REPUBLIC OF INDIA
GOVERNMENT OF RAJASTHAN
PUBLIC HEALTH ENGINEERING DEPARTMENT (PHED)

PREPARATORY SURVEY FOR RAJASTHAN RURAL WATER SUPPLY & FLUOROSIS MITIGATION PROJECT (PHASE-II)

FINAL REPORT (ADVANCED VERSION)

FEBRUARY 2021

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

NIPPON KOEI CO., LTD.
KOEI RESEARCH & CONSULTING INC.
NIPPON KOEI INDIA PVT. LTD.

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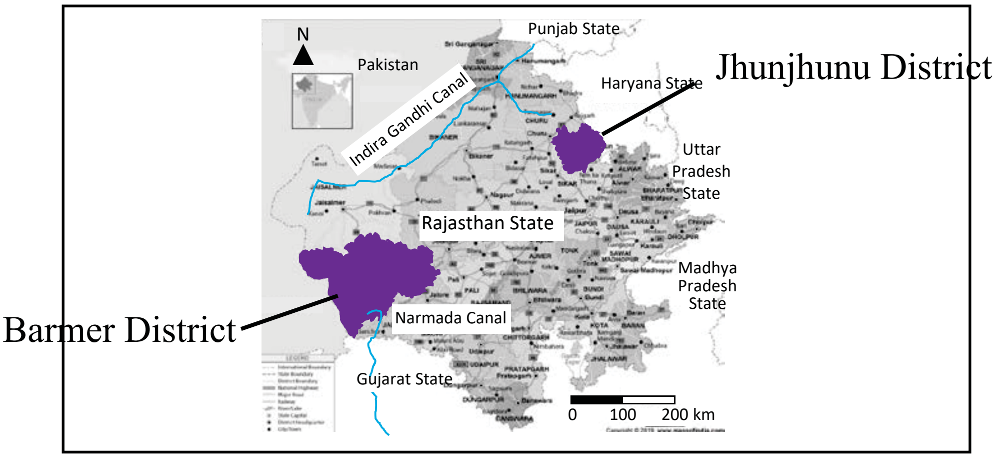
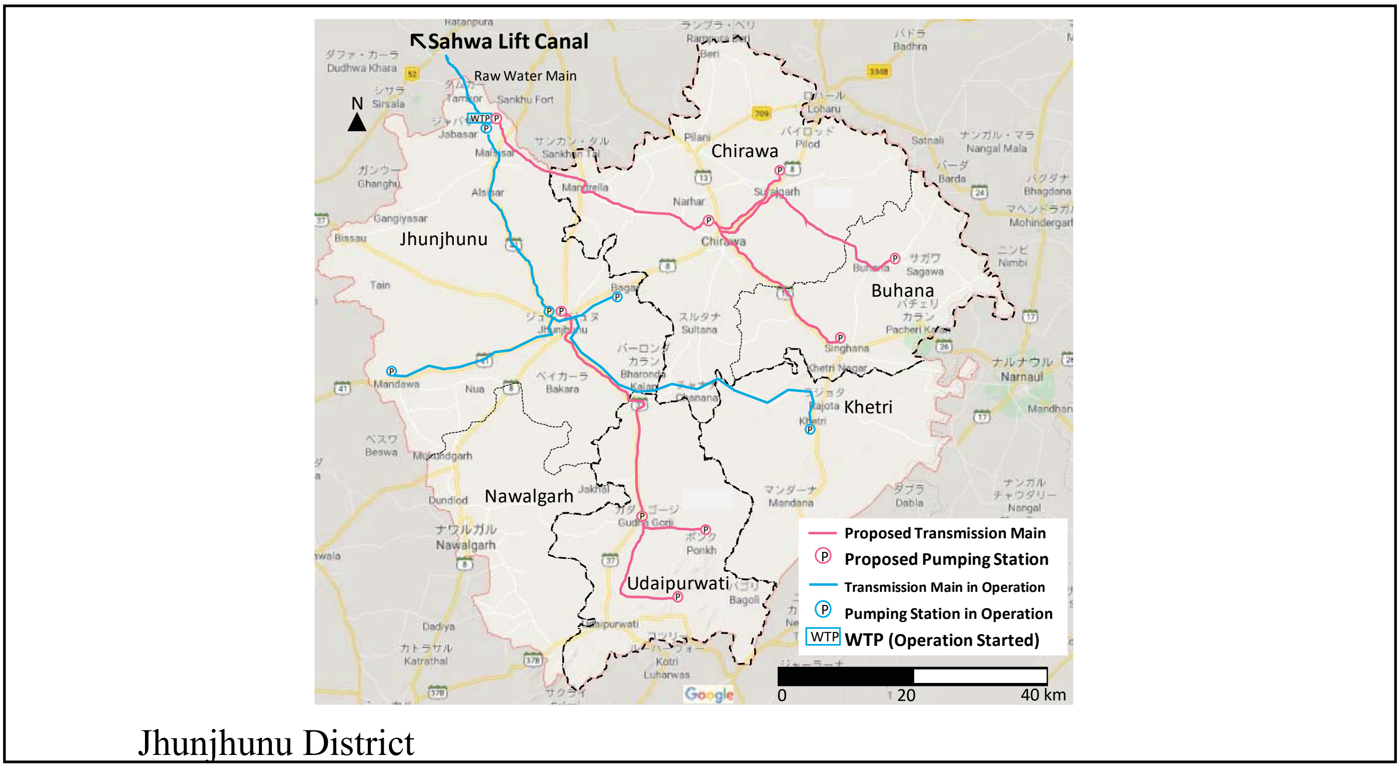
Exchange Rate

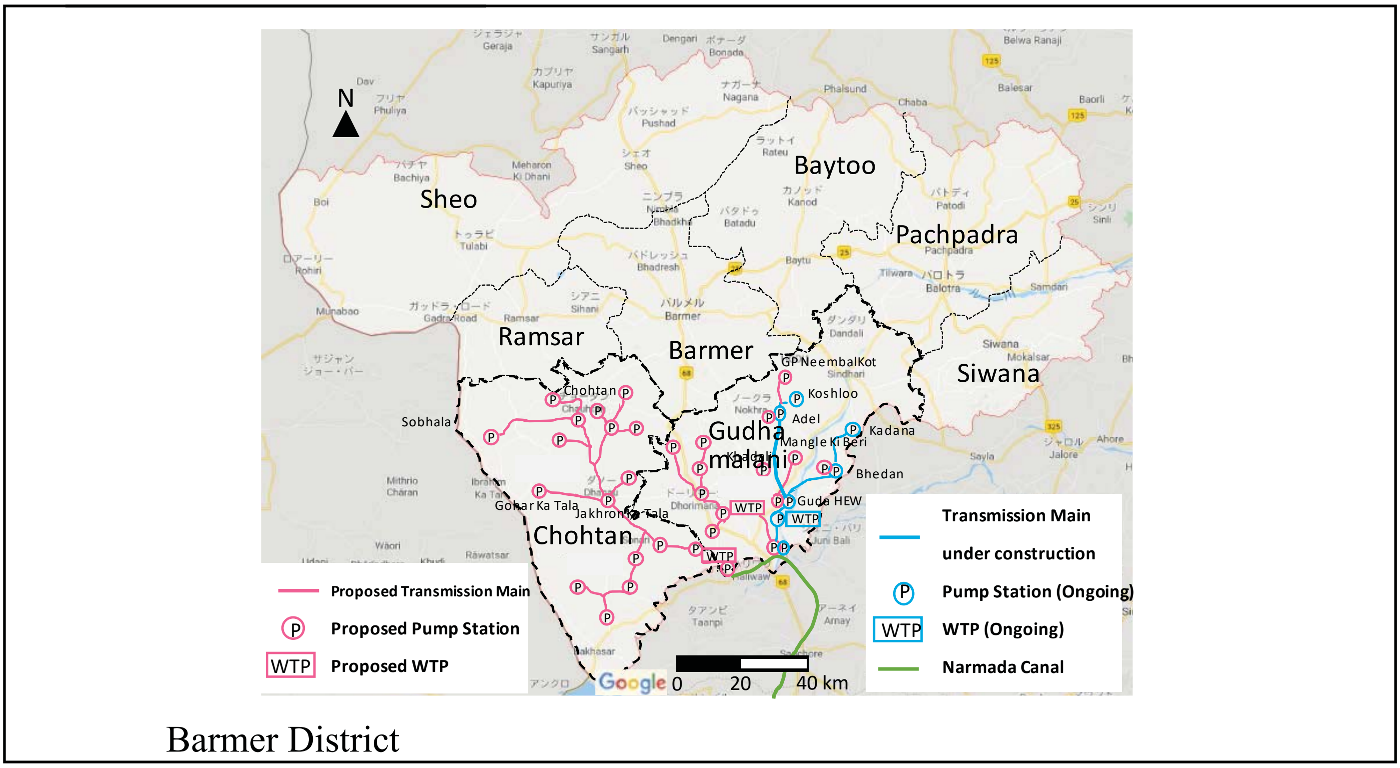
1 INR = 1.40 JPY

1 USD = 104 JPY

(As of December 2020)







Project Location Map

Table of Contents

List of Tables

List of Figures

ABBREVIATIONS

AAO	Assistance Accounting Officer
A&F	Administrative and Financial
ACE	Additional Chief Engineer
ADB	Asian Development Bank
AE	Assistant Engineer
AIMA	India Management Association
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
ANM	Auxiliary Nurse Midwife
APL	Above Poverty Line
ASCI	Administrative Staff College of India
ASHA	Accredited Social Health Activist
ASO	Assistant Senior Officer
ATP	Affordability to Pay
BC	Before Construction
B/C	Benefit Cost Ratio
BD	Blood Diagnosis
BPL	Below Poverty Line
B/S	Balance Sheet
BSR	Basic Schedule of Rates
CA	Central Assistance
CAD	Computer Aided Design
C&D	Construction and Demolition
CCA	City Convenience Allowance
CCA	Culturable Command Area
CCT	Chlorine Contact Tank
CD Block	Community Development Block
CED	Centre For Environment and Development
CGWB	Central Ground Water Board
CHC	Community Health Centre
Covid-19	Coronavirus Disease 2019
CP	Contract Package
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CPS	Cluster Pumping Station
CPWD	Central Public Works Department

CS	Construction Stage
C.S.S.	Centrally Sponsored Scheme
CTDF	Common Hazardous Waste Treatment and Disposal Facility
CWM	Clear Water Main
CWPM	Clear Water Pumping Main
CWR	Clear Water Reservoir
CWT	Cattle Water Trough
DA	Dearness Allowance
DAP	District Action Plan
DBO	Design -Build and Operation
DC	Diet Counselling
DC	District Collector
DDP	Desert Development Programme
DE	Diet Editing
DES	Directorate of Economics and Statistics
DF	Dental Fluorosis
DFR	Draft Final Report
DI	Ductile Iron
DLP	Defects Liability Period
DM, R&CD	Disaster Management, Relief & Civil Defense
DoECC	Department of Environment and Climate Change
DPR	Detailed Project Report
DTA	State Directorate of Revenue Intelligence, Treasuries & Accounts
DWSN	District Water and Sanitation Mission
EAC	Environmental Appraisal Committee
EC	Environmental Clearance
E.coli	Escherichia coli
EE	Executive Engineer
EIA	Environmental Impact Assessment
EIRR	Economical Interim Rate of Return
EMoP	Environmental Monitoring Plan
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
E/N	Exchange of Notes
E&M	Electrical and Mechanical
EOI	Expression of Interest

EPC	Engineering, Procurement, Construction
ESR	Elevated Service Reservoir
ESTI	Engineering Staff Training Institute
F	Fluoride
FC	Foreign Currency
FCA	Forest Conservation Act
FD	Financial Department
Fe	Iron
FF	Fact Finding
FGD	Focus Group Discussion
FHTC	Functional Household Tap Connection
FIDIC	International Federation of Consulting Engineers
FIRR	Financial Interim Rate of Return
FMP	Fluorosis Mitigation Programme
FRP	Fiber Reinforced Plastic
FSL	Full Surface Level
FTK	Field Test Kit
FY	Fiscal Year
GAAP	Generally Accepted Accounting Principles
GCC	General Condition of Contract
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GJTI	Gujarat Water Supply & Sewerage Board
GL	Ground Level
GLR	Ground Level Reservoir
GMHS	Govt. Model High School
GOI	Government of India
GOR	Government of Rajasthan
GP	Gram Panchayat,
GPRS	General Packet Radio Service
GRDP	Gross Regional Domestic Product
GSM	Global System for Mobile communications
GSS	Grid Substation
GST	Goods and Service Tax
GWD	Ground Water Department
HCM RIPA	Harish Chandra Mathur Rajasthan State Institute of Public Administration
HDPE	High Density Polyethylene

HH	Household
HP	Homepage
HR	H-point Right-side
HRA	House Rent Allowance
HUDCO	Housing &Urban Development Corporation Limited
HW	Head Works
IA	Impact Assessment
ICB	International Competitive Bidding
ICRW	International Center for Research on Women
IEC	Information, Education and Communication
IFMS	Integrated Finance Management System
IGMC	Indira Gandhi Main Canal
IGNP	Indira Gandhi Nahar Project
IIHS	Indian Institute for Human Settlements
IMIS	Integrated Management Information System
INR	Indian Rupee
I/O, IO	Input Output
IP	Internet Protocol
IPCC	Intergovernmental Panel on Climate Change
IPS	Intake Pumping Station
IS	Indian Standards
ISAs	Implementation Support Agencies
ITJSK	Integrated Taranagar-Jhunjhunu-Sikar-Kherti
JE	Junior Engineer
JICA	Japan International Cooperation Agency
JJM	Jal Jeevan Mission
JP, JN	Junction Point
JST	JICA study team
KRCs	Key Resource Center
L/A	Loan Agreement
LC	Local Cost
LCD	Liquid Crystal Display
LDPE	Low Density Polyethylene
LITES	Litigation Information Tracking & Evaluation System
lpcd	Liter Per Capita per Day
lps	Liter Per Second
LS	Lump Sum

MAF	Million Acre Feet
MCC	Master Control Centre
MD	Minutes of the Discussion
MH	Main Habitation
ML	Million Liter
MLD	Million Liter per Day
MM	Man-Month
MNIT	Malaviya National Institute of Technology
MoDWS	Ministry of Drinking Water and Sanitation
MoEF	Ministry of Environment and Forestry
MoEFCC	Ministry of Environment, Forest and Climate Change
MoPPGP	Ministry of Personnel, Public Grievances and Pensions
MPS	Main Pumping Station
MS	Microsoft
MS	Mild Steel
N/A	Not Applicable
NARSS	National Annual Rural Sanitation Survey
NCGG	National Centre of Good Governance
NCR	National Capital Region
NCPCR	National Commission for Protection of Child Rights
ND	Nominal Diameter
NEERI	National Environmental Engineering Research Institute
NGO	Non Governmental Organization
NH	National Highway
NIC	National Informatics Centre
NITI	National Institute for Transforming India
NJJM	National Jal Jeevan Mission
NMC	Narmada Main Canal
NO3	Nitrate
NPPCF	National Programme for Prevention and Control of Fluorosis
NRDWP	National Rural Drinking Water Programme
NRLM	National Rural Livelihoods Mission
NRW	Non-Revenue Water
O&M	Operation and Maintenance
OBC	Other Backward Class
ODA	Official Development Assistance
OH	Other Habitation

OHS	Occupational Health and Safety
OS	Operation Stage
OTS	Officers Training School
P/L	Profit and Loss Statement
PCO	Public Call Office
PHED	Public Health Engineering Department
PHC	Primary Health Centre
PIU	Project Implementation Unit
PLC	Programmable logic controller
PMC	Project Management Cell
PMSC	Project Monitoring and Supervision Consultants
PMU	Project Management Unit
PN	Pressure Nominal
PPE	Personal Protective Equipment
PQ	Prequalification
PRECIS	Providing Regional Climates for Impact Studies
PRI	Panchayati Raj Institutions
P/S, PS	Pumping Station
PSP	Public Stand Post
PTM	Parent Teacher Meeting
PUC	Pollution Under Control
PWD	Public Works Department
PWS	Piped Water Supply
R&D	Research and Development
RAPCC	Rajasthan Action Plan on Climate Change
RC	Reinforced Concrete
RD	Reach Distance
RFP	Request for Proposal
RJJK	Rashtriya Jal Jeevan Kosh
RO	Reverse Osmosis
RoW	Right of Way
Rs	Rupees
RSPCB	Rajasthan State Pollution Control Board
RTI	Right to Information
RTU	Remote Terminal Unit
RUDSICO	Rajasthan Urban Drinking Water Sewerage & Infrastructure Corporation Limited

RUIDP	Rajasthan Urban Infrastructure Development Project
RWPS	Raw Water Pump Station
RWR	Raw Water Reservoir
RWS	Rural Water Supply
RWSSMB	Rajasthan Water Supply and Sewerage Management Board
SAP	State Action Plan
SARS-Cov-2	Severe Acute Respirately Syndrome Coronavirus 2
SEAC	State-level Expert Appraisal Committee
SEIAA	State Environment Impact Assessment Authority
SC	Scheduled Caste
SCF	Standard Conversion Factor
SCADA	Supervisory Control and Data Acquisition
SE	Superintendent Engineer
SH	State Highway
SHG	Self-help Group
SLF	Secured Landfill Facility
SMCR	Semi-Master Control Room
SPCB	State Pollution Control Board
SRLM	State Rural Livelihood Mission
SRES	Special Report on Emission Scenarios
SS	Substation
ST	Scheduled Tribe
STB	Standby
STG	Staging
SWRPD	Stare Water Resource Planning Department
SWSM	State Water and Sanitation Mission
TDS	Total dissolved solids
TFT	Thin-Film-Transistor
TOR	Terms of Reference
TPL	Transmission Pipeline
TPS	Transfer Pumping Station
TSS	Traditional Source Systems
ULB	Urban Local Body
UN	United Nations
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns

UPS	Uninterruptible Power Supply
USD	United States Dollar
USEPA	United States Environmental Protection Agency
UTPCC	Union Territory Pollution Control Committee
VAT	Value Added Tax
VAP	Village Action Plan
VHWSC	Village Health and Water Sanitation Committee
VOs	Village Organizations
VT	Vertical Turbine
VTC	Village Transfer Chamber
VWHC	Village Water and Health Committee
VWSC	Village Water and Sanitation Committee
WASH	Water Sanitation and Hygiene
WHO	World Health Organization
WPI	Wholesale Price Index
WQ	Water Quality
WRD	Water Resources Department
WSSO	Water and Sanitation Support Organization
WTP	Water Treatment Plant
WTP	Willingness to Pay
WUG	Ward-level User Group

SUMMARY

Chapter 1 Introduction

1.1 Background of the Study

The Government of Rajasthan State (GOR) is promoting water supply development projects in all districts in order to provide residents with piped water supply facilities. In 2019, PHED submitted a "Project Proposal for Rajasthan Rural Water Supply Project Phase – II" to JICA, for bilateral financial cooperation. The proposed project consists of five sub-schemes in two districts, as follows:

- Jhunjhunu Scheme (Jhunjhunu District)
  Surajgarh Sub-scheme
  Udaipurwati Sub-scheme
- Barmer Scheme (Barmer District)
  HR-1&HR-2 Sub-scheme
  Chohtan-1 Sub-scheme
  Chohtan-2 Sub-scheme
  Note: HR: H-point Right-side

1.2 Objectives of the Study

The objectives of the study are to collect information and data necessary to set the details of the proposed project, which include project components, implementation schedule, implementation system, procurement and execution methods, project cost, operation and maintenance (O&M) system, and environmental and social aspects.

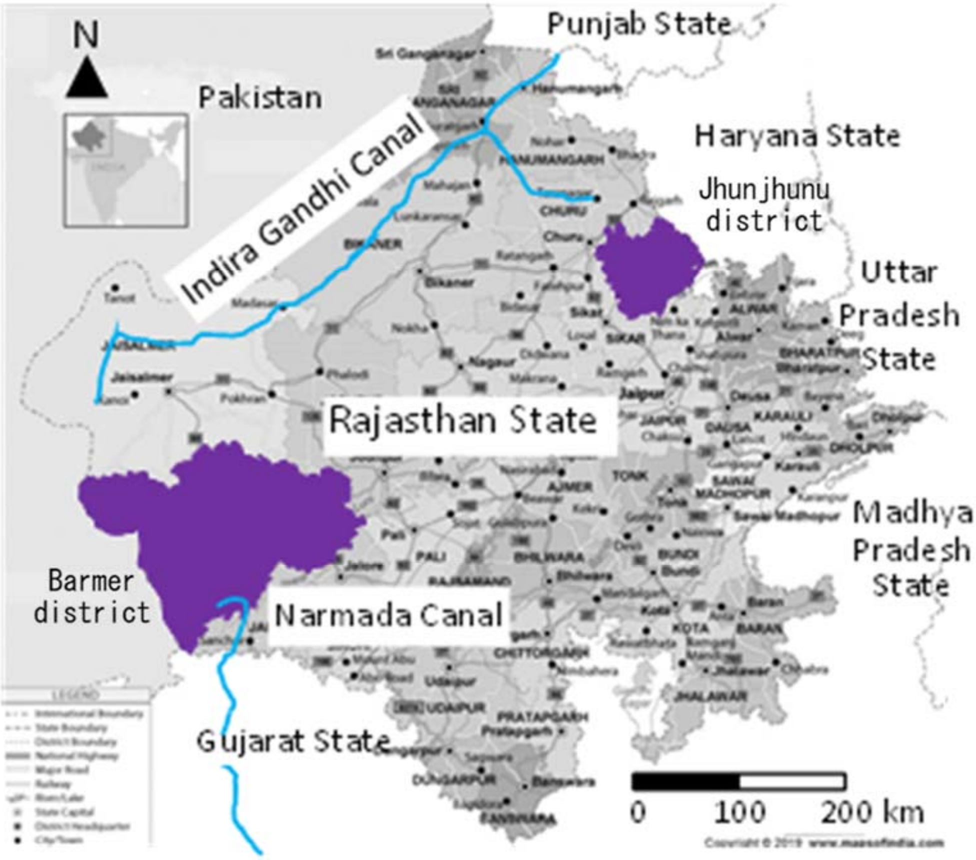
1.3 Target Area of the Project

The target areas of the proposed project are Buhana, Chirawa, and Udaipurwati Tehsils in Jhunjhunu District and Gudhamalani and Chohtan Tehsils in Barmer District.

Chapter 2 General Condition in the Project Area

2.1 Administrative Boundaries

Rajasthan State is located in the northwestern region of India and has the largest area (342,239 km^2) and the seventh largest population (over 75 million). The Project covers two districts in Rajasthan State, namely Jhunjhunu District and Barmer District. Figure 2.1 shows the location of Rajasthan State and the two target districts.



Source: JICA Study Team (JST) based on www.mapsofindia.com

Figure 2.1 Location of Rajasthan State and the Administrative Boundaries of the Target Area

2.2 Social Condition

The economic activity in Rajasthan State in 2016-2017 was composed of service sector: 43 %, industrial sector: 28%, and agricultural sector: 29%. The per capita income in Rajasthan State in 2015-2016 was INR 83,427. Regarding the land use in Rajasthan State, 53 % of land is used for agriculture activity and 8 % of the land is the forest area.

The ratio of SC[1] population in Rajasthan state is 17.2 %. Approximately 5 % of the households in Jhunjhunu District are categorized as Below Poverty Line (BPL[2]) household and approximately 35 % in Barmer District.

2.3 Natural Condition

The mean annual rainfalls in Churu and Jodhpur are 381 mm and 363 mm, respectively. Around

1 Scheduled Caste

2 The categorization of BPL is determined by Planning Commission of Government of India.

90% of rainfalls are rainfall from the southwest monsoon from June to September.

Available surface water for the project is the water of irrigation canal originating from outside of the state (Indira Gandhi Canal and Narmada Canal). The water flows of these canals are controlled by WRD and the required water flow is being maintained throughout the year. Regarding groundwater, the decline of groundwater level is observed in all the wells in Jhunjhunu District and 57% of the wells in Barmer District.

Chapter 3 Present Water Supply and Sanitation Condition in the Project Area

3.1 Present Water Supply Condition in Terms of House Connection Ratio

The ratio of rural households with piped water supply house connection as of April 2020 is 18.12 % in Jhunjhunu District, 5.36 % in Barmer District, 12.60 % in Rajasthan State, and 21.48 % in India as a whole.

3.2 Present Water Source and Its Use

There are two types of existing water supply system in the project areas. In both cases, the water source is tube wells (groundwater), installed by PHED.

1) Piped water supply through individual household connections in urban towns and large villages. There are 40 such systems in Jhunjhunu District and 7 in Barmer District.
2) Water supply by Traditional Source Systems (TSS) in other villages, having Ground Level Reservoir(s) (GLR) and Public Stand Posts (PSPs).

The result of the social condition survey on water consumption is shown in Table 3.1. The average water consumption (only for human consumption) per capita in the dry season (winter) was 35.9 Lcpd in Jhunjhunu District and 32.5 Lpcd in Barmer District. Of which, the consumption for drinking and cooking was 6.4 Lpcd in Barmer District and 5.5 Lpcd in Jhunjhunu District. In summer, the demand for water increases in both districts.

Table 3.1 Water Consumption in the Project Area

	Dry (Winter) Season		Summer Season	
	For Human Consumption (Lpcd)	Of which for Drinking and Cooking (Lpcd)	For Human Consumption (Lpcd)	Of which for Drinking and Cooking (Lpcd)
Barmer District	32.5	6.4	51.3	12.3
Jhunjhunu District	35.9	5.5	53.8	12.6

Source: Social Condition Survey

3.3 Water Quality

3.3.1 Water Quality Data of Website of JJM

Table 3.2 shows the summary of water quality data taken from the public water sources around the project area in FY2018-FY2019. In any drinking water source, arsenic contamination was not found beyond the permissible limit. All CD blocks in this project area were identified as an area affected by fluoride, nitrate, and salinity.

Table 3.2 Water Quality Data in Jhunjhunu and Barmer in FY2018-FY2019

Year	District	Block	No of Tested Sample from Public Hand	Ratio Samples found contaminated in Mandatory (above IS -10500 Permissible Limit)					
				Arsenic (AS)	Fluoride (F)	Nitrate (NO_3)	Salinity (TDS)	Iron (Fe)	Bacteriological
2018-2019	Barmer	Chohtan	392	0(0%)	49(13%)	339(86%)	204(52%)	0(0%)	0(0%)
		Sindhary	455	0(0%)	97(21%)	253(56%)	384(84%)	0(0%)	0(0%)
		Dhorimana	329	0(0%)	66(20%)	288(88%)	266(81%)	0(0%)	0(0%)
		Barmer	710	0(0%)	109(15%)	343(48%)	371(52%)	0(0%)	0(0%)
		Total	1,886	0(0%)	321(17%)	1,223(65%)	1,225(65%)	0(0%)	0(0%)
2019-2020		Chohtan	212	0(0%)	28(13%)	174(82%)	77(36%)	0(0%)	0(0%)
		Sindhary	167	0(0%)	54(32%)	58(35%)	98(59%)	0(0%)	0(0%)
		Dhorimana	195	0(0%)	40(21%)	151(77%)	143(73%)	0(0%)	0(0%)
		Barmer	423	0(0%)	87(21%)	241(57%)	233(55%)	0(0%)	0(0%)
		Total	997	0(0%)	209(21%)	624(63%)	551(55%)	0(0%)	0(0%)
2018-2019	Jhunjhunu	Udaipurwati	252	0(0%)	23(9%)	46(18%)	7(3%)	0(0%)	0(0%)
		Surajgarh	347	0(0%)	28(8%)	204(59%)	16(5%)	0(0%)	0(0%)
		Buhana	258	0(0%)	27(10%)	97(38%)	16(6%)	0(0%)	0(0%)
		Chirawa	318	0(0%)	54(17%)	150(47%)	22(7%)	0(0%)	0(0%)
		Total	1,175	0(0%)	132(11%)	451(38%)	61(5%)	0(0%)	0(0%)
2019-2020		Udaipurwati	623	0(0%)	113(18%)	153(25%)	34(5%)	0(0%)	0(0%)
		Surajgarh	486	0(0%)	53(11%)	257(53%)	21(4%)	0(0%)	0(0%)
		Buhana	510	0(0%)	29(6%)	149(29%)	38(7%)	0(0%)	0(0%)
		Chirawa	570	0(0%)	88(15%)	246(43%)	27(5%)	0(0%)	0(0%)
		Total	2,189	0(0%)	283(13%)	805(37%)	120(5%)	0(0%)	0(0%)

Source: JST based on the Ministry of Drinking Water and Sanitation, JJM, IMIS Reports "Water Quality (WQ) Testing in Laboratories"

3.3.2 Water Quality Testing by JST's Natural Condition Survey

Fluoride was detected beyond the acceptable level (1.0 mg/L) in several water sources in both districts. In addition, several water sources in Barmer District were found to have *Escherichia coli* (*E. coli*). It suggests that they may cause a variety of water-borne diseases[3].

[3] JST uses the following terms in accordance with World Health Organization (WHO)
・Water-borne diseases: Diseases caused by pathogenic microbes spread via contaminated water
・Water-related diseases: Diseases caused by various water contamination such as toxic agents (including fluoride) and water-borne diseases

3.4 Water-Related Diseases

3.4.1 Current Situation of Water-Related Diseases

In Jhunjhunu, especially around the hill areas, fluoride was detected from the government water sources. In JST's social condition survey, 60% of the respondents heard the term fluorosis. However, they do not have much understanding of the symptoms and factors of the diseases. Although it has been pointed out that the community is affected by fluorosis in Barmer District, the actual situation of fluorosis is still unknown because the survey for fluorosis has never been conducted by the health department so far.

On the other hand, various water-related diseases such as acute diarrhea and typhoid are sporadically recognized and reported every year in both Jhunjhunu and Barmer Districts. Unreported water-related diseases seem to be much more than the cases reported to PHED, according to the JST's survey results and several documents.

3.4.2 Importance of Education Activities Regarding Water-Related Diseases including Fluorosis

JST proposes to implement the activities/promotion for health and WASH (water, sanitation, and hygiene) as a countermeasure for fluorosis and other water-related diseases to be included in the soft component of the project. The evidence-based and consistent activities in communities, homes, and schools will contribute to the prevention and control of various water-related diseases.

3.5 Sewerage Condition

3.5.1 Current Sewerage Condition

According to the Swachh Bharat Mission[4], the mission's success has resulted in 100% coverage at present. However, the JST's social condition survey found out that not all households have a latrine within their own premises yet in the survey area of both Jhunjhunu and Barmer District. 23% households in Jhunjhunu District and 16% households in Barmer Dsitrict do not have a latrine. Also, 78% households in Jhunjhunu District and 98.4% households in Barmer District have no drainage system in their habitats.

3.5.2 Greywater Management by the project

After completion of the project, proper management of the greywater will be essential. Thus, it is proposed that "greywater management" be included in the capacity development of community component. It should be noted that the planning and construction of the sewerage system are not included in the project. The capacity development in the project will be limited to the sensitization of the Gram Panchayat regarding the importance of greywater management. Therefore, it is

[4] The national program with an aim to achieve the vision of a "Clean and Open Defecation-Free India" launched in 2014

recommended that PHED conduct greywater management on the project site in parallel with the project in collaboration with Panchyati Raj of Government of Rajasthan, which is in charge of the issues of greywater management.

3.6 Social Condition Survey

The social condition survey was conducted to understand: 1) current socio-economic conditions and the status of water supply and sanitation systems, and 2) water and sanitation related-knowledge, attitudes, and practices of the people in the project areas. 304 households and 18 schools from 18 sample villages in Jhunjhunu District and 364 households and 18 schools from 15 sample villages in Barmer District were chosen for the survey, and interviews were conducted by the local NGO using questionnaires. Some of the survey results are shown below.

(1) Jhunjhunu District

- About 70% of the respondents have house connections, yet many people purchase water from vendors and shops.
- The average water consumption is 35.9 Lpcd in the winter/dry season and 53.8 Lpcd in summer.
- The majority of the respondents are not satisfied with the water quantity. 93% of respondents would want to have a better water supply service
- They are willing to pay about INR 106 on average for at least two hours of water supply every day.

(2) Barmer District

- 169 out of 364 respondents are purchasing water from vendors. Nearly half of households had their own tube/bore well. Very limited numbers of households have house connections.
- The average water consumption is 32.5 Lpcd in the winter/dry season and 51.3 Lpcd in summer.
- Vast majority of the respondents are not at all satisfied with the water supply quality (72%), quantity (88%), and access (86%).
- They are willing to pay about INR 100 on average for at least two hours of water supply every day.

Chapter 4 Review of Water Supply Plan for Jhunjhunu Scheme

4.1 Target Area of the Project

The Jhunjhunu Scheme consists of two sub-schemes:

- Surajgarh Sub-Scheme with target area of 190 villages in Buhana and Chirawa Tehsils and one town (Surajgarh Town)
- Udaipurwati Sub-Scheme with target area of 94 villages in Udaipurwati Tehsil and one town (Udaipurwati Town)

4.2 Population and Water Demand Projection (Target year: 2047)

The population and water demand projections have been made as shown in Table 4.1. The per capita consumption is 55 lpcd (rural area) and 100 lpcd (urban area).

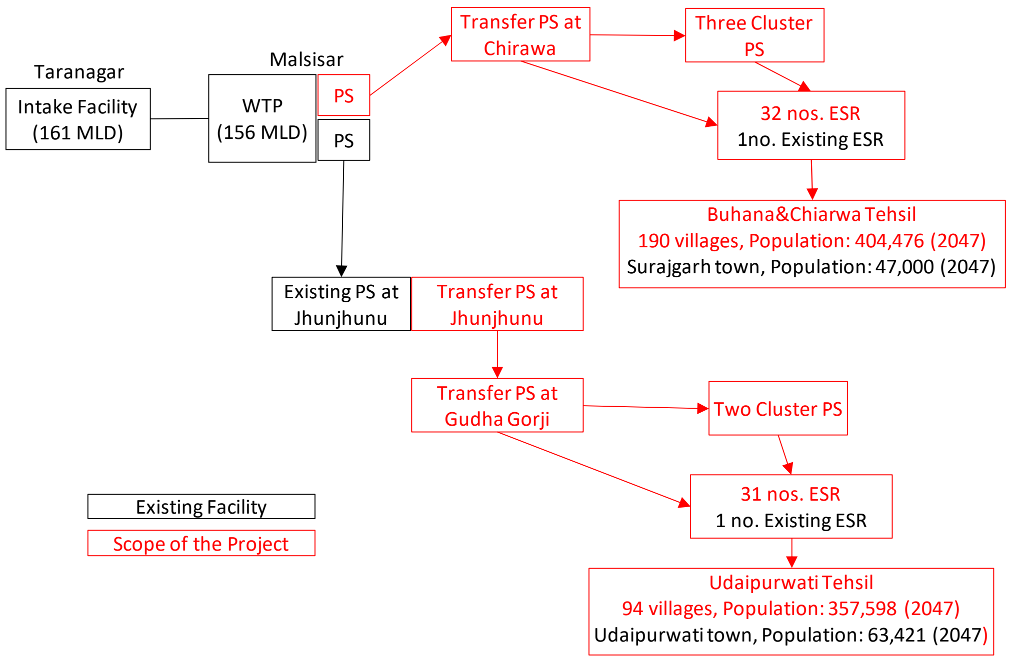
Table 4.1 Population and Water Demand Projections for Jhunjhunu Scheme

Area	Population				Clear Water Demand (m^3/day)		
	2011	2026	2032	2047	2026	2032	2047
Surajgarh Sub-Scheme							
Rural population							
Buhana Tehsil	223,405	252,905	265,768	300,863	17,387	18,272	20,684
Chirawa Tehsil	76,938	87,097	91,527	103,613	5,988	6,293	7,123
Sub-total	300,343	340,003	357,296	404,476	23,375	24,564	27,808
Urban population							
Surajgarh town	21,666	29,917	34,038	47,000	3,740	4,255	5,875
Total	322,009	369,919	391,334	451,476	27,115	28,819	33,683
Udaipurwati Sub-Scheme							
Rural population							
Udaipurwati Tehsil	265,534	300,597	315,886	357,598	20,666	21,717	24,585
Sub-total							
Urban population							
Udaipurwati town	29,236	40,369	45,931	63,421	5,046	5,741	7,928
Total	294,770	340,966	361,817	421,020	25,712	27,459	32,513
Grand Total	**616,779**	**710,885**	**753,151**	**872,496**	**52,827**	**56,277**	**66,195**

Source: JST

4.3 Scope of the Project

The scope of the project will be as shown in Figure 4.1.



Source: JST

Figure 4.1 Scope of the Project (Jhunjhunu Scheme)

The distinctive features of the water supply system of the project are:

- The following facilities will be shared with the ITJSK project (Phase-I):
  - Intake facility at Taranagar
  - Raw water transmission pipeline
  - WTP at Malsisar
  - Pump Station (PS) at Malsisar for Jhunjhunu
  - Transmission pipeline to Jhunjhunu PS
  - Existing PS at Jhunjhunu
- At first, treated water will be transmitted from PSs to Elevated Service Reservoirs (ESRs), which are located in the supply areas, then distributed to the supply area by gravity.
- Regarding the water supply to two towns (Surajgarh and Udaipurwati town), the water will be supplied to the existing ESR in the towns. The construction of water distribution facility after the existing ESR is out of the project scope. It will be undertaken by the town municipality.
- Each ESR covers several target villages (four to five villages on average).
- From ESR, the treated water will be distributed to each village.
- At the entrance of each village, a Village Transfer Chamber (VTC) will be installed.
- At VTC, water flow will be recorded and the flow record will be transferred to the master control station by Supervisory Control and Data Acquisition (SCADA) system.
- The water that passed the VTC will be distributed by the distribution pipeline network and supplied to each household by house connection. The house connection work is included in the project scope.

4.4 Availability of the Water Source for the Project

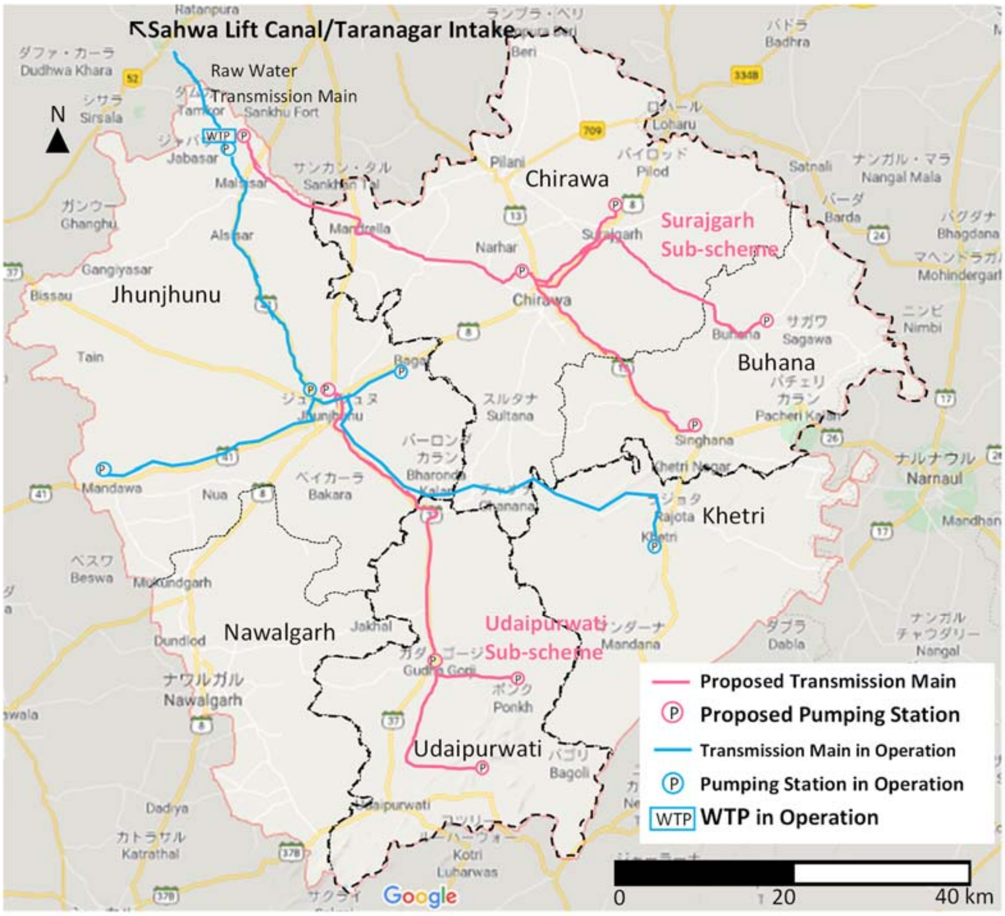
The water source of the project is Sahwa Lift Canal, which is a tributary canal of Indira Gandhi Canal. The present allocated intake amount for water supply at Taranagar Intake is 117 MLD, while the projected water demand in 2047 is 178.9 MLD.

Water Resources Department (WRD) has already agreed to increase the allocation of the water of Indira Gandhi Canal to PHED up to 5,635 MLD from the present amount of 2,523 MLD. It was confirmed that the necessary water allocation of water for the project will be made by GOR.

Chapter 5 Facility Plan for Jhunjhunu Scheme

5.1 Outline of the Project Facility

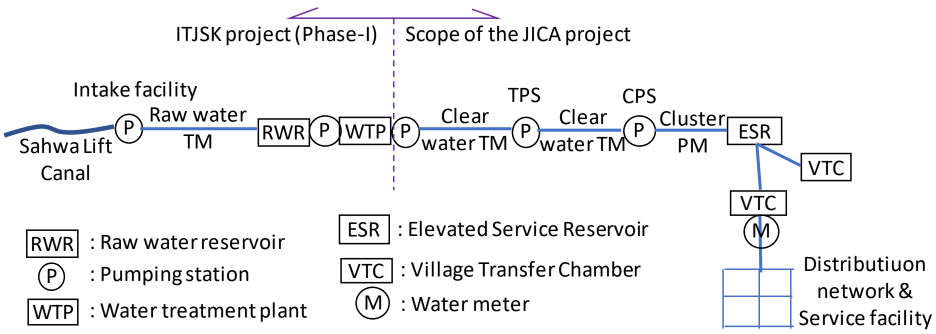
Jhunjhunu Scheme consists of two sub-schemes, i.e. Surajgarh Sub-scheme and Udaipurwati Sub-scheme. Figure 5.1 shows the facility layout of the Jhunjhunu Scheme.



Source: JST based on the DPR 地図データ ©2020

Figure 5.1 Facility Layout of the Jhunjhunu Scheme

Figure 5.2 shows the configuration of the project facility.



Source: JST based on the DPR

Figure 5.2 Configuration of the Project Facility of Jhunjhunu Scheme

5.2 Principal Feature of Project Facility

The feature of each sub-scheme is as shown in Table 5.1.

Table 5.1 Facility Feature of Jhunjhunu Scheme

Surajgarh Sub-scheme	
Facility	Principal Feature
1. Pump station (PS) with clear water reservoir	1) Transfer Pumping Station (TPS) at Malsisar WTP for Chirawa 393x4= 1,572 m^3/hr 2) TPS at Chirawa for Surajgarh, Buhana, Singhana 278x2+237x2+224x2=1,478 m^3/hr 3) 3 Cluster Pumping Station (CPS) at Surajgarh, Buhana, Singhana
2. Treated water transmission pipeline	Transmission main pipeline Pumping: D400, 1100, L = 112 km Cluster pumping main (CPS to ESRs) Pumping: D150 – D350, L = 262 km
3. Elevated service reservoir (ESR)	32 nos. Capacity: 200-1,000 m^3
4. Cluster distribution pipeline	Cluster distribution pipeline (ESR to VTC): D90 - D200 L=928 km
5. Village transfer chamber	190 nos.
6. Village distribution pipeline with house connection	Village distribution pipeline: D90 - D200 L=1,416 km House connection: 68,001 nos. (Year [illegible])
7. Power receiving facility	Provision for 33 KV power line L=23 km in total
8. SCADA system	Master Control Center at Jhunjhun PS
Udaipurwati Sub-scheme	
Facility	Principal Feature
1. Pump station (PS) with clear water reservoir	1) TPS at Jhunjhunu for Gudha Gorji 379 m^3/hr x 4= 1,516 m^3/hr 2) TPS at Gudha Gorji for Ponkh, Udaipurwati 210 x 3 + 183 x 2 = 996 m^3/hr 3) 2 CPS at Ponkh, Udaipurwati
2. Treated water transmission pipeline	Transmission main pipeline Pumping: D350,450,700, L = 75 km Cluster pumping main (CPS to ESRs) Pumping: D100 – D400, L = 236 km
3. Elevated service reservoir (ESR)	31 nos. Capacity: 200-900 m^3
4. Cluster distribution pipeline	Cluster distribution pipeline (ESR to VTC): D90 - D300 L=1,303km
5. Village Transfer Chamber	VTC: 94 nos.
6. Village Distribution pipeline with house connection	Village distribution pipeline: D90 - D200 L=1,252 km House connection: 60,119 nos. (Year [illegible])
7. Power receiving facility	Provision for 33 KV power line L=29 km in total
8. SCADA system	Master Control Center at Jhunjhun PS

Source: JST based on DPR

Chapter 6 Review of Water Supply Plan for Barmer Scheme

6.1 Target Area of the Project

Barmer Scheme consists of four sub-schemes:

- HR-1 Sub-scheme with target area of 268 villages in Gudhamalani Tehsil
- HR-2 Sub-Scheme with target area of 183 villages in Gudhamalani and Chohtan Tehsils
- Chohtan-1 Sub-Scheme with target area of 187 villages in Chohtan and Gudhamalani Tehsils
- Chohtan-2 Sub-Scheme with target area of 251 villages in Chohtan Tehsil

Chohtan-1 and Chohtan-2 Sub-Scheme constitute a single water supply system. That is, Chohtan-2 Sub-Scheme is located at the downstream of Chohtan-1 Sub-Scheme. There is no urban town in the target area. All target areas are classified into rural area.

6.2 Population and Water Demand Projection

The population and water demand projections have been made as shown in Table 6.1.

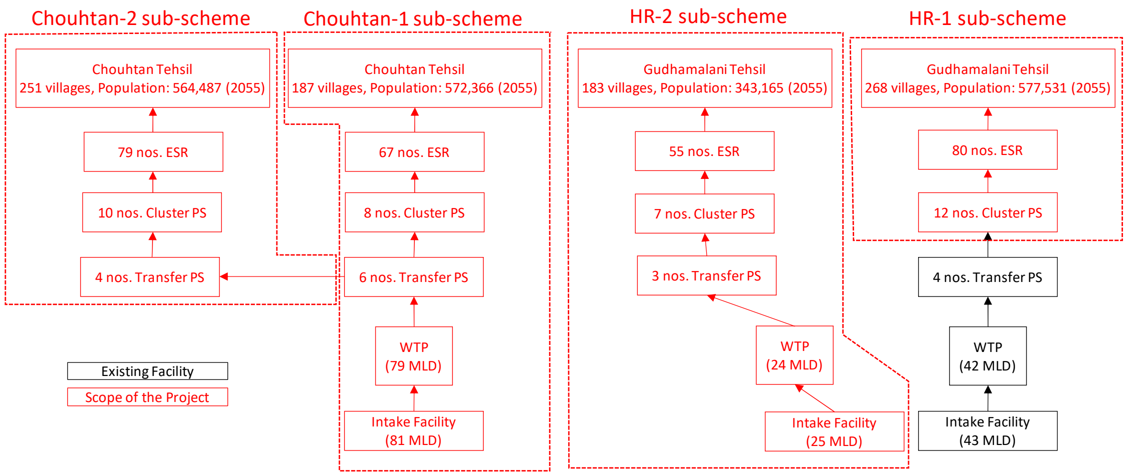
Table 6.1 Population and Water Demand Projections for Barmer Scheme

Area	Population					Clear Water Demand (m^3/day)		
	2011	2027	2031	2040	2055	2027	2040	2055
HR-1 sub-scheme	231,411	366,784	404,217	479,868	577,531	24,692	32,305	38,879
HR-2 sub-scheme	137,503	217,941	240,183	285,134	343,165	14,672	19,195	23,102
Sub-total	368,914	584,725	644,401	765,002	920,696	39,364	51,500	61,981
Chouhtan-1 sub-scheme	247,649	382,608	420,064	491,999	572,366	25,757	33,121	38,532
Chouhtan-2 sub-scheme	244,240	377,342	414,282	485,227	564,487	25,403	32,665	38,001
Sub-total	491,889	759,950	834,347	977,226	1,136,852	51,160	65,787	76,533
Grand Total	**860,803**	**1,344,675**	**1,478,747**	**1,742,228**	**2,057,548**	**90,524**	**117,287**	**138,514**

Source: JST

6.3 Scope of the Project

The scope of the proposed JICA project is as shown in Figure 6.1.



Source: JST

Figure 6.1 Scope of the Project (Barmer Scheme)

The distinctive features of the water supply system of the project are:

- The following facilities for HR-1 Sub-Scheme are being constructed:
  - Intake facility
  - Raw water transmission pipeline
  - Water Treatment Plant (WTP)
  - Transmission pipeline to Transfer Pump Station (PS) and Transfer PS
- At first, treated water will be transmitted from PSs to Elevated Service Reservoirs (ESRs), which are located in the supply areas, then distributed to the supply area by gravity.
- Each ESR covers several target villages (three to four villages on average).
- From ESR, the treated water will be distributed to each village
- At the entrance of each village, a Village Transfer Chamber (VTC) will be installed.
- At VTC, water flow will be recorded and the flow record will be transferred to the master control station by Supervisory Control and Data Acquisition (SCADA) system.
- The water that passed the VTC will be distributed by the distribution pipeline network and supplied to each household by house connection. The house connection work is included in the project scope.

6.4 Availability of the Water Source for the Project

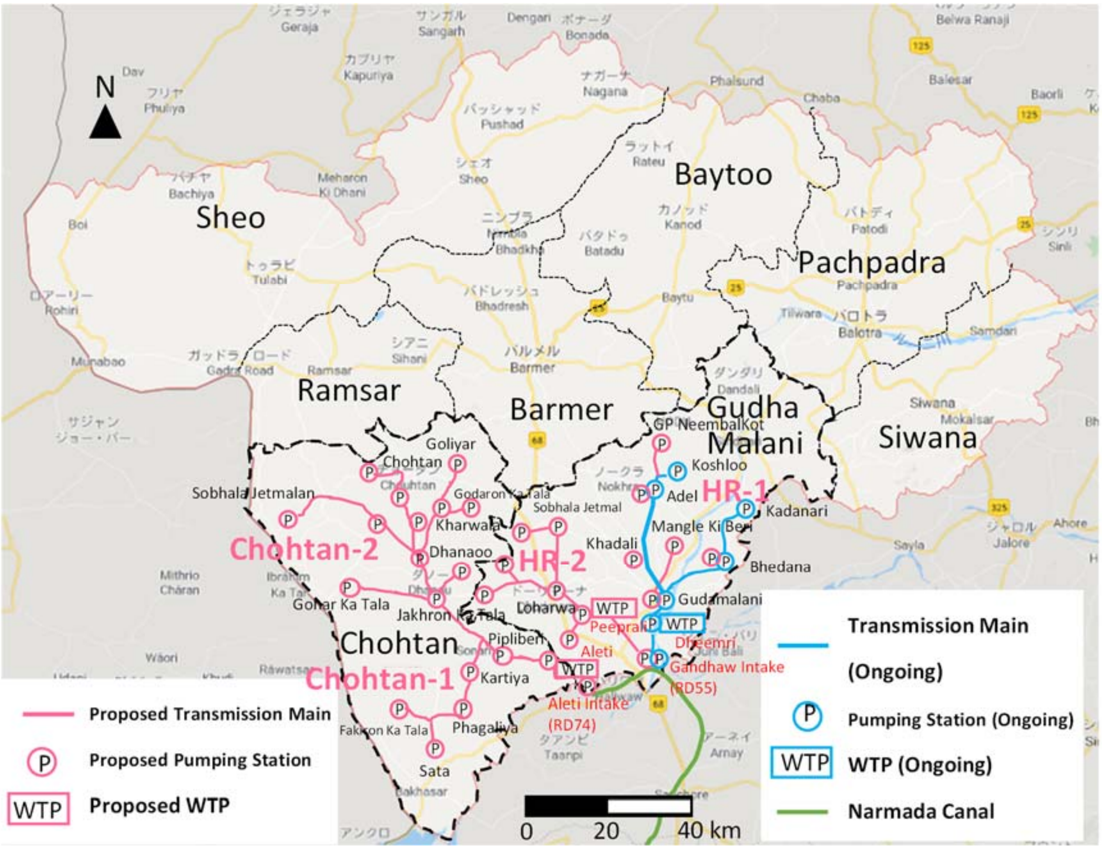
The water source of the project is Narmada Canal. The present total allocated amount of water of Narmada Canal to water supply in Rajasthan state is 359.58 MLD, while the projected water demand in 2055 is 536.74 MLD.

Water Resources Department (WRD) has already agreed to increase the allocation of the water of Narmada Canal to PHED. It was confirmed that the water necessary for the project will be allocated by GOR by utilizing the abovementioned water allocation from 359.58 MLD to 645.73 MLD.

Chapter 7 Facility Plan for Barmer Scheme

7.1 Outline of the Project Facility

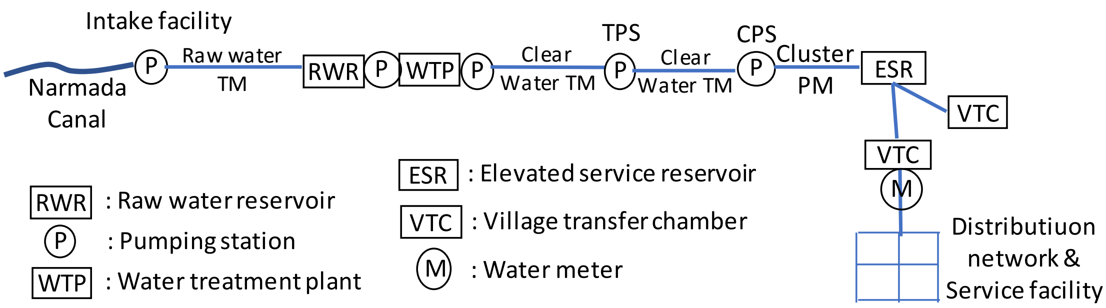
Barmer Scheme is divided into four sub-schemes: HR-1 sub-scheme, HR-2 sub-scheme, Chohtan-1 sub-scheme, and Chohtan-2 sub-scheme. Figure 7.1 shows the facility layout of the Barmer scheme.



Source: JST based on revised DPR

Figure 7.1 Facility Layout of the Barmer Scheme

Figure 7.2 shows the configuration of the project facility.



Source: JST

Figure 7.2 Configuration of the Project Facility of Barmer Scheme

7.2 Principal Feature of Project Facility

The feature of each sub-scheme are as shown in 5.2 Principal Feature of Project Facility

The feature of each sub-scheme is as shown in Table 5.1.

Table 5.1 and Table 7.2.

Table 7.1 Facility Feature of HR-1 and HR-2 Sub-schemes

Facility	Principal Feature	
	HR-1 scheme	HR-2 scheme
1. Intake facility	Constructed	Location: RD 55 (H-Point) of Narmada Canal Type of structure: Rectangular intake tower with pump station
2. Raw Water Pump Station	Constructed	Location: RD 55 (H-Point) of Narmada Canal 371 x 3 = 1,114 m^3/hr Location: Peeprali 557 x 2 = 1,114 m^3/hr
3. Raw Water Pumping Main	Constructed	D600 DI K9 pipe, L=18 km
4. Raw Water Reservoir	Under construction	Location: Peeprali, Capacity: 520 ML, Retention Time: 21 days
5. Water Treatment Plant	Under construction	Location: Peeprali Type: Rapid sand filter Capacity: 24 MLD
6. Transfer pump station (PS) with clear water reservoir	Under construction	1) Peeprali: 527 x 2 = 1,054 m^3/hr 2) Loharwa: 229 x 2 + 440 x 1 = 898 m^3/hr 3) Sobhala Jetmal: 268 m^3/hr
7. Treated water transmission pipeline	Under construction	D150 – D600, L=68 km
8. Cluster pump station with clear water reservoir	12 nos.: 1) Dheemri WTP, 2) Gudhamalani TPS, 3) Adel TPS, 4) Koshlou TPS, 5) Bhedana TPS, 6) Beri Gaon CPS, 7) Khadali CPS, 8) Nokhra CPS, 9) Neembal Kot CPS, 10) Mangle Ki Beri CPS, 11) Ratanpura CPS, 12) Kadnari CPS	7 nos: 1) Peeprali WTP, 2) Loharwa TPS 3) Shobhala Jetmal TPS 4) Borcharnan CPS 5) Dhorimanna CPS, 6) Misari Ki Beri CPS 7) Meethya Tala CPS
9. Cluster pumping main	D100 – 250 mm, L=458 km	D 100-250 mm, L=292 km
10. Elevated service reservoir (ESR)	80 nos., Capacity 100 – 500 m^3	55 nos., Capacity 100 – 450 m^3
11. Cluster distribution pipeline	D90 – D250 L=557 km	D75 – D250 L= 387 km
12. Village transfer chamber	268 nos.	183 nos.
13. Village distribution pipeline with house connection	D75 – D250 L=3,177 km House connection: 73,357 nos. (Year)	D75 – D250 L=4,985 km House connection: 43,588 nos. (Year)
14. Power receiving facility	Provision for 33 KV power line L=115 km in total	Provision for 33 KV power line L=60 km in total
15. SCADA system	Master Control Center at Dheemri WTP	Master Control Center at Peeprali WTP

Source: JST based on DPR

Table 7.2 Facility Feature of Chohtan-1 and Chohtan-2 Sub-scheme

Chohtan-1 Sub-scheme	
Facility	Principal Feature
1. Intake facility	Location: RD 74 (L-Point) of Narmada Canal Type of structure: Rectangular intake tower with pump station
2. Raw Water Pump Station	Location: RD 74 (L-Point) of Narmada Canal 973 x 4 = 3,892 m^3/hr Location: Aleti 1,947 x 2 = 3,894 m^3/hr
3. Raw Water Pumping Main	D1100 mm L=5.6km
4. Raw Water Reservoir	Capacity: 1,670 ML Retention Time: 21 days
5. Water Treatment Plant	Location: Aleti Capacity: 79 MLD
6. Transfer pump station (PS)	1) Aleti HW: 919 x 4=3,676 m^3/hr 2) TPS Peepliberi: 533 x 2 + 608 x 4 = 3,498 m^3/h 3) TPS Kartiya: 398 x 2= 796 m^3/h 4) TPS Jakhron Ka Tala: 121 m^3/h 5) TPS Dhannau: 220 x 2 + 331 x 2 + 303 x 3 = 2,011 m^3/h 6) TPS Phagliya: 278 x 2 = 556 m^3/h
7. Treated water transmission pipeline	D 250 - D1000, L=214 km
8. Cluster pump station with clear water reservoir	8 nos: 1) Aleti WTP, 2) Peepliberi TPS, 3) Kartiya TPS, 4) Phagliya TPS, 5) Jakhron Ka Tala TPS, 6) Dhannau TPS, 7) Sata CPS, 8) Fakiron Ka Niwan CPS
9. Cluster pumping pipeline	D100 - D250 L=447 km
10. Elevated service reservoir (ESR)	67 nos. Capacity 150 - 600 m^3
11. Cluster distribution pipeline	D90 - D250 L= 424 km
12. Village Transfer Chamber	187 nos.
13. Village Distribution pipeline with house connection	D75 - D200 L=4,065 km House connection: 76,522 nos. (Year)
14. Power receiving facility	Provision for 33 KV power line L=45 km in total
15. SCADA system	Master Control Center at Aleti HW
Chohtan-2 Sub-scheme	
Facility	Principal Feature
1. Transfer pump station (PS)	1) TPS Ibrahim Ka Tala: 262 m^3/hr 2) TPS Alamsar : 374 m^3/hr 3) TPS Chohtan : 153 m^3/hr 4) TPS Kharawala: 331m^3/hr
2. Treated water transmission pipeline	D 200 - D350, L=82 km
3. Cluster pump station with clear water reservoir	10 locations: 1) Alamsar TPS, 2) Kharwala TPS, 3) Choutan TPS, 4) Ibrahim K Tala TPS 5) Bhron Ka Tala CPS, 6) Goliyar CPS, 7) Godaron Ka Tala CPS 8) Dhok CPS, 9) Gohar Ka Tala CPS, 10) Sobhala Jetmalan CPS
4. Cluster pumping main	D100 - D250 mm, L=546 km,
5. Elevated service reservoir (ESR)	79 nos., Capacity 100 - 500 m^3
6. Cluster distribution pipeline	D75 - D250 L=558 km
7. Village Transfer Chamber	251 nos.
8. Village Distribution pipeline with house connection	D75 - D250 L=4,848 km House connection: 75,468 nos. (Year)
9. Power receiving facility	Provision for 33 KV power line L=110 km in total
10. SCADA system	Master Control Center at Aleti HW

Source: JST based on the revised DPR

Chapter 8 O&M Plan and Organization Plan

8.1 Sector Policies of the Government of Rajasthan

8.1.1 National Policy

The Government of India (GOI) has been engaged in improvement of the rural water supply situation. In 2019, the GOI restructured and subsumed the National Rural Drinking Water Program (NRDWP) which had been implemented since 2009 into the Jal Jeevan Mission (JJM). The main objective of this mission is to provide functional household tap connections to every rural household in India by 2024 with a service rate of 55 litters per capita per day. GOI has issued the "Operational Guidelines for the Implementation of Jal Jeevan Mission" in December 2019 as the practical guideline.

