or methods for addressing concerns raised by third parties are not described. The project proponent should consider the method of unveiling the result of self-conducted monitoring such as uploading to the website and to show the solution for concerns raised under the Environmental Management Plan.
Ecosystem and Biota		
Project must not involve significant conversion or significant degradation of critical natural habitats and critical forests.	<u>Forest (Conservation) Act 1980 and Rules 1981 as amended in 2024</u> The Forest (Conservation) Act (FCA) was adopted in 1980 to ensure the protection and conservation of forests. The Act restricts the powers of the State in respect of the de-reservation of forests and the use of forestlands for non-forest purposes. <u>Wildlife (Protection) Act 1972</u> This Act provides for the protection of wild animals, birds, and plants, and for matters connected therewith or ancillary or incidental thereto. Birds are covered under this Act making it illegal to catch, keep, kill, buy/sell birds, or damage their nests. All indigenous bird species are covered under this Act including peacocks.	No major gap.

Source: JST

10.1.4 Comparison of the Alternative Measures (Including the "Zero Option")

A comparison of alternatives, including the "no project option" or the "zero option", was conducted for the alternatives to examine whether the project is technically superior. The results of the alternatives comparison are summarized in Table 10.1.13.

- Zero option (no project): Although water supply conditions in Dharmapuri and Krishnagiri districts have improved to some extent, population growth has exceeded the initial projections, resulting in insufficient water supply. Therefore, the development of a rural water supply system sourced from the Cauvery River is essential to meet the increasing demand for domestic, commercial, and industrial water, and to achieve the target water supply level in India. This alternative is not recommended.

- Water Treatment Plant (WTP) construction site: A qualitative comparative analysis was made between government-owned land located far from the intake pumping station and privately-owned land situated near the intake. The feasibility of the project on government-owned land far from the intake pumping station was assessed to be highly feasible.

- Wastewater treatment: To minimize the impact on the water quality of the Cauvery River and the reuse of water resources, it is recommended that instead of discharging the treated water off-site, sludge be allowed to settle, and the wastewater be collected and returned to the treatment facility for reuse.

Table 10.1.13 Results from the Comparison of Alternatives

Item	Without Project Scenario	Far from intake point in government land	Near the intake point in private land	Disposal in the Cauvery River	Collecting the surface water after settling the sludge
Construction Cost Advantage (+) Disadvantage (-)	No construction work is implemented	(+) Cost for land acquisition is not necessary (-) Length of pipeline is longer and construction cost is higher	(-) Cost for land acquisition and resettlement is necessary (+) Length of pipeline can be minimized and cost of construction is lower	-	-
Environmental and Social Impact	No negative impact and positive impact	No significant impact on environment and social aspects	(-) Impact on social aspect is bigger since land acquisition and involuntary resettlement are required, and measures should be considered and implemented	(-) Impact on water quality is anticipated	(+) Water resource is reused
Overall Evaluation	-	Priority Option	-	-	Priority Option

Source: JST

A comparison of WTP construction sites is shown in Figure 10.1.12.

Source: JST

Figure 10.1.12 Comparison of WTP Construction Site

10.1.5 Scoping and TOR for the Survey on Environmental and Social Considerations

To assess the likely significant environmental and social impacts, conceivable environmental and social impacts from the project implementation were identified based on the project description and the present environmental and social conditions in and around the surrounding areas of the project sites.

The results of the scoping for the Environmental and Social Impact Assessment are shown in Table 10.1.14. Scoping was conducted in two stages: the Construction Stage (CS) and the Operation Stage (OS).

Table 10.1.14 Results of Scoping for Environmental and Social Impact Assessment

No.	Impacts	Ratings		Brief Description (Reasons for Scoping Evaluation)
		CS	OS	
Pollution Control Measures				
1	Air Quality	✓		(CS) Impact on air quality due to operation of construction machinery and traveling of construction vehicles is expected. (OS) No planned activity that will cause air pollution.
2	Water Quality	✓		(CS) Impact on water quality from the muddy water due to construction of the intake point and WTP is expected. (OS) No planned activity that will cause water pollution.
3	Waste	✓	✓	(CS) Construction waste will be generated, such as excavated soil. (OS) Sludge will be generated due to the water treatment process.
4	Soil Contamination			(CS, OS) No planned activity will cause soil contamination.
5	Noise and Vibration	✓		(CS) Increase of noise and vibration levels due to construction machineries and traveling of construction vehicle would occur temporarily. (OS) No planned activity will result in an increase of noise and vibration level. Regarding the pump station operation, noise

No.	Impacts	Ratings		Brief Description (Reasons for Scoping Evaluation)
		CS	OS	
				and vibration will not cause a significant impact because a pump station is installed in the building and is operated in a closed environment.
6	Ground Subsidence			(CS, OS) No planned activity will cause ground subsidence.
7	Offensive Odor	✓		(CS) Odors from garbage and wastewater discharged from construction workers' quarters, etc. are expected. (OS) No planned activity will cause offensive odor.
8	Bottom Sediment			(CS, OS) No planned activity will cause bottom sediment.
Natural Environment				
9	Protected Area			(CS/OS) No planned activities have impact on the protected area.
10	Flora/Fauna and Biodiversity	✓	✓	(CS) Some species might be affected by the project. (OS) There will be potential impact on downstream ecosystems due to changes in the river flow caused by water withdrawal.
11	Hydrology			(CS, OS) No planned activity will result in the increase of rainwater discharge.
12	Topography and Geology			(CS, OS) No planned activity will have adverse effects on the topography and geographical feature.
Social Environment				
13	Involuntary Resettlement/Land Acquisition			(CS, OS) Involuntary resettlement and land acquisition are not planned for the proposed project since the project is implemented within government-owned land.
14	Poverty			(CS, OS) The proportion of the population in a state of multidimensional poverty is 1.79% in Dharmapuri District and 1.78% in Krishnagiri District. In addition, it is anticipated that positive impacts include the creation of local employment.[69]
15	Ethnic Minorities and Indigenous Peoples			(CS, OS) There are no ethnic minority and indigenous people living in the proposed Project area.
16	Local Economy (Employment)			(CS, OS) Positive impacts such as creation of local employment are predicted.
	(Livelihood)			(CS, OS) Positive impacts such as creation of local employment are predicted.
17	Land Use and Utilization of Local Resources			(CS, OS) Impacts on land use and local resources are not expected because government land will be used for this project.
18	Water Usage	✓	✓	(CS) Impact on water use is expected if muddy water is discharged to the river during construction of intake point and WTP. (OS) The impact on the use of water for agriculture and drinking water downstream of the intake point is expected to be significant.
19	Existing Social Infrastructure and Service	✓		(CS) Traffic of construction vehicles and trucks, and construction machines may cause traffic jams. (OS) No activity is planned that will impact social infrastructure

[69] State Planning Commission, Government of Tamil Nadu, "Multidimensional Poverty Index for Tamil Nadu," August 2022

No.	Impacts	Ratings		Brief Description (Reasons for Scoping Evaluation)
		CS	OS	
				and service.
20	Social Institutions (Social Infrastructure) and Local Decision-making Institutions			(CS, OS) No planned activity will affect the social and local institutions.
21	Maldistribution of Damage and Benefit			(CS, OS) No planned activity will cause maldistribution of the damage or benefit.
22	Local Conflict of Interest			(CS, OS) No planned activity will cause conflict.
23	Cultural Heritage	✓		(CS) Noise and vibration in the neighborhood, and impact on traffic are expected. (OS) No activity is planned that will affect the cultural heritage because the Project area is owned by government and there is no cultural heritage.
24	Landscape			(CS, OS) No planned activity will have impact on the landscape.
25	Gender		✓	(CS) No planned activity will have negative impact on gender. (OS) Potential impact on gender-specific roles for water use and management.
26	Children's Rights			(CS, OS) No planned activity will have impact on children's rights.
27	Infectious Disease and HIV/AIDS	✓		(CS) Inflow of construction workers may increase the risks of communicable diseases. (OS) No activities are planned that will increase the risk of communicable
28	Occupational Health and Safety	✓	✓	(CS) Impact on the working conditions of construction workers is expected. (OS) Impact on the working conditions on workers of the WTP is expected.
Others				
29	Accidents	✓		(CS) Impacts of construction vehicles to the local communities are predicted. (OS) No major accidents are expected in the operating facility.
30	Cross-border Impact; Climate Change			(CS/OS) Emission of greenhouse gases (GHGs) due to construction is not expected.

Source: JST

10.1.6 Survey Result of the Environmental and Social Considerations

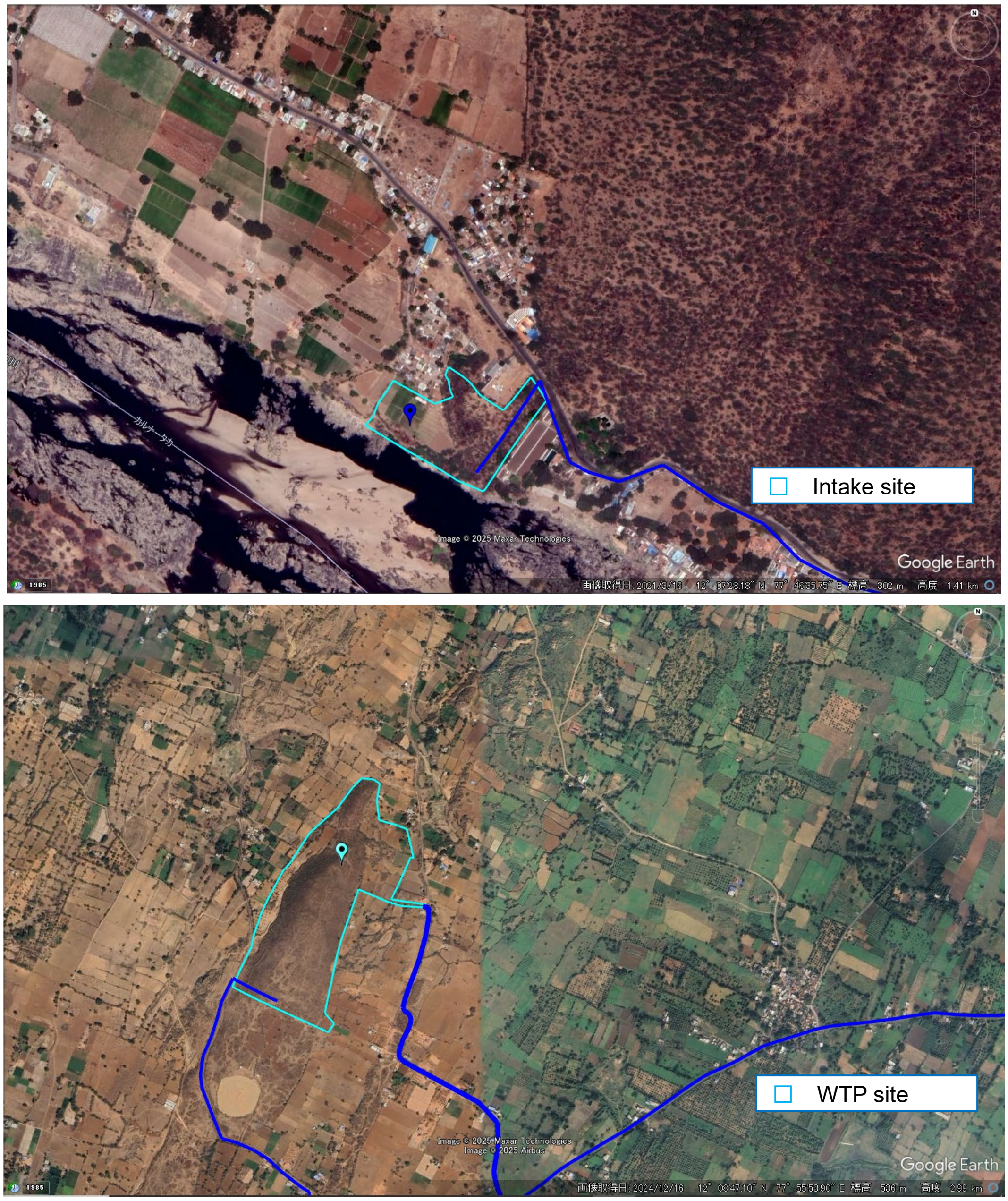
(1) Living Environment

1) Air Quality, Noise, and Vibration

During the construction stage, construction vehicles such as large cars and trucks will be used for the travel of materials and movement of workers.