8.1.2 State Policy

The Government of Rajasthan State (GOR) formulated the "State Water Policy" in 2010. According to PHED, the rural water policy of GOR is based on the JJM guideline. The management policy of each project is determined by PHED considering the actual situation of the project.

8.2 Institutional Arrangement of PHED

8.2.1 Roles of Organization

In urban area, construction and O&M of water supply facilities are generally implemented by PHED. In rural area, PHED supports the design and construction of facilities. Then, these assets are transferred to the community group after construction. PHED also monitors the quality of drinking water.

8.2.2 Number of Employees of PHED

More than 32,000 staffs including permanent and temporal contract workers are working in PHED. Out of that, around 1,700 staffs are the engineers composed of "senior engineers" and "junior engineers." Around 4,300 staffs including 358 accountants are assigned in the headquarters and sub-region offices for administrative works. Remaining 26,000 staffs are working as a technical staff for construction and O&M of the facilities.

8.2.3 Personnel System and Training Program of PHED

Permanent officers in PHED are rotating jobs every few years. Some staffs are assigned to other departments for technical supports. Staffs of PHED attend various training courses mainly provided by three public entities: Engineering Staff Training Institute (ESTI), Harish Chandra Mathur Rajasthan State Institute of Public Administration (HCM RIPA) Jaipur, and Water and Sanitation Support Organization (WSSO).

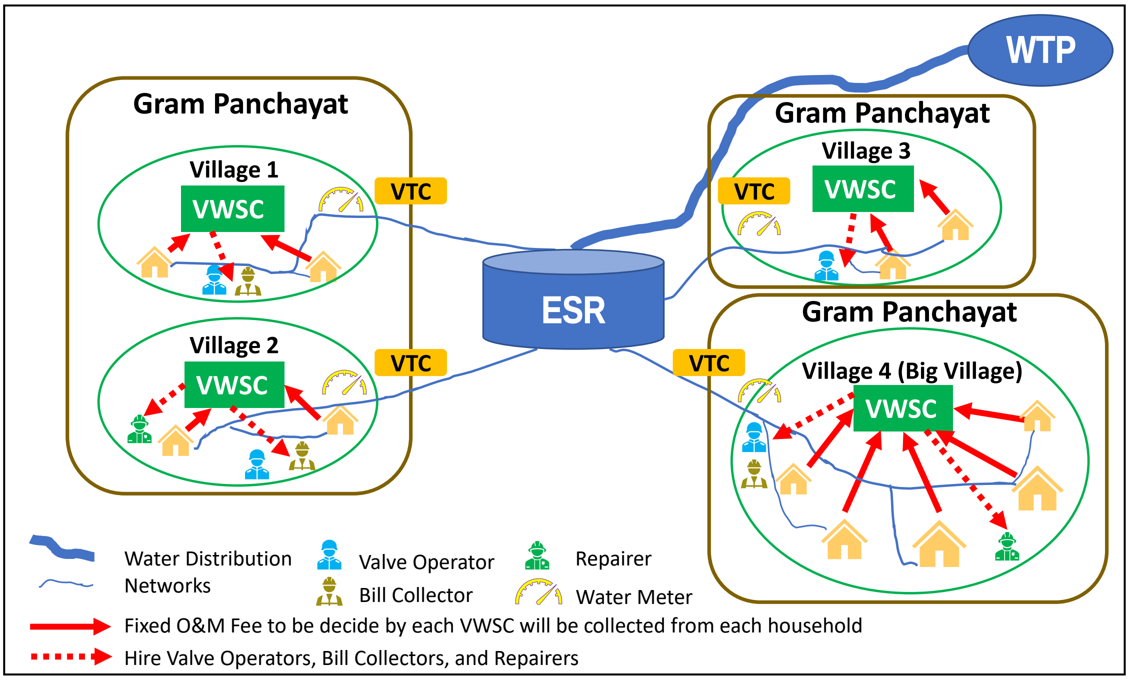
8.3 O&M Plan

8.3.1 Outline of the O&M Plan

The proposed concept of water supply operation system for the project is shown in Figure 8.1.

In line with the vision of JJM, every household is planned to have Functional Household Tap Connection (FHTC) through the village distribution network under management by Village Water Sanitation Committee (VWSC). The water treated at WTP will be distributed to each household through the elevated service reservoir (ESR). A water meter will be installed only at the Village Transfer Chamber (VTC), located at the entry point to each village and the water meter will not be installed in each household.

O&M of the facilities up to VTC will be managed by PHED and O&M after VTC will be managed by VWSCs as instructed in the JJM guideline. The Contractor will undertake overall O&M of the facilities up to VTC under the contract with PHED. VWSCs will undertake O&M of the facilities after VTC and also manage the administrative issues such as tariff collection, cash management, and conflict resolution among villagers.



Source: Created by JST through the discussion with PHED

Figure 8.1 Proposed O&M System in the Community

8.3.2 O&M Fee

As shown in Figure 8.1, the villagers pay O&M Fee to the VWSC. Since no-tariff policy[5] is currently adopted in Rajasthan State, VWSCs does not pay the bulk-water tariff to PHED. Under

5 Government of Rajasthan issued this policy in 2019. However, the maximum water volume to be free of charge was not clarified. Latest tariff policy will be clarified before implementing the project.

the no-tariff-policy, it is, indispensable for VWSCs to collect money for O&M works and the necessary payments for the related workers. It is proposed that PHED with the assistance of the consultant develop the guideline with regard to the O&M Fee setting so that each VWSC is able to determine the appropriate amount of O&M fee.

8.4 Financial Plan

8.4.1 Financial Condition of GOR

The revenue amount of GOR increased gradually from INR 745 billion in 2013-14 to INR 1,273 billion in 2017-18. The majority of revenue (69% in 2017-18) is collected as "tax revenue" composed of goods and services tax, taxes on income and expenditure, taxes on property and capital transactions, etc. Total expenditures of GOR is INR 1,261 billion in the fiscal year of 2017-18. The daily cost for services is categorized into revenue expenditure, and other capital investments are categorized into capital expenditure. The total expenditures are almost equivalent to the annual revenue, GOR does not make financial loss.

8.4.2 Financial Condition of PHED

For the financial management of water supply service by PHED, the typical accounting system of public organization as one of the departments of GOR is being applied. At present, there is no plan to apply the company accounting system for the water supply service in Rajasthan State.

Recent revenue, capital expenditures and O&M expenditures are shown in Table 8.1.

Table 8.1 Recent Trend of Revenues and Expenditures of PHED

(unit: INR million)

[redacted]

Source: PHED

As shown above, the revenue amount only covers [redacted] % of O&M expenditures. The revenue covers only [redacted] of the total cost (O&M expenditure and capital expenditures). The rest of the expenditure is basically being subsidized by the state government. The total revenue of GOR was INR [redacted] in 2017-18, while the necessary subsidy amount for water supply service was INR [redacted] assuming "no-tariff policy" was adopted to all users. This subsidy amount corresponds to [redacted] of the total revenue of GDR in the same year, and the impact of the subsidy is currently limited to GOR.

8.4.3 Water Tariff

There are two types of water tariff systems applied by PHED which are for regular project and for special project (project of more than INR 500 million). In March 2020, the Chief Minister of GOR determined to exempt the water and sewerage charges from low consumption domestic users of both regular project and special project, which is called “no-tariff policy”.

8.4.4 Mid-term Estimation of Income and Expenditure of PHED

The mid-term financial conditions of PHED were forecasted to evaluate the financial soundness and stability of PHED. In this forecast, “no-tariff policy” was not considered. The forecast shows the deficit increases year by year. In the fiscal year of 2024-25, the deficit due to O&M expenditure against revenue will reach INR , and that due to total expenditure (O&M and capital expenditure) against revenue will be INR . The financial conditions of water supply service should be carefully monitored every year.

8.5 Organization Development Action Plan

8.5.1 Action Plan of Rural Area Managed by PHED

The objective of the action plan of PHED is to ensure the project sustainably by developing the organizational structure of PHED. The short term and long term goals has been set as shown in Table 8.2. The target indicators and the its target values will be determined during implementation phase. To satisfy the short-term goals, specific activities and their implementation schedule has been designed.

Table 8.2 Short Term and Long Term Goals

	Short-term Goals	Long-term Goals
Target Year	2025	2040
Targets		
- Ratio of piped water supply	100%	100%
- Satisfaction ratio of water quality test	95%	100%
- Recovery ratio of O&M costs	Not determined	Not determined
- Revenue water ratio	Not determined	Not determined
- Total number of trained employees	Not determined	Not determined
- Asset management system is introduced	80% completion level	100% completed

Source: JST supported by PHED

8.5.2 Trainings for PHED Staff

In addition to the existing trainings provided by ESTI, HCM RIPA OTS, and WSSO, the JST proposes the several training courses to be implemented by the consultant during the project period using JICA loan. The detail of trainings will be refined during the project implementation phase.

Chapter 9 Capacity Development of Community

9.1 Overall Framework of Capacity Development of Community

9.1.1 Objectives of Component

The component aims to create awareness and build the capacity of beneficiaries to maximize the benefit of the project. The component will include activities of sensitization of the stakeholders and beneficiaries, strengthening of the institution at the village level, and development of its capacity to undertake O&M of the facility.

9.1.2 Actors in Village Water Supply Operation System

A Village Water Sanitation Committee (VWSC) is a village level unit responsible for O&M of the in-village water supply system. In line with JJM guideline, VWSC' main tasks include the followings:

- Identification and registration of household to connect the house connection
- Conduct O&M of the in-village facility and keep the record of O&M activity
- Set up accounting and tariff system and maintain the account
- Collection of O&M fund/ water tariff
- Awareness raising and handling the grievances from users

The suggested composition of the VWSC is shown in Table 9.1.

Table 9.1 Suggested Composition of VWSCs

Sr.No.	Position	Person	Number
1	Head	Sarpanch, Gram Panchayat member, Traditional village head or Senior village leader	1
2	Secretary	Gram Panchayat secretary or Patwari	1
3	Member	Principal of the local school	1
4	ditto	Auxiliary Nurse Midwife (ANM)[6]	1
5	ditto	Anganwadi Worker	1
6	ditto	Accredited Social Health Activist (ASHA)	1
7	ditto	Representative of women Self-help Group	1
8	ditto	Representative of the BPL families	1
9	ditto	Representatives of SC/ST families	2 (male and female)
10	ditto	Representative of Health Department	1
11	ditto	Junior Engineer of PHED / Panchayat department	1
12	ditto	Representatives of the association of Ward-level User Groups (WUGs)	2 (male and female)
	Total		14 to 15

Source: JST based on JJM and information from PHED

[6] A village-level female health worker in India.

9.1.3 Implementation Structure of the Component

Proposed implementation Structure of the Component is described in Figure 9.1.

Source: JST based on the discussions with PHED

Figure 9.1 Implementation Structure of Capacity Development of Community

Project Cell (PC) will supervise and manage all activities and the consultants will assist them. NGO hired by PC will implement or facilitate the programs while encouraging participation by the villagers in the community. Director (Community Participation) PC as a head of this component will develop the programs in consultation with the consultants. Under the instruction from Director (Community Participation), Manager (Community Participation) will manage the activities conducted by NGOs.

9.2 Implementation Plan of Capacity Development of Community

9.2.1 Overall Implementation Plan

The planned main activities are shown in the following tables.

Table 9.2 Implementation Schedule of Capacity Development of Community

Source: JST based on the discussion with PHED

Table 9.2 is a combination of the schedules of all the target villages, while Table 9.3 shows a case of one target village, whose activities will start just after the guidance to NGO staffs is completed.

Table 9.3 Required Period for Activities for One Village

Source: JST based on the discussion with PHED

9.2.2 Guidance to NGO Staffs

Once the procurement of NGOs is completed, orientation and training programs of the field staff of the NGOs will be conducted in order for them not only to understand and be familiarized with the project, but also to gain the skills and knowledge to effectively support VWSCs and the communities.

9.2.3 Preparatory Works in the Community

Before commencement of the capacity development activity in the village, following preparatory works will be conducted:

- Information workshops for relevant government offices/organizations at district level, block level as well as village level will be held.

- The village level facilitators (one in each village) who facilitate communication among VWSC, NGO staff, and PC will be hired.
- The household survey will be conducted by NGO in order to examine the current water supply systems in the village and to confirm the location and number of households who are willing to connect to the in-village water supply scheme provided by the project.

9.2.4 Capacity Development of VWSC

NGO will provide VWSCs with assistance programs to start functioning as a village institution and to develop its capacity. The assistance includes preparation of the village action plan (VAP), training programs, exposure visits, social auditing and handholding support by regular follow-up visits. NGOs will also assist VWSCs to motivate village communities to actively participate in O&M of the water supply facility and health promotions related to FMP and WASH.

9.2.5 Community Education Activities

Various forms, such as campaigns, distribution of brochures, posters or banners, drama plays, etc., of community education activities will also be conducted by NGOs. The topics will be related to; 1) JJM, the project, and VWSCs; 2) O&M of in-village water supply facilities; 3) conservation and judicious usage of water; 4) gender, and 5) health & WASH.

9.2.6 Assessment of the Capacity Development of the Community Component

An assessment of the component will be conducted during the project period by setting the baseline and conducting an end line survey to assess positive and negative changes before and after the project.

9.3 Activities Against Water-related Diseases including Fluorosis

The safe water distribution and education activities which promotes the villager's behavior change are recognized as the essential countermeasure for preventing water-related diseases. In this regard, the activities for health and WASH (water, sanitation, and hygiene) has been planned. Effective health promotions such as IEC activities will be implemented targeting major water-related diseases so that villagers' knowledge and motivation will be driven up. The activities will be expected to promote the behavior changes as shown in Table 9.4.

Table 9.4 Expected Behavior Changes by the Project Activities

Disease	Expected Behaviour Changes
Fluorosis	-Increase the percentage of residents with the knowledge of fluorosis (What is fluorosis, what is the cause, how to prevent, etc.) -Increase the percentage of residents drinking safe water and eating safe food -Increase the percentage of residents visiting health office and dentist for the suspected fluorosis case
Major Water-borne diseases	-Increase the percentage of residents with the knowledge of major water-borne diseases in the area -Increase the percentage of residents conducting hygienic practice such as drinking safe water, wash their hands, keep the surroundings clean etc. to prevent the diseases

	-Increase the percentage of residents visiting health office for the suspected cases

Source: JST

9.4 Gender Consideration

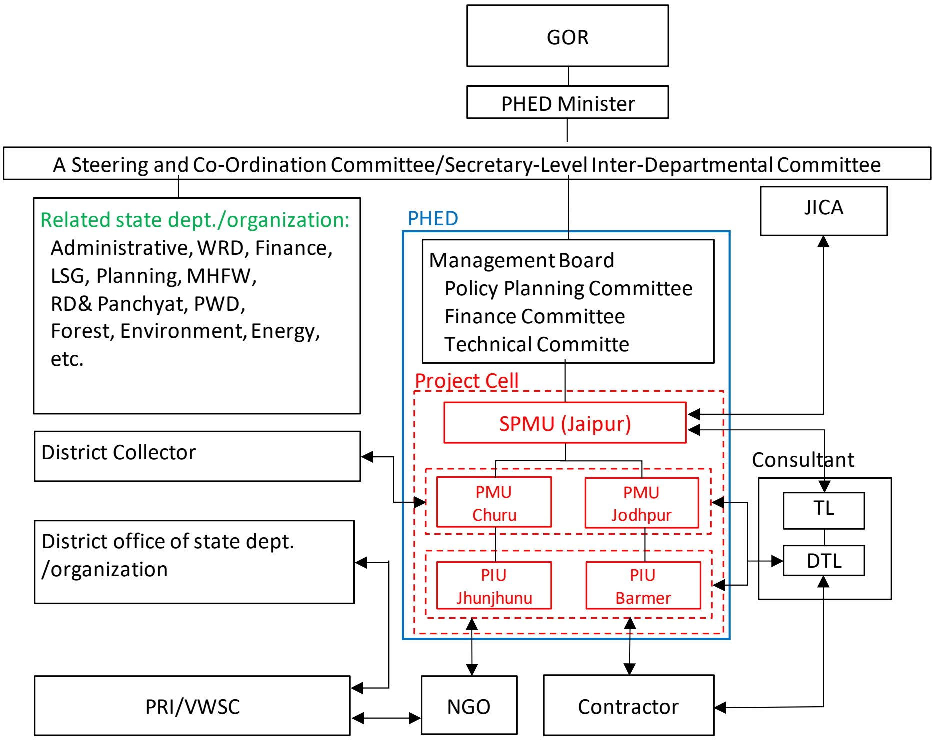
The main gender issues and needs in the project area were identified. Then a gender action plan was suggested. The plan will maximize the benefits of the project and to ensure that women will receive an equal portion of these benefits. Main actions in the plan include the following;

- Provide household water connections in target villages, which will enable both men and women to save time for collecting water, and thus they will be able to use time for other productive activities;
- Create an organizational structure that ensures sufficient gender considerations throughout all phases of the project;
- Assign an officer who has expertise in community participation and gender considerations in PIUs' positions;
- Add subjects of gender consideration to the project orientation and capacity development programs for PIU members and Gram Panchayat leaders;
- Ensure equal employment opportunities for women to engage in all project activities;
- Specify in the tender documents and contracts that gender considerations shall be extended in the implementation and O&M of the village water supply facilities;
- Include more than 33% of female members in the Ward-level User Group (WUG), and assign one male and one female representatives from each WUG as members of the association of WUGs;
- Consider women not only as beneficiaries, but also as change agents, and encourage them to participate in any community activities in the target villages;
- Include gender considerations as a subject in the capacity building program for VWSC members and village education programs; and
- Carefully choose communication tools and methods considering the women's low literacy rates and education levels in the capacity development of VWSCs and village educational programs. As necessary, separate programs for female residents may be set up to promote women's understanding.

Chapter 10 Project Implementation Plan

10.1 Organization for Project Implementation

Figure 10.1 shows the proposed overall implementation system of the project.



Source: JST based on discussion between PHED and JICA

Figure 10.1 Proposed Overall Implementation System of the Project

For implementation of the project, PHED will establish a separate and independent Project Cell, which assumes full responsibility to implement the project. Project Cell will consist of SPMU, two PMUs and two PIUs. SPMU will be chaired by Chief Engineer (Special) as Project Director of the whole Project and manage the whole scheme as the highest authority of the Project Cell and as a nodal organization to Consultant/JICA/GOR. PMUs in Churu and Jodhpur will be chaired by Additional Chief Engineer and Chief Engineer (Jodhpur) respectively as Additional Project Director. PIUs will be headed by Superintendent Engineers in each region. PIUs will be the organization to monitor the progress, evaluate results and identify and resolve constraints progress and take actions under the direction of PMUs at the ground level and it also will function as the counter-part of contractor. Project Cell will employ the consultant who will assist Project Cell in project management and communication with JICA.

It is proposed that a “Secretary-Level Inter-Departmental Committee” chaired by Principal Secretary of PHED be formed exclusively for the project in order to provide a platform to timely monitor and address the inter-departmental issues.

10.2 Procurement Plan

10.2.1 Contract Packaging

It is proposed that the project will be implemented by five contract packages (CPs):

10.2.2 Type of Procurement Method and Contract

The procurement method and contract type for each package as shown in Table 10.1 will be applied.

Table 10.1 Procurement Method and Applicable Bidding Documents

Source: JST based on discussion between PHED and JICA

It should be noted that the O&M cost will not be included in the project cost. The contract price for O&M will be classified into non-eligible portion.

10.3 Permission Relevant to the Project Implementation

Necessary permissions, related authorities, and approximate time for getting permission are shown in Table 10.2.

Table 10.2 Permissions for Construction Works

Permission	Approved/Authorized by	Tentative Period for Getting Approval
Water Rights	Water Resources Department, GOR	Upon approval by GOR
Works in the forest area	Forest Department, GOR	6 months
Land transfer of government land from Revenue Department	District Collector, Public Relations Department, GOR	3 months
Land transfer of government land from Water Resources Department	Chief Engineer of Water Resources Department, GOR	3 months
Land transfer of private land	District Collector, Public Relations Department, GOR	9 months
Railway crossing	Divisional Railway Manager, Ministry of Railways	3 months
Road occupancy (national highway)	National Highway Authority of India, Ministry of Road Transport and Highways	6 months

Road occupancy (state highway)	Rajasthan Road Development Corporation	3 months
Road occupancy (district road)	Public Works Department, Rajasthan State	3 months
Road crossing (rural road)	Rajasthan Rural Road Development Authority	1.5 months

Source: JST

10.4 Security Measures in Barmer District

During the project implementation in Barmer District, following facilities are the security priorities:

HR-1 and HR-2 Sub-scheme:	Peeprali Headworks (RWR and WTP)
	Intake pump station at RD55 of Narmada Canal
Chohtan-1 Sub-scheme:	Aleti Headworks
	Intake pump station at RD74 of Narmada Canal
Chohtan-2 Sub-scheme:	Pump station at Dhanau

It is recommended to deploy physical protection practices including: barriers, lighting, access control, doors and windows of facilities, along with security personnel for the above facilities.

10.5 Project Implementation Schedule

The contractor's contract period is composed of [redacted] The overall project implementation schedule including the procurement of consultant and implementation of [redacted] has been worked out as summarized in Figure 10.2.

[redacted]

Note: Above year indicates the Japanese fiscal year (April - March)
Source: JST

Figure 10.2 Overall Project Implementation Schedule

Chapter 11 Cost Estimate

S-29

Chapter 12 Environmental and Social Considerations

12.1 Project Activity to be Considered for Environmental and Social Impact Assessment

Environmental and social impact by the project activity at "before construction (BC) stage", "construction stage (CS)" and "operation stage (OS)" regarding following facilities, were studied.

- Intake and raw water pumping station

- Water treatment plant and Raw water reservoir
- Pumping stations: Transfer pumping stations and Cluster pumping stations
- Elevated service reservoir (ESR)
- Pipeline: Raw water transmission main, Clear water transmission main

12.2 Environmental and Social Impact Assessment

The results of the assessment on impacts from the proposed project are presented in Table 12.1. Mitigation measures and Environmental Monitoring Plan are explained in main report.

Table 12.1 Assessment of the Project

No.	Environmental Item	Survey Result		Basis/ Reason for the Survey Result
		BC/CS	OP	
Pollution control measures				
1	Air quality	B-	D	BC/CS: The construction works of pumping stations, ESRs, and pipeline near existing houses have impact on air pollution, thus mitigation measures should be taken. OS: No activity is planned that will cause air pollution.
2	Water quality	B-	D	BC/CS: If generated muddy water flow into the canal near the construction sites of intake, it has impact on water quality, thus mitigation measures should be taken. OS: No activity is planned that will cause water pollution.
3	Waste	B-	B-	BC/CS: Generated waste should be managed and transported to waste management and processing plant and surplus soil can be stored near WTP or nearest government owned land for future construction of filling work. OS: The sludge would be collected and disposed by sludge handling system in WTP.
4	Soil contamination	N/A	N/A	BC/CS, OS: No activity is planned that will cause soil contamination.
5	Noise and vibration	B-	D	BC/CS: The construction works of pumping stations, ESRs, and pipeline near existing houses have impact on noise and vibration, thus mitigation measures should be taken. OS: No activity is planned that will increase noise and vibration level.
6	Ground subsidence	N/A	N/A	BC/CS, OS: No activity is planned that will cause ground subsidence.
7	Offensive odor	N/A	N/A	BC/CS, OS: No activity is planned that will cause offensive odor during construction.
8	Bottom sediment	N/A	N/A	BC/CS, OS: No activity is planned that will cause pollution to river sediment.
Natural environment				
9	Protected area	B-	D	BC/CS: Some of the facilities are planned to be constructed in forest area and also some part of pipeline is installed along existing road within forest area. Forest area is prohibited to be developed without permission. Construction work should be started after appropriate legal procedure and issuance of permission of forest land use. OS: No activity is planned to have impact on protected area.
10	Flora/fauna and biodiversity	B-	D	BC/CS: Pumping stations and ESRs which are planned to be constructed in forest area have impact on flora/fauna and biodiversity such as cutting trees. Mitigation measures should be taken. OS: Impact on the ecosystem due to operation is not expected.
11	Hydrology	N/A	N/A	BC/CS, OS: No activity is planned that will increase rainwater discharge.
12	Topography and geology	N/A	N/A	BC/CS, OS: No activity that will adversely affect the topography and geographical features is expected.

No.	Environmental Item	Survey Result		Basis/ Reason for the Survey Result
		BC/ CS	OP	
Social environment				
13	Involuntary resettlement	N/A	N/A	BC/CS, OS: Involuntary resettlement or other impact on livelihood is not identified so far. However, if involuntary resettlement including illegal resident and agriculture etc. is required, compensation is necessary to be paid for them and resettlement is executed in accordance with JICA's guideline and legislative procedure of India.
14	Poverty	B+	B+	BC/CS, OS: The impact on social or peoples of the affected villages will be positive in terms of employment generation, provision of facilities of drinking water, and others which will be created from the project.
15	Ethnic minorities and indigenous peoples	N/A	N/A	BC/CS, OS: There are no Scheduled Tribe Area and Indigenous Peoples in Barmer and Jhunjhunu districts.
16	Local economy (Employment)	B+	B+	BC/CS, OS: Positive impacts such as creation of local employment are predicted.
	(Livelihood)	B+	B+	BC/CS, OS: Economic effects by the purchases of the foods and commodities by the workers and plant operators that will come from outside the village for the project.
17	Land use and utilization of local resources	B-	N/A	BC/CS: Location of ESRs/OHRs will be considered in non-private land as much as possible. So far, land for 1 facility is confirmed to be acquired without resettlement. OS: No activity is planned that will impact on land use and utilization of local resources.
18	Water usage	B-	D	BC/CS: If generated muddy water flow into the canal near the construction sites of intake, it has impact on water usage, thus mitigation measures should be taken. OS: No activity is planned that will impact on water usage.
19	Existing social infrastructure and service	B-	D	BC/CS: The construction works including the traveling of construction vehicles are expected to cause traffic congestion and limitation of access to social infrastructure temporarily. OS: No activity is planned that will impact on social infrastructure and services.
20	Social institutions	N/A	N/A	BC/CS, OS: No activity is planned that will affect the social and local institutions.
21	Maldistribution of damage and benefit	N/A	N/A	BC/CS, OS: No activity is planned that will cause maldistribution of the damage or benefit.
22	Local conflict of interest	N/A	N/A	BC/CS, OS: No activity is planned that will cause local conflict.
23	Cultural heritage	N/A	N/A	BC/CS, OS: No activity is planned that will affect the cultural heritage.
24	Landscape	D	D	BC/CS, OS: No activity is planned that will impact on landscape.
25	Gender	D	A+	BC/CS: No activity is planned that will impact on gender. OS: Women can save their time for activities other than water collection work and it is expected to contribute improvement of the status and right of women.
26	Children's rights	D	D	BC/CS, OS: No activity is planned that will violate the children's rights.
27	Infectious disease and HIV/AIDS	B-	D	BC/CS: During construction, workers will come to the construction site and it is expected that the risk of infectious diseases such as HIV/AIDS will increase. OS: No activities that will increase the risk of communicable diseases is expected.
28	Occupational health and safety	B-	B-	BC/CS: The workers has risk of being affected by air pollution such as dust and gas emission due to construction works and risk of heat attack. OS: There is a risk of chlorine gas inhalation for the workers in WTP.
Others				

No.	Environmental Item	Survey Result		Basis/ Reason for the Survey Result
		BC/ CS	OP	
29	Accident	B-	D	BC/CS: Due to the use of construction machinery and vehicle, risk of accident is expected to be increased in and around the construction sites. OP: The impact of accident from the operation is not expected.
30	Cross-border impact, climate change	D	D	BC/CS, OS: GHG emission from the construction works would not cause any significant impact.

Note: BC (Before-construction stage), 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 into D in the scoping phase
Source: JST

Of the above, special attention should be paid to the following:

- One site for cluster pumping station is located in private land and the land is necessary to be acquired. Also, several land acquisition may be required for construction of elevated service reservoirs. The land acquisition needs to be conducted in accordance with the relevant laws as well as JICA guideline.
- There is no Eco-Sensitive Zone in the project area. However, some of the facilities are planned to be constructed in forest area. Construction work should be started after appropriate legal procedure and issuance of permission of forest land use.

12.3 Stakeholder Consultation Meeting

10 stakeholder meetings were held in Barmer District and Jhujhunu. Almost all comments from participants were that they expect the project to solve health problem due to current water use and lack of water supply. Negative opinion/comments to the project were not received from participants. Some of comments from participants are shown in Table 12.2.

Table 12.2 Comments from Participants

Comments from participants	Answer from PHED
Requests to employ local people preferentially for the project	PHED will give job for construction works of the project to local people.
Request to complete the project as soon as possible	PHED ensure to complete the project and supply treated water.
Request to supply water everyone including Scheduled Caste and Scheduled Tribute.	PHED ensure to supply water everyone including poor society.

Source: JST

In order to include socially disadvantaged people, the meetings were facilitated in consideration for participants who are not well educated, and presenter interacted with participants in the middle of explanation and tried to promote their understanding. Moreover, information of the meetings were announced to all villagers including women by the Sarpanch and some women were invited to the meetings

Chapter 13 Global Warming Impacts

13.1 Climate Hazard

According to the Rajasthan State Action Plan on Climate Change (RAPCC) drafted by The Government of Rajasthan in 2012, increase of the evapotranspiration due to the rise of the temperature and the increase of frequency and intensity of extreme rainfall are projected. Thus, climate hazardous such as drought and flood will be caused due to such climate changes.

13.2 Exposure and Vulnerability

Exposure and vulnerability regarding the flood and the drought are shown in Table 13.1.

Table 13.1 Exposure and Vulnerability for Climate Hazard

Climate hazard	Exposure	Vulnerability
Flood	Deterioration and breakdown of infrastructure due to the flood is assumed. Intake and raw pumping stations constructed by the project has high possibility to be damaged by the flood because it is located near water body (canal).	Because almost all project site is in arid area, frequency of flood is not high, thus measures against flood is not adequate in the project site.
Drought	Depletion of groundwater which are current main water resource for local people due to drought is also assumed. However, facilities to be constructed by the project might not be affected by drought.	Groundwater is used as main water resource for their daily life without sufficient management.

Source: JST

13.3 Risk

Facilities constructed by the project, especially intake and raw water pumping station, have risk of inundation due to flood. However damage by drought is not assumed. Considering the risk in the whole project sites, restriction of daily activities and deterioration of health condition of local people by the flood and drought are assumed.

13.4 Adaptation Option

Placing of equipment in the facilities constructed by the project at higher elevation than the flood level can be adaptation measures against the flood. Moreover, implementation of the project itself also can be considered as adaptation measures for the drought in the whole project sites because the project will provide the managed and stable water supply.

Chapter 14 Economic and Financial Analysis

14.1 Economic Analysis

Social and economic feasibility of the project is evaluated by comparing the economic benefits with costs under "With" and "Without" cases of the project. Project period is assumed to be [redacted] years from [redacted] O&M period. Discount rate and Standard Conversion Factor is assumed at 10% and 0.9.

14.1.1 Economic Benefits

After the project is implemented, the current water source will be substituted by the newly constructed water supply system with house connection. Supplied water quantity and supply condition (time, pressure) will be improved from the current situation. Quantified economic benefits of the water supply project are composed of (1) benefit of reduced water supply cost, (2) benefit of willingness to pay for water usage, (3) benefit of reduced water fetching time, and (4) benefit of cost reduction of waterborne diseases.

(1) Benefit of Reduced Water Supply Cost

Under the "With" case, the new water supply system will be used instead of the current system. Therefore, the cost for using current water system will be saved. Average daily water consumption per person is calculated at 41.9 Lpcd in Barmer District and 44.9 Lpcd in Jhunjhunu District. The average alternative water supply costs are calculated at INR 48.7/m^3 in Barmer District and INR 35.2/m^3 in Jhunjhunu District based on estimation of capital cost, life period and number of users.

(2) Benefit of Willingness to Pay (WTP) for Water Usage

In the social condition survey, the expected duration of water supply time and the amount of WTP for having the said expected situation was asked. Survey result of WTPs per person were INR 17.6 per month per person in Barmer District and INR 19.8 per month per person in Jhunjhunu District.

(3) Benefit of Reduced Water Fetching Time

After completion of the project, treated water will be supplied to each household directly. The people who used to collect water from standposts, public hand pumps, and dug wells can use the saved time for other productive activities. According to the social condition survey result, the average time to fetch water per household per day are 54 minutes in Barmer District and 40 minutes in Jhunjhunu District. The average GDP per hour is calculated at INR 61.5/hour/person. Fifty percent of the saved time is assumed to be used for alternative economic works.

(4) Benefit of Reduced Waterborne Diseases

By supplying enough water by the project, medical cost for waterborne diseases in the project area could be reduced. This cost reduction is one of the benefits of the project. According to the World Bank (2017)[7], the economic costs of these waterborne diseases are estimated at USD 600 million annually with 73 million days of lost labor. The average economic cost of these waterborne diseases per person is assumed at INR 74.4 per year per person in 2020, and half of the cost is assumed to be reduced due to the project implementation.

14.1.2 Economic Costs

The economic cost is composed of capital cost including physical contingency and the cost borne by the Indian side such as administration cost and land acquisition cost, and O&M cost. Price contingency and tax are excluded.

14.1.3 Results of Economic Analysis

[redacted] This project is evaluated as economically feasible.

Table 14.1 Results of Economic Analysis

[redacted]

Source: JST

14.2 Financial Analysis

The financial analysis was conducted to evaluate the feasibility of the project by estimating revenue and cost during the project period. The cost and revenue of the project is focused, and those for managing VWSC was excluded from the calculation. Project period was assumed to be [redacted] years from [redacted] O&M period.

14.2.1 Financial Costs

The financial cost is composed of capital cost including physical contingency and cost borne by the Indian side, and O&M cost. Price contingency and tax are excluded.

14.2.2 Revenues

Revenue of this project is only the tariff revenue from users. The no-tariff-policy is being adopted in Rajasthan state for lower consumption users since March 2020. Standing on the conservative

7 Source: The World Bank (2017) "Waterlife: Improving Access to Safe Drinking Water in India"

side, the collected revenue is assumed to be zero during the project period assuming the no-tariff-policy will be also applied to the project area.

14.2.3 Results of Financial Analysis

It indicates the project is not financially feasible without subsidy from the state government or the central government.

Table 14.2 Results of Financial Analysis

Source: JST

Chapter 15 Project Evaluation and Indicators for Project Effects

15.1 Project Evaluation

15.1.1 Technical Evaluation

The facility plans of the project are described in Chapters 5 and 7. The JICA Study Team (JST) reviewed the facility plans described in the Detailed Project Report (DPR). The construction work

In conclusion, JST judged the project design and implementation plan to be reasonable.

15.1.2 Economic and Financial Evaluation

The economic internal rate of return (EIRR) is estimated at and the benefit-cost ratio (B/C) is estimated at . The major economic benefits are: 1) reduced water supply cost, 2) Willingness to pay (WTP) for water usage, 3) reduced water fetching time, and 4) reduced waterborne diseases. In conclusion, the project is economically feasible.

The expected water tariff income cannot even cover the O&M cost of the project. Government subsidy is required for the O&M cost as well as the initial costs of the project.

15.1.3 Environmental Evaluation

No serious environmental impacts have been found in the consideration. As for the social aspect, impact will be minimized by the basic policy of using government land for the installation of the facilities.

15.2 Operation and Effect Indicators

Operation and effect indicators with the target year of project completion and start of operation, are set in Table 15.1.

Table 15.1 Operation and Effect Indicators of the Project

Indicators	Original (2020)	Target	Remarks
Operation Indicators			
(1) Water supply amount by the project (m^3/day)	N/A	47,500 m^3/day (Jhunjhunu Scheme) 81,500 m^3/day (Barmer Scheme)	Water supply amount from WTP including non-domestic demand and distribution loss (90% of clear water demand at project completion year)
(2) Percentage of water samples at the tap in which residual chlorine is detected (%)	N/A	100%	
(3) Establishment of VWSC	N/A	270 (Jhunjhunu Scheme) 845 (Barmer Scheme)	95% of target villages of the project
(4) Female ratio of VWSC members (%)	N/A	50%	
Effect Indicators			
(5) Number of household connection (nos.)	N/A	108,900 nos. (Jhunjhunu Scheme) 228,600 nos. (Barmer Scheme)	85% of household in the project area at project completion year

Remarks:
(1) Daily water supply amount can be monitored via online, and it is metered at the exit point of WTP.
(2) A member of VWSC will check residual chlorine at house connection taps once a month. The record of water quality test will be kept in the VWSC office and it will be reported to the PIU office every month.
(3) List of VWSC will be kept in the PIU office
(4) The member list of each VWSC will be kept in VWSC office.
(5) VWSC will keep a list of house connections in VWSC office.
Source: JST

MAIN REPORT

Chapter 1 Introduction

1.1 Background of the Study

The Government of Rajasthan State (GOR) is promoting water supply development projects in all districts in order to provide residents with piped water supply facilities. The Public Health Engineering Department (PHED) is responsible for planning, building, operating, and maintaining urban and rural drinking water supply in the state.

PHED has been implementing Japan International Cooperation Agency (JICA) funded project, "Rajasthan Rural Water Supply and Fluorosis Mitigation Project (Nagaur)", since 2012. The target supply area of this project is 986 villages and seven urban towns in Nagaur District and 111 villages and two urban towns in Bikaner District.

In 2019, PHED submitted a "Project Proposal for Rajasthan Rural Water Supply Project Phase – II for coverage of 757 habitations of District Jhunjhnu & 637 habitations of District Barmer" to JICA, for bilateral financial cooperation.

The proposed project consists of five sub-schemes in two districts, as follows:

- Jhunjhunu Scheme (Jhunjhunu District)
  Surajgarh Sub-scheme
  Udaipurwati Sub-scheme
- Barmer Scheme (Barmer District)
  HR-1&HR-2 Sub-scheme
  Chohtan-1 Sub-scheme
  Chohtan-2 Sub-scheme
  Note: HR: H-point Right-side

In response to the project proposal, JICA decided to conduct a study titled: "Preparatory Survey for Rajasthan Rural Water Supply and Fluorosis Mitigation Project (Phase-II)".

The Detailed Project Report (DPR) of each sub-scheme was prepared in 2017 by PHED. Thereafter, the DPR of Barmer Scheme were revised in 2020 by PHED.

1.2 Objectives of the Study

The objectives of the study are:

- To confirm the background and necessity of the proposed project;
- To collect information regarding the proposed project through discussions with the concerned department of the Rajasthan state government;
- To discuss the institutional arrangement for project implementation; and

- To collect information and data necessary to set the details of the proposed project, which include project components, implementation schedule, implementation system, procurement and execution methods, project cost, operation and maintenance (O&M) system, and environmental and social aspects.

1.3 Target Area of the Project

The target areas of the proposed project are Buhana, Chirawa, and Udaipurwati Tehsils in Jhunjhunu District and Gudhamalani and Chohtan Tehsils in Barmer District.

Chapter 2 General Condition in the Project Area

2.1 Administrative Boundaries and Demography

2.1.1 Administrative Boundaries

Rajasthan State is located in the northwestern region of India and has the largest area (342,239 km^2) and the seventh largest population[1] (over 75 million). It borders Pakistan to the west and five other Indian states: Punjab to the north; Haryana and Uttar Pradesh to the northeast; Madhya Pradesh to the southeast; and Gujarat to the southwest.

(1) Jhunjhunu District

Jhunjhunu District is located in the northeast of Rajasthan State, bordering Haryana State; it covers an area of 5,928 km^2 and has a total population of 2,137,045 (Census of India, 2011). The project covers 284 villages and two towns in three tehsils, namely: Chirawa, Buhana, and Udaipurwati.

While "Tehsil" is the land-based administrative division by which the Revenue Department keeps track of land ownership and levies the land tax, "Community Development Block (CD Block)" is a sub-division under Panchayati Raj System[2] and used as the unit for development projects in India. Usually, tehsils are larger than blocks where multiple blocks are found within a given tehsil, but sometimes the blocks overlap tehsil boundaries. The target villages are located within four CD Blocks, namely: Chirawa, Surajgarh, Buhana, and Udaipurwati, as shown in Table 2.1.1[3].

Table 2.1.1 Administrative Set-up of Project Areas in Jhunjhunu District

Tehsil Name	CD Block Name
Chirawa	Chirawa
	Surajgarh
Buhana	Buhana
Udaipurwati	Udaipurwati

Source: Census of India 2011

(2) Barmer District

Barmer District is located at the western end of Rajasthan State, sharing a border with Punjab and Sindh provinces of Pakistan to the west. The total area of Barmer District is 28,387 km^2; it forms a part of the Thar Desert. The total population of Barmer in 2011 was 2,603,751 (Census

1 Based on the Census of 2011.
2 The Panchayati Raj System is a system of governance in which Gram Panchayats are the basic units of local administration. The system has three levels: Gram Panchayat (village level), Block Samiti or Panchayat Samiti (block level), and Zila Parishad (district level). It was formalized in 1992 by the 73rd amendment to the Indian Constitution.
3 Statistics and information are compiled as tehsil-wise or block-wise, depending on the information and source. Therefore, both tehsil-and block-wise information are presented in this report depending on information availability.

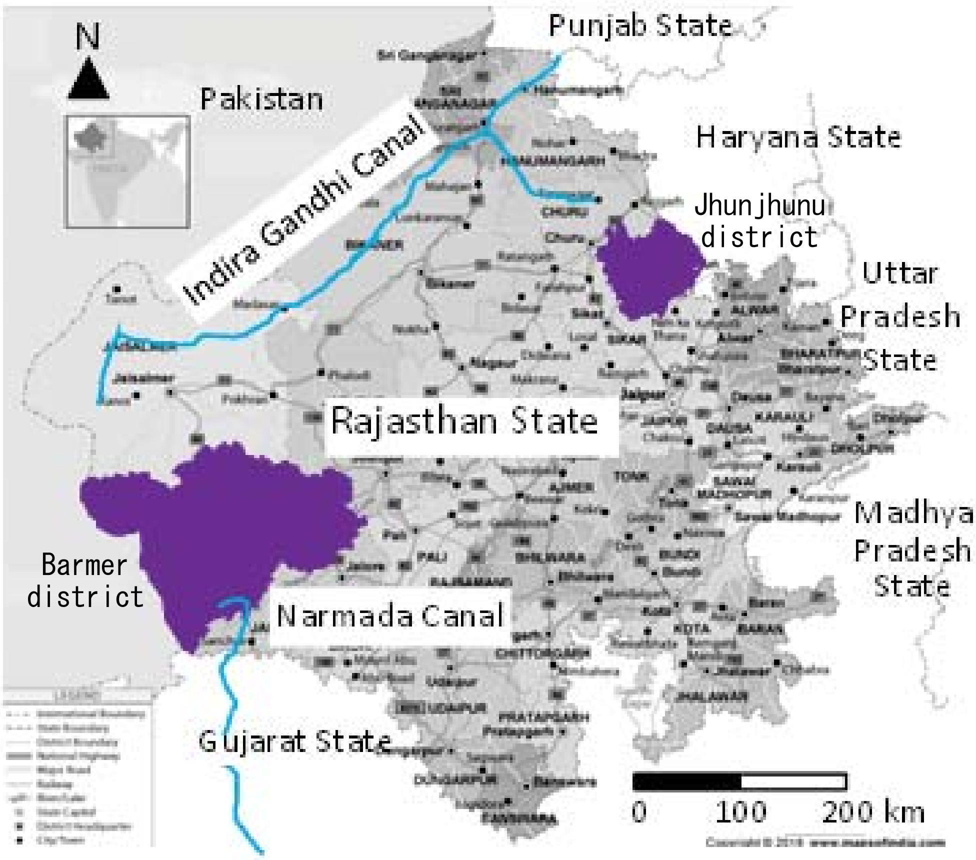
of India 2011). There are 889 target villages in Barmer: 451 villages in Gudhamalani Tehsil and 438 villages in Chohtan Tehsil, which are located within four CD Blocks, namely: Sindhari, Barmer, Dhorimanna, and Chohtan Blocks, as shown in Table 2.1.2.

Table 2.1.2 Administrative Set-up of Project Areas in Barmer District

Tehsil Name	CD Block Name
Gudhamalani	Sindhari
Gudhamalani	Barmer
Chohtan	
Gudhamalani	Dhorimanna
Chohtan	
Chohtan	Chohtan

Source: Census of India 2011

Figure 2.1.1 shows the location of Rajasthan and the two target districts.



Source: JICA Study Team (JST) based on www.mapsofindia.com

Figure 2.1.1 Location of Rajasthan State and the Administrative Boundaries of Jhunjhunu and Barmer Districts

The maps of Jhunjhunu District and Barmer District (Gudhamalani and Chohtan Tehsil) with village boundary are attached in Appendix-2.1.

2.1.2 Demography

Table 2.1.3 and Table 2.1.4 indicate the key demographic features of tehsils in both districts that include the project target villages. According to the Census of 2011, the percentage of the population having a particular social status, such as Scheduled Caste (SC) and Scheduled Tribe (ST)[4], varies among districts and tehsils. As for SC, none of the target tehsils in both Jhunjhunu and Barmer districts has a large deviation from the average percentage of SC population of India (16.6%) or Rajasthan State (17.2%). However, regarding ST population, three tehsils in Jhunjhunu District have much lower ST populations as compared with the average of Rajasthan. Especially in Buhana Tehsil, ST population accounts for only 0.6% of the whole population.

With regard to religion, the majority of the population are Hindus in both districts, accounting for 78.2% to 98.6% of the population, followed by Muslims, accounting for 1.2% to 21.1%. Less than 0.2% of the population are affiliated with other religions such as Christianity, Buddhism, and Sikhism, while the Rajasthan average is 1.5% for such population. Chohtan Tehsil in Barmer District and Surajgarh Tehsil in Jhunjhunu has relatively higher Muslim population (21.1% and 11.2 %, respectively), while Buhana Tehsil in Jhunjhunu District has a high concentration of Hindu population of 98.6%.

Table 2.1.3 Physical and Demographic Characteristics of the Target Districts

Target Tehsils	No. of Target Villages / Towns	No. of Total Inhabited Villages in the Tehsil	Total Population in 2011 in the Tehsil	Ratio of Scheduled Caste Population	Ratio of Scheduled Tribe Population
	(no.)	(no.)	(no.)	(%)	(%)
India			1,210,854,977	16.6	8.6
Rajasthan			56,507,188	17.2	12.6
Jhunjhunu District					
Chirawa Tehsil	52 villages + 1 town	212 villages + 4 towns	476,087	20.7	1.3
Buhana Tehsil	138 villages	138 villages	223,405	18.1	0.6
Udaipurwati Tehsil	94 villages + 1 town	94 villages + 1 town	294,770	13.0	3.2
Barmer District					
Gudhamalani Tehsil	451 villages	522 villages + 1 town	453,911	14.9	4.9
Chohtan Tehsil	438 villages	438 villages	485,344	21.3	8.9

Source: Census of India 2011 and DPR PHED

[4] In the Indian caste system, the untouchable caste was categorized as Scheduled Caste (SC), the backward tribes were categorized as Scheduled Tribe (ST), and the disadvantaged caste as Other Backward Caste (OBC). The SC, ST, and OBC are considered to be the most disadvantaged socio-economic groups and the Indian government provides protections and opportunities in order to improve their situation through affirmative actions, and provision of benefits and resources.

Table 2.1.4 Religious Affiliation of Populations in the Target Districts

Target Blocks / Tehsil	Hindus (%)	Muslims (%)	Jains (%)	Others (%)
Rajasthan	88.5	9.1	0.9	1.5
Jhunjhunu District				
Chirawa Block	93.1	6.8	0.0	0.1
Surajgarh Block	88.1	11.2	0.5	0.2
Buhana Tehsil (Block)	98.6	1.2	0.0	0.1
Udaipurwati Tehsil (Block)	95.3	4.6	0.0	0.1
Barmer District				
Gudhamalani Tehsil	94.8	4.5	0.6	0.1
Chohtan Tehsil	78.2	21.1	0.5	0.1

Note: Others include Christians, Buddhists, Sikhs, others, and religions not stated.
Source: JST based on Census of India 2011

2.2 Social Condition

2.2.1 Economic Situation and Activity

(1) Economic Situation

The economic situation of Rajasthan State as compared with that of whole of India is shown in Table 2.2.1. In Rajasthan State, the per capita income growth rates show that the average of the people's income level is getting higher each year. The growth rate also indicates the growing size of the economy.

Considering these two figures, the economic situation of the state has improved. In comparison with the growth rate of India, the GDP growth rate is almost the same and per capita income growth rate is a little lower than that of India as a whole.

Table 2.2.1 GDP and Per Capita Income in Rajasthan State

	GDP/ GRDP*1				Per Capita Income			
	GRDP of Rajasthan		GDP of India		Rajasthan		India	
	Amount (INR Crores)	Growth Rate (%)*2	Amount (INR Crores)	Growth Rate (%)*2	Amount (INR)	Growth Rate (%)*2	Amount (INR)	Growth Rate (%)*2
Current/ Constant	Current	Constant	Current	Constant	Current	Constant	Current	Constant
2011-2012*3	434,837	-	8,736,329	-	57,192	-	63,462	-
2012-2013*3	493,551	4.5	9,944,013	5.5	63,658	2.2	70,983	3.3
2013-2014*3	551,031	7.0	11,233,522	6.4	69,480	4.5	79,118	4.6
2014-2015*3	615,642	7.3	12,467,959	7.4	76,429	5.6	86,647	6.2
2015-2016*3	681,485	8.0	13,771,874	8.0	83,427	6.3	94,797	6.7

*1 Gross Regional Domestic Product (GRDP) is a statistic that measures the size of a region's economy.
*2 Growth rate is calculated with the constant figure.
*3 The period of each fiscal year starts in April.
Note: INR: Indian Rupee
Source:

1) Website of Government of Rajasthan (http://plan.rajasthan.gov.in/content/planning portal/en/des/publications/ECONOMIC_REVIEW_2018-19.html)
2) Website of the Government of Punjab (http://www.esopb.gov.in/)

Table 2.2.2 shows the poverty situation in Rajasthan State. In the rural area of Rajasthan State, the households whose expenditure is below INR 1,035.97 per capita per month (INR 5,179.85 per family per month, assuming a family consist of five members) is categorized as below poverty line (BPL) household[5]. This poverty line is set by the Planning Commission in India. The portion of BPL households in Rajasthan State is 24.1%. Considering the poverty ratio of whole India[6] and Rajasthan, the ratio of Jhunjhunu District is significantly low.

Table 2.2.2 Proportion of Below Poverty Line (BPL) and Above Poverty Line (APL) in the Project Area

District	CD Block	Total Number of Household	BPL Household	Percentage of BPL Household (%)	APL Household	Percentage of APL Household (%)
Jhunjhunu	Jhunjhunu	37,225	2,066	5.6	35,159	94.4
	Chirawa	28,684	514	1.8	28,170	98.2
	Buhana	41,066	2,048	5.0	39,018	95.0
	Khetri	44,192	2,418	5.5	41,774	94.5
	Nawalgarh	41,959	3,392	8.1	38,567	91.9
	Udaipurwati	44,220	1,578	3.6	42,642	96.4
	Alsisar	28,636	2,281	8.0	26,355	92.0
	Surajgarh	33,395	1,439	4.3	31,956	95.7
	Total	**299,377**	**15,736**	**5.3**	**283,641**	**94.7**
Barmer	Balotara	55,896	18,690	33.4	37,206	66.6
	Barmer	48,464	17,871	36.9	30,593	63.1
	Baytoo	45,269	25,887	57.2	19,382	42.8
	Chohtan	54,552	16,948	31.1	37,604	68.9
	Dhorimanna	47,341	13,913	29.4	33,428	70.6
	Sindhari	47,772	17,651	36.9	30,121	63.1
	Shiv	36,637	11,838	32.3	24,799	67.7
	Sivana	42,540	9,404	22.1	33,136	77.9
	Total	**378,471**	**132,202**	**34.9**	**246,269**	**65.1**
Rajasthan State		**9,309,914**	**2,247,960**	**24.1**	**7,061,954**	**75.9**

*[1] Figures marked in gray are the numbers and percentage of this project area.
Source: Created by JST based on the webpage of the Government of Rajasthan (http://bpl2002.raj.nic.in/)

[5] The poverty line in each district is estimated in "REPORT OF THE EXPERT GROUP TO REVIEW THE METHODOLOGY FOR MEASUREMENT OF POVERTY" published by Government of India Planning Commission in June, 2014

[6] The poverty ratio of the whole of India was 29.8% in 2011-2012.

(2) Economic Activities

Table 2.2.3 shows the ratio of the industrial composition in Rajasthan. The service sector makes up the largest portion (around 43%). According to the World Bank Development Indicators, the ratio of India as a whole was around 49% in 2017, which shows that the ratio of Rajasthan State is almost at the same level as that of entire India. The service sector includes hotels and restaurants, transport, financing, insurance, and real estate. According to the Economic Review 2019-20, tourist industry greatly contributes to the service sector in Rajasthan.

Table 2.2.3 Ratio of Sector Composition in Rajasthan (% to GDP)

Sector	2014-2015	2015-2016	2016-2017
Agriculture	27.36	27.26	29.42
Industry	29.31	29.38	27.76
Services	43.33	43.36	42.82
Total	100	100	100

Source: Economic Review 2019-20, Directorate of Economics and Statistics Government of Rajasthan

2.2.2 Land Use

The land utilization of the two districts and Rajasthan State is shown in Table 2.2.4.

Table 2.2.4 Land Use in Two Target Districts and Rajasthan as a Whole

	Jhunjhunu District		Barmer District		Rajasthan State	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
Total	591,536	100	2,817,424	100	34,278,551	100
Net area sown	400,482	68	1,671,041	59	18,168,741	53
Forest	40,045	7	33,329	1	2,753,245	8
Not available for cultivation	37,926	6	204,786	7	4,359,932	13
Other uncultivable land excluding fallow land	45,195	8	380,155	14	5,522,969	16
Fallow land	67,888	11	528,113	19	3,473,664	10

Source: Rajasthan Agricultural Statistics at a Glance 2017-2018, Commissionerate of Agriculture, Rajasthan, Jaipur.

Although Barmer District has low precipitation and limited water availability[7], more than 59% of land is used for agriculture, which is even higher than the Rajasthan average of 53%. Forest covers only 1.18% of the land in Barmer District.

In Jhunjhunu District, 67.7% of land is used for cultivation and forest covers 6.8% of its total land area.

[7] According to the Rajasthan Agricultural Statistics at a Glance 2017-2018, Barmer District had the third lowest annual rainfall (2016-2017) among the 33 districts in Rajasthan State.

2.2.3 Social Infrastructure

(1) Jhunjhunu District

Available social infrastructure in target CD blocks in Jhunjhunu district is summarized in Table 2.2.5.

Table 2.2.5 Percentage of Available Amenity in Target Villages in Jhunjhunu District

	CD Block Name	Percentage of Amenity Available in Villages								
		Education*	Medical**	Access to Safe Water ◆	Post Office***	Telephone #	Transport, Communications##	Banks▲	Agricultural Credit Societies	Power Supply
1	Chirawa	87.78	57.78	59.5	51.11	100	62.22	20.00	32.22	98.89
2	Surajgarh	94.35	58.87	59.5	56.45	100	62.90	18.55	23.39	100
3	Buhana	86.86	56.93	51.2	58.39	100	67.88	12.41	18.98	100
4	Udaipurwati	96.81	84.04	63.1	76.6	100	75.53	44.68	40.43	100

Note: * Education includes all educational facilities. ** Medical includes all medical facilities. *** Post office includes post offices, telegraph offices, and post and telegraph offices. # Telephone includes telephone, Public Call Offices (PCO), and mobile. ## Transport communications include bus services, rail facilities, and navigable waterways. ▲Banks include commercial banks and cooperative banks. ◆The population whose main source of drinking water is tap water from the treated source, covered well, hand pump, tube well, or spring.

Source: Census of India 2011

In Jhunjhunu District, more than half of the population has access to safe drinking water. Most of the population has power supply and telephone. More than 85% of the villages have schools within the village. One in two villages has a post office. Furthermore, physical proximity to larger cities such as Delhi and Jaipur provides opportunities for access to social services to the Jhunjhunu District population.

(2) Barmer District

Available social infrastructure in target CD blocks in Barmer district is summarized in Table 2.2.6.

Table 2.2.6 Percentage of Available Amenity in Target Villages in Barmer District

	CD Block Names	Percentage of Amenity Available in Villages								
		Education*	Medical**	Access to Safe Water ◆	Post Office***	Telephone#	Transport, communications##	Banks▲	Agricultural Credit Societies	Power Supply
1	Sindhari	70.27	42.43	24.3	27.57	100	53.78	3.51	8.65	80.00
2	Barmer	63.50	37.96	31.0	24.82	100	53.53	2.68	6.33	86.62
3	Dhorimanna	69.52	42.25	24.3	27.81	100	53.74	2.67	9.63	90.11
4	Chohtan	76.92	57.49	40.8	41.20	100	59.51	12.96	18.22	87.45

Note: *Education includes all educational facilities. **Medical includes all medical facilities. ***Post office includes post offices, telegraph offices, and post and telegraph offices. #Telephone includes telephone, PCO, and mobile. ##Transport communications include bus services, rail facilities, and navigable waterways. ▲Banks include commercial banks and cooperative banks. ◆The population whose main source of drinking water is tap water from the treated source, covered well, hand pump, tube well, or spring.

Source: Census of India 2011

In Barmer District, the population without power supply ranges from 10% to 20%. Only 24 to 41 % of the population has the access to safe drinking water. 100 % of the population has telephone. 70 % villages have schools within the village. Financial institutions are few: only 2.6% to 13.0% of villages have banks, 6.3% to 18.2% have credit societies, and 24.8% to 27.8% have post offices.

2.2.4 Transportation

Jhunjhunu District is connected by transportation networks of roads and trains from all the major cities of Rajasthan. National Highway (NH) 11, which links Jaisalmer and Rewali, goes through Jhunjhunu. State Highway (SH) 8 links Jhunjhunu to Jaipur, Sikar, and Luharu. SH 41 links Fatehpur to Rajgarh via Jhunjhunu. There are trains to Rewali in Haryana State and New Delhi in addition to major cities in Rajasthan such as Jaipur, Jodhpur, and Kota. The total length of National Highways and State Highways in Jhunjhunu and Barmer districts is shown in Table 2.2.7.

Table 2.2.7 District-wise Road Length (as of March 31, 2018)

District	National Highways (km)	State Highways (km)	Total (km)
Jhunjhunu	180.20	438.20	618.40
Barmer	226.01	575.90	801.91

Source: Basic Road Statistics Rajasthan as of 31 March 2018, Public Works Department, Rajasthan

Despite being located at the west end of the country, bordering with Pakistan, Barmer is also connected by roads and trains to major cities in Rajasthan and beyond. Two National Highways (NH), namely, NH 15 and NH 112, cross at Barmer. It also has direct trains to Jodhpur, New Delhi, Bengaluru, Haridwar, and other cities.

2.3 Natural Condition

2.3.1 Geography

(1) Jhunjhunu District

Jhunjhunu District is located in the northeastern part (bordering Haryana State) of Rajasthan State and lies between 27°38′ to 28°31′ north latitude and 75°02′ to 76°06′ east longitude. Total area of the district is 5,928 km^2.

Jhunjhunu District is mainly in the Sekhawati River basin and its northwestern part falls outside the basin, i.e., having inland drainage.

(2) Barmer District

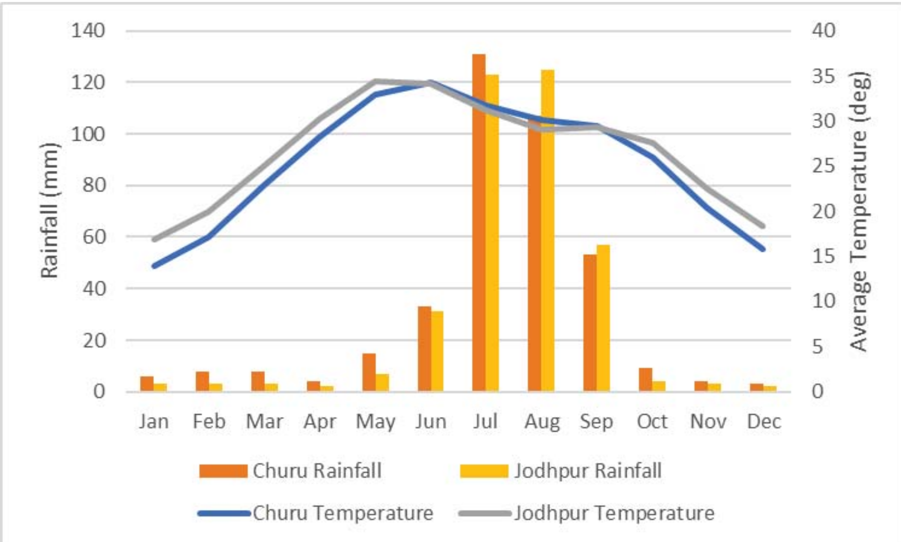
Barmer is located in the western part of the state forming a part of the Thar Desert. The district borders Jaisalmer District in the north, Jalore District in the south, Pali District and Jodhpur District in the east, and Pakistan in the west. Total area of the district is 28,387 km^2.

The district is located between 24°58' to 26°32' north latitude and 70°05' to 72°52' east longitude.

The southern part of the district is in the Luni River basin and the remaining part falls outside the basin, i.e., having inland drainage. The Luni River is 480 km in length and drains into the Gulf of Kutch passing through Jalore.

2.3.2 Climate

Figure 2.3.1 shows the annual rainfall and average temperature around the project area (Churu and Jodhpur).



Source: Climate-data.org

Figure 2.3.1 Annual Rainfall and Average Temperature around the Project Area

Climatically, the year in Rajasthan State is divided into three major seasons as follows:

- Summer season: March to end of June
- Monsoon season: End of June to September
- Winter season: October to February

The mean annual rainfalls are 381 mm and 363 mm in Churu and Jodhpur, respectively. Around 90% of rainfalls are rainfall from the southwest monsoon from June to September.

2.3.3 Surface Water

All rivers in the study area are ephemeral in nature and flow in response to heavy precipitation only during monsoon. There is no natural river which can be utilized as a surface water source.

Thus, the available surface water in the study area is the water of irrigation canal originating from outside of the state (Indira Gandhi Canal and Narmada Canal). The water flows of these canals are controlled by WRD and the required water flow is being maintained throughout the year. The outlines of these canals are described in Chapter 4 and Chapter 6, respectively.

2.3.4 Groundwater

The Central Ground Water Board has a network of 1,170 groundwater monitoring stations in Rajasthan State. The depth of groundwater level in the study area as of May 2016 is as follows:

-	Jhunjhunu District:	Min: 40.7 m	Max: 93.9 m
		More than 40 m:	100%
-	Barmer District:	Min: 4.45 m	Max: 99.15 m
		Less than 10 m:	14.5%
		10 m to 20 m:	23.6%
		20 m to 40 m:	27.3%
		More than 40 m:	34.5%

In the long-term basis (comparison between 2016 and average of 2006 to 2015), the decline of groundwater level is observed in all the wells in Jhunjhunu District and 57% of the wells in Barmer District.

Chapter 3 Present Water Supply and Sanitation Condition in the Project Area

3.1 Present Water Supply Condition in terms of House Connection Ratio

The Government of India is promoting rural water supply to provide every rural person with potable water on a sustainable basis. However, the ratio of rural households with piped water supply (PWS) house connections in India is still less than 20%. Table 3.1.1 shows the state-wise ratio of rural households with piped water supply connections as of 01 April 2020.

Table 3.1.1 State-wise Ratio of Rural Households with PWS House Connections

State	Nos. of rural household	Nos. of house connection with PWS	Ratio (%) of rural household with house connection with PWS
Goa	263,013	230,186	87.52
Puducherry	114,908	99,993	87.02
Gujarat	9,302,583	6,621,821	71.18
Sikkim	105,063	70,345	66.96
Telangana	5,437,739	3,586,419	65.95
Haryana	2,894,461	1,901,580	65.70
Himachal Pradesh	1,704,231	921,653	54.08
Punjab	3,507,138	1,754,722	50.03
Andaman & Nicobar Islands	65,096	28,547	43.85
Jammu & Kashmir	1,817,371	782,760	43.07
Maharashtra	14,236,135	5,388,428	37.85
Andhra Pradesh	9,566,332	3,193,400	33.38
Karnataka	8,961,400	2,472,668	27.59
Kerala	6,714,823	1,749,567	26.06
India	**189,330,879**	**40,663,297**	**21.48**
Mizoram	126,827	25,079	19.77
Bihar	18,353,898	3,249,051	17.70
Tamil Nadu	12,689,045	2,192,812	17.28
Arunachal Pradesh	217,623	36,146	16.61
Uttarakhand	1,461,910	217,120	14.85
Madhya Pradesh	12,124,163	1,772,303	14.62
Rajasthan	10,132,274	1,276,300	12.60
Chhattisgarh	4,548,080	415,545	9.14
Odisha	8,306,194	747,451	9.00
Tripura	800,997	70,258	8.77
Jharkhand	5,408,690	443,168	8.19
Manipur	451,566	30,379	6.73
Ladakh	44,082	1,964	4.46
Nagaland	385,699	15,826	4.10
Uttar Pradesh	26,338,776	982,082	3.73
Assam	6,335,015	160,137	2.53
West Bengal	16,325,859	219,308	1.34
Meghalaya	589,888	6,279	1.06

Source: Integrated Management Information System (IMIS) Database of Department of Drinking Water and Sanitation, Ministry of Jal Shakti

As shown in the table, the ratio in Rajasthan State is 12.60% and below the average of India. Table 3.1.2 shows the district-wise ratio of rural households with piped water supply connections in Rajasthan State as of 01 April 2020.

Table 3.1.2 District-wise Ratio of Rural Households with PWS House Connections

District	Nos. of rural household	Nos. of house connection with PWS	Ratio (%) of rural household with house connection with PWS
Pali	367,786	113,035	30.73
Rajsamand	217,117	66,331	30.55
Hanumangarh	293,339	77,845	26.54
Sirohi	174,824	45,633	26.10
Jalor	351,505	71,586	20.37
Bhilwara	439,010	80,988	18.45
Jhunjhunu	330,342	59,874	18.12
Bikaner	245,806	44,078	17.93
Jaipur	527,517	94,539	17.92
Nagaur	532,545	92,405	17.35
Ajmer	319,991	50,738	15.86
Sikar	351,023	53,169	15.15
Churu	298,844	42,612	14.26
Rajasthan	**10,132,274**	**1,276,300**	**12.60**
Alwar	542,656	56,085	10.34
Chittaurgarh	287,690	28,539	9.92
Bundi	192,080	18,018	9.38
Ganganagar	296,070	24,871	8.40
Sawai Madhopur	235,808	19,259	8.17
Udaipur	546,164	42,656	7.81
Jodhpur	375,994	28,069	7.47
Jhalawar	252,426	18,494	7.33
Karauli	217,513	15,845	7.28
Baran	226,810	15,069	6.64
Kota	171,527	11,316	6.60
Tonk	224,866	13,490	6.00
Dausa	251,200	14,300	5.69
Barmer	406,619	21,793	5.36
Dhaulpur	190,940	9,420	4.93
Dungarpur	257,252	11,731	4.56
Banswara	330,698	14,843	4.49
Pratapgarh	184,638	7,969	4.32
Bharatpur	387,550	9,258	2.39
Jaisalmer	104,124	2,442	2.35

Source: IMIS Database of Department of Drinking Water and Sanitation, Ministry of Jal Shakti

As shown in the above table, the ratio in Jhunjhunu District is 18.12%, which is higher than the average of Rajasthan State and similar to the national average. On the other hand, the ratio in Barmer District is far below the average of Rajasthan State.

Nonetheless, the house connection ratio in both Jhunjhunu and Barmer Districts is still less than 20%. The Government of Rajasthan State (GOR) is going to provide every rural household with house connection with PWS, in line with the on-going government policy: Jal Jeevan Mission (JJM). The JJM is explained in Section 8.1.1.

3.2 Present Water Source and Its Use

(1) Water Supply System

There are two types of water supply system in the project areas:

a) Piped water supply through individual household connections that have been established by the Public Health Engineering Department (PHED) in urban towns and large villages[1]
b) Water supply by Traditional Source Systems (TSS) in other villages, having Ground Level Reservoir(s) (GLR) and Public Stand Posts (PSPs)

In both cases, the water source is tube wells (groundwater), installed by PHED.

1) Piped water supply system by PHED

There are 40 villages/towns where individual household connections have been installed in Jhunjhunu District, and seven in Barmer District (within the project areas). Table 3.2.1 and Table 3.2.2 show the lists of such villages/towns.

Table 3.2.1 List of Villages/Towns with Piped Water Service – Jhunjhunu District

No.	Block	Concerned PHED Sub-divisional Office	Village/Town
1	Buhana	Buhana	Buhana
2	Buhana	Buhana	Badbar
3	Buhana	Buhana	Kuhaadwaas
4	Buhana	Buhana	Sohali
5	Buhana	Buhana	Udamandi
6	Buhana	Buhana	Dhakamandi
7	Buhana	Buhana	Khaandwa
8	Buhana	Buhana	Singhana
9	Buhana	Buhana	Maakdo
10	Buhana	Buhana	Banwaas
11	Buhana	Buhana	Pancheri Kalan
12	Buhana	Buhana	Muradpura
13	Buhana	Buhana	Dhana
14	Buhana	Buhana	Goth
15	Surajgarh	Surajgarh	Kajda
16	Surajgarh	Surajgarh	Adooka
17	Surajgarh	Surajgarh	Surajgarh (Urban)
18	Udaipurwati	Udaipurwati	GudhaGaudaki
19	Udaipurwati	Udaipurwati	Bhaudki
20	Udaipurwati	Udaipurwati	Signaur
21	Udaipurwati	Udaipurwati	Bajawa
22	Udaipurwati	Udaipurwati	Chhau
23	Udaipurwati	Udaipurwati	Badagaon
24	Udaipurwati	Udaipurwati	Hasalsar
25	Udaipurwati	Udaipurwati	Keru
26	Udaipurwati	Udaipurwati	Udaipurwati (urban)
27	Udaipurwati	Udaipurwati	Chhapoli

1 Average population is roughly 4,000 or more.

28	Udaipurwati	Udaipurwati	Mandawara
29	Udaipurwati	Udaipurwati	Panchlangi
30	Udaipurwati	Udaipurwati	Indrapura
31	Udaipurwati	Udaipurwati	Nangal
32	Udaipurwati	Udaipurwati	Raghunathpura
33	Udaipurwati	Udaipurwati	Ghamora
34	Udaipurwati	Udaipurwati	Paukh
35	Udaipurwati	Udaipurwati	Guda
36	Udaipurwati	Udaipurwati	Paapra
37	Udaipurwati	Udaipurwati	Chawra
38	Udaipurwati	Udaipurwati	Kakrana
39	Udaipurwati	Udaipurwati	Manakwas
40	Udaipurwati	Udaipurwati	Baagoli

Source: PHED Jhunjhunu Circle Office

Table 3.2.2 List of Villages with Piped Water Service – Barmer District

No.	Block	Name of Gram Panchayat	Village
1	Chohtan	Chohtan	Chohtan
2	Chohtan	Dhanau	Dhanau
3	Chohtan	Demba	Demba
4	Chohtan	Sanwa	Sanwa
5	Dhorimana	Gudhamalani	Gudhamalani
6	Dhorimana	Nagar	Nagar
7	Dhorimana	Dhorimana	Dhorimana

Source: PHED Chohtan Circle Office

Among these villages, the amount of water supplied to each household varies depending on the water availability and distance from the water source. For instance, in Surajgarh Town in Jhunjhunu District, some households near the distribution reservoir get water for 2 hours twice a day and abundant water has been supplied.

Source: JST

Figure 3.2.1 Household Connection in Surajgarh in Jhunjhunu District

On the other hand, households far away from the same distribution reservoir receive only very limited water supply. In either case, they purchase a 20-liter water bottle[2] for drinking and cooking purposes each day, due to the fact that the piped water has quality problems, mainly salinity.

Even with a household connection, some households are buying drinking water from the vendors or shops..

[2] Usually, a 20-liter water bottle costs around INR 10 to 20.

2) Traditional Source Systems (TSS)

Ground Level Reservoir (GLR) and Public Stand Posts (PSPs)[3] are installed by PHED. The residents collect water there and carry it to their homes. There are some villages that have set up their own household water connection systems linking to the GLR, through the efforts of the local Gram Panchayat or a water user group. However, their water supply is generally not stable. For example, in Bakli (Bankodi) habitation in Kishorpura Village, Jhunjhunu District, piped water is only available for up to 30 minutes once every 8 to 10 days.

(2) Problem on the Water Source

From July to September, during and after the monsoon season, almost every tube well has water, but gradually the available supply decreases from October to December. In some of the remote habitations[4] in Barmer District, they cannot receive TSS water supply services at this time. Others are having quality problems with water[5]. People are coping with these difficulties by purchasing water from private companies[6] or installing simple reverse osmosis (RO) systems at home.

(3) Other Water Sources

In addition to the water supply services provided by PHED, people are getting water from other sources, including from agricultural bore wells and through harvesting of rain water. Rain water is one of the most important sources for drinking and cooking water used in these places. Rain water harvesting systems called “tanka” (which utilize underground cisterns) can also be found in Barmer District. The rain water is collected and kept in the "tanka" and used for cooking and drinking, as it is not contaminated. The rain water is used for a few months after the monsoon season. When the tanka water supply becomes depleted, residents purchase water from private companies.

Source: JST
Figure 3.2.2 Tanka in Nokhara Village in Barmer District

3 Main water source is ground water.

4 In Rajasthan, villages are set up in such a way that there is a populated Main Habitation (MH) and several other colonial communities called Other Habitation (OH) in the area around it. OHs in Jhunjhunu District are adjacent to a MH or are located near one another. On the other hand, in Barmer District, some of the remote habitations are often located far away from the MH and households are widely dispersed even within the same village.

5 In some villages, PHED has installed reverse osmosis (RO) systems to improve the water quality. .

6 According to the villagers, the water cost is between INR 450 and INR 600 for a 4000-liter tanker truck.

(4) Current Amount of Water Use

Based on the field study by JST members, the volume of household water usage in the project areas have great variations depending on the people's lifestyle and environment. The minimum reported amount from the field interviews was 30 liters of water per capita per day (Lpcd) in Nohkara Village in Barmer District (where there are no household connections) and the maximum reported amount was 300 Lpcd for a household near the distribution reservoir in Surajgarh Town in Jhunjhunu District. The result of the social condition survey showed that the average water consumption (only for human consumption) per capita in the dry season (winter) was 35.9 Lcpd in Jhunjhunu District and 32.5 Lpcd in Barmer District. Of which, the consumption of treated water (for drinking and cooking) was 6.4 Lpcd in Barmer District and 5.5 Lpcd in Jhunjhunu District. In summer, the demand for water increases in both districts.

Table 3.2.3 Water Consumption in the Project Area

	Dry Season		Summer Season	
	For Human Consumption (Lpcd)	For Drinking and Cooking (Lpcd)	For Human Consumption (Lpcd)	For Drinking and Cooking (Lpcd)
Barmer District	32.5	6.4	51.3	12.3
Jhunjhunu District	35.9	5.5	53.8	12.6

Source: Social Condition Survey

More detailed analysis on water demand in the project area from the result of the social condition survey is presented in the latter section of this chapter, Section 3.6 Social Condition Survey.

3.3 Water Quality

(1) Water Quality Standard for Drinking Water

The Indian standard for drinking water quality is specified as IS 10500-2012 by the Bureau of Indian Standards. This standard specifies two levels, namely, "acceptable limit" and "permissible limit". Generally, the acceptable limit should be applied, but when water quality exceeds the acceptable limit and there is no other source around the area, the permissible limit is then applied. If the value exceeds the permissible limit, the sources must be rejected. The major physio-chemical pollutants like arsenic, fluoride, iron, salinity, nitrate, total dissolved solids (TDS), and *Escherichia coli* (*E-coli*)[7].

It is known that fluoride, salinity, and iron contamination are due to the area's geographical origin and that nitrate and bacteriological contamination are basically the results of animal and human activities.

[7] Refer to Chapter 8.1

Table 3.3.1 shows the Indian standards for drinking water quality. Fluoride, nitrate, and TDS are basically checked yearly based on these parameters in Jhunjhunu and Barmer Districts.

Table 3.3.1 Water Quality Standards

S No	Parameter	Unit	Acceptable Limit	Permissible Limit
1	pH	---	6.5-8.5	No relaxation
2	Arsenic	mg/L	0.01	0.05
3	Fluoride(F)	mg/L	1	1.5
4	E-Coli	---	Shall not be detectable in any 100 ml sample	
5	TDS	mg/L	500	2,000
6	Nitrate	mg/L	45	No relaxation
7	Iron (Fe)	mg/L	1	No relaxation
8	Calcium (Ca)	mg/L	75	200
9	Magnesium (Mg)	mg/L	30	100
10	Sulphate	mg/L	200	400
11	Alkalinity	mg/L	200	600
12	Turbidity	NTU	1	5
13	Chloride (Cl)	mg/L	250	1,000
14	Free residual chlorine	mg/L	0.2	1

Source: IS 10500 – 2012 Bureau of Indian Standards in May 2012

(2) Water Quality Data of website of JJM

According to the PHED laboratory technicians in Jhunjhunu and Barmer Districts, they go around every village in the district and take several water samples from registered water sources in each village to check the quality of water every month. The total number is approximately 3,000 samples per year. The results are uploaded to the website of JJM, where the Integrated Management Information System (IMIS) reports are compiled by the technicians.

1) Jhunjhunu District

Table 3.3.2 shows the summary of water quality taken from the public water sources around the project area in Jhunjhunu District in FY2018-FY2019. In any drinking water source, arsenic contamination was not found beyond the permissible limit. However, the test data indicates that this project area has some problems of water quality; all of the blocks were identified as an area affected by fluoride, nitrate, and salinity (TDS). Particularly, nitrate was detected more than fluoride.

Table 3.3.2 Water Quality Testing in Jhunjhunu District in FY2018-FY2019

Year	District	Block	No of Tested Sample from Public Hand	Ratio Samples found contaminated in Mandatory (above IS -10500 Permissible Limit)					
				Arsenic (AS)	Fluoride (F)	Nitrate (NO_3)	Salinity (TDS)	Iron (Fe)	Bacteriological
2018-2019	Jhunjhunu	Udaipurwati	252	0(0%)	23(9%)	46(18%)	7(3%)	0(0%)	0(0%)
		Surajgarh	347	0(0%)	28(8%)	204(59%)	16(5%)	0(0%)	0(0%)
		Buhana	258	0(0%)	27(10%)	97(38%)	16(6%)	0(0%)	0(0%)
		Chirawa	318	0(0%)	54(17%)	150(47%)	22(7%)	0(0%)	0(0%)
		Total	1,175	0(0%)	132(11%)	451(38%)	61(5%)	0(0%)	0(0%)
2019-2020		Udaipurwati	623	0(0%)	113(18%)	153(25%)	34(5%)	0(0%)	0(0%)
		Surajgarh	486	0(0%)	53(11%)	257(53%)	21(4%)	0(0%)	0(0%)
		Buhana	510	0(0%)	29(6%)	149(29%)	38(7%)	0(0%)	0(0%)
		Chirawa	570	0(0%)	88(15%)	246(43%)	27(5%)	0(0%)	0(0%)
		Total	2,189	0(0%)	283(13%)	805(37%)	120(5%)	0(0%)	0(0%)

Source: JST based on the Ministry of Drinking Water and Sanitation, JJM, IMIS Reports "Water Quality (WQ) Testing in Laboratories"

2) Barmer District

Table 3.3.3 shows the summary of water quality taken from the public water sources around the project area in Barmer District in FY2018-FY2019. In any drinking water source, arsenic contamination was not found beyond the permissible limit. However, the test data shows that this project area has some problems of water quality; all blocks were identified as highly affected area by fluoride, nitrate, and salinity (TDS). Particularly, nitrate and TDS were detected much more than fluoride in the project area.

Table 3.3.3 Water Quality Testing in Barmer District in FY2018-FY2019

Year	District	Block	No of Tested Sample from Public Hand	Ratio Samples found contaminated in Mandatory (above IS -10500 Permissible Limit)					
				Arsenic (AS)	Fluoride (F)	Nitrate (NO_3)	Salinity (TDS)	Iron (Fe)	Bacteriological
2018-2019	Barmer	Chohtan	392	0(0%)	49(13%)	339(86%)	204(52%)	0(0%)	0(0%)
		Sindhary	455	0(0%)	97(21%)	253(56%)	384(84%)	0(0%)	0(0%)
		Dhorimana	329	0(0%)	66(20%)	288(88%)	266(81%)	0(0%)	0(0%)
		Barmer	710	0(0%)	109(15%)	343(48%)	371(52%)	0(0%)	0(0%)
		Total	1,886	0(0%)	321(17%)	1,223(65%)	1,225(65%)	0(0%)	0(0%)
2019-2020		Chohtan	212	0(0%)	28(13%)	174(82%)	77(36%)	0(0%)	0(0%)
		Sindhary	167	0(0%)	54(32%)	58(35%)	98(59%)	0(0%)	0(0%)
		Dhorimana	195	0(0%)	40(21%)	151(77%)	143(73%)	0(0%)	0(0%)
		Barmer	423	0(0%)	87(21%)	241(57%)	233(55%)	0(0%)	0(0%)
		Total	997	0(0%)	209(21%)	624(63%)	551(55%)	0(0%)	0(0%)

Source: JST based on the Ministry of Drinking Water and Sanitation, JJM, IMIS Reports "WQ Testing in Laboratories"

(3) Water Quality Testing by JST's Natural Condition Survey

1) Overall result of the water quality testing

The JST tested a total of 61 samples of groundwater by colorimetric analysis in Jhunjhunu and Barmer Dsitricts. In Jhunjhunu District, 12 samples from Udaipuruwati, 12 samples from Chirawa, and 12 samples from Buhana were collected; in Barmer District, 13 samples from Gudhamalani and 12 samples from Chohtan were collected. The water quality test results are attached in Appendix-3.1. The summary table is shown in Table 3.3.4. In this project area, the permissible limit should be applied for these cases as shown in Table 3.3.1 because the water resource whose water quality situation is known, is still generally limited in the area.

Table 3.3.4 Water Quality Testing by JST's Natural Condition Survey

District (n=61)		Jhunjhunu (n=36)			Barmer (n=25)	
Teshil		Udaipuruwati (n=12)	Chirawa (n=12)	Buhana (n=12)	Chohthan (n=12)	Gudda Malani (n=13)
Chlorides	Above Acceptable Limit	2	3	4	6	0
	Above Permissible Limit	0	0	0	5	7
Fluoride	Above Acceptable Limit	2	4	4	9	5
	Above Permissible Limit	0	0	0	0	0
Nitrate	Above Acceptable Limit	0	0	0	5	1
	Above Permissible Limit	0	0	0	-	0
Turbidity	Above Acceptable Limit	12	12	12	0	0
	Above Permissible Limit	0	0	0	0	0
E-Coli	Detected	0	0	0	6	5
Iron	Above Acceptable Limit	0	0	0	0	0
	Above Permissible Limit	0	0	0	0	0
Manganese	Above Acceptable Limit	0	0	0	0	0
	Above Permissible Limit	0	0	0	0	0
Arsenic	Above Acceptable Limit	0	0	0	0	0
	Above Permissible Limit	0	0	0	0	0

Source: JST's Natural Condition Survey

2) Analysis of the water sources in Jhunjhunu District

The contaminations of iron and arsenic were not found from the groundwater samples in the project area. Considering fluoride, several contaminations beyond the acceptable level (1.0 mg/L) were detected (World Health Organization (WHO) Guideline shows that above 1.5 mg/L can cause dental fluorosis[8]). Regarding chlorides, several contaminations beyond the acceptable limit (250 mg/L) were also detected. Notably, all water sources had turbidity levels above the acceptable level.

3) Analysis of the water sources in Barmer District

The contaminations of iron and arsenic were not found from the groundwater samples in the

8 World Health Organization (WHO), Guidelines for Drinking Water Quality, 2nd Edition, https://www.who.int/water_sanitation_health/publications/gdwq2v1/en/index1.html

project area. With regard to fluoride, several contaminations beyond the acceptable level (1.0 mg/L) were detected although no contamination was found to exceed the permissible level. In terms of chlorides, several contaminations exceeding the acceptable limit (250 mg/L) were detected. In particular, values were detected well above the permissible limit (1,000mg/L) in some area. Regarding nitrate, several contaminations exceeding the acceptable limit (45 mg/L) were detected. One notable aspect from the results is that several water sources were found to have *E. coli*. It suggests that they may cause a variety of water-related diseases[9].

3.4 Water-related Diseases

3.4.1 Current Situation of Water-related Diseases

(1) Jhunjhunu District

1) Fluorosis

The result of the water quality test in the project area conducted by PHED laboratory in Jhunjhunu District shows that the specific community is affected by fluorosis, especially around the hill areas. Fluoride was detected at 11% (FY2018) and 13% (FY2019) of the total samples of government water sources, as shown in Table 3.3.2.

According to the Health Department in Jhunjhunu District, in terms of test for fluorosis, it established a laboratory for fluorosis in the office in 2016 based on the National Programme for Prevention and Control of Fluorosis (NPPCF). However, the results of the activities were limited, and the lack of data such as the number of confirmed patients makes it difficult to prove that fluorosis is affecting the entire area. Furthermore, only a few activities have been implemented due to lack of human resources as of 2020.

Source: JST

Figure 3.4.1 Ion Meter in Laboratory of the Health Department in Jhunjhunu District

Source: JST

Figure 3.4.2 Leaflet of Fluorosis Programme of NPPCF

[9] JST uses the following terms in accordance with World Health Organization (WHO) and medical articles
・Water-borne diseases: Diseases are caused by pathogenic microbes spread via contaminated water
・Water-related diseases: Diseases are caused by various water contamination such as toxic agents (including fluoride) and water-borne diseases etc

In the social condition survey conducted by JST, it has been observed that 60% of the respondents (182/304) have reported that they have heard the term fluorosis. However, they do not have much understanding of the symptoms and causes of the diseases.

2) Others

According to the Health Department in Jhunjhunu District, various water-borne diseases in the project area such as acute diarrhea and typhoid are being reported every year (Table 3.4.1).

Comparing the number of cases in Rajasthan state with that of Jhunjhunu District, the number of cases of diarrhoea per 10,000 people in the entire state of Rajasthan was at 17 cases per 10,000 in 2018[10], and at 1.3 cases per 10,000 in Jhunjhunu District in 2019, which is less than the rate of entire state of Rajasthan.

Table 3.4.1 Cases of Water-borne Disease in Sample Areas in Jhunjhunu District (2017-2019)

Disease Name	Year	Area Name		
		Udaipurwati	Suraggarh	Buhana
Acute Diarrhea Disease	2017	382	329	262
	2018	342	291	295
	2019	137	102	117
Bacillary Dysentery	2017	2	0	0
	2018	2	0	0
	2019	0	0	0
Enteric Fever (Tyohoid)	2017	202	277	93
	2018	274	397	169
	2019	156	179	94
Jaundice	2017	0	0	0
	2018	0	0	0
	2019	0	0	0

Source: Chief Medical and Health Officer in Jhunjhunu District

In JST's social condition survey, 79% of the respondents were aware or had knowledge of water-borne diseases (239/304). Besides, the average number of times that family members have fallen sick due to water-borne diseases in the last six months was 1.83 times. The survey results and several other reports indicate that unreported cases of various water-borne diseases might be much more than the cases reported to the health department.

(2) Barmer District

1) Fluorosis

The result of the water quality test in the project area conducted by PHED laboratory in Barmer District shows that some of the community are affected by fluorosis. Fluoride was detected in

[10] JST calculated the figure based on Central Bureau of Health Intelligence, National Health Profile 2019 and the Census of India 2011

17% (FY2018) and in 21% (FY2019) of the total samples of government water sources, as shown in Table 3.3.3.

Whereas, according to the Health Department in Barmer District, the actual situation of fluorosis is still unknown because the survey for fluorosis has never been conducted by the health department so far. Sufficient statistical data have not been obtained from surveys and academic papers in recent years, which makes it difficult to statistically present the condition of fluorosis on the entire area.

In the social condition survey in Barmer District, it has been observed that only 10% (38) of the respondents have heard the term of fluorosis. They also do not have much understanding of the symptoms and the factors of the diseases.

2) Others

According to the Health Department in Barmer District, various water-borne diseases such as acute diarrhea and typhoid are being reported every year (Table 3.4.2).

Comparing the number of cases in Rajasthan state with that of Barmer District, the number of reported cases of diarrhea in the entire state of Rajasthan was 17 cases per 10,000 in 2018, and in Barmer District 19 cases per 10,000 in 2019, which is slightly higher than the rate of entire state of Rajasthan.[11]

Table 3.4.2 Cases of Detected Water-borne Disease in Sample Blocks in Barmer District (2016-2019)

Disease Name	Year	CHC/PHC Name						
		Chohtan	Dhanau	Sedwa	Dhorimana	Gudamalani	Sindhani	Total
Acute Diarrhea Disease	2016	207	141	109	1,296	204	201	2,158
	2017	1,260	305	594	818	296	722	3,995
	2018	1,805	583	868	312	83	1,349	5,000
	2019	125	27	24	76	14	135	401
Bacillary Dysentery	2016	0	0	0	0	0	0	0
	2017	0	0	0	5	0	0	5
	2018	0	0	0	0	0	43	43
	2019	0	0	0	0	0	2	2
Enteric Fever (Tyohoid)	2016	0	0	0	140	14	137	291
	2017	0	0	0	80	23	110	213
	2018	228	0	0	53	16	0	297
	2019	16	0	0	6	6	0	28
Jaundice	2016	-	-	-	-	-	-	-
	2017	-	-	-	-	-	-	42
	2018	-	-	-	-	-	-	81
	2019	-	-	-	-	-	-	17

Note: CHC: Community Health Centre, PHC: Primary Health Centre
Source: Provided by Chief Medical and Health Officer in Barmer District

[11]JST calculated the figure based on Central Bureau of Health Intelligence, National Health Profile 2019 and the Census of India 2011

In the social condition survey in Barmer District, it has also been observed that 65% (236/364) of the respondents are not aware or do not have knowledge of water-borne diseases. Also, water quality test by JST's Natural Condition Survey shows the detection of *E. coli* from several water sources as shown in Table 3.3.4. These results and several articles indicate that unreported and potential cases of water-borne diseases might be much more than the cases reported to the health department.

3.4.2 Findings from Rajasthan Rural Water Supply and Fluorosis Mitigation Project (Nagaur)

The main objective of the Fluorosis Mitigation Programme (FMP) in the Rajasthan Rural Water Supply and Fluorosis Mitigation Project (Nagaur), hereinafter, Phase-I project, is to mitigate fluoride poisoning and fluorosis disease in the population of Nagaur District.

The program was composed of three components with the hospital, school, and community-based approaches, which were to be conducted by NGO(s). The necessary support for the implementation of the program is being provided by the Project Management Cell (PMC) and the Project Monitoring and Supervision Consultants (PMSC). The NGO directly made a contract with PMC through tender process. The scope of work of the components with three approaches is shown in Table 3.4.3

Table 3.4.3 Scope of Each Component in FMP in Phase-I Project

Approach	Hospital	School	Community
STAGE–I: Infrastructure Development & • Capacity Building	- Establishment of 5 laboratories for fluorosis Capacity. Building: • Doctors • Lab Technicians • Diet Counsellors • ASHAs & ANMs	- Capacity Building: • School teachers • Diet Counsellors • Health Assistant	- Capacity Building: • PRI members, • VHWSC members • SHG • Field Investigators
STAGE – II: Survey	- Diagnosis of Fluorosis Test: • Fluorosis test in Blood • Fluorosis test in Urine • Fluorosis test in water • X-ray of forearm	- Survey of the students (<8 yrs.) • DF • BD • Anemia Test (Hb checking, Fluoride in Urine, Fluoride in school water)	- House to House survey to record complaints of Fluorosis - Food habits - All existing water sources
STAGE–III: Introduction of Interventions (DE+DC) & Impact Assessment (IA)	- Interventions - Monitoring of the patients for IA Re-checking - Fluoride in Urine + - Hb	- Interventions - PTM - Monitoring of the students for IA - Fluoride in Urine + - Hb	- Interventions - FGD - Monitoring on reduction of health complaints for IA D8

Note: DE: Diet Editing, DC: Diet Counseling, ASHA: Accredited Social Health Activist, ANM: Auxiliary Nurse Midwife
DF: Dental Fluorosis, BD: Blood Diagnosis, PTM: Parent Teacher Meeting, PRI: Panchayati Raj Institutions
VHWSC: Village Health and Water Sanitation Committee, SHG: Self-help Group, FGD: Focus Group Discussion
Source: PMSC

According to the PMSC, the activities completed so far are the following:

- Submission of Inception Report
- Baseline Survey carried out in 50 villages in Nagaur District (2013)
- Secondary data collection from hospitals (2014-15)
- Observatory visit to the project site of "Hogenakkal Water Supply and Fluorosis Mitigation Project" (2014)
- Dental fluorosis survey of school children in 11 schools from six blocks (2018)
- Orientation Program for Community Health Workers (ASHAs and ANMs) (2018-19)

Except for the above activities, little progress has been made so far. The main reasons for the delay are considered as follows:

1) Coordination with the Departments

   The FMP is composed of three different types of approaches and the cooperation with not only PHED but also the department of medical, health, and family welfare is indispensable. However, such coordination with the selected NGOs has not been sufficient.

2) Capacity of the NGO

   The hospital component requires a certain level of expertise and experience on the establishment of diagnostic equipment and laboratories. Moreover, specialists in such field are also necessary. However, it would be difficult for NGOs, which normally do not have the experiences and the staffs who can manage the approach. In addition, the simultaneous management of several approaches was also difficult. It can be pointed out that the required work for NGOs has exceeded their working capacity.

3) Staffing of PMSC

   Although two local consultants of PMSC were assigned for the component during the project period, the input of international consultant was sporadic and short in total. Thus, it was difficult for them to manage the program sufficiently.

It was found necessary to establish the proper project management structure and to consider proper staffing and assignment of PMC, PMSC, and NGOs considering the fact that the project is not coordinated well and still delayed.

3.4.3 Importance of Education Activities Regarding Water-related Diseases Including Fluorosis

JST proposes activities/promotion for health and WASH (water, sanitation, and hygiene) as a countermeasure for fluorosis and other water-related diseases to be included in the soft component of the project based on the following reasons:

1) Recommendation against fluorosis from WHO and articles
   - Drinking safe water is the preferable way to prevent and reduce fluorosis.[12]
   - Behavioural change, which will be led by the education activities, is an effective preventive measure for fluorosis.
   - For severe fluorosis, symptomatic treatment is fundamental[13]
2) Other threats from an unhygienic environment (such as Coronavirus Disease 2019 (Covid-19))
   - The provision of safe water, sanitation and hygienic conditions, and waste management is the most essential and effective way to prevent and protect against various infectious diseases including Covid-19.[14]
   - Appropriate behaviour led by the education activity, such as washing hands with soap, using toilet, is essential for protection from other infections, including Covid-19.
3) Insufficient people's knowledge about the water-borne diseases and fluorosis

   People's knowledge of the diseases, such as preventive measures against them, is not enough, as described in Chapter 3.4.1.

Implementing evidence-based health promotion[15] and WASH activities consistently in communities, homes, and schools will contribute to the prevention and control of various water-related diseases including fluorosis. The details of the activity plan are described in Chapter 9.

3.5 Sewerage Condition

3.5.1 Current Sewerage Condition

Currently, there is no sewerage development plan in the project area.

According to State Sewerage and Wastewater Policy 2016, it is expected that the sewage treatment capacity in the state can serve around 60% of the total urban population of the state by 2021. The sewerage improvement in the urban area is being implemented under the Rajasthan Urban Infrastructure Development Project (RUIDP) funded by the Asian Development Bank (ADB). The implementing agency is the Department of Local Self Government. The status and future proposed plan of sewerage of urban local body in Jhunjhunu and Barmer District is as shown in Table 3.5.1.

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[12] WHO, Fluorosis, https://www.who.int/water_sanitation_health/diseases-risks/diseases/fluorosis/en/

[13] American International Medical University, Fluorosis: Causes, Diagnosis, Management and Prevention, https://www.aimu.us/2017/08/15/fluorosis-causes-diagnosis-management-and-prevention/

[14] WHO, Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19, July, 2020

[15] It adopts a more scientific approach that avoids the use of unendorsed and unsystematic information (WHO)

Table 3.5.1 Status of Sewerage Project in Urban Area of Jhunjhunu and Barmer District

Name of Urban Local Bodies	Population		Name of the schemes/program ongoing/sanctioned / proposed(*)	% Coverage				Population benefits				Population benefited (2016)
	Census 2011	2016		Existing	After completion of ongoing /sanctioned projects	In proposed projects (*)	Total	Existing	After completion of ongoing /sanctioned projects	In proposed project(*)	Total	
Jhunjhunu	118,473	130,202	UIDSSMTphase Ⅰ RUIDPphase Ⅲ AMRUT(*)	0%	80%	20%	100%	0	94,778	23,695	118,473	118,473
Chirawa	44,999	49,454	UIDSSMTphase Ⅰ	0%	61%	0%	61%	0	27,449	0	27,449	30,167

Note: UIDSSMT: Urban Infrastructure Development Scheme for Small and Medium Towns,
RUIDP: Rajasthan Urban Infrastructure Development Project,
AMRUT: ATAL MISSION FOR REJUVENATION AND URBAN TRANSFORMATION
Source: State Sewerage and Wastewater Policy 2016

Present condition of black water and greywater in the project area are described hereunder.

(1) Black Water

In eight CD blocks in Jhunjhunu and Barmer District, the household toilet coverages were about 54% in Jhunjhunu District and 15% in Barmer District based on the Census of India in 2011 (Table 3.5.2).

Table 3.5.2 Household by Availability of Latrines within the Project area by Census of India 2011

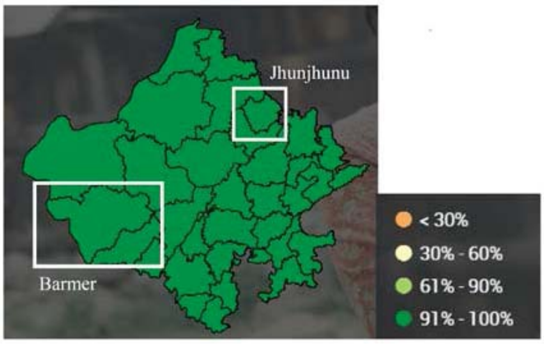
Area Name	Total Number of Households		Number of households having latrine facility within the premises		Type of latrine facility within the premises						Number of households not having latrine facility within the premises		No latrine within premises			
					Piped sewer system		Septic tank		Other system				Public latrine		Open	
District - Jhunjhunun	383,664	100%	205,571	54%	9,601	3%	151,764	40%	24,802	6%	178,093	46%	845	1>%	177,248	46%
Udaipurwati	52,826	100%	20,690	39%	1,624	3%	11,972	23%	1,762	3%	32,136	61%	166	1>%	31,970	61%
Chirawa	85,667	100%	49,349	58%	1,740	2%	32,985	39%	12,782	15%	36,318	42%	154	1>%	36,164	42%
Buhana	42,409	100%	15,396	36%	854	2%	12,903	30%	620	1%	27,013	64%	82	1>%	26,931	64%
Surajgarha	49,131	100%	16,969	35%	1,548	3%	9,271	19%	3,637	7%	32,162	65%	567	0%	31,595	64%
District - Barmer	447,776	100%	66,597	15%	9,817	2%	35,003	8%	8,005	2%	381,179	85%	2,110	1>%	379,069	85%
Chohtan	82,563	100%	3,668	4%	663	1%	2,269	3%	218	0%	78,895	96%	330	1>%	78,565	95%
Barmer	63,231	100%	22,798	36%	3,875	6%	14,560	23%	1,681	3%	40,433	64%	399	1%	40,034	99%
Dhorimanna	1,122	100%	658	59%	9	0%	634	59%	6	0%	464	41%	NA	NA	464	41%
Sindhary	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Census of India 2011, “Households by Availability of Type of Latrine Facility”

In October 2014, Swachh Bharat Mission was launched throughout the country with an aim to achieve the vision of a “Clean and Open Defecation-Free India” by October 2019.

According to the Swachh Bharat Mission website the mission's success has resulted in 100% coverage at present (Figure 3.5.1). Also, according to the report, “National Annual Rural Sanitation Survey (NARSS) Round 2 (2018-2019)”, published by the Department of Drinking

Water and Sanitation, approximately 95.6% of the households in Rajasthan have an access to toilet facility (Table 3.5.3).



Source: Ministry of Jal Shakti, Swachh Bharat Mission (Gramin) HP (accessed 03 August 2020)

Figure 3.5.1 Household Latrine Coverage across Rajasthan by the Swachh Bharat Mission

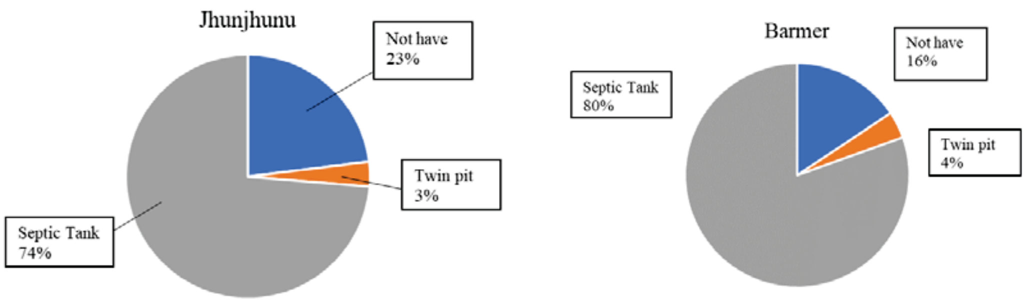
Table 3.5.3 Characteristics of Latrines and sanitation in Rajasthan by Department of Drinking Water and Sanitation

Number of Villages Surveyed	396
Number of Households Surveyed	5940
Number of Schools Surveyed	393
Access to Toilet	Overall (%)
Percentage of Households Having Access to Toilet Facility	95.6
Percentage of Schools Having Access to Toilet Facility	100
Functionally of Toilet	
Percentage of Households Having Functional Toilet	99.9
Percentage of Schools Having Functional Toilets	100
Sanitary Condition of Toilet	
Percentage of Households Where Toilets Found in Hygienic Condition	99.1
Percentage of Schools Where Toilets Found in Hygieninc Condition	100
Disposal Mechanism of Human Excreta from Toilet	
Percentage of Household Toilets with Safe Disposal Mechanism	100
Percentage of Schools Toilets with Safe Disposal Mechanism	100
Usage of Toilet	
Percentage of Individuals Using Toilet Those Having Access To It	98.8
Percentage of Schools Where Toilets Are Being Used	100
Solid and Liquid Waste Management	
Percentage of Household Where Waste Is Not Visible	99.8
Percentage of Household Where Liquid Waste/Stagnant Water Is Not Visi	99.1
Percentage of Village With Minimal Level of Littering	100
Percentage of Village With Minimal Level of Water Logging	100
Visible Faecal Matter in Public Spaces	
Percentage of the Village Where Visible Faces Not Found in The Area That Were Used for Open Defecation in The Past	99.5

Source: Department of Drinking Water and Sanitation

However, at the project area level, the JST's social condition survey found out that not all households in the survey area of both Jhunjhunu and Barmer District have a latrine within their own premises yet (Figure 3.5.2). Of the total 668 respondent households in Jhunjhunu and Barmer District[16], 3% had a twin pit latrine and 74% had a septic tank, but 23% did not have a latrine in Jhunjhunu District. Also, 4% had a twin pit latrine and 80% had a septic tank, but 16% did not have a latrine in Barmer District.

Several respondent households which do not have a latrine chose the system of open defecation. The other choices that JST confirmed were to use public latrine and make use of neighbours' latrine. JST's study also revealed that 6 and 40 households could not use the latrine in Jhunjhunu and Barmer District, respectively. In addition, 38 and 5 households in Jhunjhunu and Barmer District, respectively, answered that there was no water for flushing and the rest answered that the latrine was "broken". On the other hand, even if they had their own latrine, some households did not use the latrines because of their preference (they prefer open defecation to using latrine) (Figure 3.5.4).



Source: JST's Social Condition Survey (Single-choice, n=668)

Figure 3.5.2 Status of Household Having Latrine in the Project Area by JST's Social Condition Survey

Source: JST

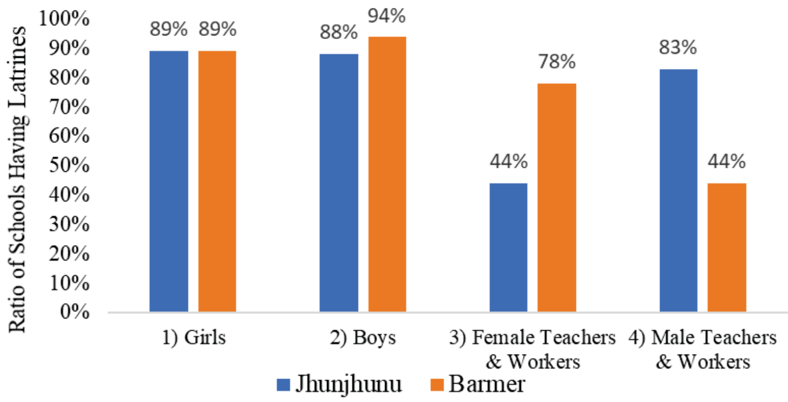
Figure 3.5.3 Standard Design of Latrine

Source: JST

Figure 3.5.4 Toilet that has been Used as a Forage Stock

[16] It should be considered that the statistical population was different with the Census of India, the Swachh Bharat Mission and other surveys.

According to Department of Drinking Water and Sanitation, 100% of schools in Rajasthan have a latrine including the urban area (Table 3.5.3). As per JST's social condition survey, 95% of the 36 schools that answered in the project area had a latrine (single-choice) in Jhunjhunu and Barmer District and that latrines were mostly cleaned on a weekly basis by sweepers and students. The major types of latrine in each block are septic tank (72%) and twin pit latrine (22%). As shown in Figure 3.5.5, the total rates of schools having separate latrines for girls and boys were 89% and 88% in Jhunjhunu District, 89% and 94% in Barmer District. The total rates of schools having latrines for "female teachers and other adults" and "male teachers and other adults" were 44% and 83% in Jhunjhunu District, 78% and 44% in Barmer District, respectively (n=18 (Jhunjhunu), 18 (Barmer),Single-choice), which indicates that some adults are also forced to use the students' latrines.



Source: JST's Social Condition Survey (Single-choice, n=18 (Jhunjhunu), 18 (Barmer))

Figure 3.5.5 Status of Schools Having Latrine in the Project Area by JST's Social Condition Survey

(2) Greywater

Although drain was not detected much in the project area, JST found open drains in some villages during the study. People directly discharge their used water out of their house or into an open drain (Figure 3.5.6, 7). In the area where open drain has not been constructed, a puddle with garbage was found in front of most houses in the community especially in Jhunjhunu District (Figure 3.5.8) or scattered garbage without puddle was found in front of many communities in Barmer District (Figure 3.5.9). The number of cattle in the project area was high and contamination from cattle manure was frequently observed in the project area.

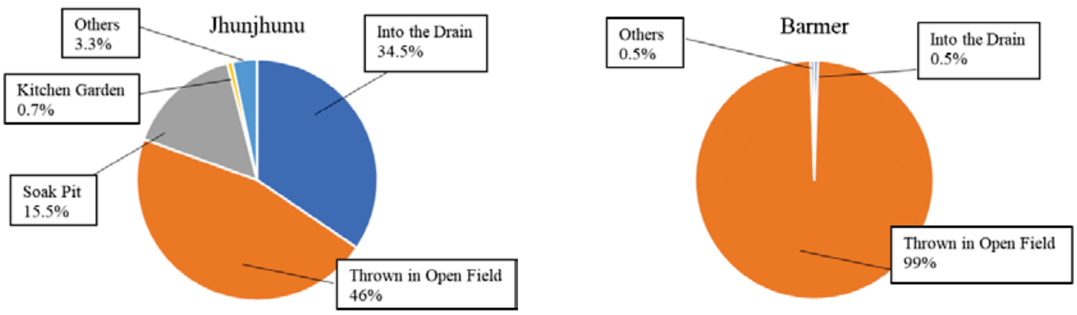
In fact, based on JST's social condition survey, it is presented that 78% of the 304 households in Jhunjhunu District and 98.4% of the 364 households in Barmer District have no drainage system in their habitats. Also, 34.5% in Jhunjhunu District and only 0.5% in Barmer District answered that they discharged the greywater into the drain. On the other hand, 46% in Jhunjhunu District and 99% in Barmer Distrfict discharged greywater into open field (Figure 3.5.10). While, only two households in Jhunjhunu District drained greywater onto the kitchen garden or agricultural land based on the assessment. These conditions can lead to unsanitary conditions through contamination and increase the risk of the spread of infectious diseases, including zoonosis, especially in areas with high livestock populations.[17]

Source: JST
Figure 3.5.6 Drain with Garbage in Jhunjhunu District

Source: JST
Figure 3.5.7 Drain with Garbage in Barmer District

Source: JST
Figure 3.5.8 Scattered Garbage in Jhunjhunu District

Source: JST
Figure 3.5.9 Garbage without puddle in Barmer District



Source: JST's Social Condition Survey (Single-choice, n=304 (Jhunjhunu), 364 (Barmer))
Figure 3.5.10 Status of greywater management in the project Area by JST's Social Condition Survey

[17] 60 to 70% of emerging infectious diseases in humans are of animal origin, World Organisation for Animal Health (OIE)

3.5.2 Greywater Management by the Project

After the completion of the project, as the volume of the water consumption in the project area will increase, a proper management of the greywater will be essential. In India, construction of proper drainage facility in rural area is the responsibility of the Gram Panchayat. In the "Operational Guidelines for the Implementation of Jal Jeevan Mission" issued in December 2019, "greywater management" is included in the components to be supported under JJM. The guideline states that the convergence of the activity is the key to the implementation of JJM. Thus, it is proposed that "greywater management" be included in the capacity development of community component: "sensitization of the stakeholders and beneficiaries" of the project.

It should be noted that the planning and construction of the sewerage system are not included in the project. The capacity development in the project will be limited to the sensitization of the Gram Panchayat regarding the importance of greywater management. Therefore, it is recommended that PHED conduct greywater management on the project site in parallel with the project in collaboration with Panchyati Raj of Government of Rajasthan, which is in charge of the issues of greywater management.

Regarding the treatment technology of greywater, "Jokaso", which is an aerobic treatment tank, can be regarded as one option for future sewerage system in some villages. Although Jokaso has a strong point of properly treating black and greywater together, the cost is relatively high. If the manufacturers of Jokaso increase and the competition among firms leads to cost reduction, Jokaso will be more feasible in the project area.

3.6 Social Condition Survey

3.6.1 Outline of the Survey

The social condition survey was conducted to provide an understanding of the current socio-economic conditions and the status of water supply and sanitation systems, and patterns of water usage as well as the related knowledge, attitudes, and practices of the people in the project areas. 304 households and 18 schools from 18 sample villages in Jhunjhunu District and 364 households and 18 schools from 15 sample villages in Barmer District were chosen for the survey, and interviews were conducted using questionnaires. The contents of the survey questions are shown in Table 3.6.1.

Table 3.6.1 Contents of Survey Questions

Survey	Subjects	Question Items
Household Survey - 304 sample households in	General Information and Socio-economic Profile of Respondents and Households	Name, gender, age, religion, social group, education, government assistance, lighting, monthly income and expenditure, etc.
	Household Water Supply	Type of water supply facilities owned, connection time, tariff system, expenses for water, persons/

Jhunjhumu district - 364 sample households in Barmer District		frequency/distance/average time required for collecting water, etc.
	Water Demand	Important source, treatment, required volume of water for daily use, satisfaction level, problems, complaints, expectations, willingness to pay, etc.
	Health and Hygiene Situation	Knowledge on water-borne diseases, morbidity, frequency, expenses of water-borne diseases, method of disposal of wastewater, ownership of latrine, type of latrine, usability, water for latrine, cleaning, situation of girls, etc.
	Media	Source of information, favourable media, etc.
School Survey - 18 sample schools from 18 villages in Jhunjhumu district - 18 sample schools from 15 villages in Barmer District	General Information	Name, type of school, address, number of students and teachers, opening hours, facilities, etc.
	Water Supply	Source of water, availability, facilities owned, treatment of water, etc.
	Health	Programs for fluorosis, etc.
	Sanitation Situation and Gender Issues	Existence of latrine, separation of latrine by gender, type of latrine, usability, cleaning, girls' attendance, etc.

Source: JICA Study Team

The survey was sub-contracted and conducted by one of the local NGOs named NIDS-Satya which has extensive working experiences in the water and sanitation sector in Rajasthan. The field survey was carried out between early January and end of February in 2020. Information obtained by the field survey was considered as representing the dry season in the project area, unless mentioned. The information was compiled in Microsoft Excel format and the final report was submitted to JST in July 2020.

The information collected through the survey was utilized for the detailed design of the water supply system, including the required scale and functions, and will also serve as the baseline data for the project evaluation. The major findings of this survey are summarized in the following section.

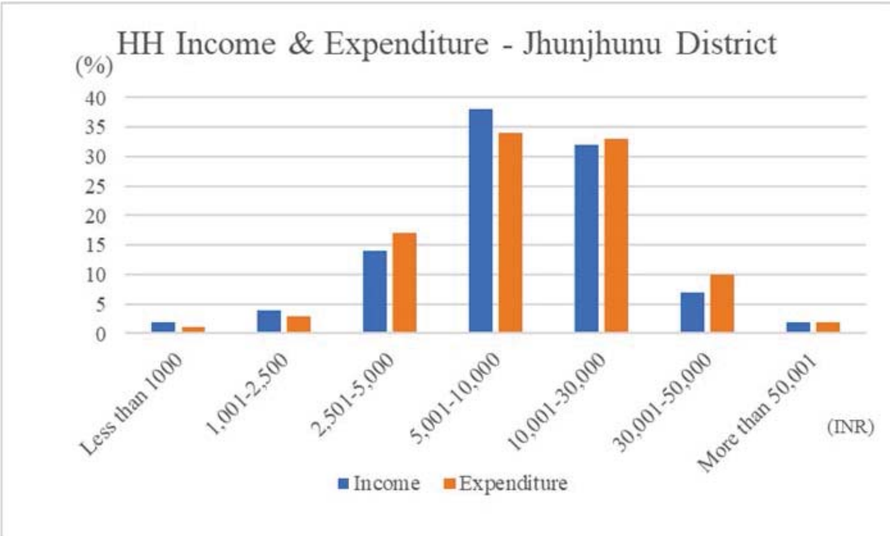
3.6.2 Survey Results

(1) General Information and Socio-economic Profile of Respondents and Households

Jhunjhunu District

- Social categories: 42.8% of the respondents belong to Other Backward Class (OBC) category; Scheduled Caste (SC) was 26%, the general category was 22.4%, and Scheduled Tribe (ST) category was only 8.9%.
- Occupations: 37% of the respondents worked in the agriculture sector, 35% were daily laborers, 6% were carpenters, 5% worked in the private services, and the remaining people had other occupations.

- Household incomes: 38% of the respondents' monthly income was INR 5,001-10,000, 32% answered INR 10,001-30,000, 14% answered INR 2,501-5,000, 4% answered INR 30,001-50,000, and 2% answered INR 1,001-2,500.
- Household expenditures: Maximum number of respondents (34%) was having household expenditure of INR 5,001-10,000, 33% of the respondents answered INR 10,001-30,000, 17% answered INR 30,001- 30,000, 10% of the respondents answered INR 2,501- 5,000, and 3% answered INR 1,001-2,500.

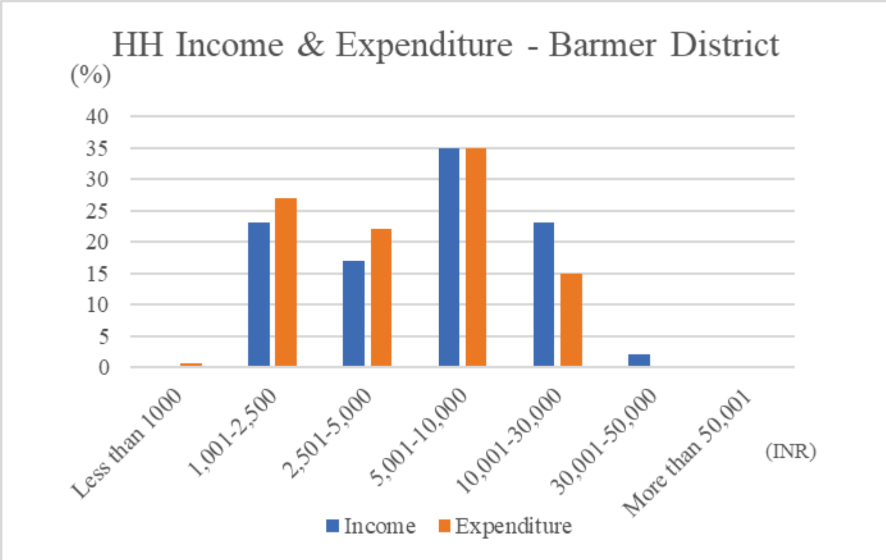


Source: Household Survey

Figure 3.6.1 Household Income and Expenditure - Jhunjhunu District

Barmer District

- Social categories: 70% of the respondents belonged to the OBC category. 11% of the respondents were SC and another 11% were ST, and the rest or 8% was in the general category.
- Occupations: The majority of the respondents (73%) were engaged in the agriculture sector, 14% of the respondents were daily-wage laborers, 5% were shopkeepers, and the remaining had different types of occupations such as pottery makers, masons, carpenters, etc.
- Household incomes: 35% of the respondents answered that their monthly income was INR 5,001-10,000, 23% of them answered INR 10,001-30,000, 23% answered INR 1,001-2,500, 17% answered INR 2,501-5,000, and about 2% answered INR 30,001-50,000.
- Household expenditures: Maximum number of respondents (35%) said that household expenditure was INR 5,001-10,000, 27% answered INR 1,001-2,500, 22% answered INR 2,501-5,000, and 15% answered INR 10,001-30,000.



Source: Household Survey

Figure 3.6.2 Household Income and Expenditure - Barmer District

(2) Household Water Supply and Demand

Jhunjhunu District

The result of the "source of the domestic water usage" in Jhunjhunu District is shown in Table 3.6.2. About 70% (227 (144 public and 83 association) out of 304) of the respondents have household connections, yet many people purchase water from vendors and shops. People secure water from multiple sources to fulfil their needs.