The operation of construction machinery and movement of these vehicles may have impacts on air quality, noise, and vibration levels. In particular, large-scale construction works—such as those for the WTP, raw water reservoirs, and pipelines—can generally have significant environmental and social impacts. As shown in Figure 10.1.13, the water intake construction site is located near a residential area, while the WTP construction site is about 1 km away from the nearest residential zone. Generally, noise and vibration levels are sufficiently attenuated at distances more than 200 m from construction sites.

Additionally, during construction, appropriate mitigation measures shall be taken to address air pollution, noise, and vibration impacts.



Source: JST

Figure 10.1.13 Intake Point and WTP Construction Site Location

2) Water Quality

Muddy water generated from construction activities may flow into nearby rivers, potentially leading to deteriorated water quality. This impact can be mitigated by installing garland drains. Figure 10.1.14 shows the source of water for the project and the proposed intake point.

Source: JST

Figure 10.1.14 Source of Water and the Proposed Intake Point

3) Waste

The contractors will be responsible for the collection, segregation, and storage of construction waste, ensuring that it is deposited at designated collection centres or handed over it to authorised processing facilities in accordance with the Construction and Demolition Waste Management Rules, 2016. During the construction phase, the workforce will also generate general refuse, comprising food scraps, paper, empty containers, etc. The volume of such waste will largely depend on the size of the workforce employed by the contractor.

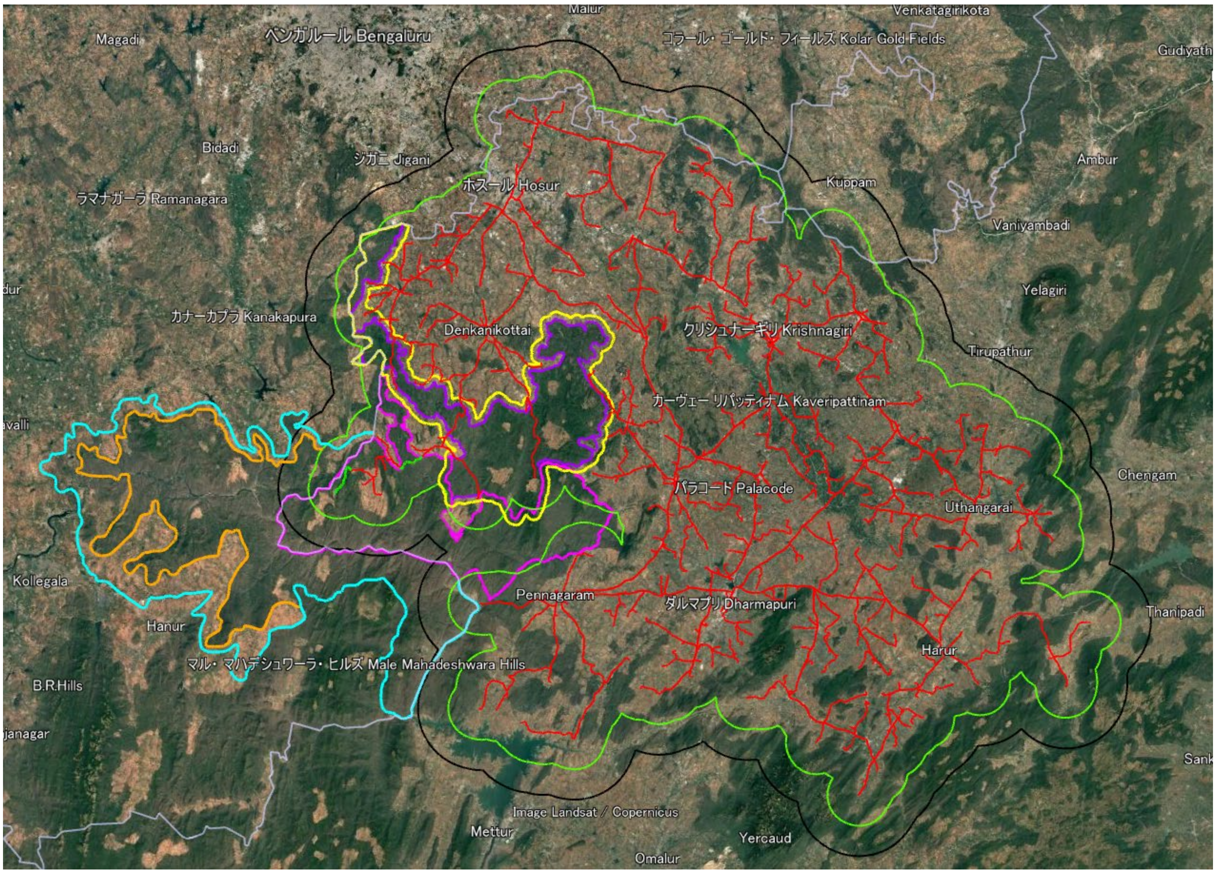
During the operation phase, small quantities of domestic waste from office area at the water intake facility and the WTP, along with chemical waste from equipment maintenance activities.. Improper onsite storage of domestic waste may lead to adverse environmental impacts, including odour nuisance, pest and vermin infestation, deterioration of water quality, and negative visual impacts.

(2) Natural Environment

The pipelines will pass through certain Reserved Forest areas. Reserved Forests are designated by the State Government as defined in the Indian Forest Act, 1927, where activities such as timber harvesting, hunting, trapping of wild animals, and livestock grazing are restricted.

Construction activities within forested areas, including the Reserved Forest under the project, may affect the ecosystem through activities such as falling 61 trees. On the other hand, construction activities at the water intake point and the WTP are expected to cause only temporary impacts during the construction phase and are not anticipated to significantly affect vegetation. Drilling activities will be of short duration (three to four months), and any impacts on existing flora and fauna in the area are expected to be temporary. No significant impacts to wildlife—other than grazing animals—are expected, although noise generated by excavation activities and equipment may result to temporary changes in terrestrial faunal activity.

Mitigation measures include controlling dust generated during construction, installing water pollution control membranes and other equipment, properly managing waste materials, and using noise-reducing equipment. Prior to the commencement of construction work, the Project is obtaining the necessary permits in compliance with legislative procedures. The image of environmentally sensitive areas is shown in Figure 10.1.15.



Note: Pipeline Cauvery North Wildlife Sanctuary Core Cauvery North Wildlife Sanctuary ESZ
Cauvery South Wildlife Sanctuary Cauvery Wildlife Sanctuary Core Cauvery Wildlife Sanctuary ESZ
State Boundary 5 km from the Project area 10 km from the Project area
Source: JST, from TWAD, Environmental Impact Assessment Report for Proposed Hogenakkal Combined Water Supply Scheme for Dharmapuri and Krishnagiri Districts – Phase 2, November 2024

Figure 10.1.15 Project Site and Environmental Sensitive Areas

(3) Social Environment

1) Poverty

CS/OS: As provided by the Project, the impacts on the affected villages will be positive in terms of employment generation, provision of facilities for drinking water, and others.

2) Local Economy (Employment)

CS/OS: Positive impacts such as the creation of local employment are predicted.

3) Local Economy (Livelihood)

CS/OS: Economic effects from the purchases of the workers and plant operators, such as food and commodities, who will come from outside the village for the project.

4) Land Use and Utilization of Local Resources

CS/OS: No planned activity will impact land use and utilization of local resources.

5) Water Usage

CS: Residents of the surrounding area who use water from the river will be restricted from accessing the river. The impact of muddy water near the construction sites of the raw water pumping stations will be mitigated by installing a garland drain.

OS: Project operation activities will not affect water usage for other purposes.

6) Existing social infrastructure and services

CS: Construction work including the transportation of construction vehicles are expected to cause traffic congestion and limitation of access to social infrastructure temporarily.

OS: No planned activity will have an impact on social infrastructure and services.

7) Landscape

CS/OS: No planned activity will impact the existing landscape.

8) Gender

CS: No planned activity will have an impact on gender.

OS: The water supply pipeline will be connected to each house and the burden of women—who are the main bearers of water collection work—is expected to be reduced. Therefore, women can save their time for activities other than water collection work, and it is expected to contribute to the improvement of the status and rights of women.

9) Children's Rights

CS/OS: No planned activity is seen to violate the children's rights.

10) Infectious Disease and HIV/AIDS

CS: As workers will come to the construction sites, an increase in the risk of infectious diseases such as HIV/AIDS is expected. The contractors shall be responsible for providing sufficient education and awareness trainings for the workers and the people in the locality.

OS: No planned activities will increase the risk of communicable diseases.

11) Occupational Health and Safety

CS: Workers have a risk of being affected by air pollution, such as dust and gas emission due to the construction works, and the risk of heart attack is increased.

OS: There is a risk of chlorine gas inhalation for the workers at the WTP.

(4) Others

1) Accident

CS: Due to the use of construction machinery and vehicles, risk of accidents is expected to increase in and around the construction sites. To minimize accidents, the contractors shall be responsible for providing education and awareness trainings for the workers and communities around the construction sites.

OS: Impact of accidents from the operation is not expected.

2) Cross-border Impact and Climate Change

CS/OS: Greenhouse gas (GHG) emissions from the construction works and facility operation do not cause a significant impact.

10.1.7 Impact Assessment

The results of the impact assessment for the proposed project are presented in Table 10.1.15.

Table 10.1.15 Assessment of the Project

No.	Impacts	Scoping Result		Survey Result		Basis/Reason for the Survey Result
		CS	OS	CS	OS	
Pollution Control Measures						
1	Air quality	✓		B-	N/A	(CS) The construction works may cause air pollution; thus, mitigation measures should be implemented. (OS) No planned activity will cause air pollution.
2	Water quality	✓		B-	N/A	(CS) Flow of the generated muddy water into rivers near the construction site of the intake point will impact the water quality, thus, mitigation measures should be taken. (OS) No planned activity will cause water pollution. Wastewater from facility operation is not discharged outside the site because after sludge precipitation, the upper water is collected and returned to the treatment facility.
3	Waste	✓	✓	B-	B-	(CS) Generated waste should be managed and transported to authorized waste management and processing plants. (OS) Sludge will be collected and disposed of by the sludge handling system in the WTP.
4	Soil Contamination			N/A	N/A	(CS, OS) No planned activity will cause soil contamination.
5	Noise and Vibration	✓		B-	N/A	(CS) The construction works near existing houses may generate noise and vibration; thus, mitigation measures should be taken. (OS) No planned activity will result in an increase of noise and vibration level.
6	Ground Subsidence			N/A	N/A	(CS, OS) No planned activity will cause ground subsidence.
7	Offensive Odor			D	N/A	(CS) Odors may be generated from food scraps, empty food and drink containers, etc. discharged by the workers. (OS) Odors from domestic waste at the water intake facilities and WTP offices may be generated.
8	Bottom Sediment			N/A	N/A	(CS, OS) No planned activity will cause bottom sediment.
Natural Environment						
9	Protected Area			N/A	N/A	(CS, OS) No planned activities will affect protected areas.
10	Flora/Fauna and Biodiversity	✓		B-	N/A	(CS) Pipelines planned for construction in forest areas will impact flora, fauna, and biodiversity, such as through tree cutting. As mitigation, TWAD will provide the State Government with twice the area of forest land to be acquired for the

No.	Impacts	Scoping Result		Survey Result		Basis/Reason for the Survey Result
		CS	OS	CS	OS	
						Project site. (OS) Water withdrawal from Cauvery River is about 5% (465 MLD out of 8,640 MLD) of the average dry season flow, and no significant downstream impacts are anticipated.
11	Hydrology			N/A	N/A	(CS, OS) No planned activity will increase rainwater discharge.
12	Topography and Geology			N/A	N/A	(CS, OS) No activity is expected to have adverse effects to the current topographical and geographical features.
Social environment						
13	Involuntary Resettlement/Land Acquisition			N/A	N/A	(CS, OS) Involuntary resettlement or other impacts on livelihoods have not been identified.
14	Poverty			N/A	N/A	(CS, OS) There will be a positive impact regarding people of the affected villages in terms of employment generation, provision of facilities for drinking water, and other social aspects which will be created from the project.
15	Ethnic Minorities and Indigenous Peoples			N/A	N/A	(CS, OS) There are no ethnic minority, and indigenous peoples present within the project site.
16	Local Economy (Employment)			N/A	N/A	(CS, OS) Positive impacts such as the creation of local employment are predicted.
	Local Economy (Livelihood)			N/A	N/A	(CS, OS) Economic effects will be affected by the purchase of food and commodities by the workers and plant operators who will be coming from outside the village for the project.
17	Land Use and Utilisation of Local Resources			N/A	N/A	(CS) The project construction will be located on government land. (OS) No planned activity will impact land use and utilization of local resources.
18	Water Usage	✓		B-	N/A	(CS) The flow of generated muddy water into the river near the construction sites of the intake point has impact on water usage, thus, mitigation measures should be taken. (OS) Water withdrawal from the Cauvery River is about 5% (465 MLD/8,640 MLD) of the average dry season flow, thus no significant downstream impacts are anticipated.
19	Existing Social Infrastructure and Service	✓		B-	N/A	(CS) The construction works including the transport of construction vehicles are expected to temporarily cause traffic congestion and limitation of access to social infrastructure. (OS) No planned activity will have an impact on social infrastructure and service.
20	Social Institutions such as Social Infrastructure and			N/A	N/A	(CS, OS) No planned activity will affect social and local institutions.