Table 3.6.2 Sources of Water for Domestic Use in Jhunjhunu District

Sources of Water	Number of Households (N=304)
Gram Panchayat Household Connection	144
Gram Panchayat Stand Post	0
Public Hand Pump	11
Own Tube/Bore Well with Hand/Power Pump	13
Independent Residents/Colony Association Pipeline Supply	83
Water Tankers/Vendors	67
Shared with Neighbors	7
Dug Wells	14
Other Sources – Bore Well	1
Other Sources - Public Tube Well Fitted with Motor	22
Other Sources - RO Purified Water from Shop	35

Note: This was a multiple-choice question.
Source: Social Condition Survey

On average, a household in Jhunjhunu District consumes 23.5 buckets (about 352.5 liters) of water per day in winter and 33.71 buckets (about 505.65 liters) in summer. The usage of water for various domestic needs is shown in Table 3.6.3.

The average consumption of water for humans, for an average family size of 5.5 members in Jhunjhunu District, was only 35.9 Lpcd in the winter/dry season and 53.8 Lpcd in summer.

Table 3.6.3 Consumption of Water for Domestic Use in Jhunjhunu District

Average Usage of Water for Various Needs (Number of buckets of 15 liters each)	Winter	Summer
Drinking and cooking	2.03	4.61
Cleaning and laundry	5.12	7.39
Bathing and personal hygiene	6.01	7.72
Cattle/animals	9.04	11.92
Others (for plants and garden)	1.31	2.02
Overall average daily consumption	23.51 (352.5 liters)	33.71 (505.65 liters)

Source: Social Condition Survey

Barmer District

The result of "the sources of domestic water usage" in Barmer District is shown in Table 3.6.4. The most common water source in Barmer District was purchasing water from vendors (169 out of 364) and close to a half of households had their own tube/bore well. Very limited numbers of households have household connections in Barmer District. It was detected that quite a few households utilize rain water. People secure water from multiple sources to fulfil their needs.

Table 3.6.4 Sources of Water for Domestic Use in Barmer District

Sources of Water	Number of Households (N=364)
Gram Panchayat Household Connection	14
Gram Panchayat Stand Post	31
Public Hand Pump	7
Own Tube/Bore Well with Hand/Power Pump	153
Independent Residents/Colony Association Pipeline Supply	0
Water Tankers/Vendors	169
Shared with Neighbors	17
Dug Wells	17
Other Sources – Bore Well	1
Other Sources - Canal Water	4
Other Sources - Rain Water Harvesting	59

Note: This was a multiple-choice question.
Source: Social Condition Survey

As for the consumption of water for domestic use, a household in Barmer District consumes 18.66 buckets (about 279.9 liters) of water per day on average in winter and 33.66 buckets (about 497.1 liters) in summer. The breakdown of the water usage for various domestic needs is shown in Table 3.6.5.

The average consumption of water for humans, for an average family size of 5.8 members in Barmer District, was only 32.5 Lpcd in the winter/dry season and 51.3 Lpcd in summer.

Table 3.6.5 Consumption of Water for Domestic Use in Barmer District

Average Usage of Water for Various Needs (Number of buckets of 15 liters each)	Winter	Summer
Drinking and cooking	2.49	4.76
Cleaning and laundry use	4.23	7.43
Bathing and personal hygiene	5.85	7.65
Cattle/animals	5.66	11.40
Others (for plants or garden)	0.44	1.90
Overall average daily consumption	18.66 (279.9 liters)	33.14 (497.1 liters)

Source: Social Condition Survey

(3) Satisfaction Level and Valuation in Current Water Supply

Jhunjhunu District

The satisfaction level of respondents is shown in Table 3.6.6. The majority of the respondents are not satisfied with the water quantity, but more than half of the respondents have better than average satisfaction about the duration of and access to the water supply in Jhunjhunu District where the majority of households have a household connection water supply every day for 30 min. to 6 hours. On the contrary, when they are asked if they would want to have a better water supply service, 93% answered “yes”. The respondents would want to have at least two hours of household connection water supply every day, and they are willing to pay about INR 106 on average for such kind of service.

Table 3.6.6 Satisfaction Level for Current Water Supply Service in Jhunjhunu District

	Highly Satisfied	Satisfied	Average	Somewhat not satisfied	Not at all satisfied
Duration of water supply	24 %	13 %	17 %	16 %	30 %
Quality of supplied water	8 %	15 %	12 %	7 %	58 %
Access to the water supply	12 %	34 %	13 %	11 %	30 %
Overall satisfaction	5 %	36 %	16 %	5 %	38 %

Source: Social Condition Survey

Table 3.6.7 Willingness to Pay for Household Connection Water Supply Service in Jhunjhunu District

Maximum Amount of Willingness to Pay (Monthly)	Number of Households
INR 200	55
INR 150	38
INR 100	103
INR 60	86
INR 0	22
Total	304

Source: Social Condition Survey

Barmer District

Respondents showed their satisfaction level as shown in Table 3.6.8 below. It became apparent that the majority of the respondents are not at all satisfied with the water supply quality, quantity, and access. Currently very few households in Barmer District have a household connection and the respondents would want to have at least two hours of household connection water supply every day, and they are willing to pay about INR 100 on average for such kind of service.

Table 3.6.8 Satisfaction Level for Current Water Supply Service in Barmer District

	Highly Satisfied	Satisfied	Average	Somewhat not satisfied	Not at all satisfied
Duration of water supply	1 %	2 %	4 %	5 %	88 %
Quality of supplied water	2 %	8 %	14 %	4 %	72 %
Access to the water supply	0 %	6 %	3 %	5 %	86 %
Overall satisfaction	0 %	17 %	4 %	4 %	75 %

Source: Social Condition Survey

Table 3.6.9 Willingness to Pay for Household Connection Water Supply Service in Barmer District

Maximum Amount of Willingness to Pay (Monthly)	Number of Households
INR 200	13
INR 150	102
INR 100	90
INR 60	151
INR 0	7
Others	1
Total	364

Source: Social Condition Survey

(4) Health and Hygiene Situation

Jhunjhunu District

- Water-borne diseases: 79% of the respondents are aware of or have the knowledge of the water borne diseases.
- Fluorosis: 60% of the respondents have reported that they have heard the term "fluorosis".
- The respondents seems not to have accurate knowledge of what fluorosis is and what kind of symptoms are shown.
- Toilets: 77% of the respondents had a toilet at their residence and 97% of these were usable. People who do not have a toilet at home go to the field for open defecation.
- Grey water discharge: Almost half (46%) of the respondents responded that greywater is released to the open field, 35% said it goes into the drain, and 15% said it goes to the soak pit. The remaining releases it into the garden, agricultural land, or a water body near the house.

Barmer District

- Water-borne diseases: only 35% of the respondents are aware of or have the knowledge of the water borne diseases.
- Fluorosis: only 10% of the respondents have reported that they have heard the term "fluorosis". The respondents seems not to have accurate knowledge of what fluorosis is and what kind of symptoms are shown.
- Toilets: 84% of the respondents had a toilet at home and 90% of those toilets were usable. Among the rest or 10%, the majority of respondents gave the reason for not using their toilet as being the lack of water for flushing the toilet.
- Grey water discharge: 99% of the households responded that greywater directly goes to the open field and only two households said that it goes to the drain.

(5) Water Supply and Health and Hygiene Situation at Schools

- Drinking water: Drinking water was not available in one school in each district. The rest of the 34 schools had drinking water.
- Toilets: In Jhunjhunu District, two schools out of 18 did not have toilets, but the other 16 schools had at least one latrine each for boys and girls. All sample schools in Jhunjhunu District had a hand washing facility.
- Toilets: All schools in Barmer District had toilets and all but two of these schools had at least one latrine each for girls and boys. Four schools did not have a hand washing facility.
- Usability of Toilets: 94% and 100% of latrines in Jhunjhunu and Barmer Districts, respectively, were usable.
- Piped water connection: In Jhunjhunu District, the great majority (15 out of 17) had a piped water connection (public or private) at school and that is the important source of drinking water. At a vast majority of schools in Barmer District (11 out of 18), the

important source of drinking water was purchased from the vendors by water tanker or filtered canned water.

- Fluorosis prevention program: None of the sample schools in both Jhunjhunu and Barmer Districts had conducted fluorosis prevention programs in the past, but one school in each district had conducted other water-related diseases prevention programs.

Chapter 4 Review of Water Supply Plan for Jhunjhunu Scheme

4.1 Target Area of the Project

The Jhunjhunu Scheme consists of two sub-schemes:

- Surajgarh Sub-Scheme with target area of 190 villages in Buhana and Chirawa Tehsils and one town (Surajgarh Town)
- Udaipurwati Sub-Scheme with target area of 94 villages in Udaipurwati Tehsil and one town (Udaipurwati Town)

The population (2011 Census) of the target area is shown in Table 4.1.1.

Table 4.1.1 Population (2011 Census) of the Target Area of Jhunjhunu Scheme

	Nos. of Village/Town	Population (2011)
Surajgarh Sub-Scheme		
Rural population		
Buhana Tehsil	138	223,405
Chirawa Tehsil	52	76,938
Sub-total	190	300,343
Urban population		
Surajgarh town	1	21,666
Total		322,009
Udaipurwati Sub-Scheme		
Rural population		
Udaipurwati Tehsil	94	265,534
Urban population		
Udaipurwati town	1	29,236
Total		294,770
Grand Total	284 villages and 2 towns	**616,779**

Source: JST based on DPR

The list of target villages with population is presented in Appendix-4.1.

4.2 Basic Policies for Water Supply Planning

It was confirmed with the Public Health Engineering Department (PHED) officials in Jhunjhunu that the following planning parameters/policies shall be applied:

(1) Target Year

The target year shall be 2047.

(2) Target Village/Town and Base Population

As mentioned in Section 4.1, the target village/town shall be:

- 190 villages in Buhana and Chirawa Tehsils and one town (Surajgarh Town)

- 94 villages in Udaipurwati Tehsil and one town (Udaipurwati Town)

The base population shall be according to the 2011 Census.

(3) Population Projection

For population projection up to the target year (2047), the following decadal growth rates shall be applied:

- Rural: 8.62%
- Urban: 24%

These figures are considered to be appropriate for the following reasons:

1) These figures have been taken from the decadal growth (2001-2011) of Jhunjhunu District: Total: 11.81% (Rural: 8.62%, Urban: 24.04%)

2) According to the "Report of the Technical Group on Population Projections" issued by the National Commission on Population Projection, Ministry of Health and Family Welfare, the projected growth rate (2011 - 2036) of Rajasthan State is 32.1%, that is, the projected decadal growth rate is 11.78%, which is similar to 11.81% mentioned in 1).

3) The percentage of urban population of Jhunjhunu District and Rajasthan State is similar (Jhunjhunu District: 22.91%, Rajasthan State: 24.89%). As a result, the projection of future population for Jhunjhunu District and Rajasthan State would have similar pattern.

4) Considering 1) to 3), it was judged that the figures (Rural: 8.62%, Urban: 24%) can be applied as the decadal growth rates for the population projection.

Thus, it was confirmed with the PHED officials in Jhunjhunu that the above decadal growth rates shall be applied for the population projection.

(4) Per Capita Water Demand

In line with the national program on water supply, described in the Jal Jeevan Mission (2019), as well as the "Guidelines and Norms for Design of Water Supply Schemes/Projects as of 01 September 2017 issued by PHED", the per capita water demand shall be the following:

- 55 Lpcd (Rural)
- 100 Lpcd (Urban)

It should be noted that 55 Lpcd is the minimum requirement for human beings of every household. For other demand such as for cattle water supply, it is envisaged that such demand will be met by conjunctive use of the existing water source such as groundwater.

In addition, the following shall be added for the design of transmission and distribution facility:

- Distribution loss: 15%
- Institutional demand: 10%

These figures were determined based on the past instances of water supply projects in Rajasthan and were prescribed in the said "Guideline" for design purposes.

(5) Type of Water Supply

In line with the Jal Jeevan Mission (2019), house connection for every household shall be provided.

4.3 Population and Water Demand Projection

Based on the conditions presented in Sections 4.1 and 4.2, the population and water demand projections have been made as shown in Table 4.3.1.

Table 4.3.1 Population and Water Demand Projections for Jhunjhunu Scheme

Area	Population				Clear Water Demand (m^3/day)		
	2011	2026	2032	2047	2026	2032	2047
Surajgarh Sub-Scheme							
Rural population							
Buhana Tehsil	223,405	252,905	265,768	300,863	17,387	18,272	20,684
Chirawa Tehsil	76,938	87,097	91,527	103,613	5,988	6,293	7,123
Sub-total	300,343	340,003	357,296	404,476	23,375	24,564	27,808
Urban population							
Surajgarh town	21,666	29,917	34,038	47,000	3,740	4,255	5,875
Total	322,009	369,919	391,334	451,476	27,115	28,819	33,683
Udaipurwati Sub-Scheme							
Rural population							
Udaipurwati Tehsil	265,534	300,597	315,886	357,598	20,666	21,717	24,585
Sub-total							
Urban population							
Udaipurwati town	29,236	40,369	45,931	63,421	5,046	5,741	7,928
Total	294,770	340,966	361,817	421,020	25,712	27,459	32,513
Grand Total	**616,779**	**710,885**	**753,151**	**872,496**	**52,827**	**56,277**	**66,195**

Source: JST

4.4 Relation of the Project with Other Water Supply Scheme That Shares Same Water Source

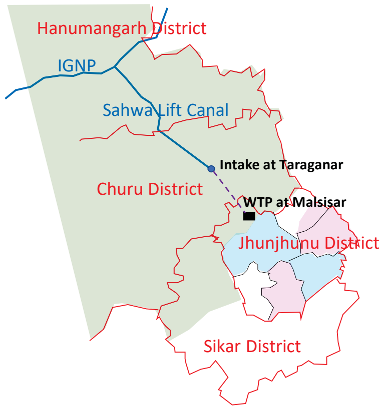
4.4.1 History of the Water Supply Project for Jhunjhunu and Sikar District

The proposed JICA project is to supply water to the part of Jhunjhunu District. The water supply project for Jhunjhunu and Sikar districts has been implemented by utilizing the water of Indira Gandhi Nahar Project (IGNP) as a water source, as shown in Table 4.4.1 and Figure 4.4.1.

Table 4.4.1 Past and Proposed Project for Jhunjhunu and Sikar Districts

Target Supply Area	Outline of the Project
(I) Past Projects - Northwest part of Jhunjhunu Tehsil - Northwest part of Sikar District	The project has been implemented for supplying water mainly to Churu and Hanumangarh districts with water source from IGNP.
(II) ITJSK Project (Phase-I) - Remaining part of Jhunjhunu Tehsil - Khetri Tehsil	The water source is Sahwa Lift Canal, tributary canal of IGNP. Intake is located at Taranagar in Churu District. WTP is located at Malsisar in Jhunjhunu District.
(III) Proposed JICA project - Part of Chirawa Tehsil and Buhana Tehsil - Udaipurwati Tehsil	Clear water for the project is supplied from the existing WTP constructed by ITJSK Project (Phase-I).

Source: JST



Source: JST

Figure 4.4.1 Past and Proposed Project for Jhunjhunu and Sikar Districts

Originally, the Integrated Taranagar-Jhunjhunu-Sikar-Kherti Water Supply Project (ITJSK project) was planned to supply water to the entire Jhunjhunu and Sikar districts (excluding the area covered by the previous project). The ITJSK project (Phase-I) was completed in 2018 and the facility is in operation.

The proposed JICA project can be positioned as Phase-II of the ITJSK project. Clear water for the project is to be supplied from the existing Water Treatment Plant (WTP) at Malsisar constructed for the ITJSK project (Phase-I).

The water demand (2047) presented in the DPR for the proposed JICA project, which was approved by PHED, is shown in Table 4.4.2.

Table 4.4.2 Water Demand Presented in DPR for the JICA Project

Supply Area	Water Demand (2047)	Remarks
Supply area of ITJSK project (Phase-I)	79.71 MLD	
Supply area of proposed JICA project		
Surajgarh Sub-Scheme	33.67 MLD	33.68 MLD (Reviewed by JST)
Udaipurwati Sub-Scheme	32.51 MLD	32.51 MLD (Reviewed by JST)
Sub-total of proposed JICA project	66.18 MLD	66.19 MLD (Reviewed by JST)
Total	145.89 MLD	

Note: MLD: million liter per day
Source: DPR of proposed JICA project

The capacity of WTP at Malsisar constructed for the ITJSK project (Phase-I) is 156 MLD. Thus, it caters to the demand of the supply area of both ITJSK project (Phase-I) and proposed JICA project.

4.4.2 Draft DPR for Remaining Area

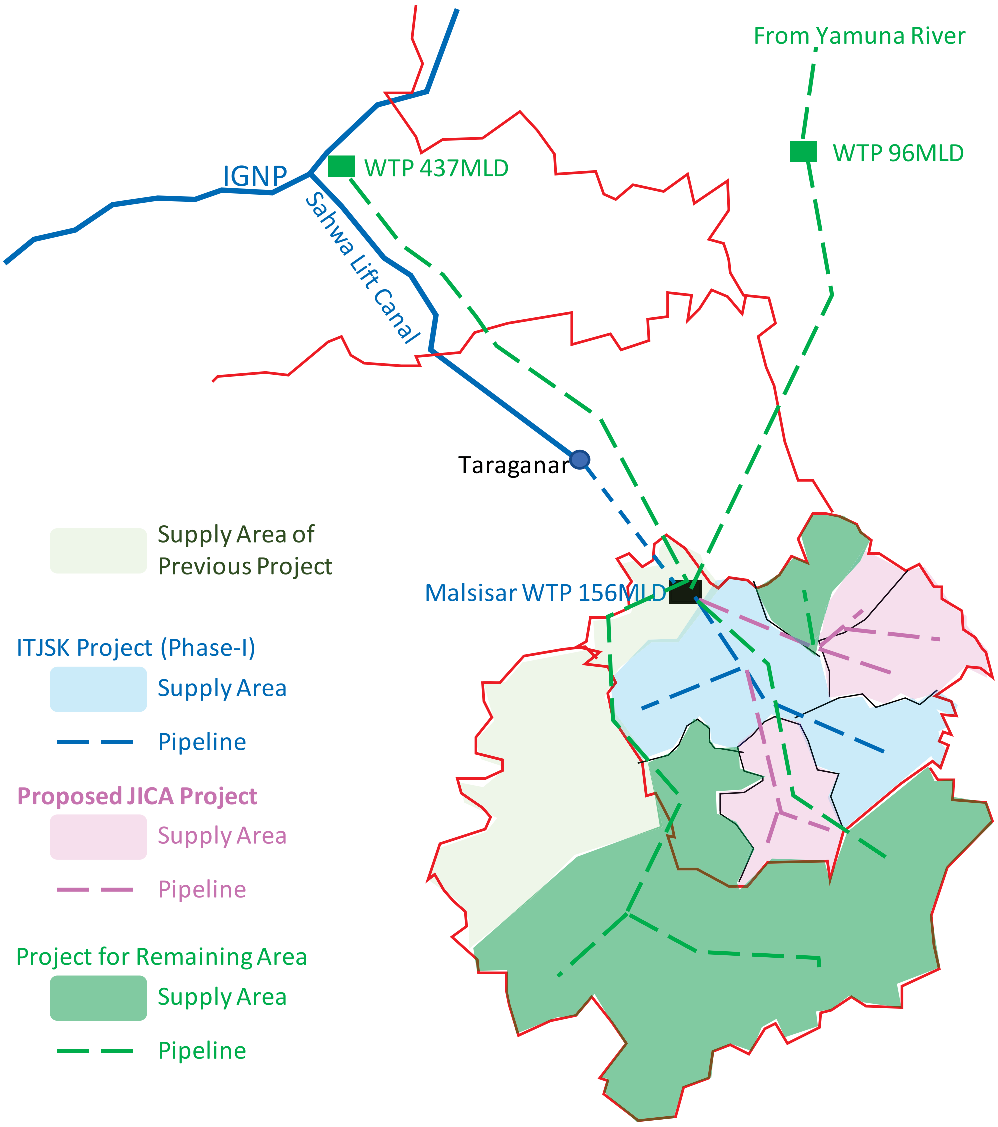
For supplying water to the remaining area (part of Chirawa Tehsil, Nawalhgarh Tehsil of Jhunjhunu District, and the remaining area of Sikar District, which is not covered by the previous project nor the proposed JICA project), a draft DPR for "Drinking Water Supply Project for Remaining Area of Sikar and Jhunjhunu Districts" is being prepared by the local consultant, PDCOR Ltd. In the draft DPR, re-formulation of the entire water supply plan for Jhunjhunu and Sikar districts is proposed. Table 4.4.3 shows the water demand projection in the said water supply plan.

Table 4.4.3 Water Demand Projection of Jhunjhunu and Sikar Districts

Year	2036	2051
Jhunjhunu District	303 MLD	352 MLD
Sikar District	290 MLD	337 MLD
Total Water Demand	593 MLD	689 MLD
Capacity of Existing WTP at Malsisar	156 MLD	156 MLD
Required Additional Production Capacity	437 MLD	437 MLD + 96 MLD

Source: Draft DPR for "Drinking Water Supply Project for Remaining Area of Sikar and Jhunjhunu Districts"

As shown above, additional production capacity is proposed to be developed. Figure 4.4.2 shows the demarcation of the supply area and the layout of the new WTP location and the trunk main pipeline of each project.



Source: JST based on Draft DPR for "Drinking Water Supply Project for Remaining Area of Sikar and Jhunjhunu Districts"

Figure 4.4.2 Demarcation of Supply Area and Layout of the Major Facility

As shown in the above figure, construction of the new WTP with capacity of 437 MLD near IGNP is proposed. In addition, development of new water source from the Yamuna River is proposed to meet the water demand of the entire Jhunjhunu and Sikar districts after 2036.

It should be noted that the water demand projection in this draft DPR is not the authorized one. The projected water demand (Year 2036) in the proposed JICA project area in this draft DPR is 72 MLD, while the water demand (Year 2047) presented in the approved DPR for the proposed JICA project is 66.18 MLD. The difference in the water demand is due to the difference in population projection (population growth rate) and the per capita demand in the urban area.

Nonetheless, the existing production capacity (156 MLD WTP at Malsisar) is not enough to cater to the future water demand in the entire Jhunjhunu and Sikar districts. Development of additional production capacity will be necessary to meet the future demand for the said area.

4.5 Availability of the Water Source for the Project

Due to unavailability of perennial river in the project area, groundwater is the only source of drinking water at present. However, groundwater has been overexploited at high rate by the pumps through tube wells or dug wells. Thus, surface source is considered the most reliable source for the drinking water requirement of the area.

The Sahwa Lift Canal, which is a tributary canal of Indira Gandhi Nahar Project (IGNP) has been considered the surface water source for the water supply of Jhunjhunu District. The IGNP is to utilize 9,367 million m^3/year (25,663 MLD) of the total 10,608 million m^3/year (29,063 MLD) allocated to Rajasthan State from the surplus waters of the Ravi and Beas rivers, mainly for irrigation purpose. The flow capacity of IGNP is 29,364 MLD (12,000 Cusec). As shown in Appendix-6.2, the Water Resources Department (WRD) has agreed to allocate 5,635 MLD (2,303 Cusec) of water for drinking purpose in the future. It was confirmed that the water necessary for the project will be allocated by GOR by utilizing the abovementioned water allocation.

IGNP has six lift irrigation schemes, namely: (1) Sahwa, (2) Kolayat, (3) Gajner, (4) Bangarsar, (5) Phalodi, and (6) Pokhran. The monthly flow of the lift irrigation canal is being controlled according to the monthly irrigation demand.

According to the latest order as of January 2018 issued by the Water Resources Department (WRD), 2,523 MLD has been allocated to PHED from IGNP in supersession to all earlier allocation orders in 2015, that was 1,835 MLD, as mentioned in Appendix-6.2. The allocated intake amount at the end of Sahwa Lift Canal at Taranagar is 117 MLD out of the total allocated amount of 2,523 MLD. The present allocation document is attached as Appendix 4.2. The present allocated amount of 2,523 MLD will be increased up to 5,635 MLD as mentioned in Appendix-6.2.

The water demand in 2047 to be supplied from Sahwa Lift Canal is 178.9 MLD as shown in Table 4.5.1.

Table 4.5.1 Water Demand to be Supplied from Sahwa Lift Canal

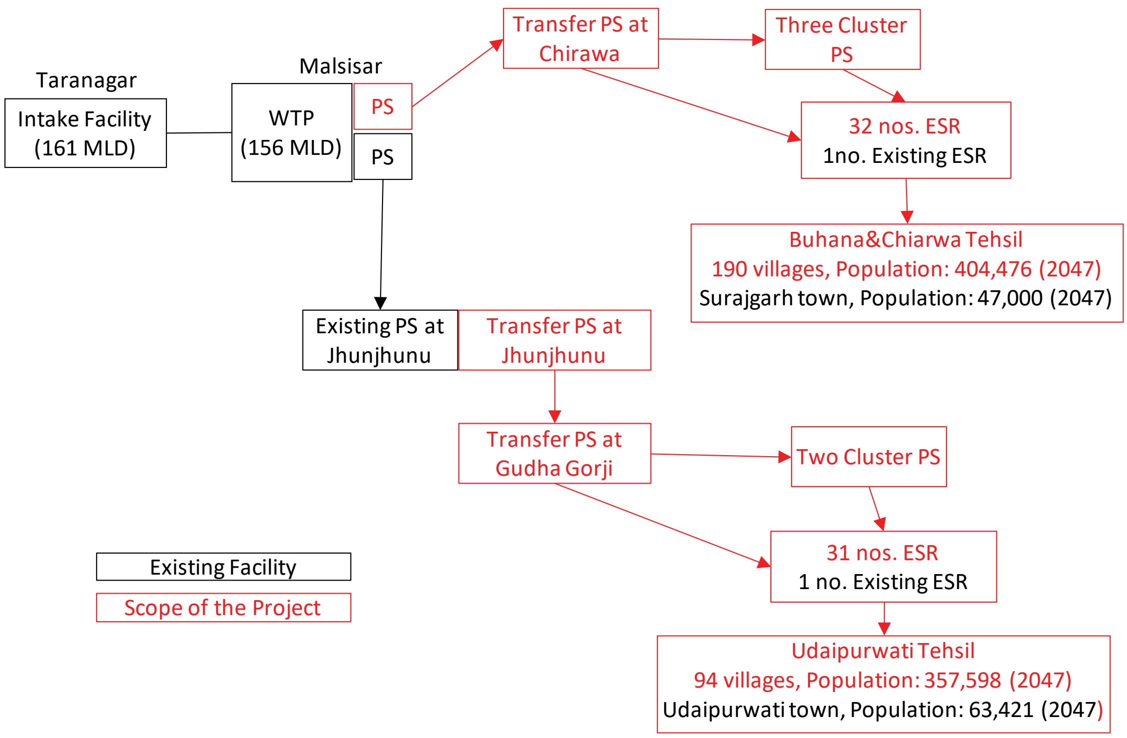
Project	Clear Water Demand	Present Allocated Amount
ITJSK project (Phase-I)	79.71 MLD	
Proposed JICA project	66.19 MLD	
Rajgarh Water Supply project	28.00 MLD	
	Total 173.9 MLD Raw water demand: 178.9 MLD	117 MLD

Source: JST based on information from PHED

PHED needs to request WRD for commencement of the negotiation regarding further water allocation for meeting the above future water demand, as well as further allocation for the remaining area as mentioned in Section 4.4. According to PHED the water allocation is the matter within Rajasthan State, thus, there is no need for consultation with other states.

4.6 Scope of the Project

As described above, the scope of the project is shown in Figure 4.6.1.



Source: JST

Figure 4.6.1 Scope of the Project (Jhunjhunu Scheme)

The distinctive features of the water supply system of the project are:

- ➢ The following facilities will be shared with the ITJSK project (Phase-I):
  - Intake facility at Taranagar
  - Raw water transmission pipeline
  - WTP at Malsisar
  - Pump Station (PS) at Malsisar for Jhunjhunu
  - Transmission pipeline to Jhunjhunu PS
  - Existing PS at Jhunjhunu
- ➢ At first, treated water will be transmitted from PSs to Elevated Service Reservoirs (ESRs), which are located in the supply areas, then distributed to the supply area by gravity.

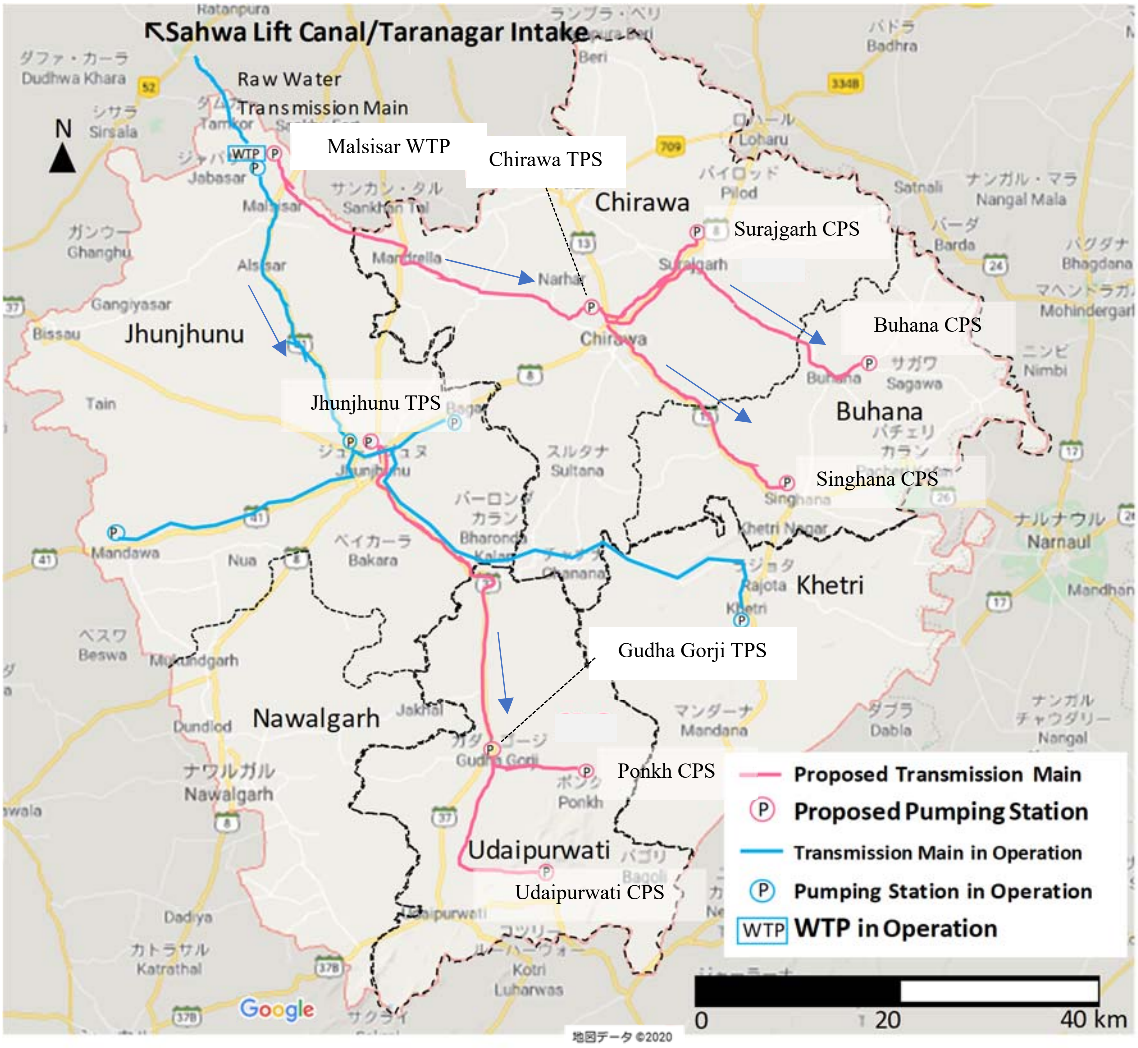
- Regarding the water supply to two towns (Surajgarh and Udaipurwati town), the water will be supplied to the existing ESR in the towns. The construction of water distribution facility after the existing ESR is out of the project scope. It will be undertaken by the town municipality.
- Each ESR covers several target villages (four to five villages on average).
- From ESR, the treated water will be distributed to each village.
- At the entrance of each village, a Village Transfer Chamber (VTC) will be installed.
- At VTC, water flow will be recorded and the flow record will be transferred to the master control station by Supervisory Control and Data Acquisition (SCADA) system.
- The water that passed the VTC will be distributed by the distribution pipeline network and supplied to each household by house connection. The house connection work is included in the project scope.

Chapter 5 Facility Plan for Jhunjhunu Scheme

5.1 Outline and Principal Feature of the Project Facility

As mentioned in Chapter 4, Jhunjhunu scheme can be positioned as Phase-II of the ITJSK project. The ITJSK project aims to supply water to Jhunjhunu District sourced from Sahwa Lift Canal, which is branched from Indira Gandhi Canal.

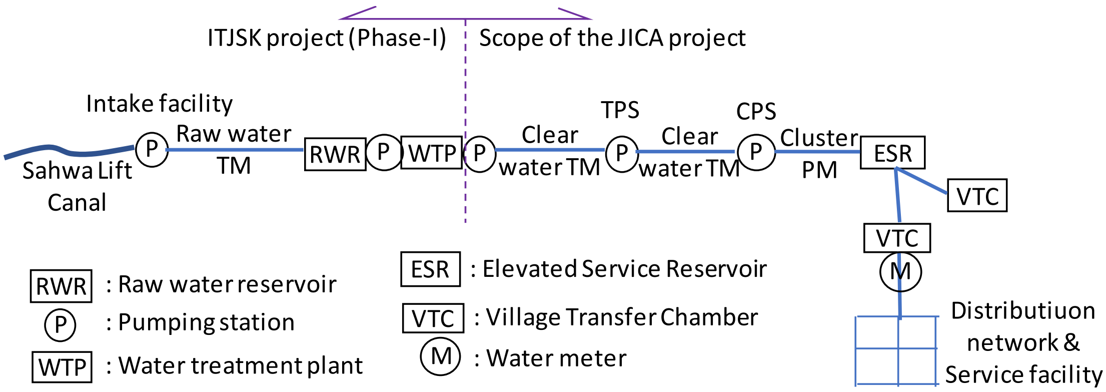
The ITJSK project (Phase-I) has already been completed. The Jhunjhunu scheme will send the water treated at the existing Malsisar WTP to three tehsils and distribute the water through the distribution facilities. Figure 5.1.1 shows the facility layout of the Jhunjhunu scheme.



Source: JST based on the DPR

Figure 5.1.1 Facility Layout of the Jhunjhunu Scheme

Figure 5.1.2 shows the configuration of the project facility.



Source: JST based on the DPR

Figure 5.1.2 Configuration of the Project Facility of Jhunjhunu Scheme

Table 5.1.1 Planning Condition and Facility Feature of Jhunjhunu Scheme Proposed by the JICA Survey Team based on the DPR

Sub-scheme	**Surajgarh**	**Udaipurwati**
Planning Condition		
Supply area	Buhana&Chirawa Tehsil	Udaipurwati Tehsil
	190 villages 1 town (Surajgarh)	94 villages 1 town (Udaipurawati)
Present population	322,009 (2011 census)	294,770 (2011 census)
Planned serive population (2047)	451,476	421,020
Clear Water Demand (2047)	33.7MLD	32.5MLD
Project Facility		
1) Intake & raw water PS	—	—
2) Raw water TM	—	—
3) Raw water reservoir (RWR)	—	—
4) Water treatment plant (WTP)	—	—
5) Pumping station (PS)	5 nos.	4 nos.
6) Clear water TM (PS to PS)	112 km	75 km
7) Cluster pumping main (PS to ESR)	262 km	236 km
8) Elevated service reservoir (ESR)	32 nos.	31 nos.
9) Cluster distribution (up to VTC)	928 km	1,303 km
10) Village Transfer Chamber (VTC)	190 nos.	94 nos.
11) Village distribution (after VTC)	1,416 km	1,252 km
12) Service facility	House connection Public standpost	House connection Public standpost

Note: MLD: million litters per day, TM: transmission main
Source: JST based on DPR

The principal feature of the project facility presented in the DPR prepared by PHED is shown in Table 5.1.1. The project basically follows these principal features and the proposed construction packages.

Table 5.1.2 Principal Features of the Project Facility of Jhunjhunu Scheme

Facility	Principal Feature	
Existing and Under Operation		
1. Intake facility	Location: Taranagar Type of structure: Rectangular intake tower with raw water sump: 20,000 m^3 with pump station	
2. Raw water pumping station	Intake pump: (6W+3S) 1,330 m^3/hr, H=99 m	
3. Raw water transmission main	MS D1600 mm, L = 52 km (Intake at Taranagar to WTP Malsisar)	
4. Raw water reservoir (RWR)	Location: Malsisar Capacity: 4.79 million m3, 1.51 million m3 (6.3 million m3 in total)	
5. Water treatment plant (WTP)	Location: Malsisar Type: Rapid sand filter, Capacity: 156 MLD	
Proposed	**Surajgarh Sub-Scheme**	**Udaipurwati Sub-Scheme**
6. Transfer pumping station (TPS)	1) Malsisar WTP to TPS Chirawa 1,570 m^3/hr, H=77 m, 4W+2S (6 pumps) 2) TPS Chirawa (9 pumps) To Surajgarh: 555m^3/hr, H=17m, 2W+1S To Buhana: 447m^3/hr, H=66m, 2W+1S To Singhana: 474m^3/hr,H=100m, 2W+1S	1) Jhunjhunu TPS to TPS Gudha Gorji 1,515 m^3/hr, H=122 m, 4W+2S (6 pumps) 2) TPS Gudha Gorji to Udaipurwati, Ponkh (8 pumps) To Udaipurwati: 631m^3/hr, H=113m, 3W+2S To Ponkh: 366 m^3/hr, H=105 m, 2W+1S
7. Clear water transmission main	MS D1100, DI (K9, K7) D400 L = 112.1 km	DI (K9) D700,450,350 L = 75.1 km
8. Cluster pumping station (CPS)	4 locations: 40 pumps in total 1. TPS Chirawa: 1W+1S (2 pumps) 2. CPS Surajgarh: 6W+6S (12 pumps) 3. CPS Buhana: 7W+7S (14 pumps) 4. CPS Singhana: 6W+6S (12 pumps)	3 locations: 38 pumps in total 1. TPS GudhaGorji: 7W+7S (14 pumps) 2. CPS Udaipurwati: 6W+6S (12 pumps) 3. CPS Ponkh: 6W+6S (12 pumps)
9. Clear water reservoir (CWR)	1. TPS Chirawa: 3,500 m^3 2. CPS Surajgarh: 1,500 m^3 3. CPS Buhana: 1,000 m^3 4. CPS Singhana: 1,000 m^3	1. TPS Jhunjhunu: 3,000 m^3 2. TPS Gudhagorji: 3,000 m^3 3. CPS Udaipurwati: 1,500 m^3 4. CPS Ponkh: 1,000 m^3
10. Cluster pumping main	DI K9,K7: D150 – D350, L = 262 km	DI K9,K7: D100 – D400, L = 236 km
11. Elevated service reservoir (ESR)	32 nos. Capacity: 200-1,000 m^3	31 nos. Capacity: 200-900 m^3
12. Cluster distribution system	L=775.3 (HDPE) + 152.3 (DI) = 928 km	L=993.6 (HDPE) + 309.7 (DI) = 1,303 km
13. Village transfer chambers (VTCs)	190 nos. (in MHs of villages)	94 nos. (in MHs of villages)
14. Village distribution network	HDPE90-200, 1,416 km	HDPE 90-200, 1,252 km
15. Service facility	House connection: 68,001 nos. Public stand post	House connection: 60,119 nos. Public stand post

Note: H: head, W: working, S: standby, MS: Mild Steel, HDPE: High Density Polyethylene, DI: Ductile IronA village transfer chamber (VTC) is to be installed at the entry point of each village. In VTC, a flow meter will be installed to measure the water flow into the village. The water flow data will be sent to the proposed master control center (MCC) in Jhunjhunu pumping station as well as the central control room at Malsisar WTP through SCADA system.

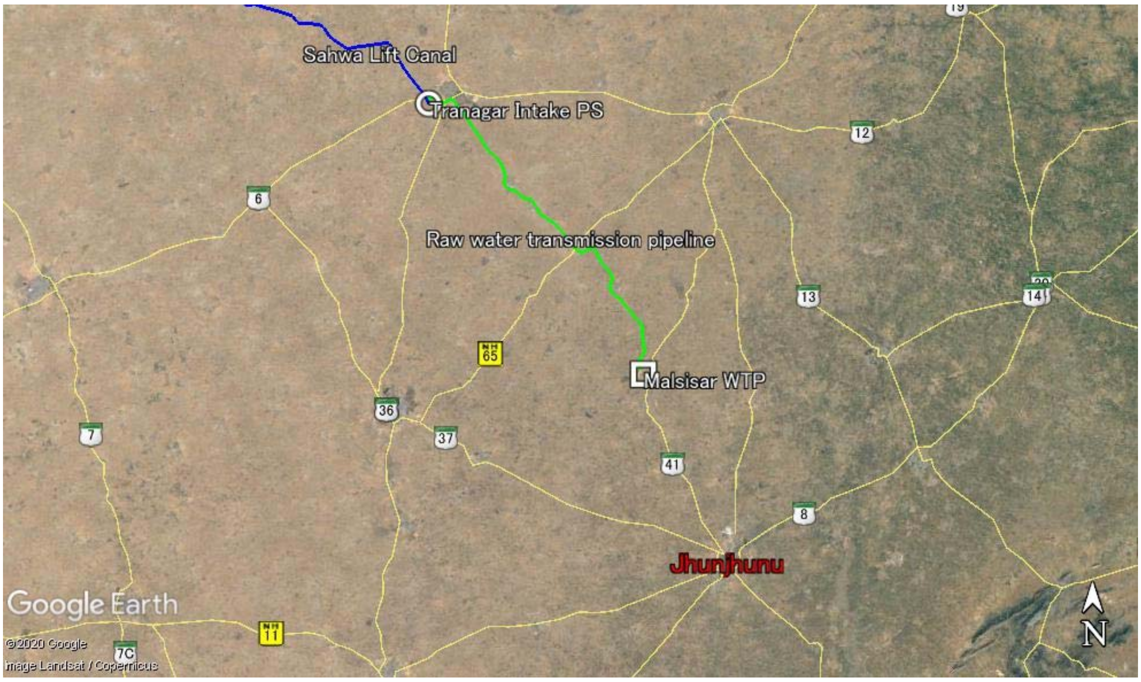
The photos of existing facility and sites for the proposed main facilities are shown in Appendix-5.1.

Source: JST based on DPR

5.2 Present Conditions of the Existing Facility

5.2.1 Common Facilities for Surajgarh and Udaipurwati Sub-schemes

The facilities from the intake to Malsisar WTP are used for both sub-schemes. The locations of Taranagar Intake and Pumping Station and Malsisar WTP are shown in the following figure:



Source: JST based on Google Earth map

Figure 5.2.1 Location of Intake to Malsisar WTP of Jhunjhunu Scheme

(1) Sahwa Lift Canal

Sahwa Lift Canal: is also known as Ch. Kumbaram Lift Canal Arya Lift Canal. The features of Sahwa Lift Canal are as follows:

- Off Take Reach Distance 108.160 L of Indira Gandhi Main Canal.
- Discharge: 23.88 m^3/sec/ 843 ft^3/sec (2,062 MLD)
- Bed Level: 186.152 m at 29° 0'1.95"N 74°29'14.83"E
- Bed Width: 5.50 m
- Free Board: 0.712 m
- Bed Slope: 1 in 12,000 m
- Side Slope: 2:1
- Velocity: 0.733 m/sec
- Bank Width (Left/Right): 7.396/ 4.956 m
- Construction Year: 2013

(2) Taranagar Intake and Raw Water Pumping Station

1) Intake Structure

- Construction year: 2016
- Type of structure: Rectangular intake tower with raw water sump: 20,000 m^3

2) Raw Water Pumping Station at Taranagar

The pumps were installed in 2016. The features of the pumping station is as follows;

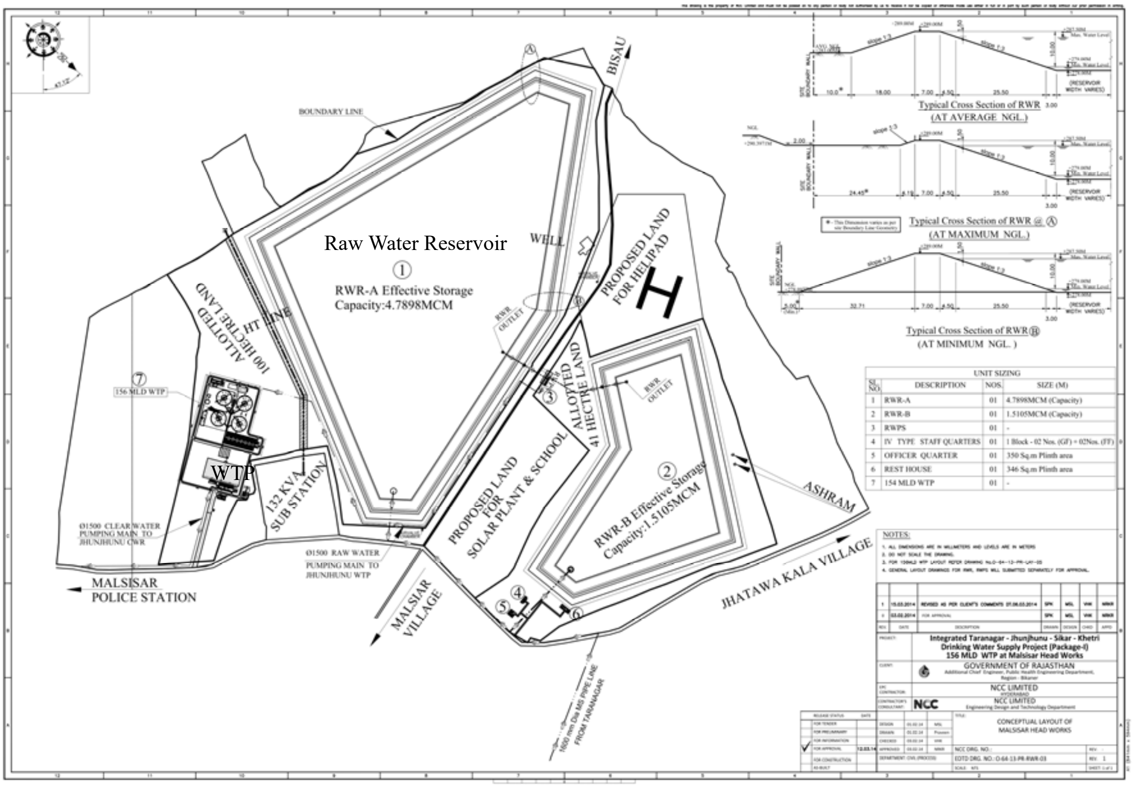
- Type of pumps; Vertical turbine pump
- Number of pumps:
- Present: 2W (Duty) + 7S (Standby), Future: 6W + 3S
- Capacity: 1,330 m^3/hr
- Head: 99 m
- Operation: 9 to 10 hrs/day

3) Raw Water Pumping Main (from Taranagar to Malsisar)

・52 km to WTP, 1600 mm x 1 pipe, Material: mild steel (MS)

(3) Malsisar Headworks (HW)

The general layout of Malsisar Headworks is shown in Figure 5.2.2.



Source: NCC (Malsisar HW Contractor)

Figure 5.2.2 Malsisar Headworks General Layout

1) Raw Water Reservoir at Malsisar

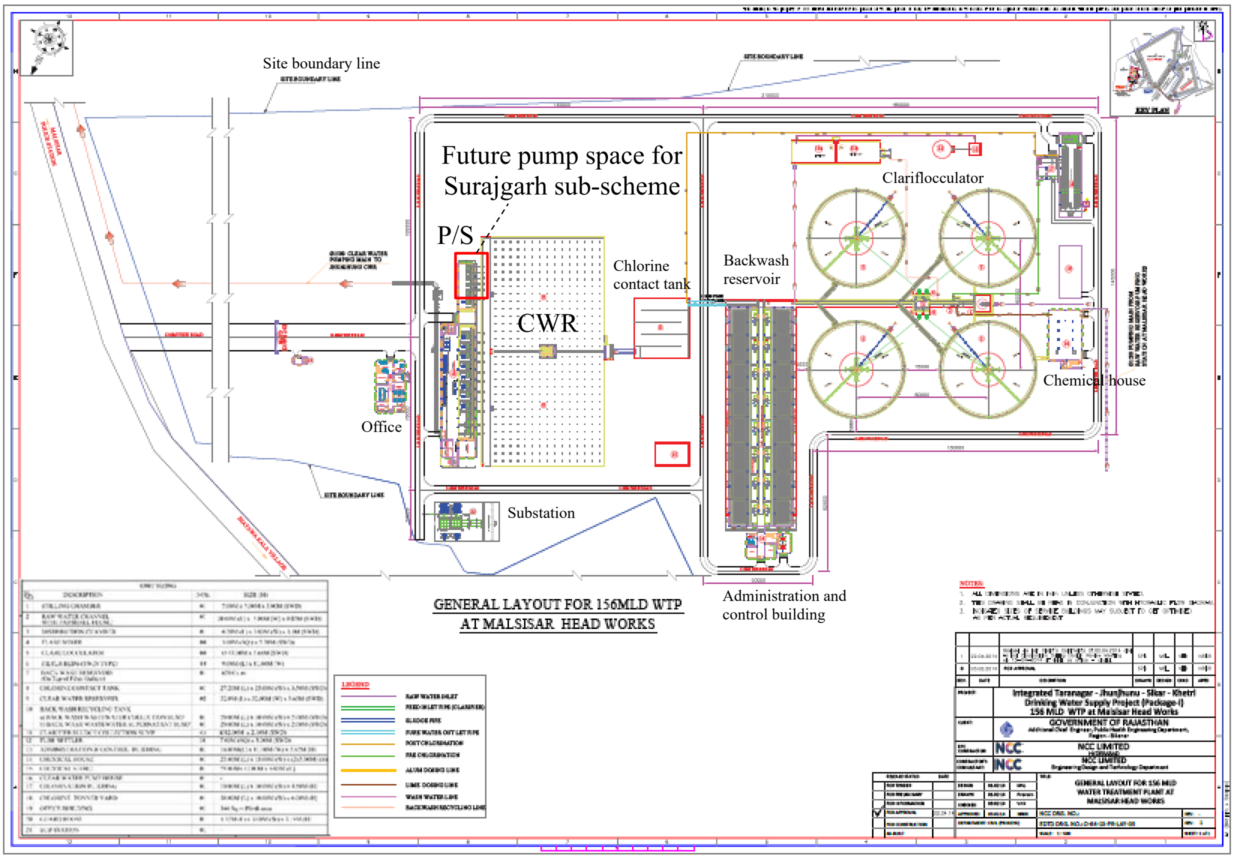
The feature of the reservoir is as follows;

- Forty days storage, 11 m depth (9.5 m water depth + 1.5 m freeboard)
- Effective storage:
  Raw Water Reservoir (RWR)-A: 4.79 million m^3, RWR-B: 1.51 million m^3
  (6.3 million m^3 in total)
- Security of reservoir: 8 hrs x 3 shifts

2) Malsisar Water Treatment Plant (WTP)

a) General Layout

The general layout of Malsisar WTP and the pump station is shown in Figure 5.2.3.



Source: NCC (Malsisar HW Contractor)

Figure 5.2.3 Malsisar WTP General Layout

b) Capacity and Supply

The capacity and water supply volume of Malsisar WTP are as follows:

Existing:

- Jhunjhunu: 49.23 MLD
- Khetri: 30.48 MLD
- Total: 79.71 MLD is working

Future:

- - Total capacity: 156 MLD

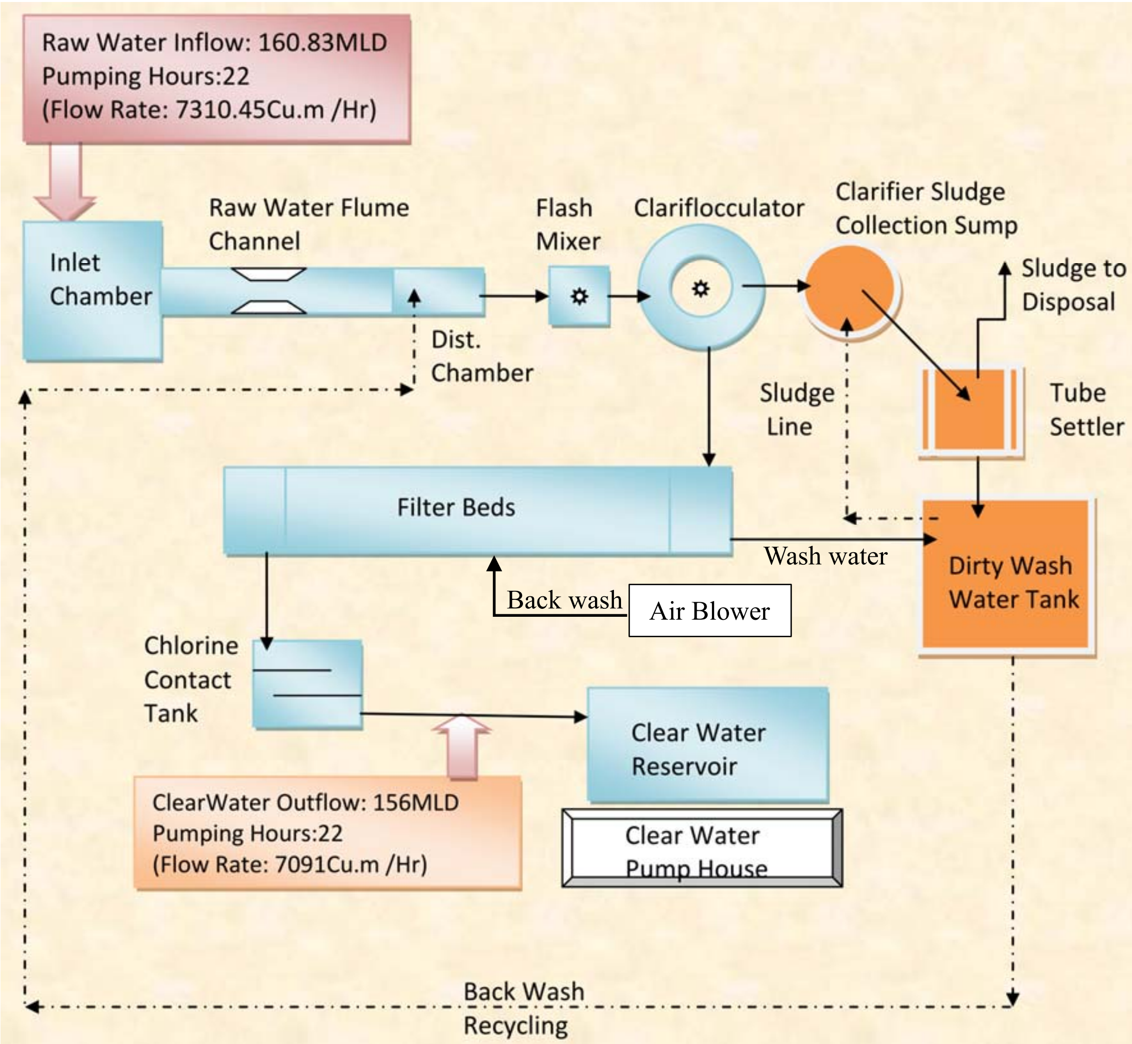
Out of the total capacity

- Surajgarh sub-scheme: 33.67 MLD
- Udaipurwati sub-scheme: 32.5 MLD

c) WTP Process Design Basis

The water treatment plant of 156 MLD output capacity with 20% hydraulic overloading has been designed as conventional one, based on coagulation, flocculation, and clarification followed by rapid gravity filters. The plant is operated for 22 hours/per day due to frequent power failures.

The process flow diagram is shown in Figure 5.2.4.



Source: "Process & Hydraulic Design for 156 MLD Water Treatment Plant" by the Contractor of the Malsisar headworks (April 2014) revised by JST

Figure 5.2.4 Process Flow Diagram of Malsisar WTP

Table 5.2.1 shows the main design parameters for the water treatment plant.

All inter-connecting channels and pipelines have been designed with allowances for water loss and service water use of totally 3% and a hydraulic overloading of 20% over the design flow.

Table 5.2.1 Main Design Parameters of Malsisar WTP

Description	Value	Unit
Net treatment capacity	156.00	MLD
Working hours	22.00	hr
Design flow rate to WTP	7,091	m^3/hr
Maximum water losses (filter backwash, de-sludging, etc.) in the treatment plant during a period of any seven consecutive days, using the recycling reservoirs	2.00	%
Service water requirements for chemical solution preparation, gardening, etc.	1.00	%
Total losses in the WTP	3.00	%
Capacity of WTP considering losses	160.83	MLD
	7,311	m^3/hr
Hydraulic overload	20.00	%
Design flow rate by considering 20% hydraulic overload	8,773	m^3/hr

Source: "Process & Hydraulic Design for 156 MLD Water Treatment Plant" by the Contractor of the Malsisar headworks (April 2014)

d) Treatment Units

The WTP consists of the following major units:

1. Inlet chamber, 2. Raw water channel with Parshall flume, 3. Distribution chamber, 4. Flash mixers, 5. Clariflocculators, 6. Chemical house, 7. Rapid sand gravity, 8. Filters, 9. Elevated service cum backwash reservoir, 9. Admin. And control building, 10. Master Control Centre, 11. Chlorine contact tank, 12. Clear water reservoir, 13. Clear water pump house, 14. Chlorination building, 15. Backwash recycling tank (Dirty wash water tank), and 16. Sludge handling system.

e) Operation

Operation at present: 10 hours (8:00 am to 6:00 pm) but being extended up to 12 hours depending on demand

- Operation and maintenance (O&M) contract until 2031 including defects notification period (DNP) of one year and O&M of ten years
- Water quality test every day by a chemist working in daytime in the WTP

3) Clear Water Reservoir

The clear water from the chlorine contact tank will be collected into the clear water reservoir which is an underground rectangular reinforced concrete (RC) reservoir in two compartments, having common inlet chamber and common outlet sump. The capacity is 19,500 m^3 to store for 3 hours of hourly water treatment volume (6,500 m3/hr).

4) Pumps

The existing pumps in Malsisar WTP which are composed of clear water pumps to pump the treated water to the current service areas and back wash pumps to pump the sludge extracted from filter beds to distribution chamber are shown in Table 5.2.2.

Table 5.2.2 Malsisar WTP Pumping Station

Name	Capacity (m^3/hr) for One Unit	Head (m)	Rated Power (kW)	Units
Clear Water Pumps	1,182.82	81	375	9 (6W+3S)
Backwash Pumps	510.00	25	55	2 (1W+1S)

Source: JST based on DPR

- Pump operation time: 6:00 am to 4:00 am (22 hours) * future: 24 hours once power supply condition will improve according to PHED
- Current pump operation: 2 to 3 pumps out of nine clear water pumps

5.2.2 Facilities for Surajgarh Sub-Scheme

The facilities after Malsisar WTP will be constructed in the project. The proposed water transmission system is explained in Section 5.3.

5.2.3 Facilities for Udaipurwati Sub-Scheme

(1) Clear Water Pumping Main from Malsisar WTP to Jhunjhunu TPS

The feature of the existing clear water pumping main from Malsisar to Jhunjhunu is as follows;

- MS Pipeline, Diameter 1500, 36.5 km
- Air valve: Every 1 km

(2) Jhunjhunu Transfer Pumping Station (TPS)

The existing pumps in Jhunjhunu TPS are shown in Table 5.2.3.

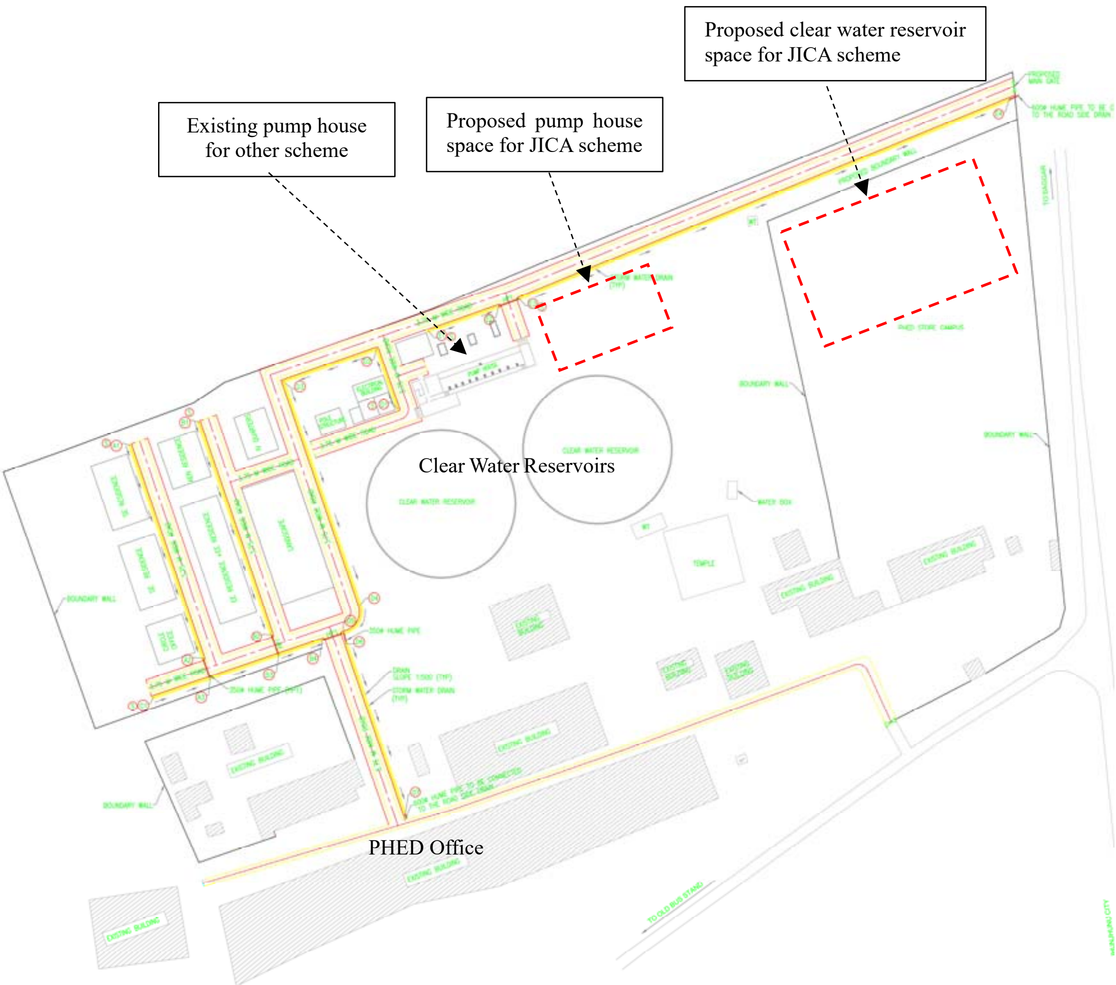
Table 5.2.3 Existing Pumps in Jhunjhunu Transfer Pumping Station

Destination	Capacity (m^3/hr)	Head (m)	Rated Power (kW)	Units of Pumps	CWR Capacity in Destination (m^3)
Clusters near Jhunjhunu	-	-	-	-	18,000 in Jhunjhunu TPS
To Cluster No. 7A, 8 & 8A (Jhunjhunu)	113.40	71	45	2 (1W+1S)	-
To Charawas PS	640.87	97	260	3 (2W+1S)	3,000
To Narsingpura PS	269.50	47	55	2 (1W+1S)	600
To Wahidpura PS	404.60	40	75	2 (1W+1S)	700
To Bagar PS	323.50	23	30	2 (1W+1S)	500

Source: JST based on Tender Document for Package-2 of Integrated Taranagar Jhunjhunu Sikar Khetri Drinking Water Supply Project from IGNP System

1) Constructed in 2017, operation from March 2019
2) Operation: 24 hours (8 hours x 3 shifts)
3) Transfer Pump Operation: 22 hours in 2047
4) Supplier: SCADA: Autosys (India); UPS (Uninterrupted Power Supply): Hitachi

The general layout of Jhunjhunu TPS is shown in Figure 5.2.5.



Source: PHED

Figure 5.2.5 Facility Layout of the Jhunjhunu TPS

5.3 Water Transmission System

5.3.1 Outline of the Transmission System

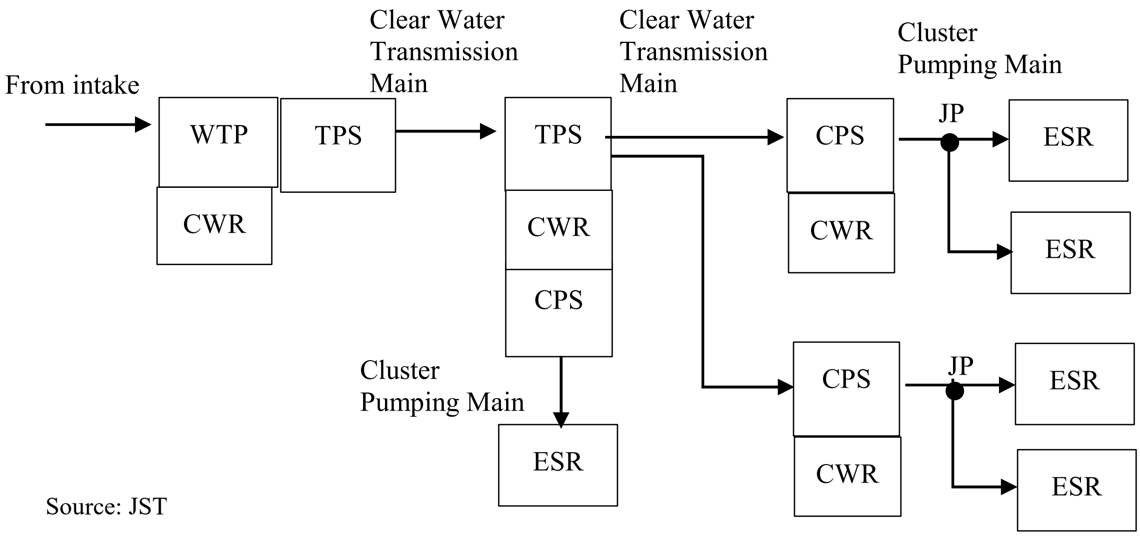
A water transmission plan has been worked out according to the water demand for each distribution reservoir and is planned for 22 hours/day of transfer pumping and 16 hours/day of cluster pumping.

The water transmission pipeline consists of:

- Pumping stations (main pumping station, transfer pumping stations (TPS), cluster pumping stations) with clear water reservoir (CWR);

- Clear Water Transmission Main pipeline "from TPS to CWR in Cluster Pumping Station (CPS)"; and
- Cluster Pumping Main pipeline "from CPS to distribution reservoir (ESR)" including the cluster pumps to ESRs in TPSs.

An image of the water transmission facilities is shown in the following figure. Most of the transmission pipelines adopt pumping flow. The cluster pumping mains have two types of 1) single line from a cluster pump to one ESR and 2) branched line from a cluster pump to ESRs (branched at junction point (JP)). The schematic diagram of transmission facilities from WTP to ESRs is shown in Appendix-5.2.



Source: JST

Figure 5.3.1 Water Transmission Facility for Jhunjhunu Scheme

5.3.2 Facility Design of the Transmission System

The facility design has been conducted in accordance with the "Manual on Water Supply and Treatment Third Edition Revised and Updated, CPHEEO 1999" and the "Manual for Preparation of Detailed Project Report for Rural Piped Water Supply Schemes, Ministry of Drinking Water and Sanitation (MoDWS) 2013".

(1) Hydraulic Design

The head loss in the pipeline was calculated using the "Modified Hazen-Williams Formula" in the "Manual on Water Supply and Treatment Third Edition Revised and Updated, CPHEEO 1999", as follows:

- $h = [L(Q/C_R)^{1.81}]/994.62\ D^{4.81}$
-
- where,
- h = friction head loss in m
- L = length of pipe in m
- Q = flow in pipe in m^3/s
- C_R = pipe roughness coefficient (1 for smooth pipes, <1 for rough pipes)
- D = internal diameter of pipe in m

The design parameters for the mechanical and electrical works are shown in Table 5.3.1.

Table 5.3.1 Design Parameters for Mechanical and Electrical Works

Design period: (year)	2047
Combined efficiency of pump set: (%)	60
Standby pumps: (%)	Main pumps: 100
	Cluster pumps: 100
Cost of pumping unit: (INR/kW)	12,250
Interest rate: (%)	10.0
Energy charges per kWh: (INR/kWh)	5.5
Pumping hours for discharge at the end of 15 years: (hours)	Transfer pumping stations: 22 hrs
	Cluster pumps: 16 hrs

Source: JST based on DPR

The pipe diameter was determined so that the residual head at the inlet of each tank/reservoir is more than 3 m considering the head loss at the inlet piping. The hydraulic calculation sheet of transmission pumping main are attached in Appendix-5.4.

(2) Result of Hydraulic Design of Pumping Station and Pumping Main

1) Surajgarh Sub-Scheme

a) Transfer Pumping Stations (TPSs)

The pump specifications and transmission mains for the TPSs are shown in Table 5.3.2.

Table 5.3.2 Proposed Transfer Pumping Stations at Surajgarh Sub-Scheme

TPS	Destination (PS)	Elevation GL (m)		Pump specifications					Transmission mains		
		Start	End	Individual flow rate (m^3/h)	Head (m)	Rated power (kW)	Units	Total flow (m^3/h)	Dia. (mm)	Length (m)	Demand (m^3/d)
Malsisar WTP	TPS Chirawa	286	319	393	77	132	6 (4W+2S)	1,572	1,100 MS10	42,500	33,684
TPS Chirawa	CPS Surajgarh	319	297	278	17	30	3 (2W+1S)	556	400 DI K7	11,000	11,900
	CPS Buhana	319	306	224	66	75	3 (2W+1S)	448	400 DI K7	32,600	9,591
	CPS Singhana	319	349	237	100	132	3 (2W+1S)	474	400 DI K9	26,000	10,167

Note: The operation hour for the pumping stations is 22 hours
Pipe dia. of transmission main has been determined considering the future water supply to the northern part of Jhunjhunu District, which is out of the project area .
Source: JST based on DPR

The result of water hammer analysis of the transmission pumping main (Malsisar WTP to TPS Chirawa) is attached in Appendix-5.5.

b) Cluster Pumping Stations

The pump specifications and transmission mains in the cluster pumping stations in the project are shown in Tables 5.3.3 and 5.3.4.

Table 5.3.3 Proposed Cluster Pumping Stations at Surajgarh Sub-Scheme (1)

CPS	Destination (ESR)	Pump specifications				Pumping main		
		Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Dia. (mm)	Length (m)	Demand (m^3/d)
Chirawa	JP	130	131	90	2 (1W+1S)	200 DI K9	5,150	2,030
	JP - ESR Lakhoo					200 DI K9	100	1,103
	JP - ESR Heerwa					150 DI K9	8,850	927
Surajgarh	ESR Surajgarh	377	27	45	2 (1W+1S)	350 DI K7	1,400	5,875
	ESR Agwana Khurd	27	43	7.5	2 (1W+1S)	150 DI K7	9,600	417
	ESR Jaisinghwas	41	47	11	2 (1W+1S)	150 DI K7	7,950	638
	JP	112	98	55	2 (1W+1S)	200 DI K9	13,850	1,750
	JP - ESR Cheema Ka Bas					150 DI K7	650	793
	JP - ESR Ureeka					200 DI K7	8,350	957
	JP	128	74	55	2 (1W+1S)	200 DI K9	9,150	1,991
	JP - ESR Jakhod					150 DI K7	100	844
	JP - ESR Panne Singhpura					200 DI K7	4,300	1,147
	JP	79	72	30	2 (1W+1S)	200 DI K7	710	1,229
	JP - ESR Khyaliyon KD					150 DI K7	450	623
	JP - ESR Sirsala					150 DI K7	9,000	606
Buhana	ESR Buhana	111	23	15	2 (1W+1S)	200 DI K7	50	1,720
	ESR Rasoolpur	61	113	37	2 (1W+1S)	150 DI K9	13,200	940
	ESR Kalakhari	53	55	15	2 (1W+1S)	150 DI K7	5,100	815
	JP	104	58	30	2 (1W+1S)	200 DI K7	6,900	1,620
	JP - ESR Narat					150 DI K7	50	994
	JP - ESR Manoharpura					150 DI K7	6,650	626
	JP	82	90	37	2 (1W+1S)	200 DI K9	9,350	1,285
	JP - ESR Nimbas					150 DI K7	4,150	798
	JP - ESR Jaitpur					150 DI K7	6,200	488
	JP	104	90	55	2 (1W+1S)	200 DI K9	7,700	1,628
	JP - ESR Khandwa					150 DI K7	1,100	906
	JP - ESR Kalothra					150 DI K7	8,350	722
	JP	102	101	55	2 (1W+1S)	200 DI K9	12,000	1,585
	JP - ESR Panthroli					150 DI K7	4,050	753
	JP - ESR D. Bhaloth					150 DI K7	6,700	832

Note: JP: Junction Point

The operation hour for the cluster pumps is 16 hours.

Source: JST based on DPR

Table 5.3.4 Proposed Cluster Pumping Stations at Surajgarh Sub-Scheme (2)

CPS	Destination (ESR)	Pump specifications				Pumping main		
		Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Dia. (mm)	Length (m)	Demand (m^3/d)
Singhana	ESR Jaimal Ka Was	56	66	18.5	2 (1W+1S)	150 DI K7	9,850	866
	ESR Banwas	54	54	15	2 (1W+1S)	150 DI K7	4,050	839
	JP	89	64	30	2 (1W+1S)	200 DI K7	2,050	1,392
	JP - ESR Mankdo					150 DI K7	50	835
	JP - ESR Arya Nagar					200 DI K7	18,450	557
	JP	105	67	37	2 (1W+1S)	200 DI K7	8,500	1,637
	JP - ESR Goth					150 DI K7	2,450	1,003
	JP - ESR Shahpura					200 DI K7	7,500	634
	JP	204	72	75	2 (1W+1S)	250 DI K9	3,400	3,189
	JP - ESR Ishakpura					200 DI K7	5,400	1,355
	JP - ESR Pancheri Khurd					200 DI K7	11,550	1,834
	N1	144	34	30	2 (1W+1S)	250 DI K7	3,300	-
	N1 - ESR Singhana					200 DI K7	50	1,053
	N1 - N2					200 DI K7	1,750	-
	N2 - ESR Gujarwas					150 DI K7	100	523
	N2 - ESR Thali					150 DI K7	6,400	669

Note: JP: Junction Point
The operation hour for the cluster pumps is 16 hours.
Source: JST based on DPR

c) Clear Water Reservoirs (CWRs) in Pumping Stations

CWR facilities shown in Table 5.3.5 are to be developed at the pumping stations in the project. CWRs are constructed to store the treated water in the pumping stations before pumping to the next pumping station and ESRs due to unstable power supply and limited operation time of pumps. CWRs have been designed for two hours pumping period storage in accordance with the design guideline of PHED.

Table 5.3.5 Proposed Clear Water Reservoirs in Pumping Stations at Surajgarh Sub-Scheme

SN	Head Works	Designed Demand (m^3/day)	CWR Capacity Required (m^3)	CWR Capacity Adopted (m^3)
1.	Chirawa TPS	33,696	3,063	3,500
2.	Surajgarh CPS	11,900	1,082	1,500
3.	Buhana CPS	9,596	872	1,000
4.	Singhana CPS	10,170	925	1,000

Source: JST based on DPR

2) Udaipurwati Sub-Scheme

a) Transfer Pumping Stations

The specifications of the newly installed pumps in the existing TPS Jhunjhunu and proposed TPS Gudha Gorji are shown in Table 5.3.6. The pumps in TPS Jhunjhunu are the additional pumps required for Udaipurwati Sub-Scheme.

Table 5.3.6 Proposed Transfer Pumping Stations at Udaipurwati Sub-Scheme

TPS	Destination (PS)	Elevation GL (m)		Pump specifications					Transmission mains		
		Start	End	Individual flow rate (m^3/h)	Head (m)	Rated power (kW)	Units	Total flow (m^3/h)	Dia. (mm)	Length (m)	Demand (m^3/d)
Jhunjhunu TPS	TPS GudhaGorji	332	406	379	122	250	6 (4W+2S)	1,516	700 DI K9	30,500	32,515
TPS GudhaGorji	CPS Ponkh	406	410	183	105	110	3 (2W+1S)	366	350 DI K9	22,200	7,814
	CPS Udaipurwati	406	450	210	113	132	5 (3W+2S)	630	450 DI K9	22,400	13,538

Note: The operation hour for the pumping stations is 22 hours in accordance with PHED guideline.
Source: JST based on DPR

The result of water hammer analysis of the transmission pumping main (Jhunjhunu TPS to TPS Gudha Gorji) is attached in Appendix-5.5.

b) Cluster Pumping Stations

The cluster pumping stations at Udaipurwati Sub-Scheme are shown in Table 5.3.7.

Table 5.3.7 Proposed Cluster Pumping Stations at Udaipurwati Sub-Scheme (1)

CPS	Destination (ESR)	Pump specifications				Pumping main		
		Individual flow rate (m^3/h)	Head (m)	Rated power (kW)	Units	Dia. (mm)	Length (m)	Demand (m^3/d)
TPS Gudha Gorji	ESR Nyangali Gujran	51	78	22	2 (1W+1S)	150 DI K9	18,200	786
	JP	103	31	18.5	2 (1W+1S)	200 DI K7	4,900	1,600
	JP - ESR Chhausari					150 DI K7	1,000	1,089
	JP - ESR Hemantpura					150 DI K7	8,100	511
	JP	101	50	30	2 (1W+1S)	200 DI K7	7,450	1,580
	JP - ESR Bamlas					150 DI K7	100	712
	JP - ESR Khatkad					150 DI K7	2,250	868
	JP	183	105	110	2 (1W+1S)	250 DI K9	5,250	2,864
	JP - ESR Gudhagorji					200 DI K7	1,300	1,675
	JP - ESR Posana					200 DI K7	6,700	1,189
	JP	116	138	90	2 (1W+1S)	250 DI K9	10,450	1,804
	JP - ESR Bhorki					150 DI K7	50	994
	JP - ESR Signor					150 DI K7	9,500	810
	JP	70	25	11	2 (1W+1S)	200 DI K7	2,400	1,090
	JP - ESR Teetanwar					150 DI K7	1,050	514
	JP - ESR Chhau					150 DI K7	8,100	576
	JP	92	43	22	2 (1W+1S)	200 DI K7	9,200	1,441
	JP - ESR Bajawa					150 DI K7	3,650	582
	JP - ESR Bada Gaon					150 DI K7	4,400	859
CPS Udaipurwati	ESR Bhorgarh	42	134	30	2 (1W+1S)	150 DI K9	16,300	646
	Udaipurwati CWR	508	22	75	2 (1W+1S)	400 DI K7	5,700	7,928
	ESR Kot	19	165	18.5	2 (1W+1S)	100 DI K9	12,750	288
	JP	145	97	75	2 (1W+1S)	250 DI K9	11,050	2,267
	JP - ESR Chhapoli					200 DI K7	200	1,696
	JP - ESR Mawta					150 DI K7	8,500	571
	JP	45	78	18.5	2 (1W+1S)	150 DI K7	1,900	706
	JP - ESR Bagora					150 DI K7	6,200	429
	JP - ESR Nangal					150 DI K7	2,200	277
	JP	109	48	30	2 (1W+1S)	200 DI K7	2,100	1,703
	JP - ESR Indrapura					150 DI K7	900	870
	JP - ESR Raghunathpura					150 DI K7	4,300	833

Note: JP: Junction Point

: The operation hour for the cluster pumps is 16 hours in accordance with PHED guideline.

Source: JST based on DPR

Table 5.3.7 Proposed Cluster Pumping Stations at Udaipurwati Sub-Scheme (2)

CPS	Destination (ESR)	Pump specifications: Individual flow rate (m^3/h)	Head (m)	Rated power (kW)	Units	Pumping main: Dia. (mm)	Length (m)	Demand (m^3/d)
CPS Ponkh	ESR Gudha	56	24	7.5	2 (1W+1S)	150 DI K7	50	860
	ESR Manaksas	43	54	15	2 (1W+1S)	150 DI K9	9,750	667
	JP	96	33	18.5	2 (1W+1S)	200 DI K7	1,300	1,500
	JP - ESR Ponkh					150 DI K7	50	506
	JP - ESR Kishorpura					150 DI K7	2,150	691
	JP	125	71	45	2 (1W+1S)	200 DI K7	5,650	1,951
	JP - ESR Chanwara					150 DI K7	200	786
	JP - ESR Kakarana					200 DI K7	4,150	1,165
	JP	84	68	30	2 (1W+1S)	200 DI K9	10,200	1,314
	JP - ESR Jodhpura					150 DI K7	100	735
	JP - ESR Bagoli					150 DI K7	3,600	579
	JP	97	103	55	2 (1W+1S)	200 DI K9	13,000	1,520
	JP - ESR Jhadaya Nagar					150 DI K7	5,400	909
	JP - ESR Papra Kalan					150 DI K7	1,640	611

Note: JP: Junction Point
: The operation hour for the cluster pumps is 16 hours.
Source: JST based on DPR

c) Clear Water Reservoirs in Pumping Stations

The following CWR facilities are to be developed at WTP and pumping stations. The design concept is same with Surajgarh Sub-scheme.

Table 5.3.8 Proposed Clear Water Reservoirs in Pumping Stations at Udaipurwati Sub-Scheme

SN	Pumping Stations	Designed Demand (m^3/day)	CWR Capacity Required (m^3)	CWR Capacity Adopted (m^3)
1.	Jhunjhunu TPS	32,515	2,956	3,000
2.	Gudhagorji TPS	32,515	2,956	3,000
3.	Udaipurwati CPS	13,539	1,231	1,500
4.	Ponkh CPS	7,814	710	1,000

Source: JST based on DPR

(3) Pipe Material

For pipes of diameter up to 1000 mm, ductile iron (DI) pipe with cement mortar lining was selected. For pipes of diameter over 1000 mm, mild steel (MS) pipe with cement mortar lining was selected due to its availability in India.

As the strata is in general sandy soil with hard dense strata, MS pipe with tape coating protection has been adopted for the main transmission from Malsisar WTP to Chirawa TPS, whereas DI pipes have been adopted for the remaining rising mains.

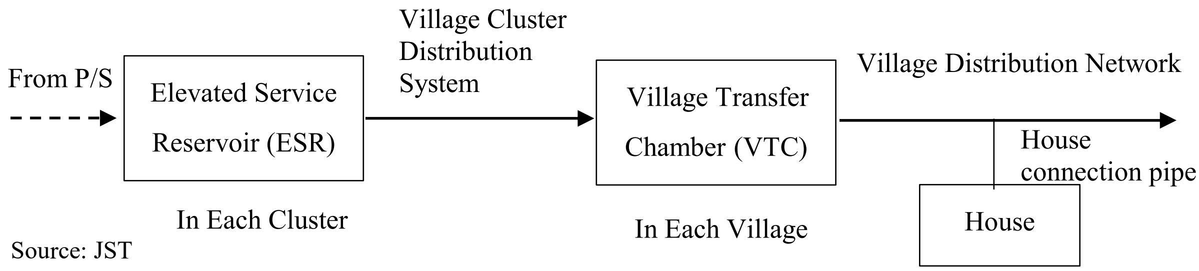
For the pumping mains or gravity mains with static head of over 75 m, type K9 was selected for DI pipes. For the gravity mains with static head within 75 m, type K7 was selected.

5.4 Water Distribution and Service Facilities

5.4.1 Outline of Water Distribution System

The distribution system consists of a distribution reservoir, village cluster distribution system from reservoir to each village, village transfer chamber (VTC) and distribution pipeline network with house connection pipe in the village. The distribution reservoir will be the elevated type made of reinforced concrete. It is called an elevated service reservoir (ESR).

Treated water will be distributed by gravity from the ESR located in each distribution area (cluster as several villages) to each household in the villages through village transfer chambers (VTCs) and house connection pipes as shown in Figure 5.4.1. A total of 63 ESRs will be provided for water supply to 284 (Surajgarh Sub-Scheme: 190 + Udaipurwati Sub-Scheme: 94) villages and 2 towns(Surajgarh and Udaipurwati).



Source: JST

Figure 5.4.1 Water Distribution and Service Facility

The capacity of ESR will be half of the daily water demand of the service area of each ESR in accordance with PHED design guideline.

The height of ESR staging and the pipe diameter of the distribution pipeline were determined by pipeline network analysis using EPANET, which is a widely-used software for pipe network analysis provided by the United States Environmental Protection Agency (USEPA). The following design conditions are used in accordance with the "Manual for Preparation of Detailed Project Report for Rural Piped Water Supply Schemes" prepared by the Ministry of Drinking Water and Sanitation (MoDWS) in 2013:

- Peak factor: 3
- Losses in distribution system: 15%
- Formula for design of pipeline: Modified Hazen William
- Minimum pipe size: 80 mm
- Assumed terminal point from VTC: 500 m
- Minimum residual pressure: 5 m

5.4.2 Elevated Service Reservoir (ESR)

The numbers of ESRs with capacity and staging height are presented in Tables 5.4.1 and 5.4.2. The lists of ESRs with ESR (cluster) names and capacities are shown in Appendix-5.3. The capacities of ESRs were determined to cater for half-day demand of the villages to be fed from the ESR.

Table 5.4.1 Number of ESR for Surajgarh Sub-Scheme

Capacity (m^3)	STG (m)	Nos.	Capacity (m^3)	STG (m)	Nos.
200	20	1	600	20	3
250	20	1	700	20	1
300	20	3	900	20	1
400	20	10	1000	20	1
500	20	11		Total	32

Source: JST based on DPR

Table 5.4.2 Number of ESR for Udaipurwati Sub-Scheme

Capacity (m^3)	STG (m)	Nos.	Capacity (m^3)	STG (m)	Nos.
200	20	2	500	20	7
300	20	8	600	20	3
400	20	9	900	20	2
				Total	31

Source: JST based on DPR

5.4.3 Cluster Distribution System

The pipeline sections from ESR (cluster-wise) to VTC (village-wise) are Cluster Distribution System and called "Cluster Primary Distribution Mains" in Jhunjhunu Scheme. The lengths of cluster primary distribution mains for HDPE pipe and DI pipe are shown in Table 5.4.3 and Table 5.4.4, respectively.

Table 5.4.3 Length of Cluster Primary Distribution Mains for Jhunjhunu Scheme (HDPE Pipe)

Diameter	Length (km)		
	Surajgarh Sub-Scheme	Udaipurwati Sub-Scheme	
HDPE	PN6	PN6	More than PN6
ND90	439.3	733.4	213.0
ND110	120.2	66.9	13.3
ND140	166.7	55.9	0
ND160	67.3	82.5	5.4
ND180	56.6	31.8	6.5
ND200	21.1	23.3	0
ND250	35.0	52.5	1.4

ND280	2.0	0	0
ND315	15.5	17.7	0
Total	923.6	1,063.8	239.5

Note: ND: Nominal Diameter, PN: Pressure Nominal
Source: JST based on DPR

Table 5.4.4 Length of Cluster Primary Distribution Mains for Jhunjhunu Scheme (DI Pipe)

Diameter	Length (km)		
	Surajgarh Sub-Scheme		Udaipurwati Sub-Scheme
DI	By Passing Enroute Villages	Rocky Terrain	More than PN6
ND100	22.4	39.2	226.3
ND125	6.7	11.7	0.0
ND150	5.0	8.7	11.9
ND200	2.2	3.9	0.0
ND250	1.0	0.0	53.9
ND300	2.0	0.0	17.7
Total	39.2	63.4	309.7

Source: JST based on DPR

5.4.4 Village Distribution Network

(1) Village Transfer Chamber (VTC)

The proposed number of VTCs, which was coordinated with PHED is shown in Table 5.4.5.
Type A is bigger in size and applicable to junctions in main habitations from where other habitations have to be connected through pipeline from this junction point including operating valves etc. (i.e. Type-A includes a transfer chamber as integral part of VTC). Type B is smaller in size and applicable for end point village only (i.e. it is terminal point of cluster distribution pipeline to feed particular village only and small size VTC is installed for it).

Table 5.4.5 Proposed Number of VTCs for the Jhunjhunu Scheme

	Number of villages	VTC Type-A	VTC Type-B	Total VTC
Surajgarh Sub-scheme	190	100	90	190
Udaipurwati Sub-scheme	94	50	44	94

Source: Questionnaire answered by PHED

(2) Village Distribution (from VTCs to houses/PSPs)

The pipelines from VTC to households are village distribution network and are called "Village Distribution Pipeline" in Jhunjhunu Scheme. The pipe material was selected as follows:

- Internal diameter of less than 200 mm: HDPE pipe
- Internal diameter of 200 mm or more: DI pipe (K7)

As per guidelines, for village distribution, the pipeline length has been taken at 3.5 m per capita for the projected design year. The length of the village distribution pipeline with differing diameters is presented in Table 5.4.6.

Table 5.4.6 Length of Village Distribution Pipeline for Jhunjhunu Scheme

HDPE Pipe			
Diameter	Ratio	Length (km)	
		Surajgarh Sub-Scheme	Udaipurwati Sub-Scheme
ND90	60%	849.4	751.0
ND110	10%	141.6	125.2
ND140	10%	141.6	125.2
ND160	10%	141.6	125.2
ND200	10%	141.6	125.2
Total		1,415.7	1,251.6

Source: JST based on DPR

5.4.5 Service Facility

As per the latest guidelines of Jal Jeevan Mission for distribution of water to the villagers, provision of house connection has been taken for all the households. The number of house connections to be included in the project has been determined based on the planned service population in the construction completion year, . Five persons per one connection was adopted for estimation of the numbers. Hence, the proposed numbers of connections are shown in the following table:

Table 5.4.7 Proposed Number of House Connections for the Jhunjhunu Scheme

Item	Surajgarh sub-scheme	Udaipurwati sub-scheme
Number of connections	68,001	60,119

Source: JST

In addition, public stand post (PSP) is included in the construction cost estimate. The number of PSP has been determined based on the questionnaire from PHED, as shown in Table 5.4.8.

Table 5.4.8 Proposed Number of PSP for the Jhunjhunu Scheme

Item	Surajgarh sub-scheme	Udaipurwati sub-scheme
Number of PSP	2 each x 69 (nos. of Other Habitation (OH)) = 138	2 each x 504 (nos. of OH) = 1,008

Source: JST based on the questionnaire from PHED

Above number is provisional and the actual installation will be implemented based on the request from the village, on the condition that the installation of PSP does not hinder the installation of house connections.

5.5 Power Receiving Facility

Power supply transmission line and the stepdown transformer substation are necessary for each of the transmission pumping station and cluster pump station. The transformer capacity is dependent on the pump capacity.

For Surajgarh Sub-scheme, the power will be supplied from the adjacent GSS (Grid Substation) at Chirawa, Surajgarh, Buhana, and Singhana.

Table 5.5.1 Specification of Adjacent Substation and Transformer Capacity (Surajgarh Sub-scheme)

Pumping Station	Transformer	Quantity	Adjacent Substation and Capacity	
TPS Chirawa	750 kVA	2 (1W+1S)	GSS Chirawa	220 kV
CPS Surajgarh	315 kVA	2 (1W+1S)	GSS Surajgarh	132 kV
CPS Buhana	400 kVA	2 (1W+1S)	GSS Buhana	132 kV
CPS Singhana	315 kVA	2 (1W+1S)	GSS Khetri Nagar	220 kV

Source: JST based on DPR

For Udaipurwati Sub-scheme, the power will be supplied from the adjacent GSS at Gudhagorji, Udaipurwati, and Ponkh.

Table 5.5.2 Specification of Adjacent Substation and Transformer Capacity (Udaipurwati Sub-scheme)

Pumping Station	Transformer	Quantity	Adjacent Substation and Capacity	
TPS Jhunjhunu	1,500 kVA	2 (1W+1S)	Jhunjhunu main head works GSS	33 kV (from existing 132 kV)
CPS Gudha Gorji	1,500 kVA	2 (1W+1S)	GSS Gudha Gorji	132 kV
CPS Udaipurwati	400 kVA	2 (1W+1S)	GSS Udaipurwati	132 kV
CPS Ponkh	315 kVA	2 (1W+1S)	GSS Ponkh	33kV

Source: JST based on DPR

According to the annual report of RVPN (Rajasthan Rajya Vidyut Prasaran Nigam Limited: Rajasthan Power Supply Corporation), the average power interruption frequency and duration in FY 2019-2020 were 2.04 times/year and 1.58 hours/year, respectively. Thus, it can be said the reliability of the power supply is ensured.

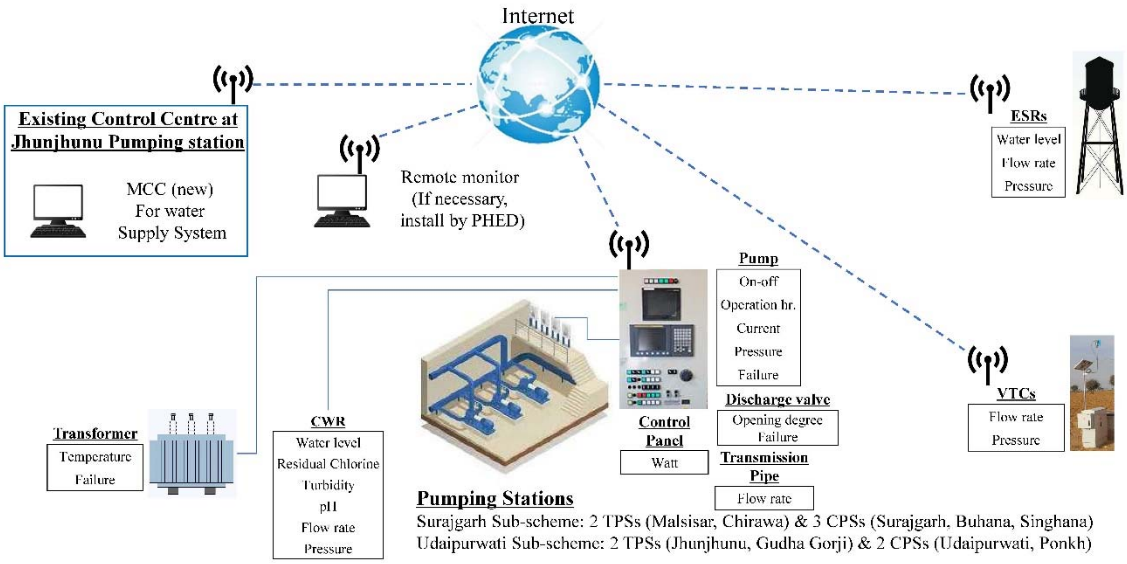
5.6 SCADA System

5.6.1 Outline of SCADA System

The SCADA system monitors the operation status of the mechanical equipment such as pumps and measuring instruments and the electrical equipment such as control panel and power supply transformers. Figure 5.6.1 shows the general concept of the control and monitoring system of pumping stations. Operation status of each pumping stations, ESRs and VTCs will be transmit the to the MCC.

The SCADA system will be capable of preparing or creating daily operation reports and monthly reports from the collected data. Furthermore, the system can also give advice for the efficient operation of the whole water transmission and distribution system.

In addition, another remote monitor for observing the water supply system can be prepared by PHED, if necessary.



Source: JST

Figure 5.6.1 Control and Monitoring Concept for Pumping Stations, ESRs, and VTCs

The outline of main facilities for SCADA system are described hereunder.

(1) Master Control Centre (MCC)

The MCC is an integrated computer system for collecting information, data analysis, data aggregation, and giving operation instructions in case of necessity. The remote control function will be limited to "EMERGENCY STOP" of pumps to secure the safety of water supply.

The MCC for the project will be installed at Jhunjhunu TPS and will be compatible to transfer the data to the existing SCADA system.

(2) Control Panel at Each of the Pumping Stations

The control panels are installed in the pumping stations to control the operations such as manually on/off of pumps, open/close of electrical valves with diameter over 500mm, etc. at site and present the status for all the related equipment and instruments (such as flow meters, pressure indicators, and electrical valves). The control panel is capable of managing and controlling all the equipment in the pumping station at site and also transmit the data to the MCC in Jhunjhunu TPS.

Normally, the pump will be automatically operated according to the water levels in the receiving tank and interlock with the water levels in the ESR. In case the pump stopped due to power failure or other causes, the manual restoration of operation will be done by the operator at site. It is not recommended to restore the pump operation from the MCC without confirming the situation in the pumping station and mutual communication between the pump station and MCC.

(3) Local Panel at Each of the ESRs and VTCs

The local panels will be installed in each of the ESRs and VTCs to present the status of the equipment and transmit the data to the MCC in Jhunjhunu TPS.

5.6.2 Monitoring and Control Item

The measuring points and monitoring & control items for the pumping stations, VTCs, and ESRs are shown in Table 5.6.1.

Table 5.6.1 Measuring Points and Monitoring & Control Items for Each of the Facilities

No.	Facility	Measuring Points	Measuring or Monitoring Items	Control Item
1	Pumping stations (TPS and CPS) Master Control Centre (MCC) for Water Supply System Located in TPS Jhunjhunu	Receiving tank (CWR)	Water level	
			Residual chlorine	
			Turbidity	
			pH	
			Flow rate	
			Pressure	
		Pump	On-Off	On-Off (at site) Emergency stop (MCC)
			Operation hours	
			Current	
			Pressure	
			Failure	
		Discharge valve	Opening degree	Open-close of electric valves (at site)
		Transmission pipeline	Flow rate	
		Distribution panel	Watt	
		Transformer substation	Temperature Failure status	
2	ESR	Reservoir	Water level Flow rate Pressure	
3	VTC	VTC	Flow rate Pressure	

Source: JST

Chapter 6 Review of Water Supply Plan for Barmer Scheme

6.1 Target Area of the Project

In the original Detailed Project Report (DPR) prepared in 2017, the list of target villages and their population was prepared based on the 2001 Census. Thus, the Public Health Engineering Department (PHED) decided to revise the DPR based on the 2011 Census. The revision work was conducted by a local consultant. Regarding the target area of the project, PHED prepared the revised target village list based on the 2011 Census.

Barmer Scheme consists of four sub-schemes:

- HR-1 Sub-scheme with target area of 268 villages in Gudhamalani Tehsil
- HR-2 Sub-Scheme with target area of 183 villages in Gudhamalani and Chohtan Tehsils
- Chohtan-1 Sub-Scheme with target area of 187 villages in Chohtan and Gudhamalani Tehsils
- Chohtan-2 Sub-Scheme with target area of 251 villages in Chohtan Tehsil

Chohtan-1 and Chohtan-2 Sub-Scheme constitute a single water supply system. That is, Chohtan-2 Sub-Scheme is located at the downstream of Chohtan-1 Sub-Scheme. There is no urban town in the target area. All target areas are classified into rural area.

The population (2011 Census) of the target area is shown in Table 6.1.1.

Table 6.1.1 Population (2011 Census) of the Target Area of Barmer Scheme

	Nos. of Village	Population (2011)
HR-1 Sub-Scheme (Gudhamalani Tehsil)	268	231,411
HR-2 Sub-Scheme (Gudhamalani and Chohtan Tehsils)	183	137,503
Sub-total	451	368,914
Chohtan-1 Sub-Scheme (Chohtan and Gudhamalani Tehsils)	187	247,649
Chohtan-2 Sub-Scheme (Chohtan Tehsil)	251	244,240
Sub-total	438	491,889
Grand Total	**889**	**860,803**

Note: HR: H point Right side of Narmada Canal
Source: JICA Study Team (JST) based on the target village list provided by PHED

The list of target villages with population is presented in Appendix-6.1.

6.2 Basic Policies for Water Supply Planning

It was confirmed with PHED Jodhpur that the following planning parameters/policies shall be applied for the water supply planning for the Barmer Scheme:

(1) Target Year

The target year shall be 2055.

(2) Target Village/Town and Base Population

As mentioned in Section 6.1, the target village shall be the following:

- 268 villages in Gudhamalani Tehsil (HR-1 Sub-Scheme)
- 183 villages in Gudhamalani and Chohtan Tehsils (HR-2 Sub-Scheme)
- 187 villages in Chohtan and Gudhamalani Tehsils (Chohtan-1 Sub-Scheme)
- 251 villages in Chohtan Tehsil (Chohtan-2 Sub-Scheme)

The base population shall be based on the 2011 Census.

(3) Population Projection

For the population projection, the following decadal growth rates were adopted in the original DPR:

	HR-1 and HR-2 Sub-Scheme (Gudhamalani Tehsil)	Chohtan-1 and Chohtan-2 Sub-Scheme (Chohtan Tehsil)
2011-2021	34.3 %	37.0 %
2021-2031	26.3 %	27.5 %
2031-2041	19.2 %	21.0 %
2041-2051	*12.1 %*	*14.5%*
2051-2061	*5.0 %*	*8.0 %*

Note: 2041-2061 was set analogically
Most of the target villages of HR-2 Scheme are in Gudhamalani Tehsil
Most of the target villages of Chohtan-1 Scheme are in Chohtan Tehsil

In the original DPR, the projected decadal growth rate (2001-2011) of Barmer District was 32.9%, which was almost similar to the actual growth rate of 32.6%. Thus, it was confirmed with PHED Jodhpur that the above decadal growth rates would be realistic and shall be applied for the population projection for the revised DPR.

(4) Per Capita Water Demand

All target areas are classified into rural area. In line with the national program on water supply, “Jal Jeevan Mission (2019)”, the per capita water demand shall be 55 Lpcd.

It should be noted that 55 Lpcd is the minimum requirement for human beings of every household. For other demand such as for cattle water supply, it is envisaged that such demand will be met by conjunctive use of the existing water source such as groundwater.

In addition, the following shall be added for the design of the distribution facility:

- Distribution loss: 15%

- Institutional demand: 5%

Lastly, the following shall be added for the design of the transmission facility:

- Losses in pumping main 2%

These figures were determined by PHED Jodhpur based on the past instances of water supply projects in their jurisdiction area as well as referring to the "Guidelines and Norms for Design of Water Supply Schemes/Projects as of 01 September 2017 issued by PHED".

(5) Type of Water Supply

In line with the Jal Jeevan Mission (2019), house connection for every household shall be provided.

6.3 Population and Water Demand Projection

Based on Sections 6.1 and 6.2, the population and water demand projections were made as shown in Table 6.3.1.

Table 6.3.1 Population and Water Demand Projections for Barmer Scheme

Area	Population					Clear Water Demand (m^3/day)		
	2011	2027	2031	2040	2055	2027	2040	2055
HR-1 sub-scheme	231,411	366,784	404,217	479,868	577,531	24,692	32,305	38,879
HR-2 sub-scheme	137,503	217,941	240,183	285,134	343,165	14,672	19,195	23,102
Sub-total	368,914	584,725	644,401	765,002	920,696	39,364	51,500	61,981
Chouhtan-1 sub-scheme	247,649	382,608	420,064	491,999	572,366	25,757	33,121	38,532
Chouhtan-2 sub-scheme	244,240	377,342	414,282	485,227	564,487	25,403	32,665	38,001
Sub-total	491,889	759,950	834,347	977,226	1,136,852	51,160	65,787	76,533
Grand Total	**860,803**	**1,344,675**	**1,478,747**	**1,742,228**	**2,057,548**	**90,524**	**117,287**	**138,514**

Source: JST

6.4 Availability of the Water Source for the Project

Due to unavailability of perennial river in the project area, groundwater is the only source of drinking water at present. However, groundwater has been overexploited at a high rate by pumps through tube wells or dug wells. Thus, surface source is considered the most reliable source for the drinking water requirement of the area.

The Narmada Canal System has been considered the surface water source for the water supply of the project area. Narmada Canal brings water from Sardar Sarovar Dam in Gujarat State. After traveling 460 km in Gujarat State, the Narmada Canal enters Jalore District of Rajasthan State. After entering Rajasthan State, it runs along Jalore District and Barmer District.

The amount of water reserved for Rajasthan State by Narmada Canal is 0.5 million acre feet (MAF) (1,689.5 MLD) which is to irrigate 246,000 ha and to provide water supply to Jalore and Barmer districts. The monthly water flow of Narmada Canal is being controlled according to the monthly irrigation water demand.

For the purpose of irrigation from the Narmada Canal System, 12 offtake points (Location (A) to Location (L)) with cross regulators were constructed. At 4 out of the 12 offtake points, an offtake facility for water supply was also constructed.
Out of 0.5 MAF (1,689.5 MLD), 0.1064 MAF (359.58 MLD) has been allocated to PHED for water supply purpose.

The features of these offtake points are shown in Table 6.4.1.

Table 6.4.1 Features of Offtake Points on Narmada Canal for Water Supply

Offtake Point	Distance from Entry Point to Rajasthan	Originally Allocated Intake Amount	Remarks
Jalore District			
Location (D)	16.00 km	146.25 MLD	
Location (E)	29.30 km	77.46 MLD	
	Sub-total	223.71 MLD	
Barmer District			
Location (H)	55.575 km	72.89 MLD	Intake point for HR-1 and HR-2 Scheme
Location (L)	74.00 km	62.98 MLD	Intake point for Chohtan-1 and Chohtan-2 Scheme
	Sub-total	135.87 MLD	
	Total	**359.58 MLD**	

Source: Original DPR

As shown above, the originally allocated amount for water supply in Barmer District is 135.87 MLD. However, as presented in Section 6.3, the planned raw water demand (105.74 % of clear water demand, considering treatment loss and intake loss) for the project (Target year: 2055) will be the following:

HR-1 Scheme:	41.11 MLD	(Clear water demand: 38.88 MLD)
HR-2 Scheme:	24.43 MLD	(“ : 23.10 MLD)
Chohtan-1 Scheme:	40.74 MLD	(“ : 38.53 MLD)
Chohtan-2 Scheme:	40.18 MLD	(“ : 38.00 MLD)
Total	146.46 MLD	

In addition, the water supply scheme for Ramar and Seho Tehsils with raw water demand of approximately 100 MLD is on-going. Moreover, according to the original DPR, additional demand of 66.57 MLD will be created in Jalore District.

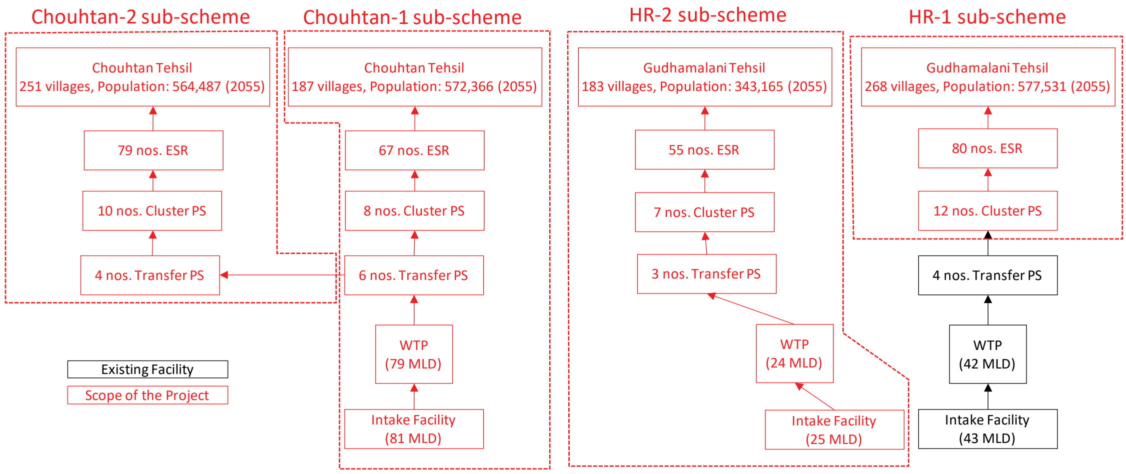
Thus, the total raw water demand (2055) from Narmada Canal for water supply will be approximately 536.74 (=223.71+146.46+100.0+66.57) MLD.

According to the letter issued by WRD on 13 January 2015, the allocation amount of Narmada Canal System for water supply will be enhanced from 359.58 MLD (0.1064 MAF) to 645.73 MLD (0.1911 MAF). The letter of WRD is shown in Appendix 6.2.

It was confirmed that the water necessary for the project will be allocated by GOR by utilizing the abovementioned water allocation. According to PHED the water allocation is the matter within Rajasthan State, thus, there is no need for consultation with other states.

6.5 Scope of the Project

The scope of the proposed JICA project is as shown in Figure 6.5.1.



Source: JST

Figure 6.5.1 Scope of the Project (Barmer Scheme)

The distinctive features of the water supply system of the project are:

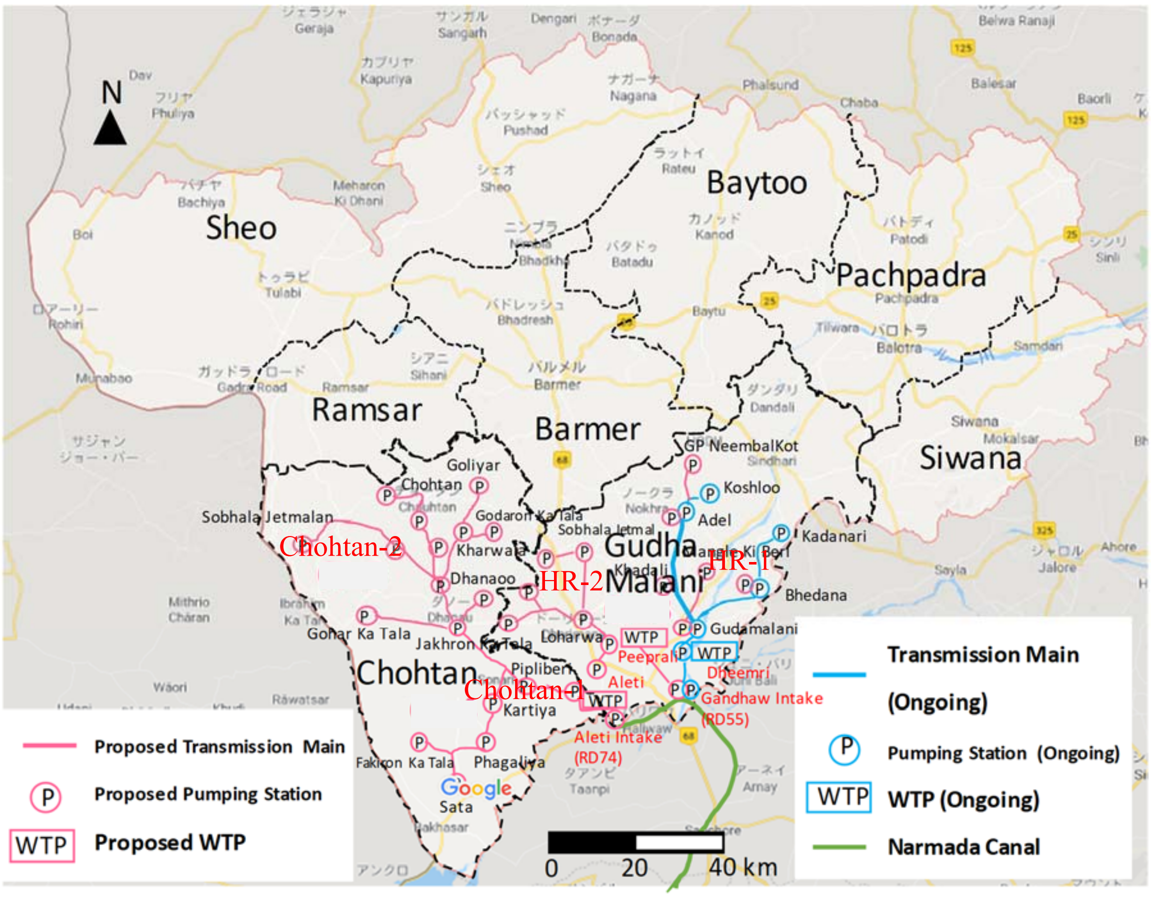
- The following facilities for HR-1 Sub-Scheme are being constructed:
  - Intake facility
  - Raw water transmission pipeline
  - Water Treatment Plant (WTP)
  - Transmission pipeline to Transfer Pump Station (PS) and Transfer PS
- At first, treated water will be transmitted from PSs to Elevated Service Reservoirs (ESRs), which are located in the supply areas, then distributed to the supply area by gravity.
- Each ESR covers several target villages (three to four villages on average).
- From ESR, the treated water will be distributed to each village

- At the entrance of each village, a Village Transfer Chamber (VTC) will be installed.
- At VTC, water flow will be recorded and the flow record will be transferred to the master control station by Supervisory Control and Data Acquisition (SCADA) system.
- The water that passed the VTC will be distributed by the distribution pipeline network and supplied to each household by house connection. The house connection work is included in the project scope.

Chapter 7 Facility Plan for Barmer Scheme

7.1 Outline and Principal Feature of the Project Facility

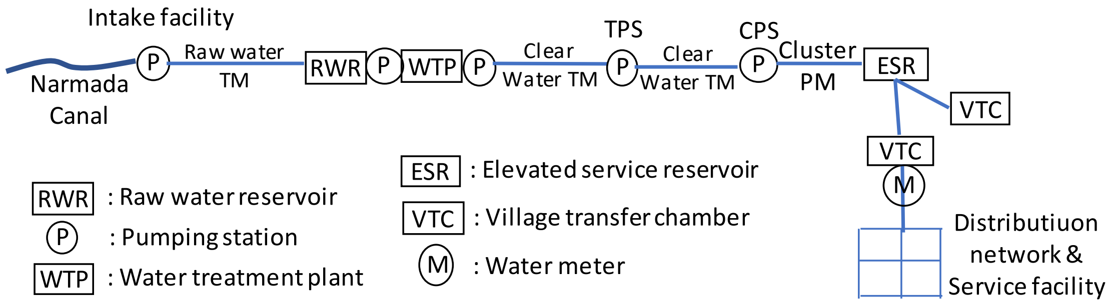
The water source of the Barmer scheme is the Narmada Canal, which is diverted from the Narmada River and runs across Gujarat State and reaches Rajasthan State. The scheme is divided into four sub-schemes: HR-1 sub-scheme, HR-2 sub-scheme, Chohtan-1 sub-scheme, and Chohtan-2 sub-scheme. The construction of the water treatment plant (WTP) and water transmission pipeline of HR-1 sub-scheme has already commenced using the state fund. The remaining facility will be constructed by the project. Chohtan-1 sub-scheme and Chohtan-2 sub-scheme constitute a single water supply system. Chohtan-2 sub-scheme receives the treated water from the WTP constructed in Chohtan-1 sub-scheme. Figure 7.1.1 shows the facility layout of the Barmer scheme.



Source: JST based on revised DPR

Figure 7.1.1 Facility Layout of the Barmer Scheme

Figure 7.1.2 shows the configuration of the project facility.



Source: JST

Figure 7.1.2 Configuration of the Project Facility of Barmer Scheme

The planning conditions and contents of the Barmer scheme prepared by the JICA Survey Team based on the revised DPR which has been prepared by a local consulting firm in 2020 is shown in Table 7.1.1. to Table 7.1.3. The project basically follows these principal features and the proposed construction packages.