No.	Impacts	Scoping Result		Survey Result		Basis/Reason for the Survey Result
		CS	OS	CS	OS	
	Local Decision-making Institutions					
21	Maldistribution of Damage and Benefit			N/A	N/A	(CS, OS) No planned activity will cause maldistribution of damages or benefits.
22	Local Conflict of Interest			N/A	N/A	(CS, OS) No planned activity is expected to cause conflict of interest.
23	Cultural Heritage	✓		B-	N/A	(CS) Noise and vibration in the surrounding neighborhood, and potential impacts on traffic, are expected. (OS) No planned activity will affect any cultural heritage, as the Project area is government-owned and contains no known cultural heritage sites.
24	Landscape			N/A	N/A	(CS, OS) No planned activity is expected to impact the present landscape.
25	Gender			D	A+	(CS) No planned activity will have negative impacts on gender. (OS) Women can utilize their time for other activities besides water collection work, contributing to the improvement of women's status and rights.
26	Children's Rights			N/A	N/A	(CS, OS) No planned activity will have an impact on children's rights.
27	Infectious Disease and HIV/AIDS	✓		B-	N/A	(CS) Since workers will be coming to the construction site, it is expected that the risk of infectious diseases such as HIV/AIDS will increase. (OS) No planned activities will increase the risk of communicable diseases.
28	Occupational Health and Safety	✓	✓	B-	B-	(CS) The workers will be at risk of being affected by air pollution, such as dust and gas emission due to construction works. The risk of heat attacks is also expected. (OS) There is a risk of chlorine gas inhalation for the workers in the WTP.
Others						
29	Accidents	✓	✓	B-	D	(CS) The use of construction machinery and vehicles is expected to increase the risk of accidents in and around the construction sites. (OS) The impact of accidents from the operation is not expected.
30	Cross-border Impact and Climate change			N/A	N/A	(CS, OS) GHG emissions from the construction works will not cause any significant impact.

Note: CS (Construction Stage), OS (Operation Stage)
A-: Significant negative impact A+: Significant positive impact
B-: Some negative impact B+: Some positive impact

C: Impacts are not clear; need more investigation
D: No impacts or impacts are negligible; no further study is required
N/A: Impact assessment is not conducted because the item was categorized as D in the scoping phase
Source: JST

10.1.8 Mitigation measures and Environmental Management Plan

The Environmental Management Plan (EMP) contains a list of mitigation measures against the possible environmental and social impacts identified in the section above. It will serve as guidance to an eco-friendly implementation of the project by ensuring;

(i) There is efficient communication between the project management consultants and contractors;

(ii) The activities are undertaken in a responsible, non-detrimental manner—providing a pro-active, feasible, and practical working tool to enable the measurement and monitoring of environmental performance on site;

(iii) A guided and controlled implementation of findings and recommendations of the environmental assessment conducted for the subproject;

(iv) Detailed actions essential to assist in mitigating the environmental impact of the subproject; and

(v) Safety recommendations are complied with.

Regarding the working environment, the Project proponent, TWAD, being a public institution, fully complies with relevant Indian laws on working conditions. Appropriate mitigation measures will be implemented to address potential health and safety risks.

The mitigation measures and implementing organization for each project stage are shown in Table 10.1.16.

Table 10.1.16 Mitigation Measures

No.	Potential Negative Impact	Mitigation Measures	Responsible Agencies	Monitoring Agencies	Cost
During Construction					
1	Air Quality	- Control dust by sprinkling water on exposed soil, and stockpiling materials on site. - Barricade areas using wind sheets. - Use tarpaulins to cover sand and other loose materials when transported by trucks. - Clean wheels and undercarriage of haul trucks prior to leaving the construction site. - Prevent entry of traffic and the public in the construction area. - Install all heavy equipment and machinery with air pollution control devices, and ensure they are properly operating.	Contractor	TWAD	Included in construction cost
2	Water Quality	- Install silt screen and sedimentation tank.	Contractor	TWAD	Included in construction cost
3	Noise and Vibration	- Conduct noise-generating activities during daytime hours. - Minimize noise from construction equipment by installing silencers on construction vehicles, noise-reducing mufflers on drills and other machinery, and installing noise barriers. - Consult with local communities in advance to avoid working at sensitive times, such as religious and cultural festivals.	Contractor	TWAD	Included in construction cost
4	Waste	- After consultation with local authorities in the Project area, waste will be properly disposed at a designated site which is selected prior to the start of construction.	Contractor	TWAD	Included in construction cost
5	Ecosystem	- The main logging activity in the area under operation involves 61 trees. TWAD will provide the Forest Department with alternative land for afforestation (equivalent to the forest area to be acquired from the State Government for the Project) and will cover the cost of afforestation, which will be carried out by the Forest Department. The Forest Department will issue a written document called “Demand Note” specifying the amount, and TWAD shall make payment accordingly. - The contractor shall take all reasonable precautions to ensure that the contractor's workers and other individuals do not remove, damage, or disturb flora (plants/vegetation) or fauna (animals), including fishing or hunting in water bodies. - If wildlife is found in the vicinity of the construction site, the contractor shall report it to the engineer as soon as it is discovered and shall follow the engineer's instructions.	Contractor	TWAD	Included in construction cost
6	Water usage	- Install silt screen and sedimentation tanks.	Contractor	TWAD	Included in construction cost
7	Existing	- Where necessary, pedestrian paths will be constructed to provide access to social	Contractor	TWAD	Included in

No.	Potential Negative Impact	Mitigation Measures	Responsible Agencies	Monitoring Agencies	Cost
	Infrastructure Service	infrastructure. - Inform residents in the vicinity in advance regarding the construction project and work schedule.			construction cost
8	Cultural Heritage	- Where necessary, pedestrian paths shall be constructed to access social infrastructures. - Inform residents in the vicinity of the construction project and work schedule in advance.	Contractor	TWAD	Included in construction cost
9	Infectious Diseases and HIV/AIDS	- Inform workers and surrounding communities about the risks of infectious diseases, preventive measures, and available treatments. - Prevent illness among workers by implementing health awareness initiatives.	Contractor	TWAD	Included in construction cost
10	Occupational Health and Safety	- Provide adequate medical facilities and first aid services within the construction site. - Provide personal safety equipment such as helmets, gloves, etc. shall be provided to workers on the Project. In addition, appropriate hazard signs and hazard markings will be provided within the facilities. - Implement soft measures to improve working conditions, such as providing health and safety training programs for workers, and conducting regular patrols at each facility.	Contractor	TWAD	Included in construction cost
11	Accident	- Provide safe driving training to all project drivers. - Share construction and safety information with surrounding communities. - Prevent unauthorized entry into the construction site.	Contractor	TWAD	Included in construction cost
Operation Phase					
1	Waste	- After consultation with local authorities in the Project area, waste shall be properly disposed at the designated site.	Contractor	TWAD	-
2	Occupational Health and Safety	- Provide workers with the appropriate personal protective equipment and train them on the their proper usage. - Use fall protection equipment when working at heights. - Have an evacuation plan in the event of chlorine gas emissions.	Contractor	TWAD	-

Source: JST

10.1.9 Environmental Monitoring Plan

The Environmental Monitoring Plan (EMoP), which presents the monitoring items, locations, frequency, and responsible parties for each project phase, is shown in Table 10.1.17 and Table 10.1.18. Moreover, the Monitoring Form and Environmental Checklist are shown in Appendix-10.2 and Appendix-10.3, respectively.

Table 10.1.17 Environmental Monitoring Plan on Construction Phase

Item	Parameters	Frequency	Location	Implementin g Agency	Responsible Agency	Cost
Air Quality	PM10, PM2.5, SO_2, NO_X, CO and Pb (Standards as per CPCB), status of mitigation measure	Quarterly	Intake point, booster stations, and the proposed WTP	Consultant	TWAD	Included in construction cost
Water Quality	Drinking water standards as per IS 10500:2012, status of mitigation measure	Quarterly	Intake point	Consultant	TWAD	Included in construction cost
Noise and Vibration	Noise level on dB(A) scale noise levels on dB(A) scale (as per MoEF Noise Rulers, 2000), status of mitigation measure	Quarterly	Intake point, booster stations, and the proposed WTP	Consultant	TWAD	Included in construction cost
Waste	Amount of excavated soil and status of disposal of excavated soil	Monthly	Intake point, booster stations and proposed WTP	Consultant	TWAD	Included in construction cost
Ecosystem	Progress of the tree cutting	Quarterly	Intake point, booster stations, and the proposed WTP	Consultant	TWAD	Included in construction cost
Water Use	Grievance from the surrounding communities	Monthly	Construction sites	Consultant	TWAD	Included in construction cost
Existing Infrastructure	Grievance from the surrounding	Monthly	Construction sites	Consultant	TWAD	Included in construction

Item	Parameters	Frequency	Location	Implementing Agency	Responsible Agency	Cost
Service	communities					cost
Cultural Heritage	Grievance from the surrounding communities	Monthly	Construction sites	Consultant	TWAD	Included in construction cost
Infectious Diseases and HIV/AIDS	Records of educational activities related to infectious diseases	Monthly	Construction sites	Consultant	TWAD	Included in construction cost
Occupational Health and Safety	Status of OHS training programs and establishment of medical facilities	Weekly	Construction sites	Consultant	TWAD	Included in construction cost
Accidents	Accident records in and around the construction site	Weekly	Construction sites	Consultant	TWAD	Included in construction cost

Source: JST

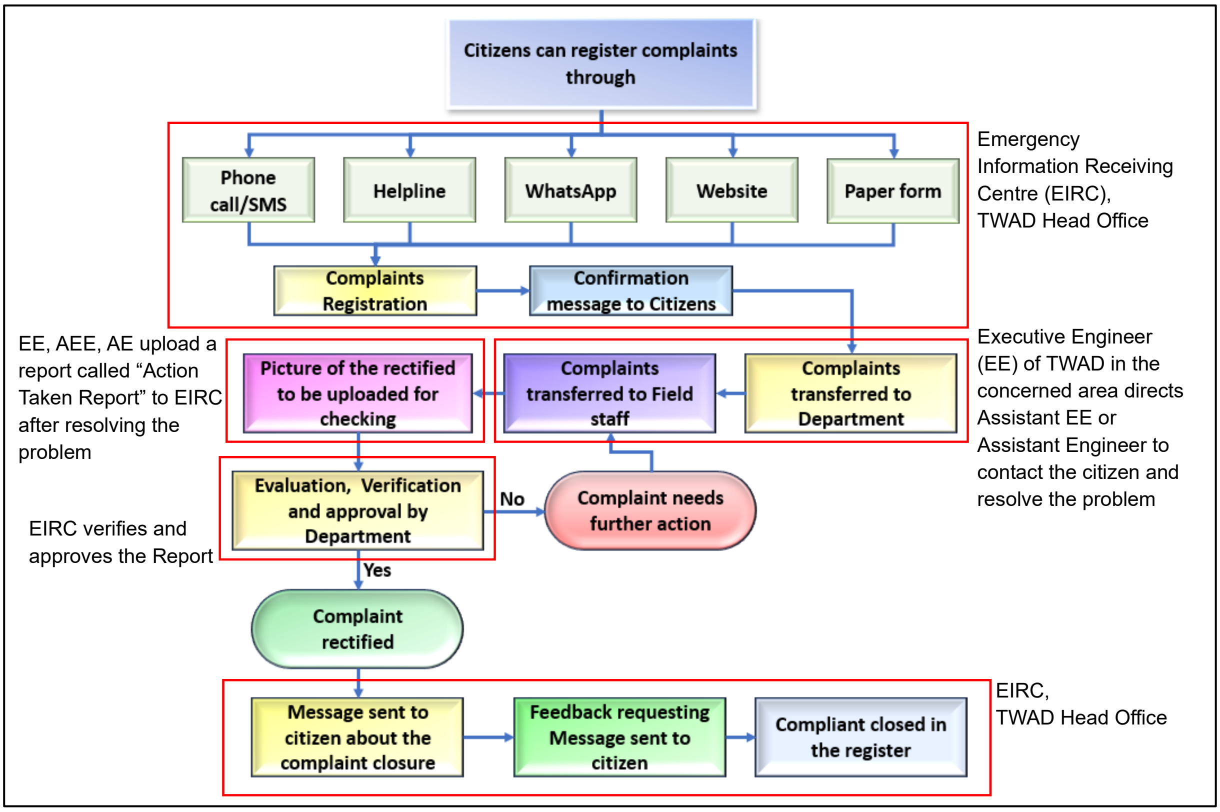
Table 10.1.18 Environmental Monitoring Plan on Operation Phase

Item	Parameters	Frequency	Location	Implementing Agency	Responsible Agency	Cost
Waste	Amount of sludge discharged and its disposal status	Monthly	WTP	Contractor	TWAD	Included in operation cost
Occupational Health and Safety	Accident records at the WTP, training records on personal protective equipment, inspection records of fall prevention equipment, and evacuation plans in case of chlorine gas emission	Monthly	WTP	Contractor	TWAD	Included in operation cost

Source: JST

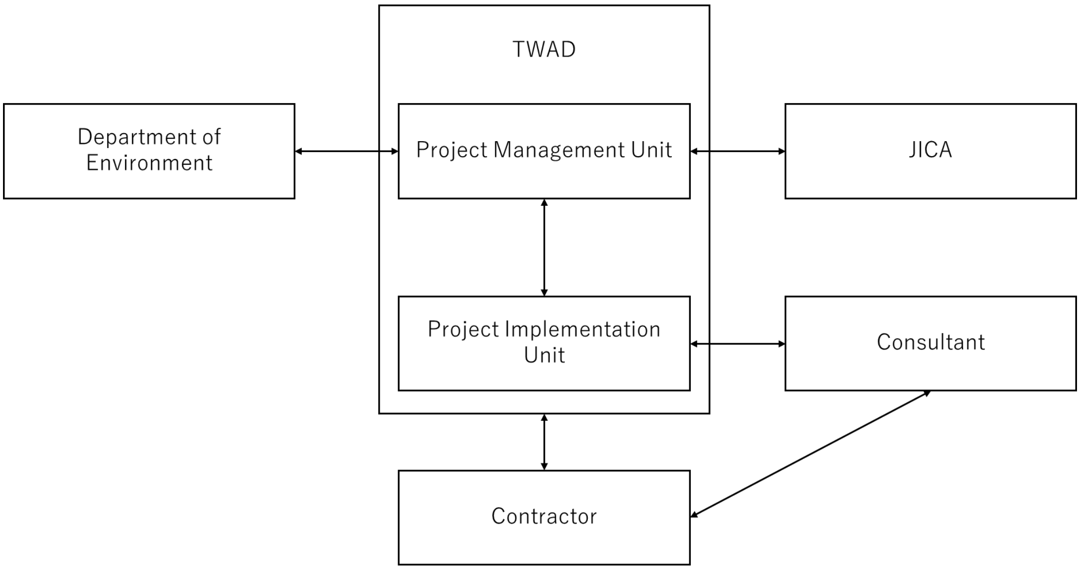
10.1.10 Implementation Structure of the Environmental Management Plan

The consultant will implement the environmental monitoring during the construction period, and prepare the monitoring report for submission to the TWAD, then the TWAD will submit it to JICA. The monitoring report and any significant impact confirmed from the monitoring report will also be shared by the TWAD to the Department of Environment of Tamil Nadu. The TWAD will further consult with the Department of Environment and conduct mitigation measures. The grievance systems and implementation structure of the EMP are shown in Figure 10.1.16, Figure 10.1.17 and Figure 10.1.18.



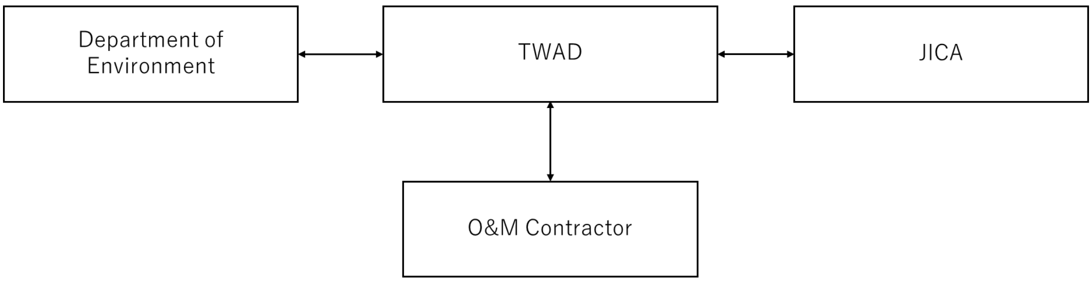
Source: JST

Figure 10.1.16 Grievance System (Both in the Construction and Operation Phases)



Source: JST

Figure 10.1.17 Implementation Structure of the Environmental Management Plan (Construction Phase)



Source: JST

Figure 10.1.18 Implementation Structure of the Environmental Management Plan (Operation Phase)

10.1.11 Stakeholder Consultation Meeting

Stakeholder consultation meetings were held once in each of Dharmapuri and Krishnagiri districts. The meetings aimed to share information on the Project and provide residents an opportunity to express their opinions to TWAD. A summary of the meetings is shown in Table 10.1.19, and comments from participants are shown in Tables 10.1.20 and 10.1.21. The minutes of the discussions are provided in Appendix-10.4.

Table 10.1.19 Outline of the Stakeholder Consultation Meetings

Item	Dharmapuri	Krishnagiri
Mode	Face-to-face	
Date & Time	February 21, 2025	February 22, 2025
Venue	Lakshmi Marriage Hall	District Collectorate Office Hall
Participant	40 men, 60 women, and 17 TWAD officers	75 men, 55 women, and 18 TWAD officers
Method of Notification	Newspaper; and letters sent to each district requesting notification to the panchayats	

Source: JST

Table 10.1.20 Comment from the Participants (Dharmapuri)

Comment from the Participants	Answer from TWAD
After commissioning, will the Project be operated by the private sector?	The project will remain government-owned and will not be converted to a private operating model.
Both groundwater and treated water are currently mixed in the water distribution. We request that separate tanks be used to prevent this problem.	New OHT tanks are proposed in areas currently served by one tank. Until construction is complete, treated water will be supplied on designated days, and groundwater will be supplied on other days. Once the Project is complete, each household will receive treated water on a daily basis.
Due to severe drought caused by the high elevation of the village; we would like to see an increased water supply.	This issue will be fully resolved during the Project period.

Source: JST

Table 10.1.21 Comment from the Participants (Krishnagiri)

Comment from the Participants	Answer from TWAD
We would like to request the assignment of an independent water supply line exclusively for public schools. It is important to provide a dedicated and reliable water source to ensure a continuous supply for students and staff. Independent connections will help maintain sanitation on school grounds and prevent water shortages that may result from shared water distribution. Please consider this request a priority to support the well-being of the school community.	While the TWAD is responsible for managing the overall water supply infrastructure and ensuring that adequate water is delivered to designated areas, specific decisions regarding internal water distribution, including the allocation of individual water supply lines, fall under the jurisdiction of the Panchayat Committee. Therefore, requests for dedicated water supply lines to public schools must be evaluated and decided by the Panchayat Committee, which oversees the local water distribution network and its implementation.
Although water meters have been installed at the water reservoirs, it remains difficult to accurately measure the amount of water being distributed due to leaks at several locations. Installing water meters at the distribution points would help the panchayat monitor and assess the exact amount of water being supplied. This way, the panchayat could reconcile the recorded measurements with the water allocated to each village, ensuring transparency and efficient water management.	Installation of water meters is planned according to the project guidelines. However, if additional meters are required beyond the original provisions, it will be the responsibility of each panchayat to implement this. Additional quantities required will be taken into account for the project. Moreover, existing gaps and inefficiencies identified in the previous phase will be addressed during project implementation to ensure improved water distribution and management.
New OHTs for water distribution has not yet been started and water distribution is being done using the old OHT. We request a conversion to water distribution using the new OHT.	The new OHT will be in operation after the Project completion.

Source: JST

10.2 Land Acquisition/Clearance

The total land required for the construction of the main facilities, including the MBR and booster stations per panchayat, etc., is 97.68 ha—all of which will be transferred by TWAD from other departments of the State Government. No land acquisition from the private sector will occur under the Project. As of March 21, 2025, the required 40.25 ha has already been transferred. Table 10.2.1 summarizes the details.

Table 10.2.1 Status of Land Requirement

No.	Item	Area	Status
1	Land alienation from other departments of the State Government	97.68 ha	Ongoing
2	State government's approval for construction work	40.25 ha	Completed

Source: TWAD

The necessary procedures, other than land acquisition, are currently underway. Clearances from the relevant organizations will be obtained by the TWAD in a timely manner to avoid project delays. For example, the TWAD will acquire 20.87 ha of new Reserve Forest for the Project and will compensate the same area of forest—the TWAD will transfer the land from TWAD's property to the Forestry Department and TWAD will bear the cost of planting trees on the land. Additionally, the clearances required for the Project are outlines in Table 10.2.2.

Table 10.2.2 Clearance Required from the Respective Authorities

No.	Activity	Clearance Required	Statutory Authority	Status
1	Withdrawal of water from the Cauvery River	No objection certificate	Public Works Department (State Government)	Certificate obtained
2	Forest clearance	No objection certificate	Ministry of Environment, Forest and Climate Change (Central Government)	Certificate obtained
3	Conveyance line crossing and laying near local roads and highways	No objection certificate	Highways Authority (Central Government and State Government)	Ongoing
4	Storage of chlorine gas	No objection certificate	Chief Controller of Explosives, Nagpur (Central Government)	Ongoing
5	Tree cutting	No objection certificate	Department of Forest (State Government)	Ongoing

Source: JST

10.3 Gender Consideration

Gender mainstreaming is handled by the Secretary cum General Manager of TWAD, and urban municipal authorities will conduct training in accordance with the Gender Action Plan. TWAD has adopted policies to promote gender equality, ensuring that both women and men benefit equally from water supply and sanitation projects by:

- Designing water supply and sanitation systems that consider the needs of women—who are often primarily responsible for water collection.
- Ensuring that water and sanitation infrastructure provides safety and dignity for women, especially in rural and marginalized communities.

- Organizing regular consultation meetings and workshops to ensure that women's voices are heard in the decision-making process and their concerns are addressed in water management policies.
- Training for five women Self Help Group members for water quality testing in each village panchayat.
- Providing women with the training needed to maintain water systems, repair infrastructure, and manage water resources in their communities.
- Organizing leadership training programs to empower women and help them take on managerial and decision-making roles in water supply projects.
- Offering training on the importance of hygiene and sanitation to improve community health, with a specific focus on women and children, who are often the primary caregivers in families.
- Special training programs are also conducted to raise awareness on gender equality in water and sanitation projects, helping to eliminate the barriers that women face in accessing services and participating in decision-making.

These initiatives ensure that that women benefit equally from the development programs implemented by TWAD.

On the other hand, India's basic policy on water resources—the National Water Policy (2012)—has no description about gender, which is pointed out to be inefficient in gender consideration[70]. Specifically, since women are in charge of collecting water, they lose time for other important activities—such as education, child care, agriculture, and other economic activities. Still, the issue is not yet included in the policy.

10.3.1 Persons Responsible for Storing Water When the Household Does Not Have a Connection

In Dharmapuri District, a substantial 77.8% of families rely on the wife to store water, indicating that women predominantly manage water-related tasks in the absence of a household water connection. Only 22.2% of families report the husband as responsible for water storage, reflecting a smaller but notable involvement of men. Moreover, families do not usually rely on other members for water storage, implying that the responsibility is largely confined to the primary adult members of the household.

Similarly, in Krishnagiri District, 82.6% of families assign this task to the wife, a rate slightly higher than in Dharmapuri, further reinforcing the trend of women as the primary water managers. Only 17.4% of families report the husband as the water-storer, slightly lower than Dharmapuri, indicating a reduced role for men in water management. As in Dharmapuri, no families report reliance on other members for water storage.