Table 7.1.1 Planning Condition and Facility Feature of Barmer Scheme

Sub-Scheme	HR-1	HR-2	Chohtan-1	Chohtan-2
Planning Condition				
Supply area	Gudhamalani Tehsil	Gudhamalani & Choutan Tehsil	Gudhamalani & Chohtan Tehsil	Chohtan Tehsil
	268 villages	183 villages	187 villages	251 villages
Present population (2011 census)	231,411	137,503	247,649	244,240
Planned service population (2055)	577,531	343,165	572,366	564,487
Clear water demand (2055)	38.9 MLD	23.1 MLD	38.5 MLD	38.0 MLD
Project Facility				
1) Intake & raw water pumping station (RWPS)	1 no. (ongoing)	1 no.	1 no.	–
2) Raw water transmission main	15 km (ongoing)	18 km	6 km	–
3) Raw water reservoir (RWR) & RWPS	1 no. (ongoing)	1 no.	1 no.	–
4) Water treatment plant (WTP)	42 MLD (ongoing)	24 MLD	79 MLD	–
5) Transfer pumping station (TPS)	5 nos. (ongoing)	3 nos.	6 nos.	4 nos.
6) Clear water transmission main	136 km (ongoing)	68 km	214 km	82 km
7) Cluster pumping station (CPS)	12 nos.	7 nos.	8 nos.	10 nos.
8) Cluster pumping main (CPS to ESR)	458 km	292 km	447 km	546 km
9) Elevated Service Reservoir (ESR)	80 nos.	55 nos.	67 nos.	79 nos.
10) Cluster distribution system (up to VTC)	557 km	387 km	424 km	558 km
11) Village transfer chamber (VTC)	268 nos.	183 nos.	187 nos.	251 nos.
12) Village distribution system (after VTC)	3,177 km	4,985 km	4,065 km	4,848 km
13) Service facility	House connection Public standpost	House connection Public standpost	House connection Public standpost	House connection Public standpost

Note: 1) TPS includes ones in WTPs, 2) CPS includes ones in WTPs and TPSs
The photos of existing facility and sites for the proposed main facilities are shown in Appendix-7.1.
Source: JST based on the revised DPR

Table 7.1.2 Principal Features of HR-1 and HR-2 Sub-schemes

	HR-1 Sub-scheme *(Shown in Italic are ongoing facilities)*	HR-2 Sub-scheme
1. Intake facility	*Location: RD 55 (H-Point), 55.575 km of Narmada Canal* *(Constructed)*	Location: RD 55 (H-Point), 55.575 km of Narmada Canal
	Type of structure: Rectangular intake tower with pump station: *Sluice Gate Dimensions = 900 mm x 600mm* *Dimensions of Inlet Chamber = 3.5 m x 2.9 m x 3m* *Dimensions of Raw Water Sump =22 m x 4.4 m x 3 m*	Type of structure: Rectangular intake tower with pump station Sluice Gate Dimensions = 900 mm x 600 mm Dimensions of Inlet Chamber =3 m x 3 m x 3 m Dimensions of Raw Water Sump =22 m x 4 m x 3 m
2. Raw water pumping station	*Location: RD 55 (H-Point), 55.575 km of Narmada Canal* *(Constructed)* *406 LPS x 2 nos., H=52.5 m* *To be replaced for future demand (2040) by PHED:* *431 LPS x 2 nos., H=67 m*	Location: RD 55 (H-Point), 55.575 km of Narmada Canal 1,114 m^3/hr, H=81 m, 3W+3S Location: Peeprali RWR 1,114 m^3/hr, H=5m, 2W+2S
3. Raw water transmission main	*DI (K7) D800, L= 15.0 km* *(Constructed)*	DI (K9,K7) D600, L=17.9 km
4. Raw water reservoir (RWR)	*Location: Dheemri, Capacity: 780 ML, 21 days* *(Constructed)*	Location: Peeprali, Capacity: 520 ML, Retention Time: 21 days
5. Water treatment plant (WTP)	*Location: Dheemri* *Type: Rapid sand filter* *Capacity: 42 MLD* *(Under construction)*	Location: Peeprali Type: Rapid sand filter Capacity: 24 MLD
6. Transfer pumping station (TPS)	*5 locations: 18 pumps in total* *1) Dheemri WTP: 4 pumps* *392 lps, H=11.5m, 1W+1S* *31 lps, H=13m, 1W+1S* *2) TPS Gudhamalani: 6 pumps* *179 lps, H=86.5m, 1W+1S* *114 lps, H=58m, 1W+1S* *26 lps: H=48m, 1W+1S* *3) TPS Bhedana: 2 pumps* *32 lps, H=47.5m, 1W+1S* *4) TPS Adel: 4 pumps* *91 lps, H=62m, 1W+1S* *39 lps, H=50m, 1W+1S* *5) TPS Koshloo: 2 pumps* *34 lps, H=58m, 1W+1S* *(Under construction)*	3 locations: 12 pumps in total 1) Peeprali WTP: 4 pumps 1,054 m^3/hr, H=6m, 2W+2S 2) TPS Loharwa: 6 pumps 458 m^3/hr, H=101m, 2W+2S 440 m^3/hr, H=64m, 1W+1S 3) TPS Sobhala Jetmal: 2 pumps 268 m^3/hr, H=59m, 1W+1S
7. Clear water transmission main	*DI (K7) D200-600, L=136 km* *(Under construction)*	DI (K9,K7) D150-600, L=67.5 km
8. Cluster pumping station (CPS)	12 locations: 72 pumps in total 1) Dheemri WTP: 2W+2S (4 pumps) 2) TPS Gudhamalani: 3W+3S (6 pumps) 3) TPS Adel: 2W+2S (4 pumps) 4) TPS Koshlou: 4W+4S (8 pumps) 5) TPS Bhedana: 3W+3S (6 pumps) 6) CPS Beri Gaon: 4W+4S (8 pumps)	7 locations: 40 pumps in total 1) Peeprali WTP: 1W+1S (2 pumps) 2) TPS Loharwa: 3W+3S (6 pumps) 3) TPS Shobhala Jetmal: 4W+4S (8) 4) CPS Borcharnan: 1W+1S (2 pumps) 5) CPS Dhorimanna: 4W+4S (8pumps) 6) CPS Misari Ki Beri: 4W+4S (8) 7) CPS Meethya Tala: 3W+3S (6)

	7) CPS Khadali 3W+3S (6 pumps) 8) CPS Nokhra: 4W+4S (8 pumps) 9) CPS Neembal Kot: 3W+3S (6) 10) CPS Mangle Ki Beri: 3W+3S (6) 11) CPS Ratanpura: 4W+4S (8 pumps) 12) CPS Kadnari: 1W+1S (2 pumps)	
9. Clear water reservoir (CWR)	1. WTP Dheemri : 260 m^3 2. TPS Gudhamalani; 3,230 m^3, 3. TPS Bhedana: 1,040 m^3 4. TPS Adel: 1,640 m^3 5. TPS Koshalu: 850 m^3 (Constructed) 6. CPS Kadanadi: 150 m^3 7. CPS Beri Gaon: 300 m^3 8. CPS Khadali: 250 m^3 9. CPS Neembal Kot: 300 m^3 10. CPS Nokhra: 350 m^3 11. CPS Mangle Ki Beri: 250 m^3 12. CPS Ratanpura: 400 m^3	1. WTP Peeprali: 2,250 m^3 2. TPS Dhorimanna: 1,200 m^3 3. CPS Dhorimanna: 900 m^3 4. CPS Meethya Tala: 600 m^3 5. CPS Shobhala Jetmal: 400 m^3 6. CPS Misari Ki Beri: 200 m^3 7. CPS Beri Gaon: 100 m^3
10. Cluster pumping main	DI D100-300, L=458.3 km	DI D100-250, L=292.5 km
11. Elevated service reservoir (ESR)	80 nos, 100 to 500 m^3, 18-25 m staging	55 nos., 100 to 450 m^3, 18-25 m staging
12. Cluster distribution system	HDPE D90-225, DI D200,250 L=557.1 km	HDPE D75-225, DI D80-250 L= 386.6 km
13. Village Transfer Chambers (VTCs)	268 nos.	183 nos.
14. Village distribution network	HDPE 75-200 mm, DI D80-250 L=3,177 km	HDPE 75-200 mm, DI (K7) D80-250 L=4,985 km
15. Service Facility	House connection: 73,357 nos. Public stand post	House connection: 43,588 nos. Public stand post

Note: ML: Million Liter, lps: liter per second, H: head, D: diameter (mm)
Source: JST based on the revised DPR

Table 7.1.3 Principal Features of Chohtan-1 and Chohtan-2 Sub-schemes

	Chohtan-1 Sub-scheme	Chohtan-2 Sub-scheme
1. Intake facility	Location: RD 74 (L-Point), 74.00 km off take of Narmada Canal	-
	Type of structure: Rectangular intake tower with pump station Sluice Gate Dimensions =1200 mm x 900 mm Dimensions of Inlet Chamber =3 m x 5 m x 4.8 m Dimensions of Raw Water Sump = 30 m X 5.6 m X 4 m	-
2. Raw water pumping station	Location: RD 74 (L-Point), 74.00 km off take of Narmada Canal 3,892 m^3/hr, H=44m, 4W+2S(6 pumps) Location: Aleti RWR 3,892 m^3/hr, H=5m, 2W+2S (4 pumps)	-
3. Raw water transmission main	DI (K9, K7) D1100, L=5,600 m	-
4. Raw water reservoir (RWR)	Capacity: 1,670 ML Retention Time: 21 days	-
5. Water treatment plant (WTP)	Location: Aleti Capacity: 79 MLD	-
6. Transfer pumping station (TPS)	6 locations: 40 pumps in total 1. Aleti WTP: 3,677 m^3/hr, H=24m, 4W+2S (6 pumps) 2. TPS Peepliberi: 10 pumps Karatiya:1,066 m^3/hr, H=40m, 2W+2S Jakhron Ka Tala & Dhannau: 2,433 m^3/h, H=99m, 4W+2S (6 pumps) 3. TPS Kartiya: 796 m^3/hr, H=74m, 2W+2S (4 pumps) 4. TPS Jakhron Ka Tala: 121 m^3/hr, H=40m, 1W+1S (2 pumps) 5. TPS Dhannau: 14 pumps Alamsar: 440 m^3/hr, H=119m, 2W+2S Kharawala: 662m^3/hr, H=88m, 2W+2S Ibrahim Ka Tala & Gohar Ka Tala 910 m^3/hr, H=130m, 3W+3S (6 pumps) 6. TPS Phagliya: 556 m^3/h, H=89m, 2W+2S (4 pumps)	4 locations : 8 pumps 1. TPS Ibrahim Ka Tala: 262 m^3/hr, H=122m, 1W+1S (2 pumps) 2. TPS Alamsar : 374 m^3/hr, H=87m, 1W+1S (2 pumps) 3. TPS Choutan : 153 m^3/hr, H=86m, 1W+1S (2 pumps) 4. TPS Kharawala: 331m^3/hr, H=85m, 1W+1S (2 pumps)
7. Clear water transmission main	DI (K9,K7) D250-1000, L=214.4 km	DI (K9) D200-350, L=81.9 km
8. Cluster pumping station (CPS)	8 locations: 54 pumps 1. Aleti WTP: 2W+2S (4 pumps) 2. TPS Peepliberi: 3W+3S (6 pumps) 3. TPS Kartiya: 3W+3S (6 pumps) 4. TPS Phagaliya: 4W+4S (8 pumps) 5. TPS Jakhron Ka Tala: 5W+5S (10) 6. TPS Dhanaoo: 2W+2S (4 pumps) 7. CPS Sata: 4W+4S (8 pumps) 8. CPS Fakiron Ka Niwan: 4W+4S (8)	10 locations: 1. Alamsar TPS, 2. Kharwala TPS 3. Choutan TPS, 4. Ibrahim K Tala TPS 5. Bhron Ka Tala CPS, 6. Goliyar CPS 7. Godaron Ka Tala CPS, 8. Dhok CPS 9. Gohar Ka Tala CPS 10. Sobhala Jetmalan CPS
9. Clear water reservoir (CWR)	8 locations, Total of 23,050 m^3	10 locations, Total of 5,750 m^3

10. Cluster pumping main	DI (K9,K7) D100-300, L=447 km	DI (K9, K7) D100-300, L=546 km,
11. Elevated service reservoir (ESR)	67 nos., 150 to 600 m^3, 18-25 m staging	79 nos., 100 to 500 m^3, 18-25 m staging
12. Village cluster distribution system	HDPE D90-225 mm, DI(K7) D200,250 L= 424.1 km	HDPE D75-225, DI (K7) D100-250 L=558.2 km
13. Village transfer chambers (VTCs)	187 nos.	251 nos.
14. Village distribution network	HDPE D75-200, DI (K7) D100-200 L=4,065 km	HDPE D75-225, DI (K7) D150-250 L=4,848 km
15. Service facility	House connection: 76,522 nos. Public stand post	House connection: 75,468 nos. Public stand post

Note: H: head, W: working, S: standby, D: diameter (mm)
Source: JST based on the revised DPR

7.2 Present Conditions of the Existing and Ongoing Facility

7.2.1 Common Facilities for Barmer Scheme

The Narmada Canal is a contour canal in northwestern India that brings water from the Sardar Sarovar Dam north through 460 km of the State of Gujarat and then 74 km into Rajasthan State. It is the main canal of an irrigation system that has 42 branches, and runs a length of 750 km (including field canals), resulting in a Culturable Command Area (CCA) of 2,129,000 hectares. The construction of the canal was completed in 2008.

For the purpose of irrigation from the Narmada Canal System, 12 offtake points (Location (A) to Location (L)) with cross regulators were constructed. At the four offtake points out of the 12 points, offtake facilities for water supply were also constructed. For this project, Locations (H) and (L) are utilized.

The available water volume is mentioned in Section 6.4 in this report.

7.2.2 Facilities for HR-1 Sub-Scheme in Gudhamalani Tehsil

The facilities of the HR-1 sub-scheme have been partly constructed for the 2041 demand. The principal features of the existing and ongoing facilities are shown in Table 7.2.1.

Table 7.2.1 Principal Features of Existing and Ongoing Facilities of the HR-1 Sub-Scheme

Facility	Principal Features
1. Intake facility	Location: RD 55 (H-Point): Gandhaw Khurd (Existing) Off-take of Bhadrai Lift distributary of the Narmada Canal System; Type of Structure: Rectangular intake tower with pump station: Sluice Gate Dimensions = 900 mm x 600 mm Dimensions of Inlet Chamber = 3.5 m x 2.9 m x 3m Dimensions of Raw Water Sump =22 m x 4.4 m x 3m
2. Raw water pumping station	RWPH at RD 55.575: Gandhaw Khurd (Existing) Commissioned: 406 LPS x 2 nos., H=52.5 m To be replaced for future demand (2040) by PHED:

	431 LPS x 2 nos., H=67 m
3. Raw water pumping main	D800 DI K7 pipe, L= 15.0 km (Existing)
4. Raw water reservoir	Location: Dheemri, Capacity: 780 ML, 21 days (Existing)
5. Water treatment plant (WTP)	Location: Dheemri (Ongoing) Type: Rapid sand filter, Capacity: 42 MLD
6. Transfer pumping station (TPS)	4 nos. (See Table 7.2.2) (Ongoing)
7. Clear water transmission main	Dia.: 250-600, Total length: 92.1 km (Ongoing) 1. Deemri to Gudhamalani: DI700 and 600, 10 km (Commissioned) 2. Gudhamalani to Bhedana: DI400 and 350, 23.4 km 3. Bhedana - Kadanali: DI250, 19.5 km 4. Gudhamalani-Adel: DI500, 450,36 km 5. Adel to Koshalu: DI300 and 250, 3.2 km

Source: JST based PHED tender drawings and interview with PHED

(1) Intake and Raw Water Pumping Station at Gandhaw Khurd

The intake structure from Narmada Canal at Gandhaw Khurd has been completed and is now under operation. The raw water pumping station beside the intake with two pumps (including one stand-by) of each 406 L/sec capacity have been completed and are now under operation. The pumps were designed for the demand in 2029. It is assumed that the existing pumps would be utilized until 2029, and if necessary, the Public Health and Engineering Department (PHED) will replace the pumps in the future.

(2) Raw Water Pumping Main

Raw water pumping main with diameter 800 and 15.0 km length from Gandhaw Khurd Intake to Dheemri Raw Water Reservoir (RWR) has been constructed.

(3) Water Treatment Plant in Dheemri

RWR with 780,000 m^3 capacity, which can store water for 21 days, is almost complete. The construction of water treatment plant with 42 MLD capacity is ongoing and scheduled to be completed on March 2021.

(4) Water Transmission System

1) Transfer Pumping Station

The transfer pumping stations for HR-1 are listed in Table 7.2.2.

Table 7.2.2 Transfer Pumping Stations for HR-1 Sub-scheme

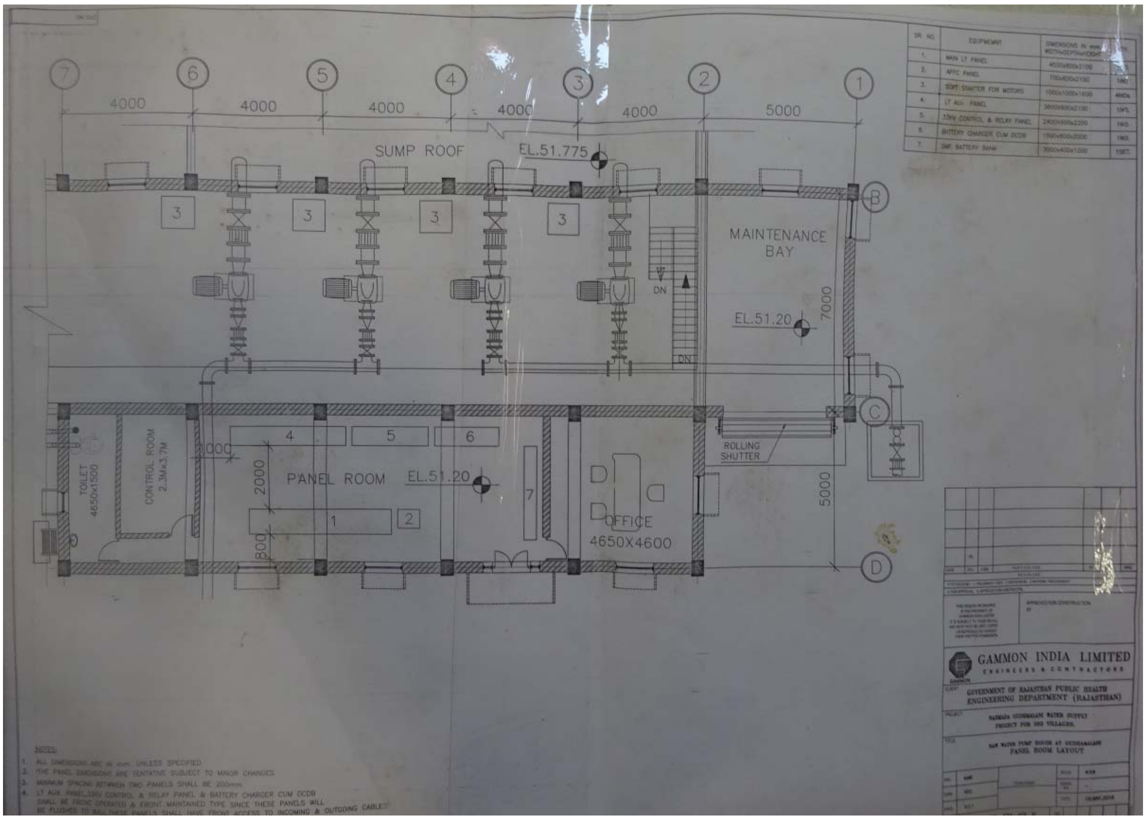
No.	PS Name	To	Capacity	Nos. of Pump	Head (m)	Status
1	TPS Dheemri in WTP	TPS Gudhamalani	392 lps	2 (1W + 1STB)	11.5	Commissioned
		CPS Beri Gaon	31 lps	2 (1W +1STB)	13	Ongoing
2	TPS Gudhamalani	TPS Bhedana and CPS Ratanpura	114 lps	2 (1W + 1STB)	58	Ongoing

		TPS Adel and CPS Khadali	179 lps	2 (1W + 1STB)	86.5	Ongoing
		CPS Mangle Ki Beri	26 lps	2 (1W + 1STB)	48	Ongoing
3	TPS Bhedana	TPS Kadanari	32 lps	2 (1W + 1STB)	47.5	Ongoing
4	TPS Adel	TPS Koshloo	91 lps	2 (1W + 1STB)	61.7	Ongoing
		CPS Nokhra	39 lps	2 (1W + 1STB)	50	Ongoing
5	TPS Koshloo	CPS Neembal Kot	34 lps	2 (1W + 1STB)	58	Ongoing

Source: JST based on PHED tender drawing, interview with PHED, and revised DPR

Out of the five pumping stations above, the JICA Survey Team visited TPS Gudhamalani. The PS was under construction and was scheduled to be completed in March 2020.

The layout of the raw water pump house is shown in Figure 7.2.1 for reference.



Source: JST (drawing of “Narmada Gudhamalani Water Supply Project for 263 Villages” in Gudhamalani P/S)

Figure 7.2.1 Layout of Raw Water Pump House at Gudhamalani

According to PHED, the civil work of the TPSs in Table 7.2.2 are completed, their pumping machineries, electrical panel, transformers and cables are procured and being installed as of end of September, 2020.

2) Transmission Main

The transmission mains for HR-1 are shown in Table 7.2.3.

Table 7.2.3 Transmission Mains for HR-1 Sub-scheme (Ongoing)

No.	From	To	Material	Dia. (mm)	Length (m)	Status
1	Dheemri (WTP)	TPS Gudhamalani	DI	600	10,650	Installed
2-1	TPS Gudhamalani	JN	DI	600	17,807	Ongoing
		TPS Adel	DI	500	18,850	Ongoing
		CPS Khadali	DI	250	2,565	Ongoing
2-2	(PS Gudhamalani)	CPS Mangle Ki Beri	DI	250	21,375	Ongoing
2-3	(PS Gudhamalani)	JN	DI	450	5,990	Ongoing
		TPS Bhedana	DI	300	18,945	Ongoing
		CPS Ratanpura	DI	300	915	Ongoing
3	TPS Bhedana	CPS Kadanari	DI	200	14,575	Ongoing
4	TPS Adel	TPS Koshloo	DI	350	6,500	Ongoing
		CPS Nokhra	DI	N/A	8,765	Ongoing
5	TPS Koshloo	CPS Neembal Kot	DI	N/A	8,730	Ongoing
Total					135,667	

Source: JST based on revised DPR

According to PHED, 2 km out of the total length above is remaining and under construction as of end of September 2020.

3) Cluster Pumping Station

The cluster pumping stations for HR-1 are to be built in the JICA project. The principal feature of the pumping stations are shown in 7.6.2 (2) in this chapter.

7.3 Intake and Raw Water Transmission Facility

7.3.1 Intake and Raw Water Pumping Station for HR-2 Sub-scheme

RD 55 (H-Point), the off-take of the Bhadrai Lift distributary of the Narmada Canal System in Gandhaw, has been considered as the intake location as shown in Figure 7.3.1. The raw water will be transmitted to the raw water reservoir (RWR) at Peeprali by the raw water transmission main with diameter D600 and 17.9 km length. The result of water hammer analysis of the raw water pumping main (PS to RWR) is attached in Appendix-7.5

Source: JST on Google Earth image

Figure 7.3.1 Intake Facility of HR-2

The proposed configuration of the raw water pumping stations based on the revised DPR is shown in Table 7.3.1.

Table 7.3.1 Proposed Pump Configuration at Raw Water Pump Stations (HR-2 Sub-scheme)

				Config. (Running + Standby)	Discharge for Pump Q (m^3/hr) per pump	Head H (m)	KW
1	RD 55.00 km H Point (Gandhaw)	Canal	RWR Peeprali	3+3	371.3	81	160
2	Peeprali (H/W)	RWR	WTP	2+2	557	5	15

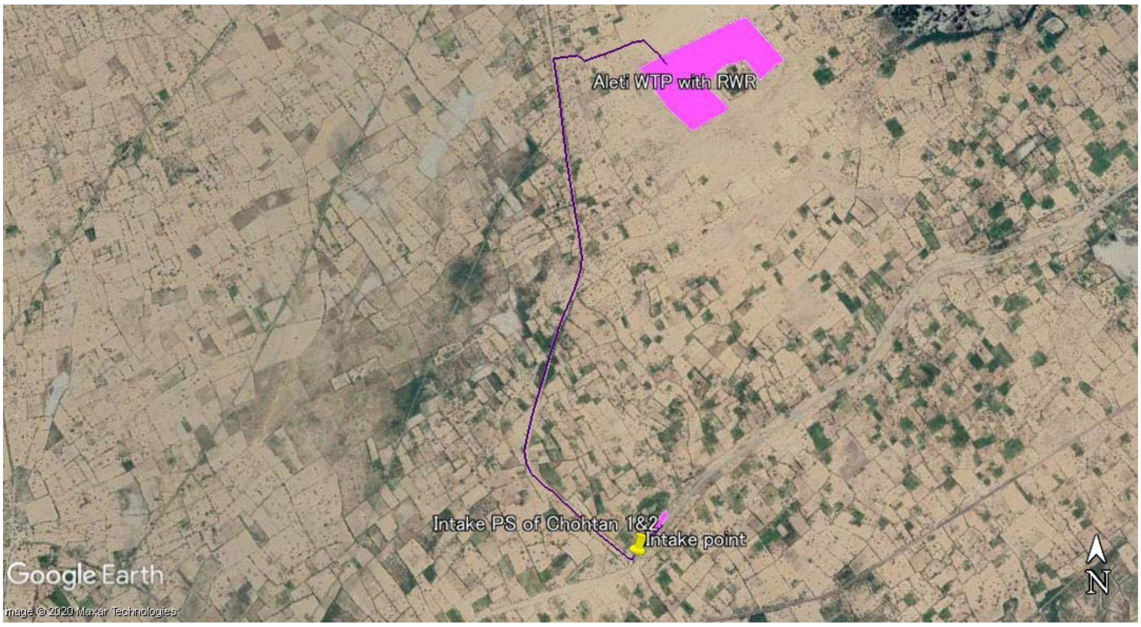
Source: JST based on the revised DPR

7.3.2 Intake and Raw Water Pumping Stations for Chohtan-1 and Chohtan-2

RD 74 (L), 74.00 kms (off take of Bhimguda distributary) of the Narmada Canal System has been considered as the intake location. The location of intake point and pipe line route of the raw water pumping main are shown in Figures 7.3.2 and 7.3.3. The raw water will be transmitted to RWR at Aleti by the raw water transmission main with diameter D1100 and 5.6 km length. The result of water hammer analysis of the raw water pumping main (PS to RWR) is attached in Appendix-7.5

Source: JST on Google Earth image

Figure 7.3.2 Intake Facility of Chohtan 1 and Chohtan 2



Source: JST on Google Earth image

Figure 7.3.3 Raw Water Transmission Main of Chohtan 1 and Chohtan 2

The proposed configuration of the raw water pumping stations based on the revised DPR is shown in Table 7.3.2.

Table 7.3.2 Proposed Pump Configuration at Raw Water Pump Stations (Chohthan-1 Sub-scheme)

				Config. (Running + Standby)	Discharge for Pump Q (m^3/hr) per pump	Head H (m)	KW
1	Intake point near NMC RD.74	Canal	RWR Aleti	4+2	973.3	44	185
2	Aleti (H/W)	RWR	WTP	2+2	1,947	6	55

Source: JST based on the revised DPR

7.4 Raw Water Reservoir

The Raw Water Reservoirs (RWR) are used to store raw water for a definite period of time. The retention time taken for both HR-2 and Chohtan 1 and 2 is 21 days. This retention time was decided in accordance with the non-working period of the canal. The principal features of the RWRs are shown in Table 7.4.1.

Table 7.4.1 Principal Features of the Raw Water Reservoirs for the Barmer Scheme

	HR-2 Sub-scheme	Chohtan-1 and Chohtan-2 Sub-scheme
Location	Peeprali	Aleti
Capacity	257,250 m^3	833,700 m^3
No. of reservoirs	2 units	2 units
Retention time	21 days	21 days
Area	7.91 ha	25.65 ha
Depth	6.5 m	6.5 m

Source: JST based on the revised DPR

7.5 Water Treatment Plant

7.5.1 Design Basis

(1) Design Basis of WTP at Peeprali for HR-2 Sub-scheme

The water treatment plant with 24 MLD (22 hours operation) and an output capacity of 20% hydraulic overloading have been designed conventionally and are based on coagulation, flocculation, and clarification followed by rapid gravity filters.

(2) Design Basis of WTP at Aleti for Chohtan-1 and Chohtan-2 Sub-scheme

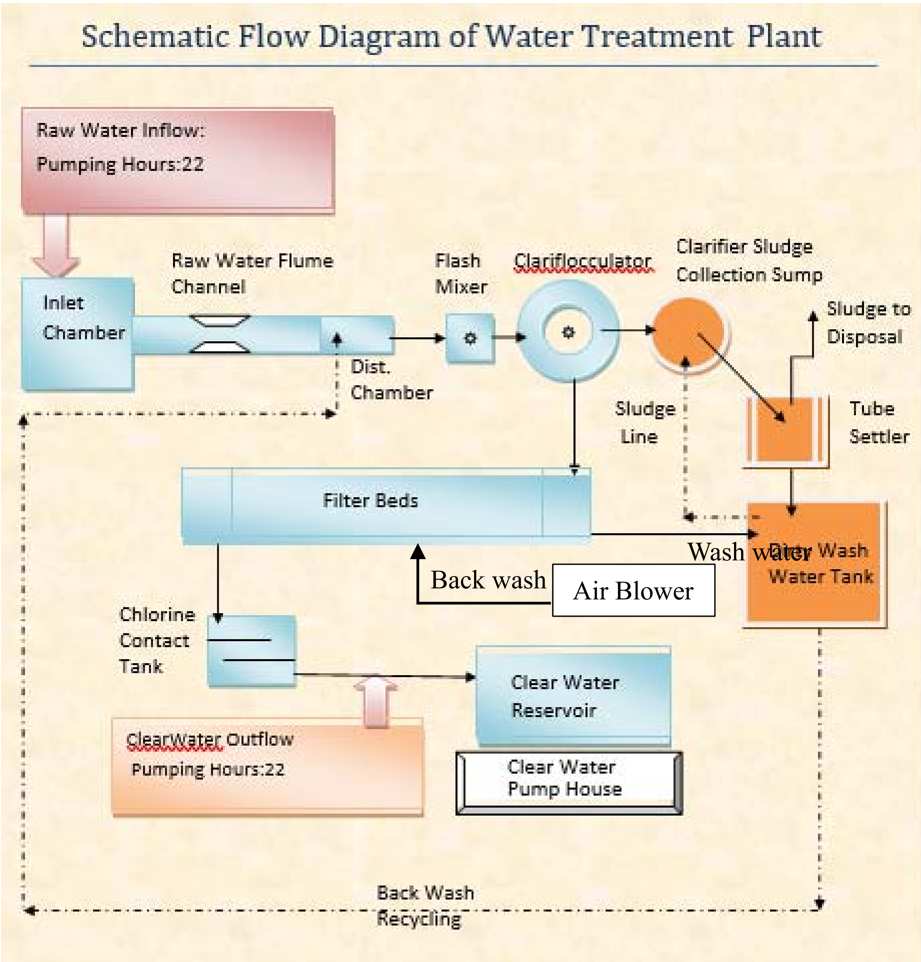
The water treatment plant with 79 MLD (22 hours operation) and an output capacity of 20% hydraulic overloading have been designed conventionally and are based on coagulation, flocculation and clarification followed by rapid gravity filters.

7.5.2 Main Design Considerations for Water Treatment Plant

All interconnecting channels and pipelines have been designed for a hydraulic overloading of 20% over the design flow. The process parameters have been selected as per the Central Public Health and Environmental Engineering Organisation (CPHEEO) manual.

(1) Main Components of WTP

The WTP will consist of the following main components: 1) inlet chamber, 2) raw water channel with parshall flume, 3) distribution chamber, 4) flash mixers, 5) clariflocculators, 6) chemical house, 7) rapid sand gravity filters, 8) elevated service cum backwash reservoir, 9) air scouring blower, 10) back recycling tank, 11) administration and control building, 12) chlorine contact tank, 13) clear water reservoir, 14) bypass arrangement, and 15) sludge handling system.
Figure 7.5.1 shows the schematic flow diagram of a WTP.



Source: "Process & Hydraulic Design for 156 MLD Water Treatment Plant" by the Contractor of the Malsisar headworks (April 2014) revised by JST

Figure 7.5.1 Process Flow Diagram of WTPs in Barmer Scheme

(2) Description and Design Parameters of the Main Components

1) Inlet Chamber

The inlet chamber is a reinforced concrete structure. The raw water from the raw water pumping station (RWPS) will enter into the inlet chamber. The top of the chamber will be accessible through the general walkway along the measuring channel. The inlet chamber will be connected to the drainage system by means of a wall duct and a gate valve. A mild steel ladder will be provided in the chamber to access the bottom. The chlorine solution (for pre-chlorination) will be injected by the bottom mounted diffuser disks or pipes. All inner surfaces of the inlet chamber shall be coated with epoxy paint that is resistive to the aggressive water to avoid corrosion in the acidic environment.

2) Raw Water Channel with Parshall Flume

The raw water will be measured in an open channel by means of a flume. A table or chart with the calibrated values of the flume will indicate the discharge. The measured discharge shall be indicated in the main control room. The flume will be designed according to the IS 14371:1996. The top of the channel will be made accessible by a lateral walkway along the channel. Alum and lime dosing arrangement will be provided at the flume section in order to best utilize the hydraulic jump created by the flume and for thorough mixing of coagulants with raw water.

3) Distribution Chamber

The distribution chamber will provide an equal distribution to each flash mixer. The top of the distribution chamber will be made accessible through the general walkway along the measuring channel. The chamber bottom will be connected to the drainage system by means of a drain pipe and a gate valve with a diameter 150 mm.

4) Flash Mixer

Each flash mixer chamber will be equipped with an impeller type high-speed mixer.

5) Clariflocculator

A conventional type of clariflocculators with an arrangement of central feed and flocculation and clarification will be adopted. Each clariflocculator will be of a circular reinforced concrete (RC) structure having a central area for coagulation and flocculation and outer area for settling. The flocculation zone and the sedimentation zone will be separated by a circular isolation wall. The clarifier will have a peripheral weir with vertically adjustable V-notch weir blades for the uniform surface withdrawal of the clarified water. A bridge with peripheral on-board drive with steel wheels travelling on the steel billets on the peripheral wall will be provided. A radial scraper system with bottom scraper blades, suspended on the bridge will be provided. 4 nos. of independently driven paddle agitators for slow mixing of the incoming raw water in the central unit will be provided. The clariflocculator will be provided with a slopped bottom and with automatic sludge bleeding arrangements.

6) Chemical House

The chemical house will be designed as a two-story building in RC frame structure with brick walls. The ground floor will consist of the chemical storage area (alum and lime) and the toilet. The first floor will consist of the area for chemical solution (alum and lime) tanks with dosing pumps and piping system, laboratory, stair case with common passage.

7) Rapid Sand Gravity Filters:

The filter beds will be a twin bed type with declining rate of filtration. All filters will be identical in terms of its internal dimensions. The operation of backwash pumps and blowers will be automated in reference to the head loss through filters, available water in backwash tank, etc. A properly designed programmable logic controller (PLC) system along with required instrumentation and provision for manual override will be provided to facilitate the automatic operation of the plant from the PLC. In addition, each filter bed will be provided with equipment for the manual operation of backwash system and a local control console for the operation of the backwashing of filter beds.

8) Elevated Service Cum Back Wash Reservoir

The backwash reservoir is a RC structure located above the filter gallery at a fixed elevation that is set according to the requirement of the backwash pressure. The capacity of the reservoir was determined so that it is sufficient to provide the water required for back-washing of two filter boxes simultaneously. It will have a minimum free board of 30 cm. The backwash reservoir filling pumps: 2 nos. (1W+1S) horizontal centrifugal pumps will fill the backwash reservoir in two hours. These pumps will be located in the clear water pump house.

9) Air Scouring Blower:

2 nos. (1W+1S) twin lobe type rotary air blower will be equipped for air scouring of the filter beds. These air blowers will be located in the administration and control building.

10) Backwash Recycling Tank (Dirty Wash Water Tank):

The backwash recycling tank has two compartments, namely the collection sump and supernatant sump. The capacity of each compartment of the backwash recycling tank is sufficiently sized to receive the washed wastewater generated from one filter backwash and also the overflow water from the tube settler of the sludge handling system. While one compartment is receiving the influent, the other compartment will be kept under settling. After settling, the supernatant will be recycled back to the upstream channel of the distribution chamber. The bottom settled sludge will be pumped periodically to the sludge draining system by portable submersible non-clog sludge pumps.

11) Administration and Control Building:

The admin and control building will consist of the air blower room, MCC room, laboratory room, staff room, and toilet block.

12) Chlorine Contact Tank (CCT):

The chlorine contact tank will be a RC structure. It will be fed from the filtered water channel. It will be designed to provide a minimum of 20 minutes hydraulic retention time. All internal and external surfaces of the tank will be provided with 20 mm thick 1:3 cement mortar (cement: sand = 1:3). In addition, food grade epoxy paint will be applied on all internal surfaces of the CCT. A suitable number of vents will be provided in the tank for ventilating free chlorine. Baffles will be constructed in the CCT for the creation of back mixing. The chlorine solution will be injected by bottom mounted diffuser disks.

13) Clear Water Reservoir (CWR)

The clear water from the CCT will be collected in to the CWR which has two compartments.

14) Bypass Arrangement:

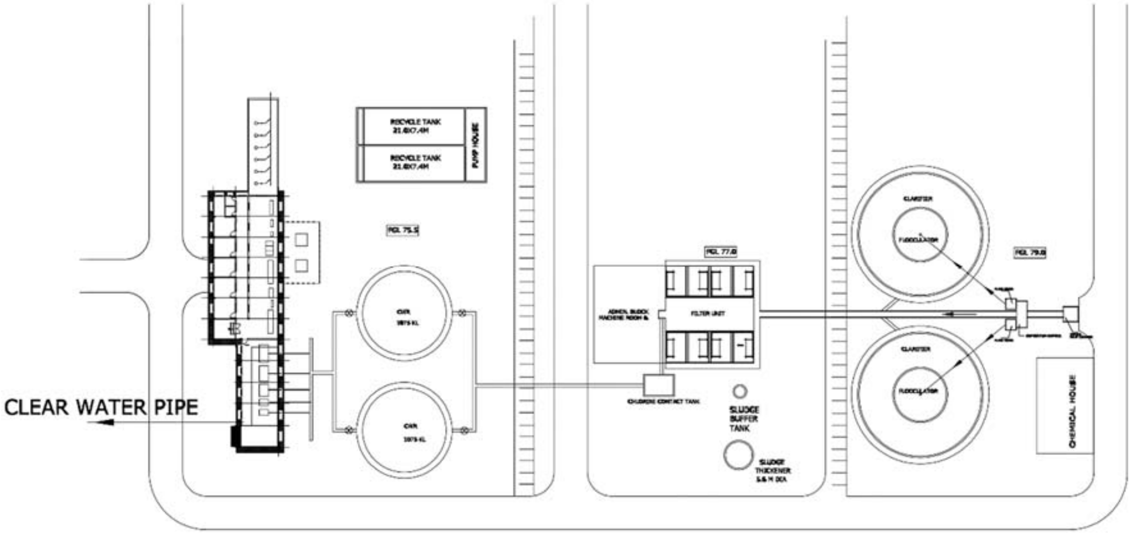
The bypass arrangement will be made between the flash mixer inlet and the clariflocculator outlet through a bypass gate provided at the distribution chamber.

15) Sludge Handling System

The sludge handling system will consist of a clarifier sludge collection sump and tube settler. The clarifier sludge collection sump is an underground RC sump in which sludge from all the clariflocculators will be collected by gravity. The settled sludge from the backwash recycling tank will also be periodically pumped to the clarifier sludge collection sump. The collected sludge will be pumped to tube settler for settling. The overflow water from the tube settler will be sent to backwash recycle tank from where it will be recycled back to the raw water distribution chamber. The settled sludge from the bottom of the tube settler will be suitably disposed of in an environmentally friendly manner.

7.5.3 Peeprali Water Treatment Plant for HR-2 Sub-scheme

The new water treatment plant will be constructed in Peeprali. Figure 7.5.2 shows the schematic layout of the WTP. The detailed design will be conducted by the contractor under a design-build contract.

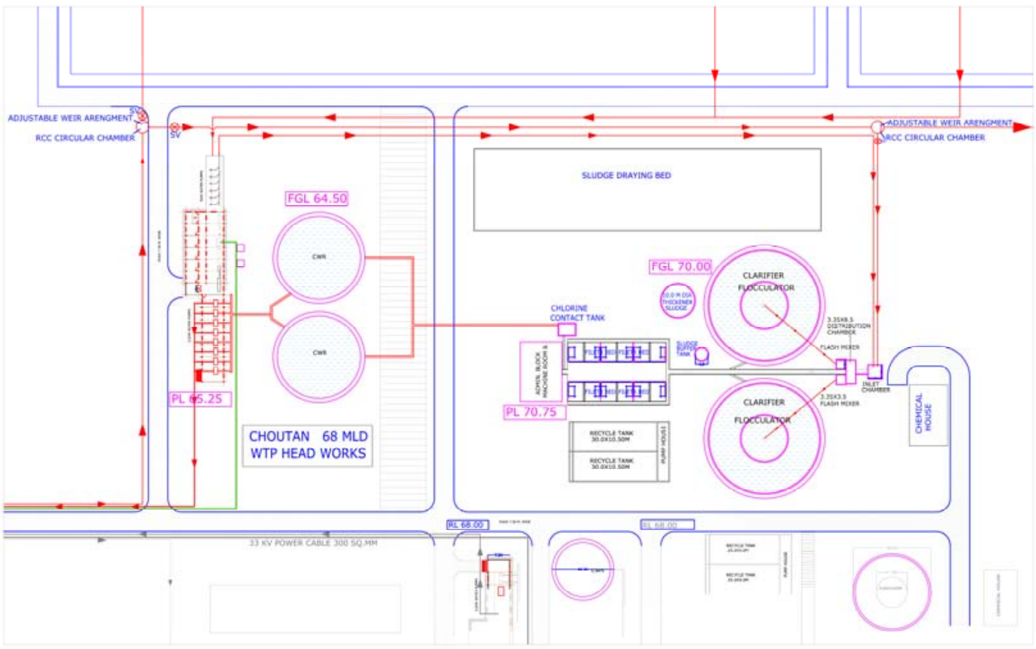


Source: Original DPR

Figure 7.5.2 General Layout of Peeprali WTP for HR-2 Sub-scheme

7.5.4 Aleti Water Treatment Plant for Chohtan-1 and Chohtan-2 Sub-scheme

The new water treatment plant will be constructed in Aleti. Figure 7.5.3 shows the general layout of the WTP. The detailed design will be conducted by the contractor under a design-build contract.



Source: Original DPR

Figure 7.5.3 General Layout of Aleti WTP for Chohtan-1 and Chohtan-2 Sub-scheme

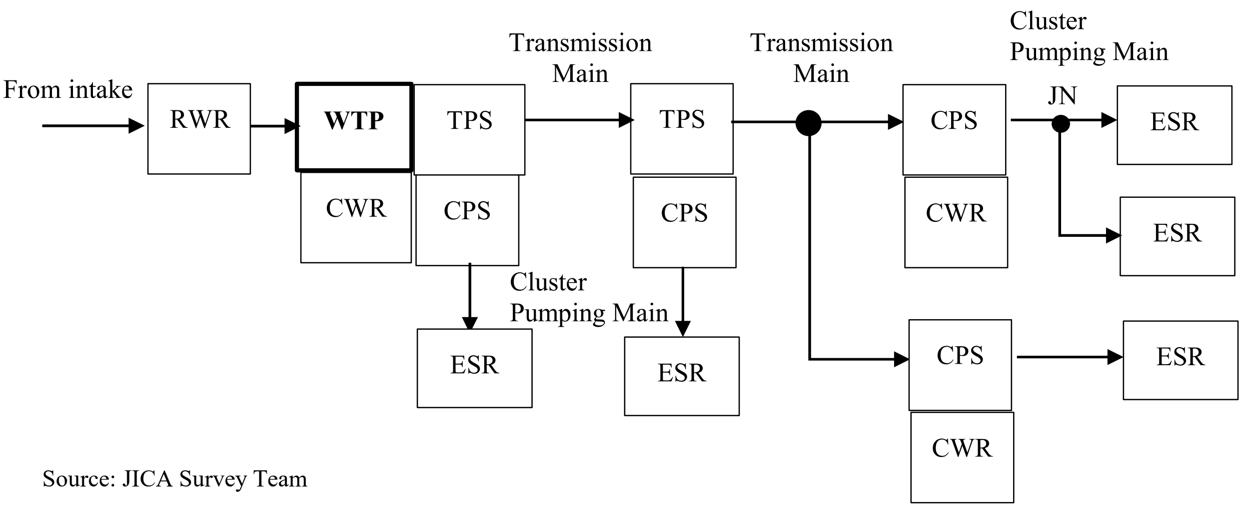
7.6 Water Transmission System

7.6.1 Outline of the Transmission System

The transmission system is composed of the following facilities:

1. Transmission main (clear water pumping main) from WTP
2. Transfer pumping station (TPS)
3. Transmission main from TPS to cluster pumping station (CPS)
4. CPS to ESRs (one per each cluster)
5. Clear water reservoirs (CWR) in pumping stations

Almost all the transmission mains are using pressure flow by pumps except for some sections from the junction on the transmission main to the lower CPS.



Source: JICA Survey Team

Figure 7.6.1 Water Transmission Facility for Barmer Scheme

The schematic diagram of transmission facilities is shown in Appendix-7.2.

7.6.2 Facility Design of the Transmission System

The facility design has been conducted in accordance with the "Manual on Water Supply and Treatment Third Edition Revised and Updated, CPHEEO 1999" and the "Manual for Preparation of Detailed Project Report for Rural Piped Water Supply Schemes, MoDWS 2013".

(1) Hydraulic Design

The head loss in the pipeline was calculated using the formula presented in "Section 6.2.4 Modified Hazen-Williams Formula" in the "Manual on Water Supply and Treatment Third Edition Revised and Updated, CPHEEO 1999":

$h = [L(Q/C_R)^{1.81}]/994.62\ D^{4.81}$

where,

h = friction head loss in m

L = length of pipe in m

Q = flow in pipe in m^3/s

C_R = Pipe roughness coefficient (1 for smooth pipes, <1 for rough pipes)

D = internal diameter of pipe in m

The design parameters for the mechanicals and electricals are shown in Table 7.6.1.

Table 7.6.1 Factors/Parameters to be Considered

Design period: (years)	2055
Combined efficiency of pump set: (%)	60
Standby pumps: (%)	Main pumps: 100
	Cluster pumps: 100
Cost of pumping unit: (INR/kW)	12,250
Interest rate: (%)	10.0
Life of electric motor and pump set: (years)	15
Energy charges per kWh: (INR/kWh)	5.5
Pumping hours for discharge at the end of 15 years: (hours)	Main pumping stations: 22 hrs
	Other pumps: 16 hrs

Source: JST based on the revised DPR

The pipe diameter was determined so that the residual head at the inlet of each tank/reservoir is more than 3 m considering the head loss at the inlet piping. The optimization of the pipe diameter considering the total lifecycle cost including O&M cost was conducted. The hydraulic calculation sheets of transmission pumping main are attached in Appendix-7.4.

(2) Result of Hydraulic Design of Pumping Station and Pumping Main

1) HR-1 and HR-2 Sub-scheme

a) Works for HR-2 Sub-scheme (West of Gudhamalani)

i) Transfer Pumping Station (HR-2)

The transfer pumping stations (TPS) and transmission mains proposed by the JICA Survey Team based on the revised DPR are shown in Table 7.6.2.

Table 7.6.2 Proposed Transfer Pumping Stations for HR-2 Sub-scheme

No.	Location	To	Pump specifications					Transmission mains		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Total flow (m^3/h)	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
1	Peeprali WTP	JN.	527	6	22	4 (2W+2S)	1,054	600 DI K7	6,220	23,175
		JN. Highest pt.						150 DI K7	2,355	-
		JN.highest pt .2						600 DI K7	11,300	-
		CWR Borcharan						150 DI K7	1,700	1,168
		CWR Loharwa						600 DI K7	654	22,007
2	TPS Loharwa	CWR Sobhala Jetmal	229	101	132	4 (2W+2S)	458	400 DI K9	17,212	10,039
		JN.	440	64	160	2 (1W+1S)	440	400 DI K7	5,560	9,684
		JN.highest point						250 DI K7	1,780	-
		CWR Dhorimana						300 DI K7	5,370	5,785
		CWR Misari ki beri						250 DI K7	1,390	3,899
3	TPS Sobhala Jetmal	CWR Meethiya Ka Tala	268	59	90	2 (1W+1S)	268	300 DI K7	13,912	5,878

Source: JST based on the revised DPR

ii) Cluster Pumping Station (HR-2)

In total, the seven cluster pumping stations (CPS) including the ones in the TPS are proposed for the HR-2 and is based on the revised DPR as shown in Table 7.6.3 to Table 7.6.6.

Table 7.6.3 Proposed Cluster Pumping Stations for HR-2 Sub-scheme (1)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
1	Peeprali WTP	ESR Punja Beri (CL-43)	25	49	7.5	2 (1W+1S)	100 DI K7	5,729	393
2	TPS Loharwa	ESR Loharwa (CL-20)	33	46	7.5	2 (1W+1S)	100 DI K7	500	515
		JN.07	66	64	22	2 (1W+1S)	200 DI K7	1,765	1,052
		ESR Savon ka Goliya (CL-21)					100 DI K7	795	343
		JN.08					150 DI K7	4,560	-
		ESR Joona Khera (CL-12)					100 DI K7	1,075	211
		ESR Naya Moodhsar (CL-53)					100 DI K7	800	214
		ESR Sanwara kalan (CL-22)					100 DI K7	1,450	284
		JN.6	62	107	37	2 (1W+1S)	150 DI K9	2,830	987
		ESR Seelgan (CL-19)					100 DI K9	2,672	318
		JN.					100 DI K7	4,776	-
		ESR Bhimthal (CL-18)					100 DI K7	1,395	385
		ESR Moodhsar (CL-53)					100 DI K7	820	284
3	TPS Sobhala Jetmal	ESR Sobhala Jetmal (CL-05)	28	36	5.5	2 (1W+1S)	100 DI K7	405	435
		JN.29	87	99	45	2 (1W+1S)	200 DI K9	5,100	1,391
		ESR Dudapur (CL-32)					100 DI K9	2,137	211
		JN.30					200 DI K9	3,100	-
		ESR Kalapura (CL-31)					100 DI K9	4,028	362
		JN.31					150 DI K9	5,260	-
		ESR Bhomiyon ka Than (CL-34)					100 DI K7	460	310
		ESR Vinayak Nagar (CL-42)					100 DI K7	5,580	508
		JN.27	83.4	138	75	2 (1W+1S)	200 DI K9	7,608	1,334
		ESR Laxmanpura (CL-35)					100 DI K9	2,425	357
		ESR Dharampura (CL-55)					100 DI K9	2,801	269
		JN.28					150 DI K9	3,760	-
		ESR Shiv Nagar (CL-36)					100 DI K9	1,316	360
		ESR Panchaniyon ki Dhani (CL-04)					100 DI K9	4,940	348
		JN.25	63	96	30	2 (1W+1S)	150 DI K9	1,100	1,001
		ESR Shashi Nadi (CL-06)					100 DI K9	4,600	247
		JN.26					150 DI K9	3,611	-
		ESR Megwalo ki Tala (CL-07)					100 DI K9	3,071	402
		ESR Khardiya (CL-02)					100 DI K9	4,840	352

Source: JST based on the revised DPR

Table 7.6.4 Proposed Cluster Pumping Stations for HR-2 Sub-scheme (2)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
4	CPS Borcharan	JN.02	73	105	45	2 (1W+1S)	200 DI K9	1,847	1,168
		JN.03					200 DI K9	933	-
		ESR Beranon ka Tala (CL-50)					100 DI K7	3,530	500
		JN.04					150 DI K7	1,105	-
		ESR Janiyon ki dhani (CL-49)					100 DI K7	1,640	290
		JN.05					100 DI K7	3,000	-
		ESR Bhadrai (CL-51)					100 DI K7	3,710	378
5	CPS Misari ki Beri	ESR Misari ki Beri (CL-13)	35	22	5.5	2 (1W+1S)	150 DI K7	800	554
		JN.09	53.23	35	11	2 (1W+1S)	150 DI K7	2,100	852
		ESR Bhilon ki Dhani (CL-25)					100 DI K7	162	483
		ESR Kharad (CL-27)					100 DI K7	3,084	368
		JN.13	84	115	55	2 (1W+1S)	200 DI K9	2,727	1,340
		ESR Rawon ki beri (CL-15)					100 DI K9	2,893	207
		JN.14					200 DI K9	7,300	-
		ESR Alamsar khurd (CL-33)					100 DI K7	5,390	444
		ESR Rohilla (CL-41)					150 DI K7	150	690
		JN.10	72.1	123	45	2 (1W+1S)	200 DI K9	5,118	1,153
		JN.11					200 DI K9	3,166	-
		ESR Bhilon ki basti (CL-14)					100 DI K9	2,383	363
		JN.12					150 DI K9	6,024	-
		ESR Sridevanagar (CL-38)					100 DI K7	2,905	405
		ESR Mukne ka tala (CL-37)					100 DI K7	3,077	385

Source: JST based on the revised DPR

Table 7.6.5 Proposed Cluster Pumping Stations for HR-2 Sub-scheme (3)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
6	CPS Dhorimana	JN.highest point	117.3	169	110	2 (1W+1S)	200 DI K9	3,900	1,877
		JN.22					250 DI K9	7,210	-
		ESR Koja (CL-10)					100 DI K9	115	412
		JN.23					200 DI K9	1,022	-
		ESR Kanaiya Nagar(CL-11)					100 DI K9	130	353
		JN.24					200 DI K9	5,363	-
		ESR Jal Beri (CL-08)					150 DI K9	5,351	702
		ESR Koliyana (CL-09)					150 DI K7	8,540	410
		JN.20	132	129	90	2 (1W+1S)	200 DI K9	2,318	2,110
		ESR Nedi Nari (CL-28)					150 DI K9	4,515	599
		JN.21					200 DI K9	1,242	-
		ESR Dhorimana (CL-26)					200 DI K7	126	1,116
		ESR Hirkrn ka than (CL-54)					150 DI K7	7,500	396
		JN.18	40	102	22	2 (1W+1S)	150 DI K9	6,092	636
		JN.19					150 DI K9	3,050	-
		ESR Methra Khurd (CL-16)					100 DI K9	310	330
		ESR Lolo ki Beri (CL-17)					100 DI K9	4,010	306
		JN.15	73	125	45	2 (1W+1S)	200 DI K9	3,031	1,162
		JN.16					100 DI K9	1,671	-
		ESR Katarla Khileriyan (CL-30)					100 DI K7	1,959	347
		JN.17					150 DI K7	1,355	-
		ESR Sudaberi Khurd (CL-29)					100 DI K7	5,265	462
		ESR Guneshaniyon ki Dhani (CL-52)					100 DI K7	560	353

Source: JST on the revised DPR

Table 7.6.6 Proposed Cluster Pumping Stations for HR-2 Sub-scheme (4)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
7	CPS Meethiya Tala	JN.39	90.5	127	75	2 (1W+1S)	200 DI K9	890	1,447
		ESR Doodiya kalan(CL-03)					100 DI K9	2,011	317
		JN.40					200 DI K9	4,308	-
		ESR Roogpura (CL-48)					100 DI K7	100	277
		ESR Bachhraoo (CL-47)					150 DI K7	5,527	853
		JN.36	179	126	132	2 (1W+1S)	250 DI K9	5,833	2,864
		JN.37					150 DI K9	7,132	-
		ESR Musalmano ki dhani(CL-24)					100 DI K9	292	464
		ESR Bhalisar (CL-23)					100 DI K9	3,980	409
		JN-41					200 DI K9	670	-
		ESR Bamnor Ameershah (CL-44)					150 DI K9	6,705	776
		JN.38					200 DI K9	1,571	-
		ESR Mithabera (CL-46)					150 DI K7	125	677
		ESR Pingalpura(CL-45)					150 DI K7	7,360	538
		JN.32	98	75	37	2 (1W+1S)	200 DI K9	100	1,567
		ESR Mangta (CL-01)					150 DI K9	5,558	687
		JN.34					150 DI K9	2,869	-
		ESR Swamiyan ki beri (CL-40)					100 DI K7	286	343
		ESR Eklavya Nagar (CL-39)					150 DI K7	5,072	537

Source: JST based on the revised DPR

iii) Clear Water Reservoir (CWR) with Pump House

The clear water reservoirs will be constructed at the transfer pumping stations including head works and cluster pumping stations for storage and onward supply.

The capacities of all these CWRs have been worked out based on the two hours pumping/flow capacity of the demand for the ultimate target year 2055. The CWRs are proposed with a provision of an inlet chamber connected to both parts of the CWR to facilitate clear water entry.

The proposed clear water reservoir for HR-2 Sub-scheme is shown in Table 7.6.7.

Table 7.6.7 Proposed CWRs for HR-2 Sub-scheme

Sr. No.	Location of CWR	Provided Capacity (m^3)
1	Peeprali WTP	1,600
2	TPS Loharwa	1,500
3	TPS Shobhala Jetmal	1,000
4	CPS Meethiya Tala	600
5	CPS Dhorimanna	550
6	CPS Misari Ki Beri	350
7	CPS Borcharnan	100

Source: JST based on the revised DPR

b) Works for HR-1 Sub-scheme (East of Gudhamalani)

i) Cluster Pumping Station (HR-1 Sub-scheme)

The construction of transfer pumping stations (TPS) is ongoing as mentioned in Subsection 7.2.2. In addition, a total of 12 cluster pumping station (CPS) are proposed as part of the JICA scope for HR-1 in the revised DPR. The JICA Survey Team proposed the configurations of pumps and pumping mains based on the DPR review as shown in Table 7.6.8 to Table 7.6.11.

Table 7.6.8 Proposed Cluster Pumping Stations for HR-1 Sub-scheme (1)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
1	Dheemri WTP	JN.	73	55	22	2 (1W+1S)	200 DI K7	4,610	1,162
		ESR Aalpura (CL-25)					150 DI K7	2,400	877
		ESR Bheemgarh (CL-24)					100 DI K7	7,427	285
		JN.	44.1	90	22	2 (1W+1S)	150 DI K9	4,610	706
		ESR Roli (CL-21)					100 DI K9	2,400	368
		ESR Gadevi (CL-22)					100 DI K9	7,427	338
2	CPS Berigaon	ESR Berigaon (CL-14)	41	28	7.5	2 (1W+1S)	150 DI K7	100	647
		JN.high	46	120	30	2 (1W+1S)	150 DI K9	7,360	736
		JN.					150 DI K9	2,665	
		ESR Manglasar (CL-79)					100 DI K7	2,995	410
		ESR Shiv ji ka Mandir (CL-80)					100 DI K7	2,505	326
		JN.	47.2	68	18.5	2 (1W+1S)	150 DI K7	4,910	755
		ESR Ram ji ka gol (CL-23)					100 DI K7	413	342
		ESR Panawali (CL-15)					100 DI K7	1,216	413
		JN.	57	60	18.5	2 (1W+1S)	200 DI K7	425	909
		ESR Gandhaw kalan (CL-16)					100 DI K7	6,822	312
		ESR Paliyali (CL-17)					150 DI K7	5,895	597
3	TPS Gudamalani	JN.	98	96	55	2 (1W+1S)	200 DI K9	2,790	1,568
		ESR Gudamalani (CL-30)					200 DI K7	2,115	1,085
		ESR Borli (CL-13)					100 DI K7	3,215	483
		JN.	52	110	30	2 (1W+1S)	150 DI K9	8,607	825
		ESR Gormaniyon ki Dhani (CL-09)					100 DI K7	5,872	228
		ESR Nagar (CL-08)					100 DI K7	1,630	597
		JN.	122	59	37	2 (1W+1S)	200 DI K7	830	1,944
		ESR Dabad (CL-29)					150 DI K7	2,420	703
		JN.01					200 DI K7	2,256	
		ESR Mokhwa (CL-31)					150 DI K7	7,435	744
		ESR Barasan (CL-12)					150 DI K7	8,210	498

Note: JN: junction
Source: JST based on the revised DPR

Table 7.6.9 Proposed Cluster Pumping Stations for HR-1 Sub-scheme (2)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
4	CPS Mangle ki Beri	ESR Chotu (CL-39)	20	78	7.5	2 (1W+1S)	100 DI K9	109	305
		JN-13	95.5	109	55	2 (1W+1S)	200 DI K9	4,246	1,528
		ESR Aasuon ki Dhani(CL-45)					150 DI K9	2,198	612
		JN-14					150 DI K7	85	
		ESR Mangle ki Beri (CL-54)					100 DI K7	1,885	473
		ESR Khoobri Beri (CL-47)					100 DI K7	6,515	443
		JN-12	43	90	22	2 (1W+1S)	150 DI K9	9,567	681
		ESR Shivpura (CL-07					100 DI K7	725	301
		ESR Nehron ka Was (CL-06)					150 DI K7	4,010	380
5	CPS Khadali	ESR Khadali (CL-11)	31	65	11	2 (1W+1S)	100 DI K7	1,112	487
		JN.	105.1	132	75	2 (1W+1S)	250 DI K9	7,761	1,682
		ESR Band (CL-52)					150 DI K9	980	923
		JN, high pt.					150 DI K9	2,179	
		ESR Adarsh Goliya (CL-41)					200 DI K7	6,266	759
		JN.	40	89	22	2 (1W+1S)	150 DI K9	9,270	640
		ESR Ramasar khurd (CL-53)					100 DI K7	55	541
		ESR Bakani Sarnon ki Dhani (CL-42)					100 DI K7	6,250	99
6	CPS Nokhra	ESR Adarsh Chhotu (CL-40	51	79	22	2 (1W+1S)	150 DI K9	1,875	801
		JN.	95.5	99	55	2 (1W+1S)	200 DI K9	2,891	1,528
		ESR Ankhiya (CL-50)					100 DI K7	3,195	345
		JN.01					200 DI K7	3,985	
		ESR Hukmani Khoton ki Dhani (CL-43)					150 DI K7	395	600
		ESR Daukiyo ki Dhani (CL-44)					150 DI K7	4,517	583
		JN.	51	76	22	2 (1W+1S)	150 DI K9	310	809
		ESR Sadecha (CL-34)					150 DI K7	6,935	550
		ESR Hudon ka Tala (CL-51)					100 DI K7	4,371	259
		JN.	43.3	87	22	2 (1W+1S)	150 DI K9	70	693
		ESR Nokhra (CL-48)					100 DI K9	870	299
		ESR Nehron ka Tala (CL-49)					100 DI K9	1,875	394

Source: JST based on the revised DPR

Table 7.6.10 Proposed Cluster Pumping Stations for HR-1 Sub-scheme (3)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
7	CPS Neembal kot	JN.high pt.	65.2	117	45	2 (1W+1S)	200 DI K9	4,720	1,043
		JN.					200 DI K9	5,120	-
		ESR Jogasar (CL-77)					150 DI K9	7,513	474
		ESR Pananiyon ka Tala (CL-76)					150 DI K9	4,506	569
		JN.	94	94	55	2 (1W+1S)	200 DI K9	1,155	1,498
		ESR Janiyon ki Dhani (CL-33)					150 DI K7	100	631
		ESR Khariya Khurd (CL-35)					150 DI K7	3,968	867
		JN.high	47	105	30	2 (1W+1S)	150 DI K9	4,730	750
		JN.					150 DI K9	3,630	
		JN. High pt.					100 DI K7	2,102	
		ESR Meethiyawas (CL-78)					100 DI K7	1,285	468
		ESR Potliyon ki Dhani (CL-75)					100 DI K7	2,700	282
8	TPS Koshlou	JN-33	134	122	90	2 (1W+1S)	250 DI K9	5,084	2,103
		ESR Saranon Ka Tala (CL-65)					100 DI K9	100	231
		JN-34,35					200 DI K9	4,104	-
		ESR Bhalkari(CL-71)					100 DI K7	4,085	420
		JN.02					200 DI K7	8,240	-
		ESR Payla Kalla (CL-55)					150 DI K7	310	1,016
		ESR Motisara (CL-70)					150 DI K7	4,385	437
		JN.	61	87	30	2 (1W+1S)	150 DI K9	100	970
		ESR Neeriya Nada (CL-56)					150 DI K9	7,670	317
		ESR Megwalon kidhani (CL-36)					150 DI K9	3,625	653
		JN.	104	93	55	2 (1W+1S)	200 DI K9	2,230	1,658
		JN.01					200 DI K9	2,270	
		ESR Sara Jhoond (CL-63)					100 DI K7	755	396
		JN.02					200 DI K7	7,189	
		ESR Sara(CL-61)					100 DI K7	50	501
		JN.03					150 DI K7	4,221	
		ESR Bhatala (CL-62)					100 DI K7	280	258
		ESR Khudala (CL-72)					150 DI K7	4,005	503
		JN-31	64	91	30	2 (1W+1S)	150 DI K9	7,845	1,024
		ESR Vishnu Mandir Ka Bas (CL-59)					150 DI K7	100	692
		ESR Ed Amar Singh (CL-60)					100 DI K7	6,132	333

Source: JST based on the revised DPR

Table 7.6.11 Proposed Cluster Pumping Stations for HR-1 Sub-scheme (4)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
9	CPS Kadnari	JN-46	96.1	122	75	2 (1W+1S)	200 DI K9	3,420	1,537
		ESR Kadnari (CL-57)					100 DI K9	50	328
		JN-47					200 DI K9	3,338	-
		ESR Thavon ki Dhani (CL-58)					100 DI K9	3,686	335
		JN-48					150 DI K9	5,268	
		ESR Loona Kalan (CL-69)					150 DI K7	605	598
		ESR Amarpura (CL-68)					100 DI K7	6,558	276
10	TPS Bhedana	ESR Deonagar (CL-19)	22	23	3.7	2 (1W+1S)	100 DI K7	100	339
		JN.	122	65	45	2 (1W+1S)	200 DI K7	100	1,945
		ESR Sarswati Nagar (CL-18)					150 DI K7	6,375	531
		JN.01					200 DI K7	1,302	-
		ESR Songaro ki Dhani (CL-74)					150 DI K7	5,650	803
		ESR Loonwajageer (CL-32)					150 DI K7	3,620	611
		JN.	91	82	37	2 (1W+1S)	200 DI K9	5,130	1,449
		ESR Prabhu Nagar (CL-64)					100 DI K7	3,875	287
		JN.01					200 DI K7	3,275	-
		ESR Toonkiya (CL-66)					150 DI K7	5,985	693
		ESR Talbariyo ki dhani (CL-67)					100 DI K7	200	470
11	CPS Ratanpura	ESR Ratanpura (CL-27)	35	25	5.5	2 (1W+1S)	150 DI K7	100	558
		JN.	52.4	83	22	2 (1W+1S)	150 DI K9	1,214	838
		ESR Dedawas Charan (CL-28)					150 DI K7	5,910	574
		ESR Koda (CL-26)					100 DI K7	5,649	264
		JN.	104	73	45	2 (1W+1S)	200 DI K9	4,016	1,658
		ESR Bhakharpura (CL-03)					100 DI K7	165	408
		JN.01					200 DI K7	4,973	-
		ESR Sindhasawa Harniyan (CL-01)					150 DI K7	150	750
		ESR Salu ki Dhani (CL-02)					150 DI K7	7,283	500
		JN.	66.1	75	30	2 (1W+1S)	200 DI K9	4,035	1,058
		ESR Baroodi (CL-04)					150 DI K7	3,730	559
		ESR Kharwa (CL-05)					100 DI K7	3,402	499
12	TPS Adel	ESR Saiylon ka tala (CL-38)	14	42	3.7	2 (1W+1S)	100 DI K7	3,645	223
		ESR Adel (CL-37)	48	45	11	2 (1W+1S)	150 DI K7	55	755

Source: JST based on the revised DPR

ii) Clear Water Reservoir (CWR) with Pump House

The proposed capacities of the CWRs for HR-1 are shown in Table 7.6.12. The reservoirs for TPSs are under construction. The ones for the CPSs will be constructed in the proposed JICA project.