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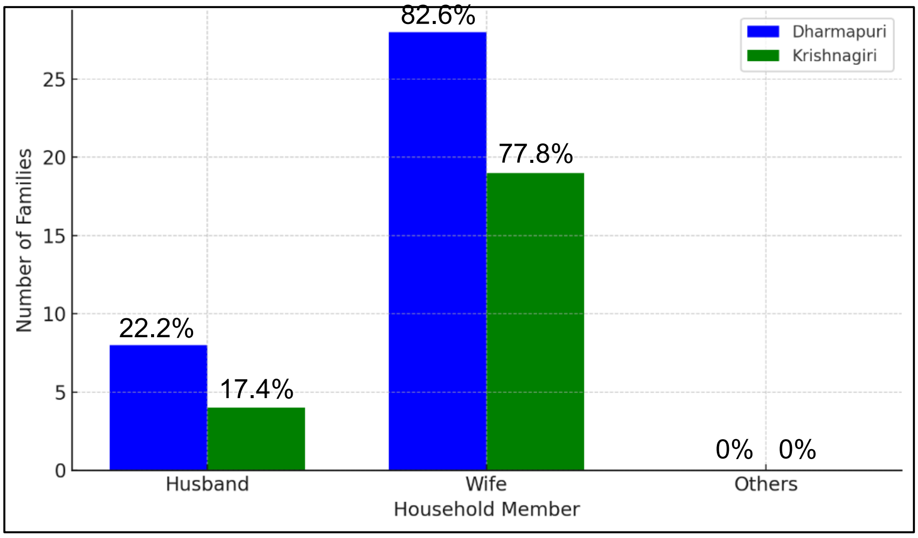
[70] Tanusree Paul, Economic and Political Weekly Vol. 52, Issue No. 48, 02 Dec 2017 "Viewing National Water Policies through a Gendered Lens" https://www.epw.in/journal/2017/48/special-articles/viewing-national-water-policies-through-gendered-lens.html

Women are overwhelmingly responsible for water storage in both districts, reflecting an enforced traditional gender role in water management. Krishnagiri shows a slightly higher proportion of families relying on wives (82.6%) compared with Dharmapuri (77.8%), suggesting potentially stronger adherence to traditional roles or a larger workload for women in Krishnagiri. Across both districts, there is limited involvement of husbands, although it slightly higher in Dharmapuri (22.2%) compared with Krishnagiri (17.4%). Figure 10.3.1 presents the rates of gender responsibility for water storage per district.



Source: JST

Figure 10.3.1 Persons Responsible for Storing Water

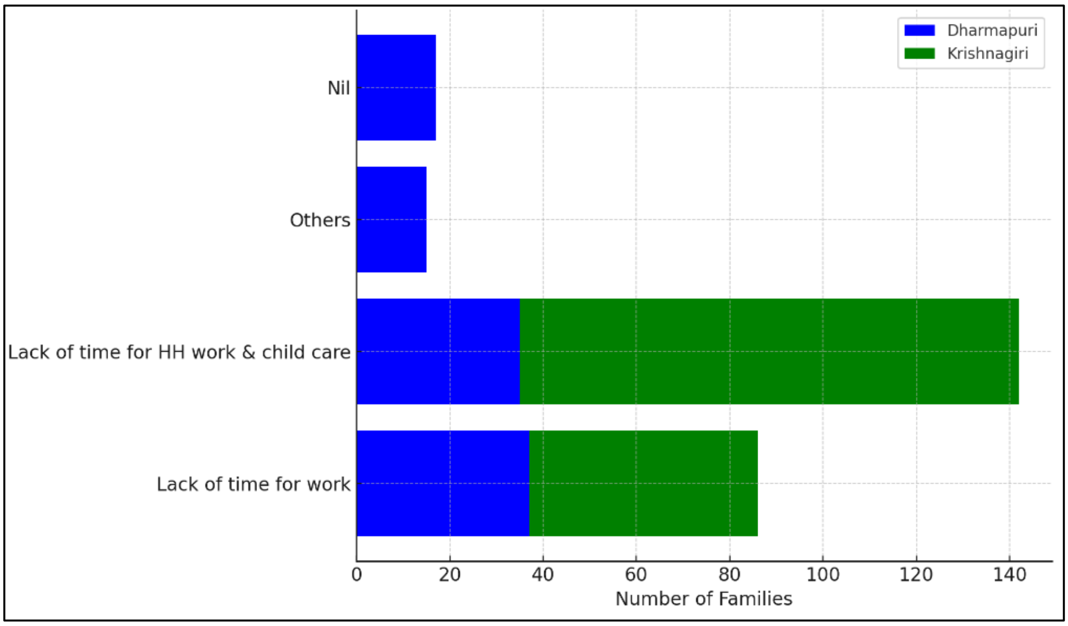
10.3.2 Disadvantages of the Unpredictable Water Supply Times

In Dharmapuri, 35.6% of families reported unpredictable water supply schedules as a disadvantage, indicating a significant impact on livelihoods. This issue affects 33.7 % of families, reflecting a strain on household responsibilities caused by the management of water supply. While issues that fall outside the predefined categories are reported by 14.4% of families, highlighting additional challenges related to water supply schedules. On the other hand, 16.3% of families have no issues with changing the designated water supply times, indicating that some households have managed to adapt effectively.

In Krishnagiri, 31.4% of families, slightly lower than in Dharmapuri, reported a lesser impact on their livelihood. While 68.6% of families cited a major disruption to household routines and responsibilities, a far more pronounced rate than that in Dharmapuri. Moreover, no families reported disadvantages outside the predefined categories, indicating a narrower scope of issues in Krishnagiri. But no families reported the absence of issues, reflecting that all households experience some form of disruption due to the changing water supply times.

Dharmapuri shows a more even distribution of disadvantages, while Krishnagiri has a dominant concern regarding the lack of time for household work and child care (68.6%). Both districts report a 'lack of time for work' as a significant issue, though it is slightly higher in Dharmapuri (35.6%) than in

Krishnagiri (31.4%). Dharmapuri also records 14.4% of families reporting miscellaneous issues—a category absent in Krishnagiri—while 16.3% of families in Dharmapuri report no disadvantages, suggesting better adaptability or less dependency on precise water supply timings compared with Krishnagiri.



Source: JST

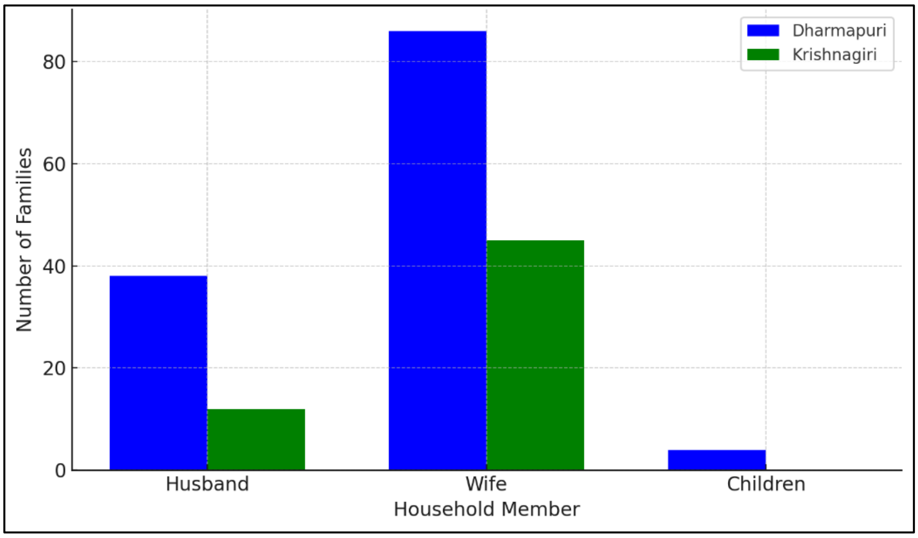
Figure 10.3.2 Disadvantages of the Unpredictable Water Supply Times

10.3.3 Persons Who Collect Water When the Source is at a Distance

In Dharmapuri, 67.2% of families depend on the wife to collect water when the source is at a distance, indicating that water collection remains a predominantly female responsibility. Meanwhile, 29.7% of families rely on the husband, reflecting notable male involvement in this task. Moreover, only 3.1% of families report children as the primary water collectors, suggesting minimal involvement of younger family members in this activity.

In Krishnagiri, an even higher 78.9% of families rely on the wife to collect water, emphasizing the role of women in managing household water needs, while 21.1% of families depend on the husband for water collection, indicating reduced male participation compared with Dharmapuri. No families report children as water collectors, highlighting that this responsibility is confined to adults.

Overall, women are the primary water collectors in both districts, with their role more pronounced in Krishnagiri (78.9%) compared with Dharmapuri (67.2%). Dharmapuri shows higher share of families relying on husbands (29.7%) than Krishnagiri (21.1%), reflecting greater male involvement in Dharmapuri. Children play a negligible role, with no families in Krishnagiri and only 3.1% in Dharmapuri assigning this task to them.



Source: JST

Figure 10.3.3 Person Collecting Water When Source is at a Distance

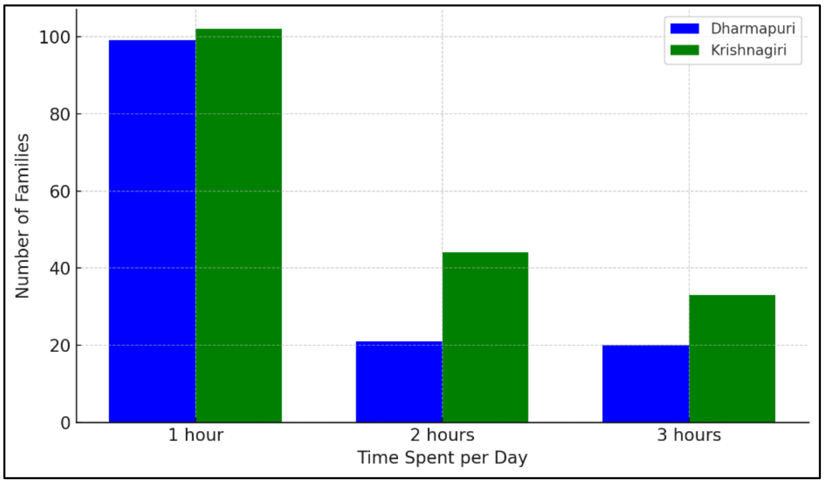
10.3.4 Time Spent Daily for Water Collection

In Dharmapuri, 70.7% of families spend one hour per day collecting water. This indicates that the district has relatively manageable access to water sources for most households. While 15.0% of families report spending two hours on water collection, reflecting increased effort for a smaller portion of households. With a significant burden on 14.3% of families that report spending three hours daily on water collection.

In Krishnagiri, 57% of families, a smaller proportion than Dharmapuri, manage to collect water within one hour. This suggests relatively challenging access for Krishnagiri households. While 24.6% of families spend two hours collecting water, higher than Dharmapuri, indicating a more widespread moderate effort requirement. Moreover, 18.4% of families spend three hours on water collection, noting a heavy time burden.

Shorter Collection Times: In both districts, the majority of families spend only one hour on water collection, but the proportion is higher in Dharmapuri (70.7%) than in Krishnagiri (57.0%), indicating better access to water sources in Dharmapuri. Krishnagiri shows higher percentages for two-hour (24.6%) and three-hour (18.4%) collection times compared with Dharmapuri, suggesting that more households face significant water collection challenges.

Higher Burden on Certain Households: Around 14.3–18.4% of families in both districts face extended water collection times of up to three hours, indicating a persistent issue for these households.



Source: JST

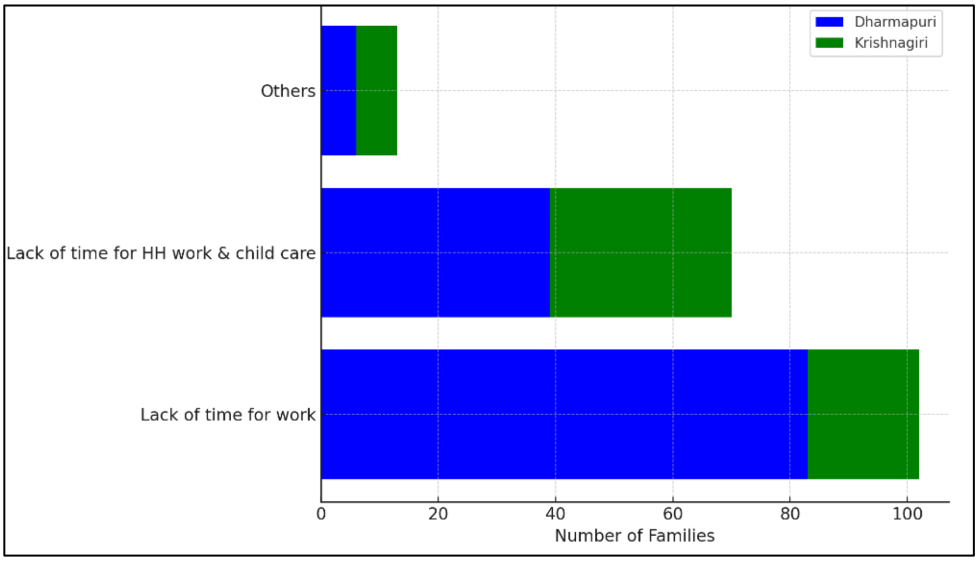
Figure 10.3.4 Time Spent Daily for Water Collection

10.3.5 Disadvantages of Collecting Water from a Distant Source

In Dharmapuri, lack of time for work remains the most significant disadvantage of collecting water from a distant source. With 64.8% of families citing that water collection impacts their ability to engage in income-generating activities, and 30.5% of families report challenges in balancing water collection with household responsibilities. A smaller proportion of 4.7% of families mention other challenges, indicating the presence of additional but less common issues.

In Krishnagiri, 33.3% of families experience a 'lack of time for work' as an issue, which is significantly lower than Dharmapuri, suggesting lesser disruption to livelihoods. Meanwhile, 54.4% of families cite a 'lack of time for household work and childcare' as a problem, making it the most prominent concern in Krishnagiri and highlighting a major impact on household routines. Issues from 2.3% of families report 'other disadvantages', a higher rate than Dharmapuri which indicates a broader range of challenges related to distant water sources.

In Dharmapuri, the primary concern is the 'lack of time for work' (64.8%), while in Krishnagiri, it is the 'lack of time for household work and childcare' (54.4%). A higher percentage of families in Krishnagiri report 'other' disadvantages (12.3%) compared with Dharmapuri (4.7%), suggesting more diverse challenges in managing water collection. The impact on work is notably higher in Dharmapuri, whereas Krishnagiri exhibits a more balanced distribution of challenges across categories, as seen in Figure 10.3.5.



Source: JST

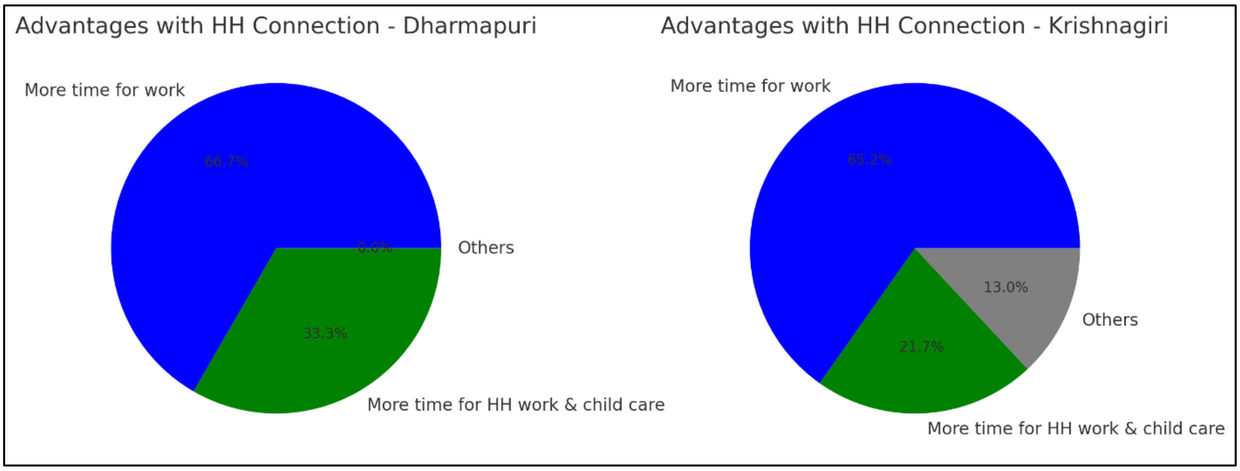
Figure 10.3.5 Disadvantages of Collecting Water from a Distant Source

10.3.6 Perceived Advantages of a Household Connection (by families that do not have one presently)

In Dharmapuri, having a household connection is reported as an advantage by a significant 66.7% of families, indicating that access to water at home significantly reduces the time spent on water collection and allows more time for income-generating activities. Having more time for household work and child care as a benefit is reported by 33.3% of families showing a reduced burden on daily responsibilities due to improved water access. No families reported any other advantages, suggesting that the benefits are well-captured within the above two categories.

Similarly, Krishnagiri reports that 65.2% of families cite more time for work as a major advantage, indicating that the impact of a household connection on productivity is consistent across both districts. Having more time for household work and childcare is reported as an advantage by 21.7% of families, a lower proportion compared with Dharmapuri, reflecting that the impact on household responsibilities is less pronounced in this district. While 13.0% of families reported advantages under 'others,' suggesting additional but less common benefits from having a household connection.

Both districts show that the main benefit of having a household connection is the ability to allocate more time for work, with comparable percentages (66.7% in Dharmapuri and 65.2% in Krishnagiri). Dharmapuri families report a higher share of improved time for household work and child care (33.3%) compared with Krishnagiri (21.7%), suggesting a greater impact on household routines in Dharmapuri. Only Krishnagiri families (13.0%) reported other advantages, indicating a slightly broader range of perceived benefits in this district.



Source: JST

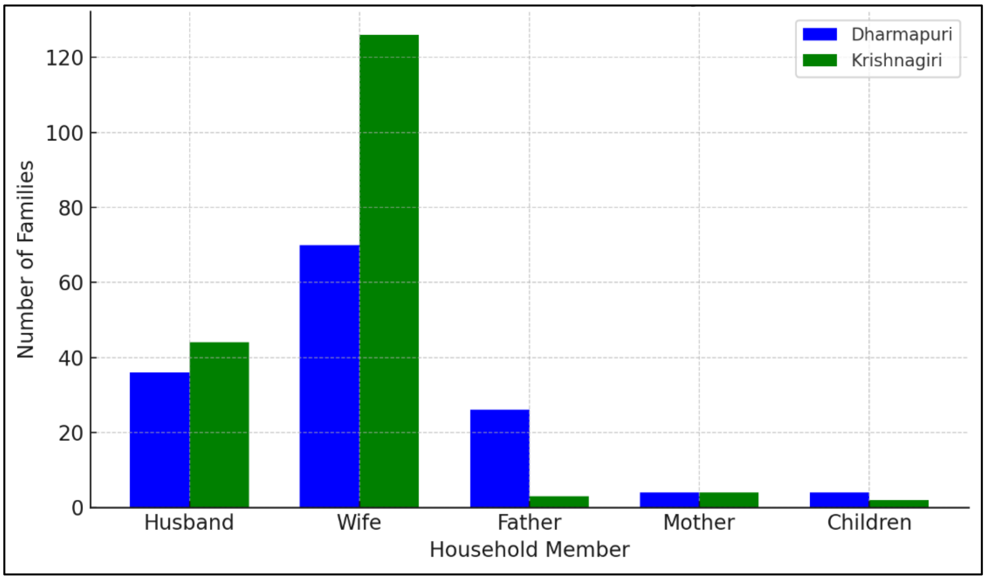
Figure 10.3.6 Advantages of Having a Household Connection

10.3.7 Person-in-charge of Water Quality Checking

In Dharmapuri, 50% of families report that the wife is the person responsible for checking water quality, indicating that women primarily handle this task. While 25.7% of families rely on the husband for checking water quality, reflecting more male involvement in this responsibility. Additionally, 18.6% of families depend on the father for this task, suggesting an additional male contributor within the household. A smaller share of 2.9% assigns this responsibility to the mother or children, indicating minimal involvement from these members.

In Krishnagiri, an overwhelming 70.4% of families rely on the wife to check water quality, significantly higher than Dharmapuri, showcasing the dominant role of women in ensuring water safety. While 24.6% of families report the husband as the quality checker, slightly lower than Dharmapuri, reflecting consistent male involvement across districts. Only 1.7% of families assign this responsibility to the father, drastically lower than Dharmapuri, indicating limited male contribution beyond the husband. Moreover, 2.2% rely on the mother and 1.1% rely on children, exhibiting a minimal role for these members—even lower than Dharmapuri.

In both districts, the wife is the primary person who assumes the role of checking water quality, with a higher percentage in Krishnagiri (70.4%) compared with Dharmapuri (50.0%). Husbands play a similar role in both districts (~25%), while fathers are notably more involved in Dharmapuri (18.6%) compared with Krishnagiri (1.7%). Mothers and children have a negligible role in checking water quality in both districts, indicating that the task is primarily handled by adult men and women.



Source: JST

Figure 10.3.7 Person-in-charge of Water Quality Checking

Chapter 11 Consideration of Climate Change Impacts

11.1 Climate Trend

Dharmapuri and Krishnagiri districts receive rainfall under the influence of the southwest and northeast monsoons, with the usual annual rainfall at approximately 760 to 910 mm. The northeast monsoon accounts for nearly 40% of the total rainfall and the southwest monsoon 30% to 50%. The annual rainfall for the period from the year 2004 to 2023 is shown in Table 11.1.1.

Table 11.1.1 Annual Rainfall

Year	Dharmapuri (mm)	Krishnagiri (mm)
2004	1,075.6	1,075.6
2005	872.7	827.7
2006	1,312.5	1,206.6
2007	963.4	637.1
2008	987.6	795.0
2009	812.7	971.8
2010	761.6	920.5
2011	785.7	1,000.8
2012	757.4	835.5
2013	883.6	695.1
2014	895.7	757.6
2015	622.4	1,049.7
2016	902.1	590.6
2017	1,058	1,145.9
2018	735.0	811.0
2019	838.0	730.0
2020	1,323	1,099.5
2021	1027.8	985.4
2022	1,166	1,204.6
2023	794.4	729.2

Source: JST

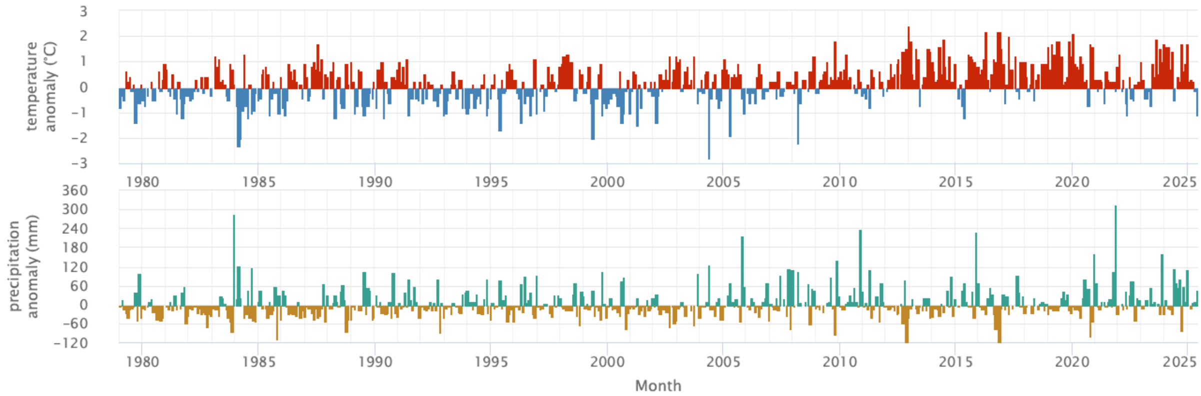
Additionally, Table 11.1.2 shows the average monthly temperatures for Krishnagiri and Dharmapuri districts for a 20-year period 2004 to 2024.

Table 11.1.2 Monthly Temperature

	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Average °C	22.8	25	27.8	29.5	28.9	27.2	26.7	26.4	26.3	25.1	23.5	22.4
Min °C	17.4	19	21.5	24	24.3	23.5	23.2	22.8	22.4	21.6	19.8	17.9
Max °C	28.9	31.7	34.5	35.8	34.7	32	31.5	31.1	31.1	29.5	27.9	27.3
Humidity %	62	51	45	51	59	64	64	65	66	73	73	69
Daylight hours	7.7	9.0	9.9	10.5	10.8	10.0	9.3	9.0	9.2	8.4	6.8	6.5

Source: JST

Although no major trends of climatic changes have been observed so far in the Project area, the intensity and frequency of extreme rainfall events in Tamil Nadu have been increasing in the 21st century. Figure 11.1.1 shows the deviation of average monthly temperature and precipitation from 1979 to 2025 compared with those from 1980 to 2010 in Tamil Nadu.