Table 7.6.12 Proposed CWRs for HR-1 Sub-scheme

S.No.	Location	Capacity (m^3)
1	Dheemri WTP	260 (under construction)
2	TPS Gudhamalani	3,230 (“)
3	TPS Adel	1,640 (“)
4	TPS Bhedna	1,040 (“)
5	TPS Koshlu	850 (“)
6	CPS Kadanari	150
7	CPS Beri Gaon	300
8	CPS Khadali	250
9	CPS Neembal Kot	300
10	CPS Nokhra	350
11	PS Mangle Ki Beri	250
12	PS Ratanpura	400

Source: JST based on the revised DPR

2) Chohtan-1 Sub-scheme

a) Transfer Pumping Station

The transfer pumping stations (TPSs) including the one in Aleti WTP for Chohtan-1 Sub-scheme shown in Table 7.6.13.

Table 7.6.13 Proposed Transfer Pumping Stations for Chohtan-1 Sub-scheme

PS	To	Pump specifications					Transmission mains		
		Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Total flow (m^3/h)	Pipe size (mm)	Pipe length (m)	Ultimate flow (m^3/d)
Aleti PS	CWR Peepliberi	919.3	24	110	6 (4W+2S)	3,677	1000 DI K9	25,000	80,885
TPS Peepliberi	CWR Karatiya	533	40	110	4 (2W+2S)	1,066	600 DI K7	12,500	23,442
	JN.highest point	608.3	99	315	6 (4W+2S)	2,433	900 DI K9	32,700	53,526
	JN						900 DI K9	350	-
	CWR Dhannau						900 DI K9	5,050	43,129
	CWR Jakhron ka Tala						400 DI K9	200	10,397
TPS Karatiya	CWR Phagaliya	398	74	150	4 (2W+2S)	796	450 DI K9	18,500	17,498
TPS Jakhron ka Tala	CWR Bhron ka Tala	121	40	30	2 (1W+1S)	121	250 DI K7	16,200	2,643
TPS Dhannau	CWR Alamsar	220	119	132	4 (2W+2S)	440	350 DI K9	16,680	9,648
	CWR Kharawala	331	88	160	4 (2W+2S)	662	450 DI K9	16,680	14,523
	JN.	303.32	130	200	6 (3W+3S)	910	600 DI K9	3,854	20,019
	JN.highest pt						450 DI K9	15,300	-
	JN.7						350 DI K9	11,700	
	CWR Ibrahim ka tala						450 DI K9	645	11,973
	CWR Gohar ka tala						350 DI K9	8,110	8,047
TPS Phagaliya	JN.	278	89	132	4 (2W+2S)	556	450 DI K9	9,100	12,219
	JN.highest point						300 DI K9	2,300	-
	CWR Fakiro ka niwan						300 DI K9	8,460	5,950
	CWR Sata						300 DI K9	10,900	6,269

Source: JST based on the revised DPR

b) Cluster Pumping Station

The list of cluster pumping stations for Chohtan-1 Sub-scheme is shown in Table 7.6.14 to Table 7.6.16.

Table 7.6.14 Proposed Cluster Pumping Stations for Chohtan-1 Sub-scheme (1)

No.	Location	Destination (ESR)	Pump specifications				Pumping mains		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
1	Aleti WTP	ESR Aleti (CL-23)	38	23	5.5	2 (1W+1S)	150 DI K7	250	597
		JN.03	103.3	92	55	2 (1W+1S)	200 DI K9	7,567	1,652
		ESR Pratap Nagar (CL-22)					100 DI K9	2,275	465
		JN.01					150 DI K9	4,265	
		ESR Radoo (CL-14)					100 DI K9	4,830	300
		JN.02					150 DI K9	730	
		ESR Dhakon ka Goliya (CL-16)					100 DI K9	4,300	450
		ESR Arniyali (CL-21)					100 DI K9	680	438
2	TPS Peepliberi	ESR Bamarla (CL-18)	40	72	15	2 (1W+1S)	150 DI K7	6,000	632
		JN.05	110.2	75	45	2 (1W+1S)	200 DI K9	5,543	1,763
		ESR Maylon ki Beri (CL-15)					200 DI K9	8,088	803
		JN-06					150 DI K9	1,118	
		ESR Bhawanipura (CL-24)					150 DI K9	79	584
		ESR Chalkana (CL-25)					100 DI K9	2,838	375
		JN.04	95.1	90	45	2 (1W+1S)	200 DI K9	1,140	1,522
		JN.07					200 DI K9	2,615	
		ESR Bharte ki beri (CL-05)					150 DI K9	3,430	553
		JN.08					200 DI K9	8,087	
		ESR Moti ki beri(CL-19)					150 DI K9	621	638
		ESR Bhagbre ki beri(CL-13)					100 DI K9	3,384	332
3	TPS Jakhron ka Tala	ESR Kitnoriya (CL-04)	40	51	11	2 (1W+1S)	150 DI K7	5,600	635
		JN.44	103	112	75	2 (1W+1S)	200 DI K9	19,325	1,647
		ESR Salariya (CL-58)					100 DI K7	1,175	528
		JN.46					200 DI K7	4,075	
		ESR Sinhar (CL-10)					100 DI K7	485	510
		ESR Harpaliya (CL-29)					150 DI K7	5,870	609
		JN.42	118.3	75	45	2 (1W+1S)	200 DI K9	2,890	1,892
		ESR Jakhron ki dhani (CL-64)					100 DI K7	147	511
		JN.43					200 DI K7	3,565	
		ESR Shobhala Darsan (CL-07)					150 DI K7	8,690	808
		ESR Mandon ki Beri (CL-06)					150 DI K7	8,550	573
		JN.39	141	87	75	2 (1W+1S)	200 DI K9	7,056	2,254
		ESR Sanwa (CL-08)					150 DI K7	435	803
		JN.40					200 DI K7	4,972	
		ESR Burhan ka tala (CL-09)					150 DI K7	3,005	804
		ESR Poonjasar (CL-57)					150 DI K7	3,640	648
		JN.41	83	72	30	2 (1W+1S)	200 DI K7	9,125	1,326
		ESR Kundanpura (CL-63)					100 DI K7	1,110	571
		ESR Serwa (CL-11)					150 DI K7	8,586	755
4	TPS Dhannau	ESR Dhannau (CL-02)	59	69	22	2 (1W+1S)	150 DI K7	2,060	940
		JN.48	63	73	30	2 (1W+1S)	150 DI K9	100	1,008
		ESR Kumbhaniyon ka Tala (CL-01)					150 DI K7	3,835	630
		ESR Surte Ki Dhani (CL-03)					150 DI K7	6,555	377

Source: JST based on the revised DPR

Table 7.6.15 Proposed Cluster Pumping Stations for Chohtan-1 Sub-scheme (2)

No.	Location	Destination (ESR)	Pump specifications: Individual capacity (m^3/h)	Pump specifications: Head (m)	Pump specifications: Rated power (kW)	Pump specifications: Units	Pumping main: Pipe size (mm)	Pumping main: Pipe length (m)	Pumping main: Demand (m^3/d)
5	TPS Kartiya	JN.14	133.45	118	90	2 (1W+1S)	200 DI K9	2,975	2,135
		ESR Samawali (CL-27)					150 DI K7	10,651	457
		JN-15					200 DI K7	6,250	
		ESR Gora (CL-35)					150 DI K7	435	875
		ESR Ganga sara (CL-33)					150 DI K7	3,715	803
		JN.9	96.1	125	75	2 (1W+1S)	200 DI K9	6,690	1,538
		ESR Pabuberi (CL-20)					100 DI K9	1,445	214
		JN.12					200 DI K9	660	
		ESR Dob ki beri (CL-66)					150 DI K7	790	660
		JN.13					150 DI K7	4,220	
		ESR Sonri (CL-65)					100 DI K7	850	240
		ESR Rohilla (CL-12)					100 DI K7	3,525	424
		JN.10	142	75	55	2 (1W+1S)	200 DI K9	2,927	2,272
		ESR Sherpur (CL-17)					150 DI K7	4,312	623
		JN.11					200 DI K7	638	
		ESR Aakal (CL-26)					150 DI K7	1,334	803
		ESR Kharader (CL-36)					150 DI K7	4,097	846
6	TPS Phagaliya	ESR Phagaliya (CL-41)	69	81	30	2 (1W+1S)	150 DI K9	2,480	1,100
		JN.18	58	130	45	2 (1W+1S)	150 DI K9	4,320	887
		JN.49					150 DI K9	4,810	
		ESR Sinhaniya (CL-40)					100 DI K7	590	529
		ESR Bamarlader (CL-31)					100 DI K7	3,125	358
		JN.19	63	142	45	2 (1W+1S)	150 DI K9	9,306	1,005
		ESR Bhada (CL-34)					100 DI K7	970	497
		ESR Samon ki Dhani (CL-28)					150 DI K7	4,985	508
		JN.16	141	96	75	2 (1W+1S)	250 DI K9	5,230	2,251
		ESR Panoriya (CL-42)					150 DI K7	1,215	721
		JN.17					200 DI K7	2,475	
		ESR Boli (CL-43)					150 DI K7	6,801	816
		ESR Khari (CL-44)					150 DI K7	6,530	714

Source: JST based on the revised DPR

Table 7.6.16 Proposed Cluster Pumping Stations for Chohtan-1 Sub-scheme (3)

No.	Location	Destination (ESR)	Pump specifications: Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pumping main: Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
7	CPS Sata	ESR Sata (CL-51)	39	20	5.5	2 (1W+1S)	150 DI K7	3,236	623
		JN.30	132	79	55	2 (1W+1S)	200 DI K9	6,600	2,105
		ESR Gangasariya(CL-50)					100 DI K9	1,245	388
		JN-31					200 DI K7	1,600	
		JN.32					200 DI K7	1,630	
		ESR Tarla (CL-47)					100 DI K7	500	561
		JN.33					200 DI K7	3,163	
		ESR Bhanwariya (CL-49)					100 DI K7	500	413
		JN.34					150 DI K7	1,800	
		ESR Gira (CL-48)					150 DI K7	3,900	744
		JN.35	113	73	45	2 (1W+1S)	250 DI K9	9,900	1,800
		JN.36					150 DI K7	6,290	
		JN.37					150 DI K7	1,900	
		ESR Tareesara(CL-56)					100 DI K7	675	314
		ESR Bawarwala (CL-62)					150 DI K7	3,760	722
		JN.38					150 DI K7	4,330	
		ESR Ranwa (CL-53)					100 DI K7	3,900	282
		ESR Nawapura (CL-54)					150 DI K7	4,150	482
		JN.27	109	95	55	2 (1W+1S)	200 DI K9	9,760	1,740
		ESR Bakhasar (CL-52)					150 DI K7	810	813
		JN.28					150 DI K9	500	
		ESR Chota Hathla (CL-61)					150 DI K9	8,092	432
		JN-29					100 DI K7	2,700	
		ESR Bhalgaon (CL-55)					150 DI K7	4,800	495
8	CPS Fakiro ka Niwan	ESR Bhanwar (CL-32)	47	92	22	2 (1W+1S)	150 DI K9	7,682	749
		JN.23	112	126	75	2 (1W+1S)	200 DI K9	3,900	1,718
		ESR Sujon Ka Niwan (CL-59)					100 DI K9	2,590	551
		JN.24					200 DI K9	5,475	
		ESR Sarla (CL-30)					150 DI K7	1,900	883
		ESR Deepla (CL-67)					100 DI K7	8,080	284
		JN.20	101.5	79	45	2 (1W+1S)	200 DI K9	7,075	1,624
		ESR Jharpa(CL-38)					150 DI K7	100	617
		JN.21					200 DI K7	6,455	1,007
		ESR Bhara (CL-45)					200 DI K7	3,500	638
		ESR Nawatala Bakshkar(CL-37)					100 DI K7	1,020	369
		JN-25	112	91	55	2 (1W+1S)	200 DI K9	9,325	1,723
		ESR Moolani (CL-39)					150 DI K7	1,920	610
		JN.01					200 DI K7	3,135	
		ESR Arti (CL-60)					100 DI K7	3,070	451
		ESR Meethri (CL-46)					150 DI K7	8,830	662

Source: JST based on the revised DPR

c) Clear Water Reservoir (CWR) with Pump House in Pumping Stations

The clear water reservoirs constructed in the pumping stations are shown in Table 7.6.17.

Table 7.6.17 Proposed CWRs for Chohtan-1 Sub-scheme

Sr. No.	Location	Capacity (m^3)
1	WTP Aleti	7,000
2	TPS Peepli Beri	6,800
3	TPS Kartiya	2,100
4	TPS Jakhron Ka Tala	900
5	TPS Dhanoo	3,500
6	TPS Phagliya	1,600
7	CPS Fakiron Ka Niwan	550
8	CPS Sata	600

Source: JST based on the revised DPR

3) Chohtan-2 Sub-scheme

a) Transfer Pumping Station (TPS)

The following four transfer pumping stations are proposed based on the revised DPR.

Table 7.6.18 Proposed Transfer Pumping Stations for Chohtan-2 Sub-scheme

PS	To	Pump specifications						Transmission mains		
		Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Total (m^3/h)	Daily supply (m^3/d)	Pipe size (mm)	Pipe length (m)	Ultimate flow (m^3/d)
TPS Ibrahim ka Tala	CWR Sobhala Jethmalan	262	122	160	2 (1W+1S)	262	5,764	300 DI K9	30,712	5,762
TPS Alamsar	CWR Choutan	374	87	180	2 (1W+1S)	374	8,228	350 DI K9	17,188	8,222
TPS Choutan	CWR DHOK	153	86	75	2 (1W+1S)	153	3,366	250 DI K9	4,965	3,348
TPS Kharwala	JN.	331.1	85	160	2 (1W+1S)	331	7,284	350 DI K9	13,215	7,284
	CWR Goliyar							300 DI K9	5,900	4,889
	CWR Godaron ka tala							200 DI K9	9,675	2,395

Source: JST based on the revised DPR

b) Cluster Pumping Station

The list of the proposed cluster pumping stations for Chohtan-2 Sub-scheme is shown in Table 7.6.19 to Table 7.6.21.

Table 7.6.19 Proposed Cluster Pumping Stations for Chohtan-2 Sub-scheme (1)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
1	TPS Ibrahim ka Tala	ESR Ibrahim ka Tal (CL-60)	48	39	11	2 (1W+1S)	150 DI K7	1,120	767
		JN.01	90	113	55	2 (1W+1S)	200 DI K9	9,350	1,439
		ESR Ratanpura (CL-53)					100 DI K9	925	336
		ESR Mate ka Tala (CL-56)					200 DI K9	6,768	1,104
		JN.2	86.2	56	30	2 (1W+1S)	200 DI K7	645	1,379
		ESR Bawri Kala (CL-57)					150 DI K7	420	767
		ESR Booth Rathoran (CL-75)					150 DI K7	4,730	612
		JN.3	86	62	30	2 (1W+1S)	200 DI K9	6,030	1,371
		ESR Deengarh (CL-51)					150 DI K9	5,786	498
		ESR Konra (CL-52)					150 DI K9	6,706	873
		JN.4	78.41	50	22	2 (1W+1S)	200 DI K7	11,453	1,255
		ESR Itada (CL-61)					100 DI K7	370	514
		ESR Rabasar (CL-62)					150 DI K7	5,513	741
2	CPS Sobhala Jethmalan	JN.13	99.3	107	55	2 (1W+1S)	200 DI K9	10,345	1,589
		ESR Arbi ki gafan(CL-06)					100 DI K7	800	323
		JN.14					200 DI K9	4,708	-
		ESR Bhaboote ki Dhani (CL-01)					100 DI K7	3,897	372
		JN.15					150 DI K7	2,552	-
		ESR Ramzan ki Gafan (CL-02)					100 DI K7	1,150	380
		ESR Chhota Bhojriya (CL-03)					150 DI K7	5,430	513
		JN.17	79	60	30	2 (1W+1S)	200 DI K7	890	1,264
		JN.18					200 DI K7	1,720	-
		ESR Huron ka Tala (CL-08)					150 DI K7	7,340	817
		ESR Kelnor (CL-07)					150 DI K7	5,680	447
		JN.19	79	95	45	2 (1W+1S)	200 DI K9	7,560	1,263
		JN.20					200 DI K7	3,505	-
		ESR Bijrar (CL-11)					150 DI K7	2,781	745
		ESR Mahadevpura (CL-04)					100 DI K7	5,250	518
		JN.16	103	79	45	2 (1W+1S)	200 DI K9	7,925	1,646
		ESR Beendoniyon ki Dhani (CL-05)					150 DI K9	1,118	842
		ESR Deedoosar (CL-10)					150 DI K9	5,135	805
3	CPS Gohar ka Tala	ESR Gohar ka Tala (CL-72)	30	67	11	2 (1W+1S)	100 DI K7	1,910	471
		JN.07	100	70	37	2 (1W+1S)	250 DI K9	15,178	1,599
		ESR Fitkariya(CL-68)					100 DI K7	1,815	440
		JN-08					200 DI K7	2,552	-
		JN.09					200 DI K7	3,168	-
		ESR Beesasar (CL-69)					150 DI K7	3,460	592
		JN.10					150 DI K7	2,726	-
		ESR Saraiyon ka tala (CL-67)					150 DI K7	5,984	568
		JN.11	82	75	37	2 (1W+1S)	200 DI K9	995	1,308
		ESR Aginshah ki Dhani (CL-65)					150 DI K7	3,753	470
		ESR Sarroppe ka Tala (CL-64)					200 DI K7	11,915	837
		JN.06	87.4	112	55	2 (1W+1S)	200 DI K9	7,122	1,398
		ESR Beejsar (CL-63)					150 DI K9	700	761
		ESR Meethe ka Tala (CL-58)					150 DI K9	6,485	638
		JN.05	79.24	140	55	2 (1W+1S)	200 DI K9	7,505	1,268
		ESR Mitharaoo (CL-09)					150 DI K9	7,970	817
		ESR Bhara Gulmohmmad (CL-59)					150 DI K9	9,575	451
		JN.12	125.1	134	90	2 (1W+1S)	200 DI K9	6,558	2,002
		ESR Somrad (CL-74)					150 DI K7	5,220	1,020
		ESR Talasar (CL-66)					150 DI K7	6,570	982

Source: JST based on revised DPR

Table 7.6.20 Proposed Cluster Pumping Stations for Chohtan-2 Sub-scheme (2)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
4	TPS Alamsar	JN.29	89.1	133	75	2 (1W+1S)	200 DI K9	3,610	1,426
		ESR Khairaj ka tala (CL-39)					100 DI K7	1,140	286
		JN.30					200 DI K7	1,195	-
		ESR Alamsar (CL-38)					150 DI K7	4,000	822
		ESR Devaniyon ka Tala (CL-54)					100 DI K7	8,470	318
5	TPS Choutan	ESR Vishnu Nagar (CL-79)	30	101	15	2 (1W+1S)	100 DI K9	5,405	472
		ESR Deopura (CL-22)	26	122	22	2 (1W+1S)	100 DI K9	13,592	402
		JN.27	90	139	75	4 (2W+2S)	250 DI K9	50	2,871
		ESR Chohtan (CL-20)					200 DI K9	3,730	1,978
		JN.28					150 DI K9	5,036	-
		ESR Manasar (CL-25)					150 DI K7	8,555	424
		ESR Jato ki Dhani (CL-21)					100 DI K7	3,240	469
		JN.26	71	132	55	2 (1W+1S)	200 DI K9	4,925	1,129
		ESR Antiya (CL-35)					150 DI K9	4,970	646
		ESR Lakhwara (CL-34)					100 DI K9	3,460	483
6	CPS Dhok	ESR Dhok (CL-19)	31	29	5.5	2 (1W+1S)	100 DI K7	100	483
		ESR Sewron ka Tala (CL-55)	30	54	11	2 (1W+1S)	100 DI K9	7,898	472
		JN.21	43	58	15	2 (1W+1S)	150 DI K7	3,302	685
		ESR Adarsh Dharasar (CL-18)					100 DI K7	7,808	151
		JN.22					150 DI K7	4,382	-
		ESR Aidan ki Dhani (CL-13)					100 DI K7	920	210
		ESR Ghoniya (CL-70)					100 DI K7	3,730	324
		JN.25	33.4	31	5.5	2 (1W+1S)	150 DI K7	16,655	534
		ESR Bajrangpura (CL-14)					100 DI K7	370	277
		ESR Bankana (CL-17)					100 DI K7	2,435	257
		JN.23	73.3	78	30	2 (1W+1S)	200 DI K9	19,830	1,173
		ESR Jaisar(CL-16)					150 DI K7	8,625	473
		JN.24					150 DI K9	930	-
		ESR Ratasar (CL-12)					100 DI K7	50	307
		ESR Jandooyon ka Tala(CL-15)					100 DI K7	2,937	393

Source: JST based on revised DPR

Table 7.6.21 Proposed Cluster Pumping Stations for Chohtan-2 Sub-scheme (3)

No.	Location	Destination (ESR)	Pump specifications				Pumping main		
			Individual capacity (m^3/h)	Head (m)	Rated power (kW)	Units	Pipe size (mm)	Pipe length (m)	Demand (m^3/d)
7	CPS Bhron ka Tala	ESR Dhakon ka tala (CL-46)	23	56	7.5	2 (1W+1S)	100 DI K9	4,668	361
		JN.36	97	89	45	2 (1W+1S)	200 DI K9	5,700	1,547
		ESR Nawatala Rathoran (CL-48)					100 DI K7	1,192	379
		JN.37					200 DI K7	4,780	-
		ESR Bisarniya (CL-45)					150 DI K7	51	760
		ESR Bojawas (CL-76)					100 DI K9	3,718	408
		JN.38	46	46	15	2 (1W+1S)	150 DI K7	1,916	734
		ESR Lomrodon ka Tala (CL-47)					100 DI K7	2,700	224
		ESR Bhooniya (CL-73)					150 DI K7	3,740	510
8	TPS Kharwala	JN.31	66	65	22	2 (1W+1S)	200 DI K7	1,206	1,050
		ESR Pokrasar (CL-36)					150 DI K7	7,227	660
		ESR Harpuniyon wala (CL-44)					150 DI K7	6,166	390
		JN.32	34	34	6	2 (1W+1S)	100 DI K7	2,660	538
		ESR Nimbala (CL-37)					100 DI K7	2,155	211
		ESR Bhilon ka Tala(CL-49)					100 DI K7	5,515	326
9	CPS Goliyar	JN.40	86	93	45	2 (1W+1S)	200 DI K9	3,182	1,370
		ESR Sarnon ka Tala (CL-33)					100 DI K7	6,315	243
		JN.41					200 DI K9	250	-
		ESR Ramderiya (CL-78)					100 DI K7	150	243
		JN.42					150 DI K7	2,452	-
		ESR Bagoniyon ki Dhani (CL-71)					100 DI K7	2,040	324
		JN.43					100 DI K7	2,540	-
		ESR Godaron ki Dhani (CL-30)					100 DI K7	1,040	560
		JN.46	81	64	30	2 (1W+1S)	200 DI K7	5,640	1,294
		JN.47					200 DI K7	4,506	-
		ESR Taratara math (CL-28)					150 DI K7	720	905
		ESR Taratarader(CL-77)					100 DI K7	4,020	390
		JN.44	80.2	107	45	2 (1W+1S)	200 DI K9	1,032	1,283
		ESR Rarli (CL-24)					150 DI K9	7,255	682
		JN.45					150 DI K9	1,925	-
		ESR Ranisar (CL-23)					100 DI K9	1,180	211
		ESR Neembali (CL-27)					100 DI K9	1,380	390
		JN.39	59	108	37	2 (1W+1S)	150 DI K9	7,740	941
		ESR Hajiyoniyo ki Dhani (CL-29)					150 DI K7	3,732	472
		ESR Dudhwa Khurd (CL-26)					150 DI K7	4,380	469
10	CPS Godaron Ka Tala	JN.33	46.5	100	30	2 (1W+1S)	150 DI K9	5,588	744
		ESR Leelsar(CL-41)					100 DI K7	80	487
		ESR Beerron ka Tala (CL-31)					100 DI K7	2,355	257
		JN.34	54	113	37	2 (1W+1S)	150 DI K9	5,672	859
		ESR Sodiyar(CL-40)					100 DI K7	250	469
		ESR Bhomasar (CL-32)					150 DI K7	6,050	390
		JN.35	50	54	15	2 (1W+1S)	150 DI K7	250	793
		ESR Budiyon Ka Tala (CL-43)					150 DI K7	6,655	441
		ESR Godaron ka Tala (CL-42)					150 DI K7	5,714	352

Source: JST based on revised DPR

c) Clear Water Reservoir (CWR) with Pump House in Pumping Stations

The proposed clear water reservoirs constructed in the pumping stations are shown in Table 7.6.22.

Table 7.6.22 Proposed CWRs for Chohtan-2 Sub-scheme

Sr. No.	Location	Capacity (m^3)
1	CPS Sobhala Jetmalan	500
2	TPS Choutan	700
3	CPS Dhok	300
4	TPS Ibrahim Ka Tala	1,000
5	CPS Gohar Ka Tala	650
6	CPS Goliyar	400
7	CPS Godaron Ka Tala	250
8	TPS Alamsar	950
9	CPS Bahron Ka Tala	250
10	TPS Kharwala	750

Source: JST based on revised DPR

(3) Pipe Material

For pipes with diameters up to 1000 mm, the ductile iron pipe with cement mortar lining was selected. For pumping mains or gravity mains with static head of over 75 m, the K9 type was selected. For gravity mains with static head within 75 m, the K7 type was selected.

For pipes with diameters over 1000 mm, the mild steel pipe with cement mortar lining was selected due to availability in India.

(4) Summary of pipeline length by diameter and class

Table 7.6.23 to Table 7.6.27 shows the summary of pipeline length by diameter and class of transmission main and cluster pumping main.

Table 7.6.23 Proposed Transmission Mains for HR-2 Sub-scheme

Sr. No.	From	To	Length (km)	Dia. (mm)	Material	
1	Peeprali WTP	JN	6.2	600	DI	K-7
	JN	TPS Loharwa	12.0	600	DI	K-7
	JN	CPS Borcharnan	4.1	150	DI	K-7
2	TPS Loharwa	TPS Sobhala Jetmal	17.2	400	DI	K-9
	TPS Loharwa	JN.	5.6	400	DI	K-9
	JN.	JN. highest point	1.8	250	DI	K-7
	JN. highest point	CPS Dhorimana	5.4	300	DI	K-7
	JN. highest point	CPS Misari Ki Beri	1.4	250	DI	K-7
3	TPS Sobhala Jetmal	CPS Meethiya Tala	13.9	300	DI	K-7
		Total	**67.5**			

Source: JST based on the revised DPR

Table 7.6.24 Proposed Transmission Mains for Chohtan-1 Sub-scheme

S.N.	From	TO	Length (km)	Dia. (mm)	Material
1	Aleti WTP	TPS Peepliberi	25.0	1000	DI K9
2	TPS Peepliberi	TPS Karatiya	12.5	600	DI K7
	TPS Peepliberi	JN	33.1	900	DI K9
	JN	TPS Dhannau	5.1	900	DI K9
	JN	TPS Jakhron Ka Tala	0.2	400	DI K9
3	TPS Karatiya	TPS Phagaliya	18.5	450	DI K9
4	TPS Jakhron Ka Tala	CPS Bhron Ka Tala (CP-5)	16.2	250	DI K7
5	TPS Dhannau	TPS Alamsar (CP-5)	16.7	350	DI K9
	TPS Dhannau	TPS Kharawala (CP-5)	16.7	450	DI K9
	TPS Dhannau	JN-1	3.9	600	DI K9
	JN-1	JN-2	15.3	450	DI K9
	JN-2	JN-3	11.7	350	DI K9
	JN-3	TPS Ibrahim Ka Tala (CP-5)	0.6	450	DI K9
	JN-3	CPS Gohar Ka Tala (CP-5)	8.1	350	DI K9
6	TPS Phagaliya	JN-1	9.1	450	DI K9
	JN-1	JN-2	2.3	300	DI K9
	JN-2	CPS Fakiro Ka Niwan	8.5	300	DI K9
	JN-2	CPS Sata	10.9	300	DI K9
Total			214.2		

Source: JST based on the revised DPR

Table 7.6.25 Proposed Transmission Mains for Chohtan-2 Sub-scheme

S.N.	From	To	Length (km)	Dia. (mm)	Material
1	TPS Ibrahim Ka Tala	CWR Sobhala Jethmalan	30.7	300	DI K9
2	TPS Alamsar	CWR Choutan	17.2	350	DI K9
3	TPS Choutan	CWR Dhok	5.0	250	DI K9
4	TPS Kharwala	JN.	13.2	350	DI K9
	JN.	CWR Goliyar	5.9	300	DI K9
	JN.	CWR Godaron Ka Tala	9.7	200	DI K9
Total			81.7		

Source: JST based on the revised DPR

Table 7.6.26 Proposed Cluster Pumping Mains for HR-1 and HR-2 Sub-scheme

Sr. No.	Dia. (mm)	Length (km)			
		HR-2 Sub-scheme		HR-1 Sub-scheme	
		DI K-7	DI K-9	DI K-7	DI K-9
1	100	51.7	46.2	92.3	32.6
2	150	66.0	52.4	110.9	98.9
3	200	0.1	59.2	33.6	80.7
4	250	0.0	16.8	0.0	9.2
	Total	**117.9**	**174.6**	**236.8**	**221.5**

Source: JST based on the revised DPR

Table 7.6.27 Proposed Cluster Pumping Mains for Chotan-1 and Chohtan-2 Sub-scheme

Sr. No.	Dia. (mm)	Length (km)			
		Chohtan-1		Chohtan-2	
		DI K-7	DI K-9	DI K-7	DI K-9
Gudhamalani and Chohtan Tehsils					
1	100	55.5	4.0	91.1	30.4
2	150	171.4	45.3	202.7	29.9
3	200	69.7	79.1	79.1	97.2
4	250	0.0	21.8	0.0	15.2
5	300	0.0	0.0	0.0	0.0
	Total	**296.6**	**150.2**	**432.9**	**172.7**

Source: JST based on the revised DPR

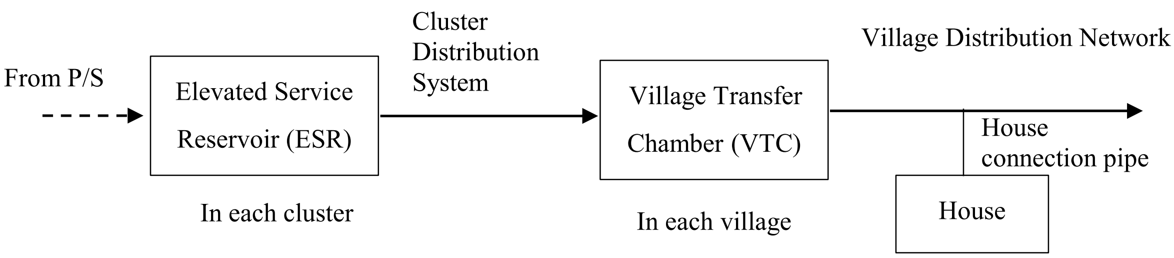
7.7 Water Distribution and Service Facility

7.7.1 Outline of the Distribution Facility

The distribution facility consists of a village transfer chamber (VTC) and a distribution pipeline network with a house connection pipe. The distribution reservoir will be an elevated type made of RC. Treated water will be distributed by gravity from the distribution reservoirs (ESRs) located in each distribution area to each household through a house connection pipe. A total of 281 units of ESRs will be constructed to provide water supply to 889 villages.

The capacity of the ESR will be half of the daily water demand of the service area of each ESR, in accordance with the PHED guideline. The height of ESR staging and the pipe diameter of the distribution pipeline were determined by the pipeline network analysis using EPANET, which is a widely used free software for pipe network analysis provided by United States Environmental Protection Agency (USEPA. The following design conditions are used in accordance with the "Manual for the Preparation of Detailed Project Report for Rural Piped Water Supply Schemes" prepared by The Ministry of Drinking Water and Sanitation (MoDWS) in 2013:

Hourly Peak factor: 3
Minimum pipe size: 80 mm
Minimum residual pressure: 7 m



Source: JICA Survey Team

Figure 7.7.1 Water Distribution and Service Facility

7.7.2 Elevated Service Reservoir (ESR)

The ESR for each cluster is proposed at a location from where water can be supplied to all the villages of that cluster up to the VTC through the cluster distribution pipelines. The number of ESRs are the same with the number of clusters in the target area. The capacity of a service reservoir is proposed to be 50% of the design water demand, i.e., the total design water demand for the year 2055 of all the villages of that cluster. Staging of the ESR is proposed to be varied from 18 m to 25 m and will be dependent on the elevations and distances to villages to obtain at least 12 m terminal head at the VTC clusters. Capacity-wise details of the ESRs that are proposed to be constructed under the project are as follows:

Table 7.7.1 Proposed Number of ESRs for the Barmer Scheme

S. No.	Capacity (m^3)	Quantity (nos.)			
		HR-2	HR-1	Chohtan-1	Chohtan-2
1	100	2	2	0	7
2	150	11	16	6	11
3	200	20	17	9	16
4	250	10	14	14	19
5	300	6	15	13	10
6	350	4	6	10	5
7	400	1	6	10	8
8	450	1	2	3	2
9	500		2	1	1
10	600			1	
	Total	**55**	**80**	**67**	**79**
		281			

Source: JST based on the revised DPR

The lists of ESRs with ESR (cluster) names and capacities are shown in Appendix-7.3.

7.7.3 Cluster Distribution Pipeline

The pipeline from the ESR (cluster wise) to the VTC (village wise) are called as "Cluster Distribution Pipeline".

The pipe materials that were selected are as follows:

- Diameter of less than 200 mm: HDPE pipe
- Diameter of 200 mm or more: DI pipe (K7)

The lengths of the distribution pipeline along with the different diameters are presented in Table 7.7.2 and 7.7.3.

Table 7.7.2 Proposed Cluster Distribution Pipeline (HR-1 and HR-2 Sub-scheme)

	HDPE Pipe		DI Pipe (K7)		
Diameter	Length (km)		Diameter	Length (km)	
	HR-2	HR-1		HR-2	HR-1
ND 75	9.7		ND 80	1.3	
ND 90	10.4	14.5	ND 100	1.4	
ND 110	35.4	34.5	ND 150	7.1	
ND 125	40.6	31.8	ND 200	7.9	0.7
ND 140	42.9	43.5	ND 250	16.5	71.5
ND 160	55.1	79.0			
ND 180	62.3	105.5			
ND 200	50.5	90.4			
ND 225	45.5	85.7			
Total HDPE Pipe	**352.4**	**484.9**	**Total DI K7 Pipe**	**34.2**	**72.2**
			Grand Total	**386.6**	**557.1**

Source: JST based on the revised DPR

Table 7.7.3 Proposed Cluster Distribution Pipeline (Chohtan-1 and Chohtan-2 Sub-Scheme)

	HDPE Pipe		DI Pipe (K7)		
Diameter	Length (km)		Diameter	Length (km)	
	Chohtan-1	Chohtan-2		Chohtan-1	Chohtan-2
ND 75		9.4	ND 100		9.8
ND 90	3.5	15.3	ND 150		22.4
ND 110	13.2	32.1	ND 200	4.6	14.3
ND 125	25.2	47.1	ND 250	82.7	51.1
ND 140	55.1	75.3			
ND 160	43.9	84.3			
ND 180	43.5	85.4			
ND 200	62.4	49.8			
ND 225	90.9	61.9			
Total HDPE Pipe	**336.8**	**460.6**	**Total DI K7 Pipe**	**87.3**	**97.6**
			Grand Total	**424.1**	**558.2**

Source: JST based on the revised DPR

7.7.4 Village Distribution Network

(1) Village Transfer Chamber (VTC)

The proposed number of VTCs, which was determined as shown in Table 7.7.4.

Table 7.7.4 Proposed Number of VTCs for the Barmer Scheme

Sub-scheme	Number of villages	VTC Type-A	VTC Type-B	Total VTC
HR-2	183	145	38	183
HR-1	268	203	65	268
Chohtan-1	187	126	61	187
Chohtan-2	251	160	91	251

Source: Questionnaire answered by PHED

(2) Village Distribution Pipeline (from VTCs to houses/PSPs)

The length of village distribution pipelines by pipe material and diameter are shown in Table 7.7.5 to Table 7.7.8. The length was determined by the model design conducted by the local consultant for the revised DPR

Table 7.7.5 Length of Village Distribution Pipeline Proposed for HR-2 Sub-scheme

HDPE Pipe		DI Pipe (K7)	
Diameter	Length (km)	Diameter	Length (km)
ND 75	1,793.4	ND 80	167.7
ND 90	1,095.3	ND 100	20.7
ND 110	716.7	ND 150	18.2
ND 125	395.7	ND 200	27.3
ND 140	330.1	ND 250	9.1
ND 160	304.7	**Total DI K7 Pipe**	**243.1**
ND 180	0		
ND 200	105.9		
ND 225			
Total HDPE Pipe	**4,741.8**	**Grand Total**	**4,984.9**

Source: JST based on the revised DPR

Table 7.7.6 Length of Village Distribution Pipeline Proposed for HR-1 Sub-scheme

HDPE Pipe		DI Pipe (K7)	
Diameter	Length (km)	Diameter	Length (km)
ND 75	1,046.2	ND 80	60.3
ND 90	665.6	ND 100	90.4
ND 110	401.3	ND 150	75.3
ND 125	262.3	ND 200	60.3
ND 140	233.8	ND 250	15.1
ND 160	192.4	**Total DI K7 Pipe**	**301.4**
ND 180	0		
ND 200	73.6		
ND 225			
Total HDPE Pipe	**2,875.3**	**Grand Total**	**3,176.7**

Source: JST based on the revised DPR

Table 7.7.7 Length of Village Distribution Pipeline Proposed for Chohtan-1 Sub-scheme

HDPE Pipe		DI Pipe (K7)	
Diameter	Length (km)	Diameter	Length (km)
ND 75	1,442.0	ND 100	206.5
ND 90	918.3	ND 150	142.1
ND 110	502.4	ND 200	16.3
ND 125	302.9	**Total DI K7 Pipe**	**364.9**
ND 140	259.4		
ND 160	194.5		
ND 180	0		
ND 200	81.0		
ND 225			
Total HDPE Pipe	**3,700.6**	**Grand Total**	**4,065.5**

Source: JST based on the revised DPR

Table 7.7.8 Length of Village Distribution Pipeline Proposed for Chohtan-2 Sub-scheme

HDPE Pipe		DI Pipe (K7)	
Diameter	Length (km)	Diameter	Length (km)
ND 75	2,414.0	ND 150	136.3
ND 90	991.5	ND 200	99.1
ND 110	501.9	ND 250	12.4
ND 125	279.7	**Total DI K7 Pipe**	**247.7**
ND 140	206.8		
ND 160	164.6		
ND 180	0		
ND 200	41.9		
Total HDPE Pipe	**4,600.3**	**Grand Total**	**4,848.1**

Source: JST based on the revised DPR

7.7.5 Service Facility

As per the latest guidelines of Jal Jeevan Mission for distribution of water to the villagers, provision of house connection has been taken for all the households. The number of house connections to be included in the project has been determined based on the planned service population in the construction completion year, [redacted]. Five persons per one connection was adopted for estimation of the numbers. Hence, the proposed numbers of connections for each sub-scheme are shown in the following table:

Table 7.7.9 Proposed Number of House Connections for the Barmer Scheme

	HR-1	HR-2	Chohtan-1	Chohtan-2
Number of connections	73,357	43,588	76,522	75,468

Source: JST

In addition, public stand post (PSP) is included in the construction cost estimate. The number of PSP has been determined based on the questionnaire from PHED, as shown in Table 7.7.10.

Table 7.7.10 Proposed Number of PSP for the Barmer Scheme

	HR-1 sub-scheme	HR-2 sub-scheme
Number of PSP	2 each x 1253 (nos. of (village + OH)) = 2,506	2 each x 922 (nos. of (village +OH)) = 1,844
	Chohtan-1 sub-scheme	Chohtan-2 sub-scheme
Number of PSP	2 each x 939 (nos. of (village + OH)) = 1,878	2 each x 1,357 (nos. of (village + OH)) = 2,714

Source: JST based on the questionnaire from PHED

Above number is provisional and the actual installation will be implemented based on the request from the village, on the condition that the installation of PSP does not hinder the installation of house connections.

7.8 Power Receiving Facility

A power supply transmission line and the stepdown transformer substation are necessary for each of the transfer pumping stations and the cluster pumping stations. The power receiving capacity is dependent on the pump capacity.

The power transmission lines will be supplied from the adjacent power stations to the pumping stations.

The specifications of the transformers at the pumping stations are shown in Table 7.8.1 to Table 7.8.4.

Table 7.8.1 Specifications of Transformers at Pumping Stations (HR-2 Sub-scheme)

Pumping Station	Transformer	Quantity
Intake Point Gandhaw	750 kVA	2 (1W+1S)
RWR Peeprali PS	75 kVA	2 (1W+1S)
TPS Loharwa	750 kVA	2 (1W+1S)
TPS Sobhala Jetmal	400 kVA	2 (1W+1S)
Peeprali WTP	100 kVA	2 (1W+1S)
CPS Misari Ki Beri	200 kVA	2 (1W+1S)
CPS Borcharan	100kVA	2 (1W+1S)
CPS Dhorimana	400 kVA	2 (1W+1S)
CPS Meethiya Tala	400 kVA	2 (1W+1S)

Source: JST

Table 7.8.2 Specifications of Transformers at Pumping Stations (HR-1 Sub-scheme)

Pumping Station	Transformer	Quantity
CPS at Dheemri WTP	100 kVA	2 (1W+1S)
CPS Khadali	200 kVA	2 (1W+1S)
TPS Bhedana	150 kVA	2 (1W+1S)
CPS Berigaon	150 kVA	2 (1W+1S)
CPS Nokhra	200 kVA	2 (1W+1S)
CPS Ratanpura	200 kVA	2 (1W+1S)
CPS Mangle Ki Beri	150 kVA	2 (1W+1S)
TPS Adel	75 kVA	2 (1W+1S)
TPS Gudhamalani	300 kVA	2 (1W+1S)
CPS Neembal Kot	200 kVA	2 (1W+1S)
TPS Koshlou	300 kVA	2 (1W+1S)
CPS Kadnari	150 kVA	2 (1W+1S)

Source: JST

Table 7.8.3 Specifications of Transformers at Pumping Stations (Chohtan-1 Sub-scheme)

Pumping Station	Transformer	Quantity
Intake point near NMC RD.74	1000 kVA	2 (1W+1S)
RWR Aleti	200 kVA	2 (1W+1S)

Aleti WTP	750 kVA	2 (1W+1S)
TPS Peepliberi	2000 kVA	2 (1W+1S)
TPS Karatiya	400 kVA	2 (1W+1S)
TPS Jakhron Ka Tala	400 kVA	2 (1W+1S)
TPS Dhannau	1500 kVA	2 (1W+1S)
CPS Fakiro Ka Niwan	300 kVA	2 (1W+1S)
CPS Sata	300 kVA	2 (1W+1S)
TPS Phagaliya	750 kVA	2 (1W+1S)
CPS Kartiya	300 kVA	2 (1W+1S)

Source: JST

Table 7.8.4 Specifications of Transformers at Pumping Stations (Chohtan-2 Sub-scheme)

Pumping Station	Transformer	Quantity
TPS Alamsar	400 kVA	2 (1W+1S)
TPS Choutan	200 kVA	2 (1W+1S)
TPS Ibrahim Ka Tala	300 kVA	2 (1W+1S)
CPS Gohar Ka Tala	300 kVA	2 (1W+1S)
CPS Dhok	150 kVA	2 (1W+1S)
CPS Bhron Ka Tala	150 kVA	2 (1W+1S)
TPS Kharwala	300 kVA	2 (1W+1S)
CPS Chohtan	300 kVA	2 (1W+1S)
CPS Sobhala Jethmalan	300 kVA	2 (1W+1S)
CPS Ibraham Ka Tala	200 kVA	2 (1W+1S)
CPS Goliyar	300 kVA	2 (1W+1S)
CPS Godaron Ka Tala	150 kVA	2 (1W+1S)

Source: JST

According to the annual report of RVPN (Rajasthan Rajya Vidyut Prasaran Nigam Limited: Rajasthan Power Supply Corporation), the average power interruption frequency and duration in FY 2019-2020 were 2.04 times/year and 1.58 hours/year, respectively. Thus, it can be said the reliability of the power supply is ensured.

7.9 SCADA System

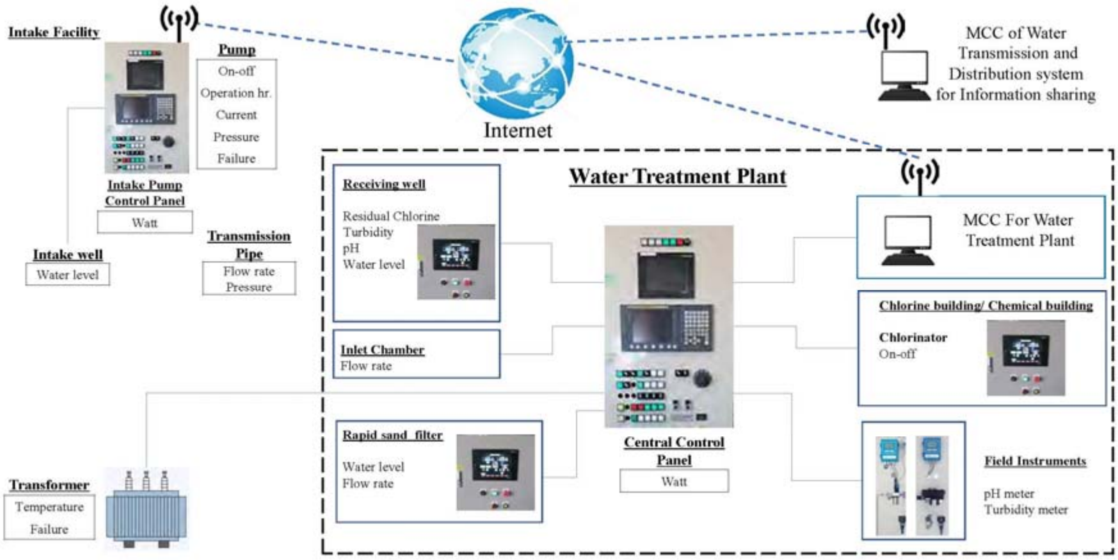
7.9.1 Outline of SCADA System

The SCADA system is used for the monitoring of the operation status of the mechanical equipment such as pumps, measuring instruments and the electrical equipment like the control panel or power supply transformers. There will be two kinds of SCADA Systems for Barmer Scheme: 1) SCADA system for the water treatment plant and 2) SCADA system for the water transmission and distribution system. Each SCADA system will have a Master Control Center (MCC). The MCC for each SCADA system will be located at the control room of each WTP:

HR-1 Sub-scheme:	WTP at Dheemri
HR-2 Sub-scheme:	WTP at Peeprali
Chohtan-1 and Chohtan-2 Sub-scheme:	WTP at Aleti

(1) SCADA system for the Water Treatment Plant

Figure 7.9.1 shows the general concept for the control and monitoring system of water treatment plant and related facilities. The operation information of the equipment in the intake facility will be transmitted via the internet to the MCC at WTP.



Source: JST

Figure 7.9.1 Control and Monitoring Concept for the Water Treatment Plant

The outline of main facilities for SCADA system are described hereunder.

1) Master Control Center (MCC)

A master control centre (MCC) for the water treatment system will be installed at the WTP. The MCC, an integrated computer system, is for the collection of information, data analysis, data aggregation and operation instructions in case of necessity. The remote control for the operation will be limited to "EMERGENCY STOP" of pumps and blowers etc.

2) Central Control Panel in the Treatment Plant

A central control panel will be installed in the treatment plant to integrate the operations and indicate the status for all related equipment and instruments. Each treatment unit can be controlled by the local control panel automatically and can correct the operation status and forward it to the central control panel. The central control panel will correct the information from each units of treatment process.

3) Local Control Panel at Each Units

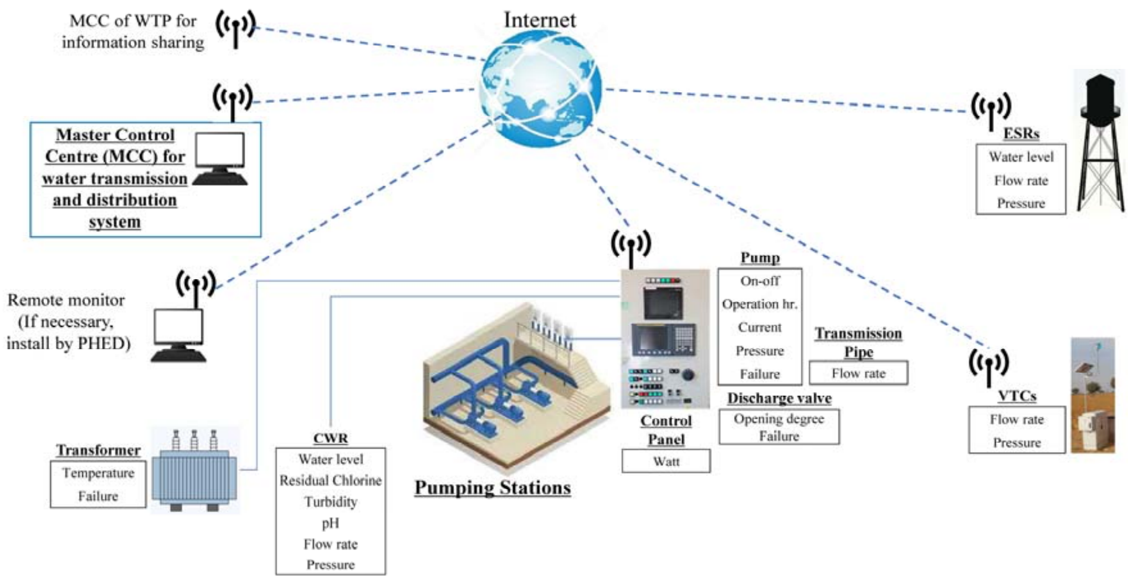
The local control panels will be installed in each of the treatment units to control and indicate the status of the equipment. The panels will be capable of managing and controlling all the equipment in each of the unit and transmit the data to the Central Control Panel. Normally, the operation of equipment in each of the facilities or units will be pre-set. In case any unexpected stop of the equipment due to power failure or other causes, the manual restoration of operation will be conducted by the operator at site. It is not recommended to restore the operation from the MCC without confirming the situation of site.

(2) SCADA System for the Water Transmission and Distribution System

The SCADA system monitors the operation status of the mechanical equipment such as pumps and measuring instruments and the electrical equipment such as control panel and power supply transformers. Figure 7.9.2 shows the general concept of the control and monitoring system of pumping stations. Operation status of each pumping stations, ESRs and VTCs will be transmit the to the MCC.

The SCADA system will be capable to prepare or create daily operation reports and monthly reports from the collected data. Furthermore, the system can also give advice for the efficient operation of the whole water transmission and distribution system.

In addition, another remote monitor for observing the water supply system can be prepared by PHED, if necessary.



Source: JST

Figure 7.9.2 Control and Monitoring Concept for Pumping Stations, ESRs, and VTCs

The outline of main facilities for SCADA system are described hereunder.

1) Master Control Center (MCC)

The MCC is an integrated computer system for collecting information, data analysis, data aggregation, and giving operation instructions in case of necessary. The remote control function will be limited to ”EMERGENCY STOP” of pumps to secure the safety of water supply.

The MCC for the project will be installed at Jhunjhunu TPS and will be compatible to transfer the data to the existing SCADA system.

2) Control Panel at Each of the Pumping Stations

The control panels are installed in the pumping stations to control the operations such as manually on/off of pumps, open/close of electrical valves with diameter over 500mm, etc. at site and present the status for all the related equipment and instruments (such as flow meters, pressure indicators, and electrical valves). The control panel is capable of managing and controlling all the equipment in the pumping station at site and also transmit the data to the MCC.

Normally, the pump will be automatically operated according to the water levels in the receiving tank and interlock with the water levels in the ESR. In case the pump stopped due to power failure or other causes, the manual restoration of operation will be done by the operator at site. It is not recommended to restore the pump operation from the MCC without confirming the situation in the pumping station and mutual communication between the pump station and MCC.

3) Local Panel at Each of the ESRs and VTCs

The local panels will be installed in each of the ESRs and VTCs to present the status of the equipment and transmit the data to the MCC.

7.9.2 Monitoring and Control Items

(1) Monitoring and Control Items for the Water Treatment Plant

The measuring points, monitoring and control items for the facilities in the water treatment plants are shown in Table 7.9.1.

Table 7.9.1 Measuring Points, Monitoring and Control Items for the Water Treatment Plant Facilities

No.	Facility	Measuring Points	Measuring or monitoring Items	Control items
1	Intake facility	Intake well	Water level	
		Pump	On-Off Operation hours Motor current Pressure Failure status	On-off (at site) Emergency stop (MCC)
		Transmission pipeline	Flow rate and pressure	

		Control panel	Watt	
2	WTP Master Control Centre (MCC) for WTP Located at Peeprali and Aleti	Receiving well	Turbidity	
			pH	
		Inlet chamber	Flow rate	
		Rapid sand filter basin	Flow rate from each of twin bed	
		Mechanical equipment (Backwash Air Blower and Pump Set)	On-Off	On-off (at site) Emergency stop (MCC) for pump and blower
			Failure status	
		Control panel	Watt	
		Chlorinator	On-Off	Dosing rate (at site)

Source: JST

(2) Monitoring and Control Items for Water Supply System

The measuring points, monitoring and control items for the facilities in the water supply system are shown in Table 7.9.2.

Table 7.9.2 Measuring Points, Monitoring and Control Items for Each of the Pumping Stations, ESRs and VTCs

No.	Facility	Measuring Points	Measuring or monitoring Items	Control items
1	Pumping stations (TPS and CPS) Master Control Centre (MCC) for Water Transmission and Distribution located at Dheemri, Peeprali and Aleti.	Receiving tank (CWR)	Water level Residual chlorine Turbidity pH Flow Rate	
		Pump	On-Off Operation hours Motor current Pressure Failure status Bearing Temperature	On-off (at site) Emergency stop (MCC)
		Discharge valve	Opening degree	Open-close of electric valves (at site)
		Transmission pipeline	Flow rate	
		Distribution panel	Watt	
		Transformer substation	Temperature Failure status	
2	ESR	Reservoir	Water level Flow Rate Pressure	
3	VTC	VTC	Flow rate Pressure	

Source: JST

Chapter 8 O&M Plan and Organization Plan

8.1 Sector Policies and Institutional Arrangement of the Government of Rajasthan

8.1.1 National Policy

The Government of India (GOI) has been engaged in improvement of the rural water supply situation. In 2019, the GOI restructured and subsumed the National Rural Drinking Water Program (NRDWP) which had been implemented since 2009, into the Jal Jeevan Mission (JJM).

GOI has issued the "Operational Guidelines for the Implementation of Jal Jeevan Mission" in December 2019 as the practical guideline so that the state governments and other related organizations can implement the mission. The main objective and the contents are as follows:

(1) Objectives of JJM

The main objective of this mission is to provide functional household tap connection (FHTC)s to every rural household in India by 2024 with a service rate of 55 litters per capita per day (Lpcd).

(2) Institutional Mechanism for JJM

To implement the mission, institutional arrangements at various levels have been made and the state's Public Health Engineering Department (PHED)/Rural Water Supply (RWS) Department are to play a critical role in helping Gram Panchayat and/or its subcommittee to plan, implement, manage, operate, and maintain its in-village water supply systems. The four tier systems are applied in JJM mission at national, state, district, and community level. The higher level of mission manages the lower one. The role of each mission is explained as follows.

<u>National Level - National Jal Jeevan Mission (NJJM)</u>

At the national level, NJJM headed by a Mission Director of Directorate of National Jal Jeevan Mission is organized. The officers have all powers needed for the successful implementation of the mission to secure a long-term strategy in providing drinking water to rural communities. Some of the key roles are as follows:

- Approval of the State Annual Action Plans for implementation of the mission;
- Operate Rashtriya Jal Jeevan Kosh (RJJK)[1] and mobilize resources; and
- Facilitate capacity building of SWSM, DWSM, and state engineering departments/boards.

[1] As part of Indian ethos to help each other in providing drinking water; it is considered that various individuals, corporate/industrial houses, charitable institutions, etc. should contribute and donate regularly. Collected money will be used for the activities to achieve the goal of JJM.

State Level - State Water and Sanitation Mission (SWSM)

The SWSM is a state level institution headed by the Chief Secretary with Principal Secretary/Secretary in-charge of PHED/RWS Department as Mission Director. This is the organization responsible for implementation of JJM in the state. The existing Water and Sanitation Support Organization (WSSO) will be subsumed under the SWSM. The structure of the mission and human resources will be decided by the state.