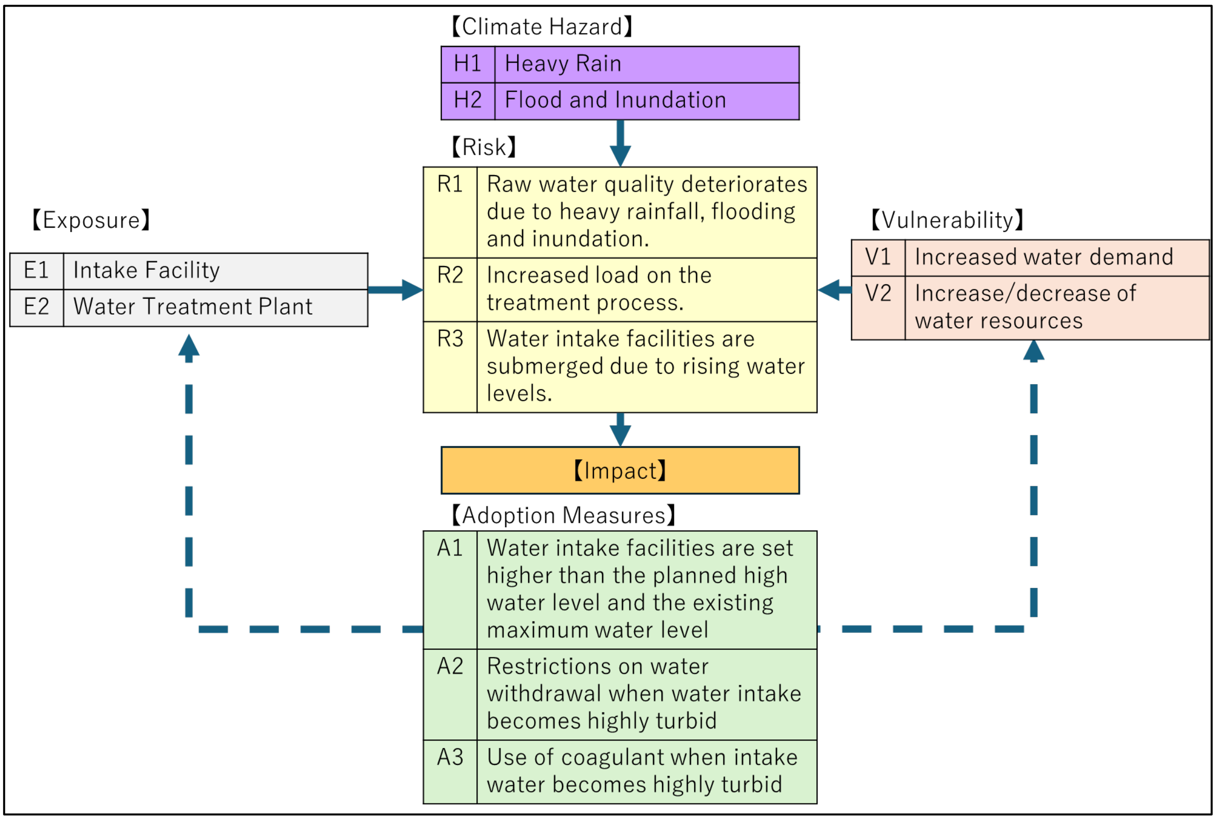


Source: Meteoblue (https://www.meteoblue.com/en/climate-change/tamil-nadu_india_1255053)

Figure 11.1.1 Deviation of Temperature and Precipitation from Average

11.2 Climate Risk

A climate risk tree illustrating the potential climate risks is shown in Figure 11.2.1. Concerns exist about the stable operation of water intake and related facilities during extreme weather and climate events. Although the beneficiary population is approximately five million, the population density being serviced by the main facilities is not high; therefore, the risk of exposure is considered low. In terms of quantity, since the water source is from a river, vulnerability is reduced as compared to having groundwater as the source.



Source: JST

Figure 11.2.1 Climate Risk Tree

The following describes the Project's potential as a climate change action initiative, viewed from the perspective of adaptation and mitigation.

11.3 Adaption Measures

Water supply relying on groundwater sources is vulnerable to epidemics and droughts caused by climate change. The Project shall contribute to a stable water supply under the risk caused by climate change, as the water supply will be sourced from the surface water in Cauvery River and is considered as an adaptation measure against epidemics and droughts.

In addition, the design water level of water intake facility of the Project is set at 254.00 m, which is higher than the planned high-water level of 252.06 m and the past maximum water level of 253.70 m. This serves as an adaptation measure addressing the risk of submergence due to the upper level of the water table, such as large heavy rains (SDG 13: Climate Action). If water withdrawal becomes highly turbid due to heavy rain, etc., the basic approach is to restrict water withdrawal, but the addition of coagulants is also considered (SDG 6: Clean Water and Sanitation).

11.4 Mitigation Measures

India has ratified the Paris Agreement and submitted its first Nationally Determined Contribution (NDC) in August 2022. The NDC specifies a 45% reduction in GDP emission intensity from the levels in 2005 by the year 2030.

As a mitigation measure, JST proposes changing the type of pumping equipment in the water conveyance trunk line from the vertical type planned in the DPR to a more energy-efficient horizontal type. Furthermore, by using an inverter to drive the pumps, the facility will operate at 72% of its total capacity during the first 15 years of service, which is expected to reduce power consumption between 2026 and 2041.[71] Table 11.4.1 shows the energy-saving effects of changing the pump model, while Table 11.4.2 presents the energy-saving effects of introducing an inverter drive.

Table 11.4.1 Amount of Electricity Saved by Changing the Main Water Supply Pump

Item	Vertical Pump	Horizontal Pump	Difference
Electricity consumption of the pump from WTP to MBR (kWh/day)	10,532	10,006	527
Electricity consumption of the pump from WTP to the Sugarmill pumping station (kWh/day)	27,384	25,804	1,580
		Sub-total 1	**2,106**

Source: JST

[71] The energy savings are estimated based on the assumption that about 80% of the total water volume will be used in 2041, and another 90% on average from the start of operation to 2041 (total x 0.8 x 0.9).

Table 11.4.2 Amount of Electricity Saved by Introducing an Inverter

Item	Without Inverter	With Inverter	Difference
Electricity consumption of the pump from WTP to Sugarmill pumping station (kWh/day)	25,804	20,952	4,852
		Sub-total 2	**4,852**

Source: JST

The electricity reduced from the operation commencement to year 2041 will be:

Sub-Total 1 + Sub-Total 2 = 6,958 kWh/day

According to Appendix 3 of JICA Climate-FIT Ver.5.0, the CO_2 emission factor for the electricity in India is:

$0.608 \text{ t} - CO_2/\text{MWh} = 608 \text{ g} - CO_2/\text{kWh}$

Furthermore, the reduction in CO_2 emissions = emission factor x energy saving effect

$= 608 \text{ g} - CO_2/\text{kWh} \times 6{,}958 \text{ kWh/day} = 4{,}230.464 \text{ kg} - CO_2/\text{day}$

$= 1{,}544 \text{ t} - CO_2/\text{year}$

Table 11.4.3 The CO_2 Emission Reduction from Pump Model Change (2041)

	Value	Unit
Emission reduction	1,544	tCO_2/year
Baseline emission	8,414	tCO_2/year
Production capacity (or other appropriate factors) in the baseline	0	-
Production capacity (or other appropriate factors) in the project	0	-
Electricity consumption in the baseline in year y	13,839	MWh/year
Consumption of the fuel i in the baseline in year y	0	t/year
CO_2 emission factor of the grid electricity	1	t-CO_2/MWh
Net calorific value of fuel i	0	TJ/t
CO_2 emission factor of fuel i	0	t-CO_2/TJ
Project emission	6,870	tCO_2/year
Electricity consumption in the project in year y	11,300	MWh/year
Consumption of the fuel i in the project in year y	0	t/year
CO_2 emission factor of the grid electricity	1	t-CO_2/MWh
Net calorific value of fuel i	0	TJ/t
CO_2 emission factor of fuel i	0	t-CO_2/TJ

Source: JST

Table 11.4.4 shows the energy-saving effects in the year 2056—the final year of the Project.

Table 11.4.4 Amount of Electricity Saved in 2056

Item	Vertical Pump	Horizontal Pump	Difference
Electricity consumption of the pump from WTP to MBR (kWh/day)	14,720	13,984	736
Electricity consumption of the pump from WTP to Sugarmill pumping station (kWh/day)	38,272	36,064	2,208
		Total	2,944

Source: JST

Reduction in CO_2 emissions in 2056 = emission factor x energy saving effect

$= 608\ g - CO_2/kWh \times 2{,}944\ kWh/day = 1{,}789.952\ kg - CO_2/day$

$= 653\ t - CO_2/year$

Table 11.4.5 CO_2 Emission Reduction from Pump Model Change (2056)

	Value	Unit
Emission reduction	653	tCO_2/year
Baseline emission	11760	tCO_2/year
Production capacity (or other appropriate factors) in the baseline	0	-
Production capacity (or other appropriate factors) in the project	0	-
Electricity consumption in the baseline in year y	19342.08	MWh/year
Consumption of the fuel i in the baseline in year y	0	t/year
CO_2 emission factor of the grid electricity	0.608	t-CO_2/MWh
Net calorific value of fuel i	0	TJ/t
CO_2 emission factor of fuel i	0	t-CO_2/TJ
Project emission	11107	tCO_2/year
Electricity consumption in the project in year y	18267.52	MWh/year
Consumption of the fuel i in the project in year y	0	t/year
CO_2 emission factor of the grid electricity	0.608	t-CO_2/MWh
Net calorific value of fuel i	0	TJ/t
CO_2 emission factor of fuel i	0	t-CO_2/TJ

Source: JST

JST proposes changing only some of the water pumps from vertical to horizontal type, but if other pump facilities were also changed into the horizontal-type, the reduction in electricity and CO_2 emissions is expected to reach approximately 9,000 kWh/day and 2,033 t-CO_2/year, respectively. However, as described in 6.6(1), the vertical-shaft type is common in India, and for years the TWAD is already accustomed to maintaining and managing vertical turbine pumps, further leading to the decision of retaining the vertical model. Although concerns were raised about adopting a horizontal-shaft type for maintenance and management reasons, based on the results of other JICA projects, the TWAD decided to adopt this pump for the water purification plant as it is seen to be the most effective.

Table 11.4.6 Reduction in Electricity (Case of Changing all Pumps into Horizontal-type)

		DPR(Vertical)	If all horizontal	Reduction
		(kwh/d)	(kwh/d)	(kwh/d)
No.	Pump performance	85%	85～87%	-
1	Intake	75,994	75,110	884
2	BPS1	143,219	141,554	1,665
3	BPS2	102,300	101,110	1,190
4	WTP PS-1	14,720	13,984	736
5	WTP PS-2	38,272	36,064	2,208
6	Sugarmill1	36,062	35,643	419
7	Sugarmill2	8,612	8,512	100
8	Sugarmill4	1,683	1,683	0
9	Sugarmill4	155	155	0
10	Mahendramangaiam	47,517	46,965	553
11	Kaduchettipatti-1	38,550	38,102	448
12	Kaduchettipatti-2	4,130	4,082	48
13	Kaduchettipatti-3	394	390	5
14	Ullukurukkai	44,292	43,777	515
15	Manjalagiri	33,572	33,182	390
	計	589,474	580,313	9,161

Source: JST

Chapter 12 Financial and Economic Analysis

Chapter 13 Expected Project Effect

13.1 Operational and Expected Effect Indicators of the Project

Table 13.1.1 presents the proposed operational and effect indicators of the Project.

Table 13.1.1 Operational and Effect Indicators of the Project

Indicator	Baseline (2024)	Target（2032）[Two years after completion of the construction work]	Means for Obtaining/Calculation of the Value
Operational Indicator			
(1) Average Amount of Water Supply	174,550 m^3/day (Existing: 36,550 m^3/day; Previous Phase: 138,000 m^3/day)	372,150 m^3/day (Existing: 36,550 m^3/day; Previous Phase: 159,900 m^3/day; Project: 175,700 m^3/day)	Operation record of the O&M contractor.
(2) Number of House Service Connections in 11 Target ULBs	71,745	161,318	Customer ledgers of each ULB.
Effect Indicator			
(3) Population Served in the Project Area (1,000 persons)	3,816 (Including Public Tapping)	4,105 (100 % by House Service Connection)	Calculated by multiplying the number of house service connections registered in the customer ledger by the number of persons per household.
(4) Per Capita Water Supply (lpcd)	Corporation and Municipalities: 93 lpcd Town Panchayats: 64 lpcd Rural Panchayats: 35 lpcd	Corporation and Municipalities: 135 lpcd Town Panchayats: 70 lpcd Rural Panchayats: 55 lpcd	Calculated by Indicators (1) and (3).
(5) Average Water Supply Hours per Day (Urban and Rural)	1 to 2 hours on Alternate Days (Urban and Rural)	Urban: 8 hours/day Rural: 4 hours/day	Interview with each local body.

Source: JST

The calculation of each indicator’s value is described hereunder:

(1) Average Amount of Water Supply

<u>Baseline (2024)</u>

Existing: 36,550 m^3/day: Information from city corporation/municipality and TWAD.

Previous Phase: 138,000 m^3/day: Operation records of the O&M contractor for the past two years.

<u>Target (2032)</u>

Existing: 36,550 m^3/day: No further increase is planned after 2024.

Previous Phase: 159,900 m^3/day: Planned maximum capacity of the Previous Hogenakkal Project.

Project: 175,700 m^3/day: Planned supply amount of the Project in 2032.

(2) Number of house service connections in 11 Target ULBs

Baseline (2024) 71,745 nos.: DPR (TWAD)

Target (2032) 161,318 nos.: DPR (Baseline + New Connection by the Project)

(3) Population Served in the Project Area

Baseline (2024)	3,816,000:	Information from TWAD.
Target (2032)	4,105,000:	Population projection for the Project area.

(4) Per Capita Water Supply (lpcd)

Baseline (2024)

Calculated based on the population and daily supply amount for each category in 2024, as shown in Table 13.1.2.

Table 13.1.2 Baseline of Per Capita Water Supply (2024)

	Population in 2024 (A)	Daily Average Water Supply (m^3/day)			Per Capita Water Supply Per Day (lpcd) [(B)/(A)]
		Previous Hogenakkal Project	Existing Water Supply Facilities	Total (B)	
City Corporation/ Municipality	482,000	22,200	22,400	44,600	93
Town Panchayat	278,000	10,840	7,070	17,910	64
Village Panchayat	3,056,000	100,290	7,080	107,370	35
		(Industrial) 4,670			
Total	3,816,000	138,000	36,550	174,550	

Source: JST

Target (2032)

City Corporation/Municipality	135 lpcd:	Planned value of the Project.
Town Panchayat	70 lpcd:	Planned value of the Project.
Village Panchayat	55 lpcd:	Planned value of the Project.

(5) Average Water Supply Hours Per Day (Urban and Rural)

Baseline (2024):

1 to 2 hours on Alternate Days (Urban and Rural): Based on the Social Condition Survey.

Target (2032):

Urban: 8 hours/day, Rural: 4 hours/day: Target value considering the increase of water supply.

The project plans to provide a facility capable of supplying water 24 hours a day, 7 days a week. However, this is based on the design condition that residents will open the water tap each time they need to use it. Therefore, achieving a 24-hour water supply will be challenging unless residents change their habit of opening the taps only until the daily usage is stored in the water tanks at once. Since it is assumed that a drastic change in residents' usage habits will take time and be difficult to achieve, the target values were set at eight hours of water supply in urban areas and four hours of water supply in rural areas in 2032, immediately after the start of the Project.

13.2 Qualitative Effects

The expected qualitative effects of the Project include:

- Increased opportunities for women's participation in social activities by reducing the time required to fetch water through the implementation of the house service connections.
- Capacity development of TWAD and the target local bodies through the implementation of the Project.
- Development of the water supply operational capacity of local bodies through soft components and sharing lessons learnt from the pilot implementation of 24-hour water supply with other districts and states.
- Increased awareness of hygiene and women's social participation in the Project area through soft components.

Chapter 14 Project Evaluation and Note for Project Implementation

14.1 Project Evaluation

Necessity of the Project and Review of the Facility Plan

In the Project area, the water supply facilities constructed under the Previous Hogenakkal Project have been in operation since 2013. The current utilization rate of the trunk facilities—water intake, raw water conveyance facility, and water treatment plant (WTP)—is generally stable at 80%–90%, with occasional peaks reaching 90%–100%. The demand-supply balance is expected to become increasingly tight in the near future.

The facility plan for the Project is based on the Detailed Project Report (DPR) prepared by the Tamil Nadu Water Supply and Drainage (TWAD) in 2023. The JICA Study Team (JST) reviewed the water demand projections and facility plans to verify their validity. The water intake facility will be located in a low-lying area within the Project area, which means the energy costs for pump operation account for more than 80% of the facility's operation and management costs. For this reason, the JST has proposed the use of energy-efficient pumps for some of the pump units.

Project Scope, Cost, and Implementation Plan

The Project covers a series of water supply facilities, ranging from water intake to house service connections. As a result, the effects of the Project will be realized immediately after its completion, with an exception for CP-2A. However, water distribution pipelines and house service connections in 8 of the 19 total Urban Local Bodies (ULBs) and village panchayats in the Project area will be constructed separately by the Tamil Nadu state government. It is necessary to ensure that the construction of these water distribution pipelines and house service connections is also implemented.

Considering the timing for equipment replacement at the WTP and the main pump facility, it has been proposed to install the number of units corresponding to the intermediate design year (2041).

The construction cost of the Project is based on a cost estimate prepared in accordance with the cost estimate standards of the Tamil Nadu State. The JST confirmed the relevance of the construction cost by comparing it with the construction contract amounts of the Previous Hogenakkal Project and the similar Yen Loan Projects in India.

Project Effect and Environmental and Social Consideration

The Economic Internal Rate of Return (EIRR) for the Project was calculated to be 14.7%, confirming its economic feasibility. On the other hand, TWAD requires financial subsidies for its operation due to the low current bulk water tariff. The JST proposed an increase in the bulk tariff based on the projected revenues and expenditures of the Project.

No serious environmental impacts as a result of the Project were identified. The raw water conveyance pipeline will pass through a forest area, but compensation procedures are underway. All the land for the construction of the facility is public land, and no private land acquisition is required.

Operation and Maintenance Plan

The operation and maintenance system for the facilities to be constructed under the Project is as follows:

- O&M of the water intake, raw water conveyance, WTP, and treated water transmission to the OHTs: TWAD will handle this by contracting with an O&M contractor.
- O&M of water distribution from the OHTs in each water distribution area: This will be implemented by each local body.

The former is expected to be implemented without issues by selecting a qualified and experienced O&M contractor. On the other hand, the implementation system for the latter is considered weak in ensuring the sustainable development of the Project's effects. For this reason, a soft component has been proposed to provide technical support for each local body.

The Project aims to provide 24 x 7 water supply in urban areas, in line with the Government of India’s policy of promoting a 24 x 7 water supply in the future. The Manual on Water Supply and Treatment, revised by the Central Public Health and Environmental Engineering Organization (CPHEEO) in 2023, outlines CPHEEO's vision for a gradual shift to 24-hour water supply by 2047. To achieve this, however, it is essential to establish a facility management system and introduce a metered tariff system to restrain excessive consumption. The manual also highlights the introduction of a metered tariff system as one of the requirements for an adequate water supply system.

The Project plans to equip all house service connections in urban areas with water meters, thereby accommodating the metered tariff system. The timing of the introduction of the metered tariff system in the Project area is not yet clear. However, since it has been already introduced in Chennai, it is expected to be introduced in other cities in Tamil Nadu State in due course. In addition, since the water meters to be installed by the Project will be ultrasonic meters, which have low measurement errors even under intermittent water supply conditions, there is expected to be relatively little distrust of the metered values by customers when metered tariff is introduced. According to the manufacturer's documentation, the battery life of ultrasonic AMR meters is 16 years. If a meter is installed in 2031, the meter will operate until 2047, by which time the transition to a metered tariff system will likely proceed.

Even after the completion of the Project, each local body will need to continue installing additional water distribution pipelines and additional service connections in response to subsequent growth in demand. Therefore, the capacity development for each local body is essential for strengthening the financial base required for conducting such service expansion works.

14.2 Risk Management Framework

Table 14.2.1 presents the risk management framework of the Project.

Table 14.2.1 Risk Management Framework of the Project

Potential Project Risks	Assessment	Probability	Impact	Mitigation Measures
1. Stakeholder Risk				
Delay in project implementation due to delays in obtaining work permission for the construction activities.	Work permissions for forest clearance and for work along or crossing the roads or railways need to be provided in a timely to the Contractor.	Middle (High)	High	The PIU shall request the Contractor to prepare and submit the construction drawings to ULBs and relevant authorities in a timely manner.
Delay in budget arrangements and disbursement of the project cost to be borne by the Indian government.	The project implementation will be delayed if the budget arrangements and disbursement are delayed.	Low	High	Monitoring and coordination by the state-level committee.
Delay in the introduction of the metered water tariff in ULBs.	Without introducing metered water tariff, achieving 24 x 7 water supply will be difficult.	Middle (High)	High	Monitoring and arrangement by the state-level committee.
2. Executing Agency Risk				
Delay in the project due to the delays in providing necessary data to PMC for preparing the Bidding Documents.	The bidding documents and BOQ are to be prepared by PMC based on the DPR provided by TWAD and any modifications suggested by JICA or JST.	Middle (High)	High	TWAD shall arrange and provide the necessary DPR to the PMC.
Delay in the construction of distribution systems in eight town panchayats not included in the Project Scope.	The distribution systems in eight town panchayats will be implemented by the respective local bodies.	Middle (High)	High	TWAD shall coordinate with the MA&WS department to ensure the implementation of the distribution systems.
Delay in the construction of the distribution systems in the villages.	The distribution systems in the villages will be implemented by the Rural Development Department.	Middle (High)	High	TWAD shall coordinate with the Rural Development Department through the MA&WS Department to ensure the implementation of the distribution system.
Delay in revision of bulk water charge by TWAD.	TWAD's operations will be affected by the delays in the revision of the bulk water charge.	Middle (High)	High	TWAD shall apply for the timely revision of the bulk water charge through the MA&WS Department.
3. Project Risk				
3.1 Design Risk				
Inadequate design due to insufficient information about the existing facilities, may lead to delays in construction work.	Without sufficient information on the location of the existing facilities, the adequate location of the pipeline will not be possible to determine.	Middle (High)	High	TWAD shall provide the detailed as-built drawings of the Previous Hogenakkal Project.
3.2 Delivery Risk				
Delay in project implementation due to the technical incapability of the Contractor.	The MS pipeline with large diameter (more than 1400 mm) needs to be executed by an experienced contractor	Middle (High)	High	The experience of the Contractor shall be checked during the technical evaluation of the Bid.

Increase in Project Cost.	Increase in project cost due to the extension of the construction period.	Middle (High)	High	Monitoring and coordination by the component-wise monitoring committee to manage and control costs.
3.3 Operation Risk				
Shortfall in government subsidy.	TWAD relies on State Government grants for operation and maintenance. A reduction in these grants could hinder its operations.	Middle (High)	High	TWAD shall obtain an understanding of the State Government's budgetary measures through the MA&WS Department.
Outages of operation due to frequent power failures.	The operation of the project facilities highly dependent on electric power. An unstable power supply would hinder the operation of the facility.	Middle (High)	High	TWAD shall request the provision of a reliable power reception be made through the MA&WS Department.

Note: The probability indicated in "( )" represents the likelihood when the proposed mitigation measure is either not taken or unsuccessful.
Source: JST

14.3 Note for Project Implementation

Considering the nature and conditions of the Project, the following are key to ensuring efficient project implementation:

1) Selection of Experienced and Capable Contractors

The technical requirements in the bidding documents should be carefully prepared to select experienced and capable contractors who can handle complex construction works, such as construction of headworks at the Cauvery River, construction of large-diameter MS pipeline, and other construction activities.

2) Provision of Necessary Data and Documents from TWAD to the PMC for Preparation of the Bidding Documents

TWAD is required to provide the following documents to the PMC, upon which the PMC will prepare the bidding documents:

- DPR along with all relevant data, designs, drawings, and cost estimates.
- Bid schedule and Bill of Quantities to be applied for each contract package.
- Available site information, including as-built drawings of the Previous Hogenakkal Project.

TWAD is required to make the necessary arrangements for the above prior to entering into the contract with the PMC.

5) Arrangement for Introduction of Ultrasonic AMR Water Meter

The ULBs in the Project area are not familiar with ultrasonic AMR water meter. TWAD is required to arrange for the introduction of ultrasonic AMR water meter to ULBs with the assistance from the Contractor and the Consultant, such as:

- Introduction of ultrasonic AMR water meters, including the installation of a data collection gateway and the software for data management and billing system.
- Introduction of metered water tariff system.
- Introduction of Non-Revenue Water (NRW) Management, which can be commenced after the introduction of the metering of the customers.