District Level - District Water and Sanitation Mission (DWSM)

At the district level, DWSM is responsible for the overall implementation of JJM. DWSM will be headed by the Deputy Commissioner/District Collector (DC). The Executive Engineer (EE) of the PHED/RWS Department will be the member secretary.

Community-Level - Gram Panchayat and/or its Subcommittee, i.e., Village Water and Sanitation Committee (VWSC[2])/Paani Samiti/User Group

It is envisaged under JJM that the community will play a lead role in planning, implementation, management, operation, and maintenance of the in-village water supply infrastructure thereby leading to FHTCs to every rural household. The group may consist of 10 – 15 members comprising elected members of the Panchayat up to 25% of the composition; 50% women members (key to success); and the remaining 25% may consist of representatives of weaker sections of the village (SC/ST) proportional to their population.

(3) Action Plan

Under the JJM guidelines, action plans at village, district, and state levels will be formulated as follows.

Village Action Plan (VAP) – The Village Action Plan will be prepared by Gram Panchayat and/or its subcommittee, i.e. VWSC/Paani Samiti/User Group, etc. based on the baseline survey, resource mapping, and felt needs of the village community to provide FHTC to every rural household and treat the generated greywater, among others. VAP also indicates the fund requirement and timelines for the completion of the works.

District Action Plan (DAP) – A plan prepared by the DWSM by aggregating all VAPs and additional works, i.e., bulk water transfer, distribution network, laboratories, etc. to ensure drinking water security in all the villages/habitations of the district along with financial details and timelines.

2 VWSC is a village level unit (a sub-committee in Gram Panchayat) responsible for the operation and maintenance after VTC. The details are explained in Chapter 9.1,2.

State Action Plan (SAP) – A plan prepared by SWSM by aggregating all DAPs and regional water supply schemes, bulk water transfer and treatment plants, etc. to achieve overall drinking water security in the state and shall be used for the financial planning to cover all rural households in the state.

The VAPs of all villages will be aggregated based on the need to formulate the District Action Plan (DAP) and the State Action Plan (SAP), respectively. Furthermore, the state will also prepare an Annual Action Plan detailing yearly targets commensurate to the annual allocation.

(4) Role of NGOs/Support Organizations

To assist the village community for in-village water resource management and water supply related infrastructure, NGOs, voluntary organizations/women self-help groups (SHGs) under National Rural Livelihoods Mission (NRLM)/ State Rural Livelihood Mission (SRLM), etc., will be associated as partners to facilitate the communities in awareness creation, capacity building, planning, and implementation of the schemes.

(5) Gender

Rural women and adolescent girls spend a lot of time and energy in getting water for day-to-day use. This results in lack of participation of women in income generating opportunities, loss of school days for girls, and adverse health impacts. JJM is to play a significant role in bringing 'ease of living' for residents of the rural community, especially women. Active participation of women at all levels of the institutional arrangements with special emphasis at the village level is to be ensured. This is key to the success of JJM.

8.1.2 State Policy

(1) State Water Policy (2010)

The Government of Rajasthan State (GOR) has formulated the "State Water Policy" in 2010. Regarding drinking water supply, the following policies are prescribed:

- The state government will ensure provision of adequate potable drinking water to every citizen, both in urban and rural areas.
- Drinking water needs of human and livestock will be the first charge on any available water source. In multi-purpose irrigation projects, top priority will be given to drinking water.
- The urban and rural drinking water schemes will be planned on the basis of conjunctive use of surface and groundwater so that minimum surface water is required to be transported.

(2) State Policy for Rural Water Supply

According to PHED, the rural water policy of GOR is based on the JJM guideline. The management policy of each project is determined considering the actual situation of the project by PHED. Thus, the proposed plan of this project is also drawn up based on the JJM guideline and through the discussions with PHED.

8.1.3 Institutional Framework of GOR for the Rural Water Supply Sector in Rajasthan

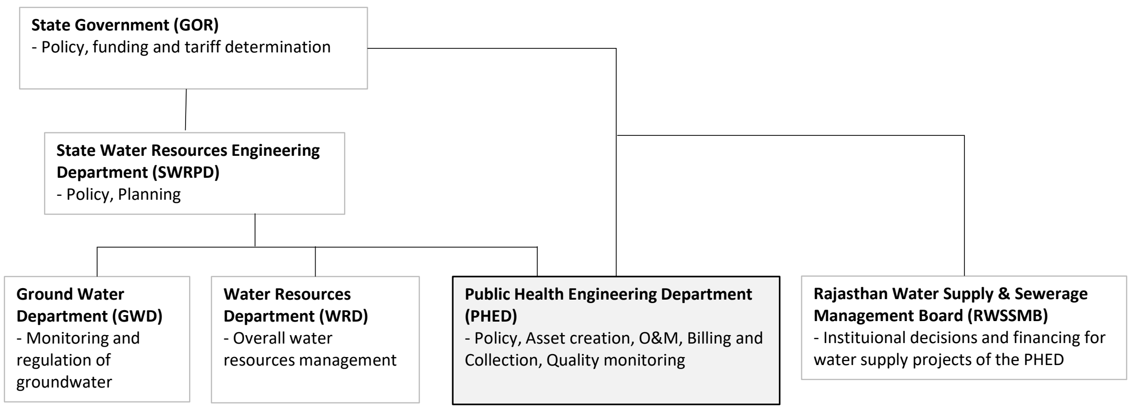
Table 8.1.1 shows the institutional framework for the water supply sector in Rajasthan.

Table 8.1.1 Institutional Framework for the Rural Water Supply Sector

Institutions/Agencies	Roles/Responsibilities
State Government	Policy, funding, and tariff determination
State Water Resource Planning Department (SWRPD)	Policy and planning
Public Health Engineering Department (PHED)	Policy, constructing facilities, asset management, O&M of facilities, billing and collection of tariff, and quality monitoring
Rajasthan Water Supply& Sewerage Management Board (RWSSMB)	Institutional decisions and financing for water supply projects of PHED
Water Resources Department (WRD)/Ground Water Department (GWD)	Overall water resources management, monitoring, and regulation of groundwater

Source: Rajasthan Urban Water Supply Policy (2018)

PHED is the nodal department of GOR for rural water supply in Rajasthan State. The relation between PHED and the above institutions/agencies is shown in Figure 8.1.1.



Source: Rajasthan Urban Water Supply Policy (2018)

Figure 8.1.1 Relations Between the PHED and Related Institution/Agency for Rural Water Supply in Rajasthan State

8.2 Institutional Arrangement of PHED

8.2.1 Role and Organization

PHED of GOR provides water service to urban and rural areas in Rajasthan State. PHED divides the service area into urban area and rural area. The water is basically distributed from the water treatment plant to individual households in the urban area. Construction and O&M of facilities are generally implemented by PHED.

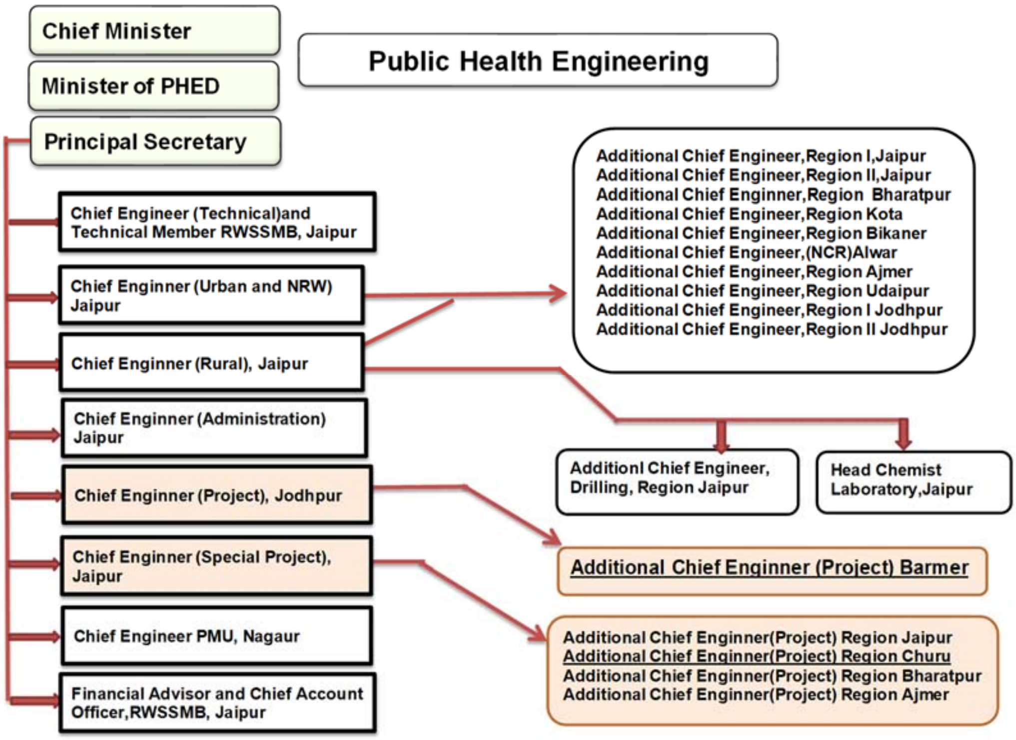
In the rural area, basic facilities for water supply are mainly constructed with the subsidy of the central government. PHED supports the design and construction of facilities such as deep well, elevated tanks, and standpipes. These assets are transferred to the community group after construction.

PHED also plays a key role in terms of monitoring the quality of drinking water in urban and rural areas. PHED gives budgets for these activities.

8.2.2 Organizational Structure of PHED

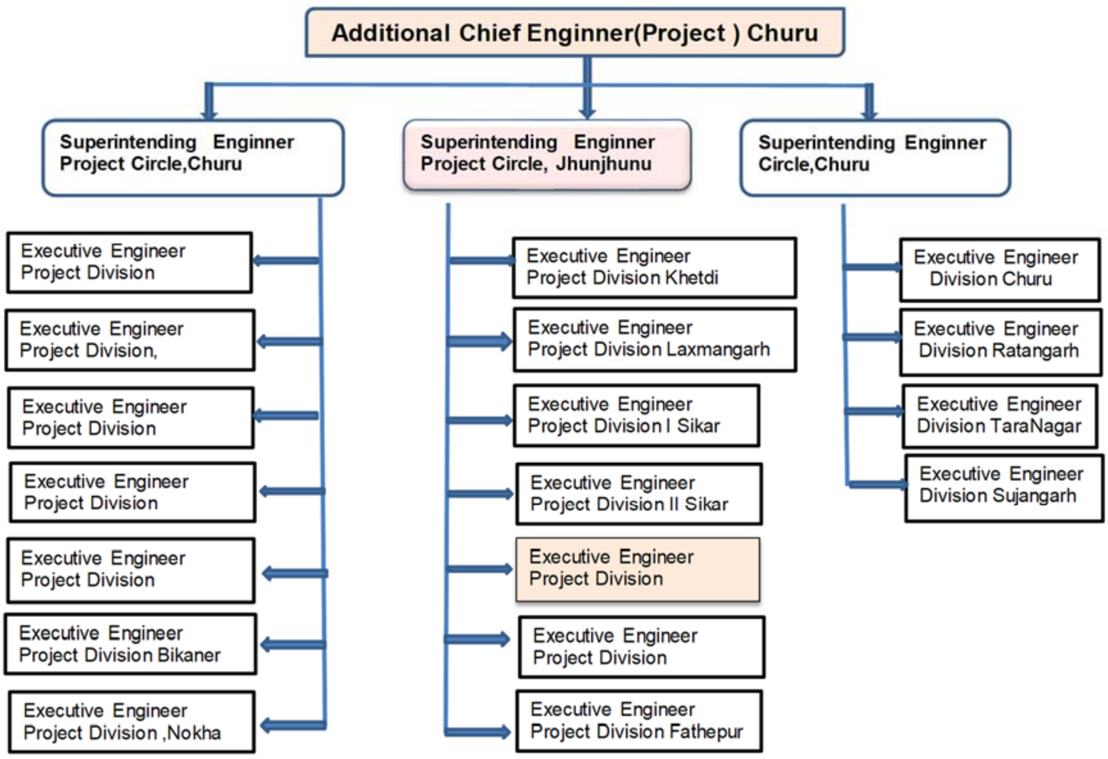
The organizational chart of PHED, as of January 2020, is shown in Figure 8.2.1. Under the principal secretary, chief engineers for urban area, rural area, and special project (for international fund) are assigned. Other junior staff are allocated to each chief engineer to work in different division offices.

Main counterparts of the project are highlighted in the succeeding figures. In case the project is implemented using an international fund source, the chief engineer of special project will be in charge. During construction and the O&M phase, additional chief engineers in Barmer and Churu regions will take care of the facilities. Under these additonal chief engineers, there will be executive engineers working in the sub-region office of PHED who will be implementing the construction and O&M of water supply facilities in the rural area.



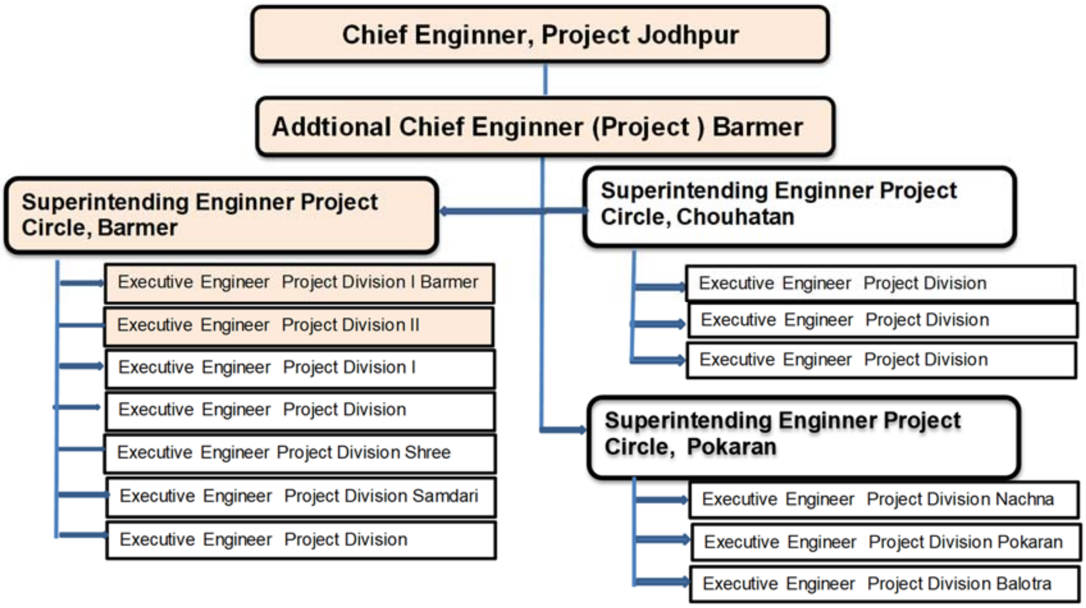
Source：PHED

Figure 8.2.1 Organizational Chart of PHED, GOR



Source：PHED

Figure 8.2.2 Organizational Chart in Churu Area



Source：PHED

Figure 8.2.3 Organizational Chart in Jodhpur Area

8.2.3 Number of Employees of PHED

The numbers of staff members and their basic salaries as of January 2020 are shown in Table 8.2.1. There are more than 32,000 staffs working in PHED, including permanent and temporal contract workers. Some staff are currently assigned to work outside of PHED, such as Urban Development and Housing Department of GOR. Some positions are vacant as of January 2020. These vacant positions are filled by persons promoted within PHED or recruited from outside.

There are around 1,700 engineers composed of “senior engineers” and “junior engineers.” In addition, around 4,300 officers are assigned in the headquarters and sub-region offices for administrative works including 358 accountants. Related to water quality analysis work, 46 staff are employed as “chemists” and “laboratory assistants”. In addition to those working in the office, a total of 26,000 technical staffs are working for the construction and O&M works of the facilities in the urban and rural areas.

Table 8.2.1 Number of Staff and Basic Salary of PHED

No.	Name of Post	Sanctioned	Working	Vacant	Pay Matrix (Basic Salary Per Month)
	Senior Engineers	**2,245**	**1,094**	**1,026**	
1	Chief Engineer	9	4	5	INR 148,800
2	Additional Chief Engineeer	25	22	3	INR 123,100
3	Superintending Engineer	86	77	9	INR 79,000
4	Executive Engineer	449	400	49	INR 67,000
5	Assistant Engineer	1,676	591	960	INR 56,100
	Engineers/Chemists	**1,185**	**868**	**317**	
6	Junior Engineer	1,133	822	311	INR 33,800
7	Chief Chemist	1	1	0	INR 123,100
8	Superintending Chemist	4	4	0	INR 79,000
9	Senior Chemist	10	9	1	INR 60,700
10	Junior Chemist	37	32	5	INR 44,300
	Zoologist	**1**	**1**	**0**	
11	Zoologist	1	1	0	INR 44,300
	Officers	**3,917**	**2,768**	**1,149**	
12	Establishment Officer	12	4	8	INR 60,700
13	Administrative Officer	30	2	28	INR 44,300
14	Additional Administrative Officer	184	91	93	INR 37,800
15	Assistant Administrative Officer	600	268	332	INR 33,800
16	Senior Assistant	1,136	823	313	INR 26,300
17	Junior Assistant	1,736	1,475	261	INR 20,800
18	Personal Secretary	4	3	1	INR 60,700
19	Additional Personal Secretary	14	11	3	INR 44,300
20	Personal Assistant	69	28	41	INR 37,800
21	Stenographer	132	63	69	INR 33,800
	Draftman	**99**	**22**	**77**	
22	Chief Draftsman	1	1	0	
23	Senior Draftsman	21	5	16	INR 33,800
24	Junior Draftsman	14	2	12	INR 26,300
25	Tracer	22	5	17	
26	Draftsman	41	9	32	INR 33,800
	Labo Assistant	**165**	**89**	**76**	
27	Senior Lab Assistant	36	7	29	
28	Junior Lab Assistant	56	56	0	
29	Sample Taker	3	0	3	
30	Caretaker of Laboratory	70	26	44	
	Employees	**1,722**	**1,120**	**602**	
31	Fourth Class Employee	1,615	1,093	522	
32	Jemadar	107	27	80	INR 17,700
	Accountants		**358**		
	Technical Staff	**30,106**	**25,722**	**4,384**	
	Total	**39,440**	**32,042**	**7,631**	

Source: Information provided by PHED

8.2.4 Organizational Structure of GOR

The existing departments of GOR are summarized in Table 8.2.2. Water supply service is managed by PHED, and sewerage service is implemented under the control of the Urban Development and Housing Department. Other basic and social infrastructures, such as energy provision, public phone, agriculture, education, and health, are also provided by corresponding departments of GOR.

Table 8.2.2 Departments of GOR

	Sector	Department
1	Agriculture	Agriculture, Animal Husbandry, Fisheries, Horticulture, Watershed Development and Soil Conservation
2	Communication	Information Technology and Communication, RajCOMP Info Service Ltd.
3	Education	College Education, Education, Medical Education, Sanskrit Education, Technical Education
4	Environment Forest	Environment, Forest
5	Finance	Commercial Taxes, Employment State Insurance, Excise, Finance, Pension and Pensioners Welfare, Registration and Stamps, State Directorate of Revenue Intelligence, Treasuries and Accounts (DTA) Raj.
6	Food	Food and Civil Supply
7	Governance and Administration	Administrative Reforms, Chief Ministers Office, Local Self Government, Panchayati Raj, Personnel, Raj Bhawan, General Administration and Cabinet Secretariat
8	Planning	Economics and Statistics, Evaluating Organization, Planning
9	Health and Family Welfare	Ayurveda, Medical Health and Family Welfare
10	Home Affairs and Enforcement	Anti-Corruption Bureau, Home, Prosecution, Rajasthan Police, Rajasthan Prisons, Rajasthan Civil Defense and Home Guards
11	Urban Development and Housing	Town Planning, Urban Development and Housing
12	Industries	Cooperation, Factories and Boilers Inspection, Industries Portal, Mines and Geology
13	Information and Broadcasting	Information and Public Relations
14	Infrastructure	Public Works
15	Labour and Employment	Employment, Labour, Skill Employment and Entrepreneurship
16	Law and Justice	Advocate General Rajasthan, Justice, Rajasthan High Court
17	Power and Energy	Energy, Petroleum
18	Science and Technology	Science and Technology
19	Social Development	Minority Affairs, Social Justice and Empowerment, Tribal Area Development
20	Transport	Transport
21	Travel and Tourism	Tourism
22	Revenue	Board of Revenue, Revenue
23	Water and Sanitation	Public Health Engineering, Water Resources

Source: Information provided by GOR

8.2.5 Personnel System and Training Program of PHED

(1) Working Position

Permanent officers in PHED are rotating jobs every few years. Some staffs are assigned to other departments for technical supports. In order to assure the continuity of the project it is recommended that the main counterparts are not to be changed during the design and implementation phase.

(2) Salary

The basic salaries of staffs are indicated in Table 8.2.1. The actual received salary amount includes the said basic salary and the following allowances:

- DA: Dearness Allowance (+12% of basic salary)
- HRA : House Rent Allowance (+16% of basic salary)
- CCA : City Convenience Allowance (+1,000 fixed rate)

The salary amount increases every year reflecting inflation and their working performance.

(3) Promotion and Training

Promotion is conducted based on the performance and policies of GOR. A permanent staff needs to submit the reports to GOR for the promotion.

Staffs of PHED attend various training courses mainly provided by three public entities shown in Table 8.2.3. Engineering Staff Training Institute (ESTI) organizes training courses for engineers of GOR especially for the Public Works Department (PWD), Water Resource Development (WRD), and PHED. Harish Chandra Mathur Rajasthan State Institute of Public Administration (HCM RIPA) provides various training courses for administrative officers. These two entities are certified as Key Resource Centers (KRCs) and funded by the central government. Water and Sanitation Support Organization (WSSO) is the unit inside PHED which provides capacity building service including community related issues focusing on rural water supply. The courses of WSSO is funded by the central government and partially from the grant of UNICEF. The details of training courses are shown in Appendix 8.1.

Table 8.2.3 Main Training Organizations for PHED Staffs

Training Organization	Main Subject	Number of Trainees	Position of Participants
Engineering Staff Training Institute (ESTI)	Trainings for engineers including PHED and other water-related department	320 (Apr.-Dec. 2019)	JE/AE/EE
HCM RIPA (OTS: Officers Training School) Jaipur	Trainings for administrative officers	315 (Apr.-Dec. 2019)	AE/EE/ SE/ACE
Water and Sanitation Support Organization (WSSO)	Mainly focused on rural water supply including community participation	825 (Apr. 2018-Mar. 2019)	JE/AE/EE/SE

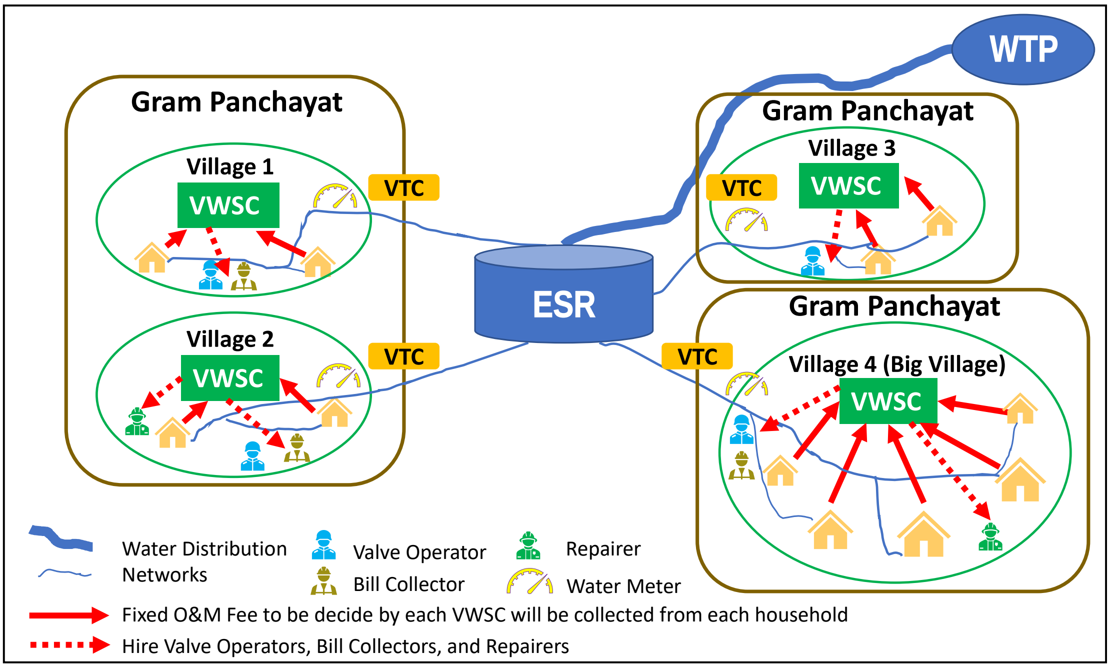
Source: Information provided by PHED

8.3 O&M Plan

8.3.1 Outline of O&M Plan

The proposed concept of water supply operation system for the project is shown in Figure 8.3.1. The water treated at WTP will be transmitted to the elevated service reservoir (ESR), which caters to several target villages. From the ESR, the water will be distributed to each target village. A water meter will be installed only at the Village Transfer Chamber (VTC). The meters will be located only at the entry point to each village and it will not be installed in each household[3].

O&M after VTC is to be managed by Village Water and Sanitation Committee (VWSC) as instructed in the JJM guideline. In line with the vision of JJM, every rural household is planned to have Functional Household Tap Connection (FHTC) through the village distribution network under the management by VWSC.



Source: Created by JST through the discussion with PHED

Figure 8.3.1 Proposed O&M System in the Community

3 In rural piped water scheme in India, the amount of water provided to each household is so limited that households can fetch it only for approximately one hour per day on average, thus villagers normally continue to fetch water for the entire period while water is provided. As a result, each household collects almost the same amount of water. This is the appropriateness of not installing water meters in each household.

In addition to FHTC, Public Stand Post (PSP) may be installed based on VWSC's requests, so that the villagers without home and the households which may take time in installing house connection will also be able to receive the water. O&M of PSP will be conducted by the VWSCs.

In case of a big village where PHED currently takes care of O&M, VWSCs will be established since the JJM guideline prescribes that VWSCs will be established in all villages.

The detail management system in the community is explained in Chapter 9.

8.3.2 O&M Fee

As shown in Figure 8.3.1, the villagers shall pay the O&M Fee to the VWSC. The collected fee will be used for the in-village O&M, such as hiring a valve operator, a bill collector, and a repairer in case technical problems happen. According to PHED, no-tariff policy[4] is currently adopted in Rajasthan State. Thus, VWSCs will not be required to pay the bulk-water tariff to PHED. Under the no-tariff-policy, it is indispensable for VWSCs to collect money for O&M works and the necessary payments for the related workers. In addition, a small amount of honorarium may be considered for the villagers who help the O&M works, such as collection of charges from villagers.

It is proposed that PHED with the assistance of a consultant should develop the guideline with regard to the O&M Fee setting during the project implementation, so that each VWSC will be able to determine the appropriate amount of fee. NGOs will assist VWSCs to collect the O&M Fee from each household through the hand-holding activity.

8.3.3 Application of DBO Contract

The O&M of the facility within the village will be undertaken by the village, as mentioned below.

8.3.4 Demarcation of O&M between PHED and VWSC

O&M of the facilities up to VTC will be managed by PHED and O&M after VTC will be managed by VWSCs as instructed in the JJM guideline. The Contractor will undertake overall O&M of the facilities up to VTC under the contract with PHED.

4 According to PHED, Government of Rajasthan issued this policy in 2019 and it will be applied for the project. However, the maximum water volume to be free of charge was not clear during the study. Before implementing the project, the latest tariff policy should be confirmed.

VWSCs will undertake O&M of the facilities after VTC and also manage the administrative issues such as tariff collection, cash management, and conflict resolution among villagers.

The O&M activities to be undertaken by VWSCs will be as follows:

- Control the valves of the village distribution network to allocate the water for each ward in the village
- Check if there is any damage/leakage in the pipeline and valves
- Undertake minor repair/replacement works of the pipes/valves
- Check the water quality using (FTK) Field Test Kits
- Manage administrative issues such as tariff collection/cash management/keeping account book/conflict resolution among villagers.
- Conduct education campaigns on judicious use of water, health promotion, etc.

Since VWSCs don't have enough technical skills to fix the major technical issues, in case VWSCs face the difficulties, the Junior Engineers of PHED who will be one of the members of VWSCs will report it to PHED/Contractor. Then, PHED will take necessary action to support the activities of VWSCs.

Member and tasks of the VWSC are explained in Section 9.1.

8.4 Financial Plan

In this section, the financial conditions of GOR and PHED, and the water tariff system are explained. In addition, the rough future forecast of PHED's financial conditions is made in the latter part.

8.4.1 Financial Condition of GOR

The water supply service is heavily dependent on the subsidy provided by GOR. Therefore, the financial condition of GOR is analysed to evaluate its soundness and stability.

(1) Revenue

The revenue of GOR is summarized in Table 8.4.1. The revenue amount increased gradually from INR 745 billion in 2013-14 to INR 1,273 billion in 2017-18.

The majority of revenue (69% in 2017-18) is collected as "tax revenue" composed of goods and services tax, taxes on income and expenditure, taxes on property and capital transactions, etc. The tax revenue is divided into two groups, namely, state own tax and shared union tax. The composition of the state own tax, which the state government has the right to collect, is 58-66% of the total tax revenue in the last five years. Non-tax revenue takes a share of 12% in 2017-18, which is composed of financial revenue, social services, and economic services. Grant in aid is the subsidy given from the central government. It takes a share of 19% of the total revenue.

Table 8.4.1 Past Trend of Revenues of GOR

(unit: INR billion)

Year	2013-14	2014-15	2015-16	2016-17	2017-18
Tax Revenue	521.5	584.9	706.3	779.3	876.3 (69%)
- State Own Tax	334.8	386.7	427.1	443.7	506.0 (40%)
- Share of Union Tax	186.7	198.2	279.2	335.6	370.3 (29%)
Non-Tax Revenue	135.8	132.3	109.3	116.2	157.3 (12%)
Grant in Aid	87.5	196.1	187.3	194.8	239.4 (19%)
Total Revenue Receipt	**744.7**	**913.3**	**1,002.9**	**1,090.3**	**1,273.1**

Source: Account at a Glance 2017-18, Government of Rajasthan

(2) Expenditures

The expenditures of GOR are summarized in Table 8.4.2. The daily cost for services is categorized into revenue expenditure, and other capital investments are categorized into capital expenditure. As the total expenditures are almost equivalent to the annual revenue, the financial condition of GOR does not make financial loss.

Table 8.4.2 Past Trend of Expenditures of GOR

(unit: INR billion)

Year	2013-14	2014-15	2015-16	2016-17	2017-18
Revenue Expenditure	444.1	641.8	708.7	897.0	1,041.5
Capital Expenditure	144.8	168.0	585.9	299.5	219.6
Total	**588.8**	**809.8**	**1,294.6**	**1,196.4**	**1,261.1**

* Summed value of each item does not match to the total value in some years as the rounded figures are used.
Source: Account at a Glance 2017-18, Government of Rajasthan

8.4.2 Financial Condition of PHED

(1) Overall Financial Situation of PHED

For the financial management of water supply service, the typical accounting system of public organization is applied as one of the departments of GOR in which the annual budget and expenditures are controlled per every fiscal year. It means that the company accounting system is not applied, and basic financial statements such as P/L, B/S, and cash flow statement are not available to evaluate the financial condition of the water supply service separately from financial condition of GOR. At present, there is no plan to apply the company accounting system for the water supply service in Rajasthan.

The total revenue, O&M expenditures, and capital expenditures of PHED are summarized in Table 8.4.3. The revenue amount only covers O&M expenditures in the last five years. Assuming the capital expenditures are added to O&M expenditures, the revenue covers only the total cost (O&M expenditure and capital expenditures). The deficit of the expenditures and revenue is subsidized by the central and the state government.

Basically, staffs in PHED consider that water is essential for human life, and it should be provided inexpensively as a social welfare. There is no clear target how much amount of expenditures should be covered by the revenue from water service at the moment.

Table 8.4.3 Recent Trend of Revenues and Expenditures of PHED

(unit: INR million)

[redacted]

Source: PHED

(2) Revenue of PHED

The past trend of revenue of water supply service is summarized in Table 8.4.4 and Figure 8.4.1. The revenue amount in the latest three years varied from INR [redacted] to INR [redacted]. After the Chief Minister of Rajasthan declared the free water policy in March 2019, water charge is exempted from low consumption users. The impact of such policy is significant especially in rural areas.

In the fiscal year of 2018-19, [redacted] of revenue (INR [redacted]) is collected from urban areas, and the other [redacted] (INR [redacted]) is collected from rural areas. The remaining [redacted] (INR [redacted]) consists of other charges such as connection fee. The collected revenues in the project areas, Barmer and Jhunjhunu, in 2018-19, were respectively INR [redacted] and INR [redacted] in urban areas, and INR [redacted] and INR [redacted] in rural areas.

Table 8.4.4 Recent Trend of Revenues Collected by PHED

(unit: INR million)

[redacted]

* Data from April 2019 until Dec. 2019 (9 months) were available.
** Summed value of each item does not match to the total value in some years as the rounded figures are used.
Source: PHED

[redacted]

Source: PHED

Figure 8.4.1 Recent Trend of Revenues Collected by PHED

(3) Capital Expenditures of PHED

The capital expenditures of PHED in the last five years are summarized in Table 8.4.5 and Figure 8.4.2. The total amount is around INR [redacted] in 2018-19, and [redacted] of the budget (INR [redacted]) was spent in rural areas. These costs are mainly covered by the state budget, but the cost in rural areas is partially subsidized by the central government, which is called as Centrally Sponsored Scheme (C.S.S.).

Table 8.4.5 Recent Trend of Capital Expenditures of PHED

[redacted]

Source: PHED

[redacted]

Source: PHED

Figure 8.4.2 Recent Trend of Capital Expenditures of PHED

(4) O&M Expenditures of PHED

The O&M expenditures of PHED in the recent five years are summarized in Table 8.4.6 and Figure 8.4.3. The total expenditure increases every year due to expansion of water supply system and price escalation. Total O&M expenditure is INR [redacted] in 2018-19 composed of expenditures for urban area (INR [redacted]), for rural area (INR [redacted]), and for project execution (INR [redacted]). Comparing the share of each item, salary (INR [redacted]) and electricity charge (INR [redacted]) account for the largest shares of the total expenditures in 2018-19.

Table 8.4.6 Recent Trend of O&M Expenditures of PHED

[redacted]

Source: PHED

[redacted]

Source: PHED

Figure 8.4.3 Past Trend of O&M Expenditures of PHED

8.4.3 Water Tariff

There are two types of water tariff systems applied by PHED: 1) For regular project and 2) For special project. The users supplied by smaller water supply system are charged by regular tariff system, whereas the users using larger water supply system which is above INR 500 million, including projects of international donors, the latter tariff table is applied.

(1) Tariff System of Regular Project

The current water and sewerage tariff table of regular project is shown in Table 8.4.7. There are three user categories, which are “(A) domestic users”, “(B) non-domestic users”, and “(C) industrial users”. Public organizations and schools are categorized into non-domestic users, and usual business entities such as shops and restaurants are categorized into industrial users. The tariff rate is lowest for domestic users and highest for industrial users.

The water charge is determined by the consumption for metered users and the fixed cost is charged for those without meters. For a metered user, block tariff system is applied. The water rate is lower for low consumption block (0-8 m^3/month), and higher rate is applied to higher consumption block (such as more than 40 m^3/month). The monthly minimum charges are determined per user category.

In addition to 1) water charge, some other charges are added such as 2) meter service charge, 3) sewerage tax, and 4) sewerage treatment plant charge. The two latter charges are imposed only within the area with sewerage service.

The abovementioned rate of water charge was determined in March 2017 and revised in March 2019. The Chief Minister of GOR determined to exempt the water and sewerage charges from low consumption domestic users who consume lower than 15 m^3/month, which is called “no-tariff policy”. Therefore, the tariff rate of domestic users, who consume less than 15m^3/month, has been free of charge since March 2019, as shown in the table below (highlighted cell).

Table 8.4.7 Current Water and Sewerage Charges (Regular Project)

<table>
<tr><th rowspan="2">Water Charge</th><th rowspan="2">Diameter of Service Line (mm)</th><th rowspan="2">Consumption (m^3)</th><th colspan="2">(A) Domestic (INR)</th><th rowspan="2">(B) Non-Domestic (INR)</th><th rowspan="2">(C) Industrial (INR)</th></tr>
<tr><th>Since Mar. 2017</th><th>After Mar. 2019</th></tr>
<tr><td rowspan="5">1. Water Charge
1) Rate per Consumption (With Meter) (INR/m^3)</td><td rowspan="4">15 - 25</td><td>0 - 8</td><td>1.72</td><td>0.00</td><td rowspan="2">9.90</td><td rowspan="2">38.50</td></tr>
<tr><td>8 - 15</td><td>2.20</td><td>0.00</td></tr>
<tr><td>15 - 40</td><td colspan="2">4.40</td><td>18.15</td><td>49.50</td></tr>
<tr><td>40 -</td><td colspan="2">5.50</td><td>24.20</td><td>55.00</td></tr>
<tr><td>> 40</td><td></td><td colspan="2">6.05</td><td>24.20</td><td>55.00</td></tr>
<tr><td rowspan="3">2) Minimum Charge for Metered Users (INR/month)</td><td rowspan="3">15</td><td>0 - 8</td><td>22.0</td><td>0.0</td><td rowspan="3">220.0</td><td rowspan="3">550.0</td></tr>
<tr><td>8 - 15</td><td rowspan="2">55.0</td><td>0.0</td></tr>
<tr><td>15 -</td><td>55.0</td></tr>
</table>

	20		220.0		550.0	990.0
	25		550.0		880.0	1,540.0
	> 40		1,650-37,950		2,640-37,950	4,950-66,550
3) Fixed Charge (Without Meter) (INR/month)			27.50	0.00	-	-
2. Meter Service Charge (INR/month)			15mm 22.00, 20mm 55.00, 25mm 110			
3. Sewerage Tax for PHED Water Supply			20% of "1. Water Charge"			
4. Sewerage Treatment Plant Charges			13% of "1. Water Charge"			

Source: PHED

The newly connected users need to pay the connection charge of INR 550 for domestic users, INR 1,100 for non-domestic users, and INR 2,200 for industrial users.

(2) Tariff System of Special Project

In case of the water is supplied by larger water supply system (facility costs more than INR 500 million), users are charged by tariff table for Special Project. The tariff level for special service (project implemented by international fund) is set at INR 1.65/m^3 for first 10 Lpcd, INR 3.85/m^3 for 10-40 Lpcd, and INR 4.95/m^3 for over 40 Lpcd. According to PHED staffs, no-tariff-policy for low consumption users was also applied to some part of special project area, but the detail information was not available during the survey.

8.4.4 Subsidy from GOR

As described in section 8.4.2 (1), there is financial deficit in the water supply service. The revenue can only cover [redacted] of O&M expenditures. The rest of the expenditure is basically subsidized by the state government. The subsidized amount for O&M expenditure was INR [redacted] in the latest five years. In addition, the whole capital cost, which was around INR [redacted], was funded by the state or central government.

The Chief Minister of Rajasthan State decided to make the water and sanitation fee zero for low consumption users in May 2019. This policy made the total revenue of PHED less, and more subsidy is needed from GOR to sustain the financial condition of PHED.

From the viewpoint of sustainability of the service, it is suggested to collect certain amount of tariff preferably up to an affordable level from users so that the revenue could cover the majority of the O&M expenditure in the future.

Regarding the impact of "no-tariff policy" on the financial condition of GOR, the total revenue of GOR was INR 1,273 billion in 2017-18 as shown in in Table 8.4.1. In the same year, the total revenue of PHED was INR [redacted] and the total expenditure of PHED was INR [redacted] as shown in Table 8.4.3. Assuming that no-tariff policy had been applied to all users and thus the revenue had been zero, the necessary subsidy amount for water supply service would have been INR . This amount corresponds to the total revenue of GOR in the same year. Thus, the impact of the subsidy is currently limited to the financial condition of GOR.

8.4.5 Mid-term Estimation of Income and Expenditure of PHED

The mid-term financial conditions of PHED are forecasted to evaluate the financial soundness and stability of PHED. In this evaluation, "no-tariff policy" is not considered.

The revenue and expenditures of PHED are estimated based on the recent trends of revenue and expenditures for past five years, and the possible deficit amount of PHED in the next five years will be estimated. The deficit amount is compared with the forecast revenue of GOR to evaluate the financial capability of GOR to subsidize the water service of PHED.

Based on the recent trend of revenue and expenditures shown in the Table 8.4.3, the revenue and O&M expenditures are assumed to increase by 5% and 12% annually. The capital expenditure is assumed to be constant at INR until the year 2024-25. Estimated future revenue and expenditures are shown in Table 8.4.8 and Figure 8.4.4.

From the above assumption, the deficit of the service increases year by year. In the fiscal year of 2024-25, the deficit of O&M cost and revenue will reach INR , and that of the total cost (O&M and capital expenditure) and revenue will be INR . It is noted that the deficit of the service could be larger than the above estimation as the influence of the no-tariff policy is not included. Therefore, the financial conditions of water supply service should be carefully monitored every year.

Table 8.4.8 Forecast Revenue and Expenditures until 2024-25

Source: JST

Source: JST

Figure 8.4.4 Mid-term Estimation of Revenue and Expenditures

8.4.6 Suggested Water Tariff Level

PHED does not have any future target of tariff level as the state government implemented “free-water policy” since 2019. According to the current financial conditions and future forecast, the revenue amount covers . It is ideal that the tariff level will be increased by 7 to 10 times to balance the revenue and O&M expenditures in the future in harmony with the development of local economy.

8.5 Organization Development Action Plan

8.5.1 Action Plan of Rural Area Managed by PHED

(1) Objectives of PHED Action Plan

This action plan is proposed to implement the project sustainably by developing the organizational structure of PHED during the planning phase and O&M phase. The action plan covers a wide range of activities in water services provided by PHED including the technical, financial, and institutional aspects.

(2) Goals

The draft plans of short-term (until 2025) and long-term (until 2040) goals are made through a series of discussions between PHED and JST. The indicators and their target numbers will be modified depending on the technical and financial conditions of PHED during implementation phase.

Table 8.5.1 Short Term and Long Term Goals

	Short-term Goals	Long-term Goals
Target Year	2025(next five years)	2040 (next 20 years)
Targets		
- Ratio of piped water supply	100% (Jal Jeevan Mission aims at providing 100% house connections and piped water supply by 2024.)	100%
- Satisfaction ratio of water quality test	95% (All water supply is being shifted to surface water sources. Water quality test facilities are being strengthened up to the block level.)	100%
- Recovery ratio of O&M costs	Not determined	Not determined
- Revenue water ratio	Not determined	Not determined
- Total number of trained employees	Not determined	Not determined
- Asset management system is introduced	80% completion level (PHED is increasing the use of IT, and assets are being tagged to the GIS system)	100% completed

Source: JST supported by PHED

(3) Activities and Overall Schedule for Organizational Development

To satisfy the short-term goals, specific activities and their implementation schedule are designed as shown in Table 8.5.2. The short-term target is set for the year [redacted]x, and the water supply of the project is planned to start in [redacted] in Jhunjhunu District and [redacted] in Barmer District. In accordance with these plans, the activities and schedule are set until the year [redacted].

Table 8.5.2 Action Plan for Organizational Improvement

Source: JST supported by PHED

8.5.2 Trainings for PHED Staff

The outline of current training courses for PHED staff provided by ESTI, HCM RIPA OTS, and WSSO are described in the section 8.2.5. Those existing trainings will be certainly useful to PHED staff training. In addition to those, JST proposes the following training courses to be implemented by the consultant for the project using JICA loan.

Table 8.5.3 Training Plan of PHED Staff

Training Course	Contents	Type of Participants
Theory of project management	- Concept of project management - Schedule planning - Roles and responsibilities of project manager - Procurement process	PIU members, engineers, and administration staff of PHED
Contract administration and procurement procedures	- Outline of FIDIC contract (forms, terms, risk allocation) - Procurement process through FIDIC framework	PIU members, engineers, and administration staff of PHED
Monitoring process of the project	- Indicators of monitoring - Management method of project progress - Typical report of the project management	PIU members, engineers, and administration staff of PHED
Financial management of the project	-GAAP (Generally Accepted Accounting Principles) - Concept of financial statements - Financial indicators of water supply service - Forecast of future financial condition	PIU members and administration staff of PHED
Management of community water supply system	- Relation between PHED and VWSC -Role of VWSC, WUG (Ward-level User Groups) in O&M of water supply systems - Payment and cash management in VWSC - Effective method of awareness campaign in the community	PIU members, engineers, and administration staffs of PHED
Gender considerations in the community for water supply schemes	-Roles, responsibilities, and needs related to gender in water management in communities and households - Importance of women's participation in community activities	PIU members, engineers, and administration staff of PHED
Heath and WASH in the community	-Importance of the education activity of water-related diseases caused by unsafe/contaminated water - Prevention measures for the diseases - Safe disposal of gray water and solid waste	PIU members, engineers, and administration staff of PHED

Source: JST

The detail of trainings will be refined during the project implementation phase as discussed with PHED.

Chapter 9 Capacity Development of Community

9.1 Overall Framework of Capacity Development of Community

9.1.1 Objectives of Component

The Capacity Development of Community component aims to create awareness and build the capacity of beneficiaries in order for them to enjoy the maximized benefit of the newly established water supply systems of the project. The component will include activities of sensitization of the stakeholders and beneficiaries, strengthening of the institution at the village level, and the development of its capacity to undertake O&M and handle any conflicts and issues that may arise during the O&M stage.

In addition, it is intended to create an enabling environment for the project. Thus, capacity development and sensitization of the stakeholders will also be planned under this component. With regard to awareness-raising on fluorosis and other water-related diseases, utilizing the Information, Education, and Communication (IEC) is an effective way to mitigate these issues as described in Section 3.4. Therefore, health and Water, Sanitation and Hygiene (WASH) promotion activities will also be included.

The Capacity Development of Community component will be conducted throughout three stages: the preparation stage (before the in-village pipeline construction starts), the implementation stage (during the in-village pipeline construction) and the operational stage (after the completion of the in-village pipeline construction and water supply has been started).

9.1.2 Actors in Village Water Supply Operation System

(1) Village Water Sanitation Committee (VWSC)

A Village Water Sanitation Committee (VWSC) is a village level unit (a sub-committee in Gram Panchayat) responsible for the operation and maintenance of the in-village water supply distribution system (after the VTC) in the project. Under the JJM initiative, GOR has issued an order[1] that directs each rural village to set up a VWSC to play a key role in FHTC. This order also instructed to avoid the creation of multiple similar committees in the Panchayat, and existing Village Health, Sanitation, Drinking Water and Nutrition Committees[2] will be converted to VWSCs with some additional members and responsibilities.

The suggested composition of the VWSC for the project is shown in Table 9.1.1. It complies with the JJM guideline as well as the GOR order mentioned above. The head of VWSC is chosen from

[1] S. No. F.3 (WQ) WSSO/SWSM/WQ/2020-21/1815-2049, dated on 29 May 2020

[2] They are created under the National Health Mission in 2005. The National Rural Water Development Programme, which was launched in 2010, also directed that Village Water and Sanitation Committees are to be established. However, there is no reference to them in PHED GOR's Order.

among the following: Sarpanch, one of the Gram Panchayat members, traditional village head, or senior village leader of each Gram Panchayat. The Gram Panchayat Secretary or Patwari will act as the secretary cum treasurer. Other VWSC members consist of current Village Health, Sanitation, Drinking Water and Nutrition Committee members (Nos. 3 to 10 of Table 9.1.1), and new members suggested by the State Order (No. 11 of Table 9.1.1). In addition, representatives of the association of Ward-level User Groups[3] (No. 12 of Table 9.1.1) will be added in this project in order to fairly reflect the voices of the user households. It is required, as indicated in the JJM guideline that 50% of these VWSC members will be female and 25% may be Scheduled Castes (SC) /Scheduled Tribes (ST). The composition of VWSC as well as the VWSC head, secretary, and members will be selected by communities at Gram Sabha, reflecting each community's situation and resident's opinions. Those members who are representing the government departments to provide technical support to VWSCs will be nominated from the concerned departments.

Table 9.1.1 Suggested Composition of VWSCs

Sr.No.	Position	Person	Number
1	Head	Sarpanch, Gram Panchayat member, Traditional village head or Senior village leader	1
2	Secretary	Gram Panchayat secretary or Patwari[4]	1
3	Member	Principal of the local school	1
4	ditto	Auxiliary Nurse Midwife (ANM)[5]	1
5	ditto	Anganwadi[6] Worker	1
6	ditto	Accredited Social Health Activist (ASHA)	1
7	ditto	Representative of women Self-help Group	1
8	ditto	Representative of the BPL families	1
9	ditto	Representatives of SC/ST families	2 (male and female)
10	ditto	Representative of Health Department	1
11	ditto	Junior Engineer of PHED / Panchayat department	1
12	ditto	Representatives of the association of Ward-level User Groups (WUGs)	2 (male and female)
	Total		14 to 15

Source: JST based on JJM and information from PHED

The tenure of VWSC members is five years. The major responsibilities of VWSCs are presented in Table 9.1.2.

3 It is explained in the latter part of this section.

4 The village account or the government administrative officer who is responsible for maintaining land records of the village.

5 A village-level female health worker in India.

6 The village childcare center.

Table 9.1.2 Key Responsibilities of VWSCs

Task	Details of the Task
Preparation for the FHTC	• Constitute the VWSCs, identify rules and regulations (including tariff systems, billing systems, security deposit, O&M fund, contributions, salaries of employees, etc.), and receive the approval at Gram Sabha • Sign the contract with PHED on behalf of the villagers • Conduct the familiarization program(s) for villagers explaining JJM, creation of VWSCs, new village water supply system, services and benefits for villagers, promotion of FHTC, tariff systems, etc. • Conduct baseline mapping for confirmation of existing water supply systems in the village • Conduct a survey for registration of households for FHTC and collect security deposit
Village Action Plan for Water Supply	• Prepare, approve, and implement the Village Action Plan (VAP) for water supply schemes, including traditional water schemes, and locations of PSPs and CWTs if they are to be constructed
Maintenance of Account	• Open bank account or use existing account for VWSC operation
O&M Fund/Water Tariff Collection	• Collect water tariff, user charges (if any), and O&M fund from households • Mobilize the community to collect contributions for in-village infrastructure capital expenditure, as necessary
Payments	• Prepare and make payments for relevant expenses of VWSCs
Records Keeping	• Maintain all the records of village piped water supply scheme such as meeting minutes, water connection register, stock register, monthly bill issuance, water tariff collection record, water supply meter reading record, water supply logbook, assets details, etc.
O&M of Scheme	• Plan, design, implement, operate, and maintain the in-village water supply scheme, including FHTC to every existing rural households (HHs) and new HHs that may emerge in the future, including scattered HHs located away from main settlements • Monitor the proper installation of FHTC • Manage regular O&M of in-village water supply system including local water sources, traditional water schemes, PSPs, CWTs, etc. • Monitor and control VTC and distribution systems, and inspect the connections to check for breakage and leakages and illegal connections, etc. • Hire or arrange workers, including valve operator, bill collector and/or technician, for regular repair and maintenance work • Resolve minor technical problems within the village • Contact PHED/contractors and resolve major technical problems • Plan and implement, as necessary, construction of in-village infrastructure for source sustainability, greywater reuse, water conservation measures, soak pits, etc. • Hold periodic meetings to discuss O&M situation, issues, future plans, etc. and maintain minutes/records of the same • Ensure water quality testing using Field Test Kits (FTKs)
Water Quality Control	• Ensure water quality using FTKs • Conduct periodic testing at laboratories and consult PHED, if necessary • Engage and train rural youth, students, and women to carry out these activities
Awareness- Raising and Education Activities	• Conduct education activities for villagers on the judicious use of water, water conservation and traditional water scheme, no misuse of water, water handling, usage of toilets, gender, and other topics regarding village piped water supply system, healthy environment and health promotion such as Fluorosis Mitigation Program (FMP), hand washing with soap, gray water handling, and water, sanitation, and hygiene (WASH) • Mobilize and motivate villagers for active participation in activities related to the piped water supply system for their support

Grievance Redressal and Conflict Resolution	• Solve problems among villagers regarding water supply • Handle grievances from users

Source: JST based on JJM Guideline and information from PHED

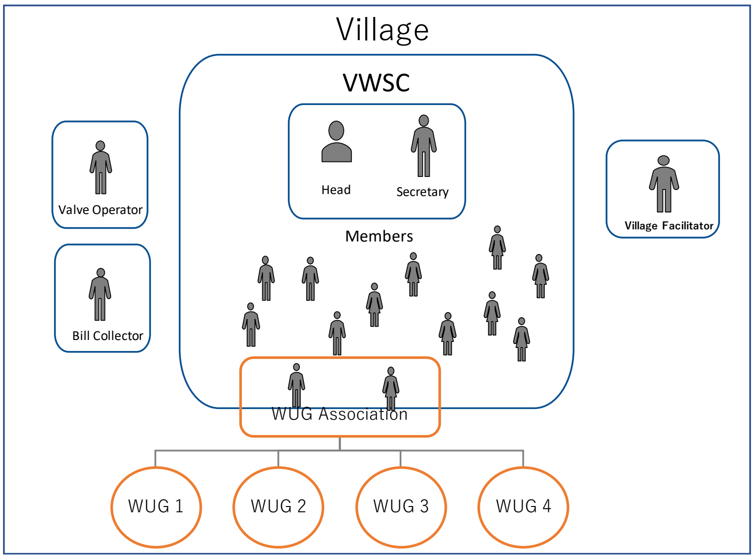
In order to fulfil above responsibilities, VWSCs could hire employees such as a valve operator to control the water supply to each ward, and a bill collector to collect bills from each household. In addition, under the project, a village facilitator to be selected from villagers will be hired by NGOs in order to facilitate communications among VWSC, NGO staff, and Project Implementation Unit (PIU) of PHED. The facilitator will also be engaged in village activities together with NGOs.

(2) Ward-level User Groups (WUGs)

It is recommended that WUGs will be formed as the lowest level community institutions for the water supply scheme in order to secure users' participation in the O&M activities. They would be created at each ward or habitation within a target village, and all households that have access to drinking water from the water supply scheme network would be WUG members. The management officers of the WUG, consisting of three to five members depending on the total number of households, would be nominated by the members at the ward's or habitation's open meeting. The officers of the WUG would be composed of equal numbers of male and female members, excluding the WUG leader. They would serve for a period of two years, after which they would be replaced by new members elected by the households residing in that ward or habitation. The WUG would be responsible for the collection and security of O&M fund, water fees (if any), or contributions from households accessing drinking water from the water supply scheme network, and support VWSCs for O&M activities. Each WUG would be responsible for suggesting the locations of PSPs to VWSCs and safeguarding[7] them. The WUG would also voice out the water supply-related concerns in the VWSC meetings. The WUG ought to have at least quarterly meeting to discuss the abovementioned issues.

The association of the WUGs, consisting of all WUGs in the Gram Panchayat, would be formed in each village as a coordinating organization, and two representatives (male and female) from each WUG would participate in the association meeting. The meetings are to be held at least four times each year. The head and deputy head (one male and one female) of the WUG association would be chosen in the meeting and serve as the member of the VWSC for two years as shown in Figure 9.1.1.

[7] Safeguarding includes maintaining and ensuring cleanliness, etc.



Source: JST

Figure 9.1.1 Proposed Organizational Structure of VWSC

(3) Women's Group/Self-help Group

It is very important to assure the women's participation in the project activities. Existing women's groups, including Self-help Groups (SHGs), in the villages are considered as the key link between the project and the communities. Therefore, the representatives of SHGs will serve as members of VWSCs. In addition, women groups will be encouraged to become the key platform to convey information regarding health and WASH to the people in the communities.

9.1.3 Implementation Structure of Component

Implementation Structure of the Component is described in Figure 9.1.2.

Source: JST based on the discussions with PHED

Figure 9.1.2 Implementation Structure of Capacity Development of Community

Project Cell (PC) needs to supervise and manage all of the activities and the consultants will assist them. NGO hired by PC will implement or facilitate programs encouraging the villagers in the community. Director (Community Participation) of PC as a head of this component will develop the programmes in consultation with the consultants. Under the instruction of the officer, Manager (Community Participation) will manage the activities conducted by NGOs.

As mentioned above, PC has critical roles in 1) overall control of activities 2) development of all of the activity plans, 3) management of the consultants, and 4) supervision of NGOs located in each district, so that community participation and capacity development program will be smoothly implemented. However, currently no official who takes care of these issues are posted in PHED except a few WSSO consultants who are operating the training program.

Considering this situation, posting a Director (Community Participation), who will work in PC, and four Managers (Community Participation) in each PMU/PIUs are proposed. Since the Director (Community Participation) has the key role, Director of WSSO, a senior personnel with enough knowledge in community participation, should be in charge of this position.

In order to make it sustainable, it is suggested that PHED hire them with its own budget. In addition, it is expected that the officers eventually contribute to community development activities to be conducted throughout Rajasthan with their experience of management in this project.

Under these officials, four NGOs will be deployed as Implementation Support Agency (ISA). NGOs will carry out the activities under the control of PMU/PIU assisted by the consultants . Since the two project areas (Jhunjhunu and Barmer) are located far from each other, some of the local consultants and supporting staff are separately posted in each area. Roles of the consultants are described in Appendix-10.1 Draft terms of reference of the consulting service.

9.2 Implementation Plan of Capacity Development of Community

9.2.1 Overall Implementation Plan

The planned activities mainly consist of Procurement of NGOs, Guidance to NGO Staffs, Community Education Activities and Capacity Development of VWSCs, and Assessment of the effect of the activities. Before the project activities is commenced, under the framework of JJM, PHED will implement its own programs for establishment of VWSC, targeting the entire Rajasthan state including the project area. The project activity will be implemented on the basis of the output and lesson learnt from the said programs by PHED.

The draft TOR of the component and the cost estimate for this component are presented in Appendix-9.1 and Appendix-9.2, respectively. Some costs that are not included in the estimate, such as the cost for meeting arrangement of the guidance and the training for related organizations, should be borne as administration cost of the borrower portion.

The following Table 9.2.1 and Table 9.2.2 illustrates the implementation schedule of the main work items.

Table 9.2.1 Implementation Schedule of Capacity Development of Community

Source: JST based on the discussion with PHED

The table 9.2.1 above is a combination of the schedules of all the target villages, while the following Table 9.2.2 shows a case of one target village, whose activities will start just after the guidance to NGO staffs.

Table 9.2.2 Required Period for Activities for One Village

Source: JST based on the discussion with PHED

9.2.2 Procurement of NGOs

While the PMU/PIU will be responsible for the supervision of project implementation in the field, one NGO for the Jhunjhunu Scheme and three NGOs for the Barmer Scheme will be engaged to execute the field level capacity development activities. The activities are to be carried out by the NGOs including IEC activities, training for the VWSCs, baseline and end line survey, and hand-holding. The NGOs will be procured through local competitive bidding. The consultants will assist PC and PMU/PIU in this procurement process. Each NGO will be required to set up a team comprising a 1) team leader, 2) project coordinator, 3) community mobilizers, and 4) surveyor as shown in Figure 9.1.2.

In addition, the NGOs will engage with a village level facilitator for each village They will be selected from villagers by the recommendation from panchayat. Their tasks are mostly to facilitate the communication between VWSCs and NGO staffs and VWSCs and PIU. Their responsibilities also include the provision of continuous support to the VWSCs. The list of the potential NGOs is shown in Appendix-9.3. The team leader will continuously work as he is hired from the start of the preparation period to the end of the activity. The village level facilitator will be hired for two years during the period while the activities in the village are conducted. Other NGO staffs, community mobilizer, and project coordinator will be hired during the period of the activities. The indicative NGO staff has been estimated and is presented in Table 9.2.3 below. The figures were derived from the approximate time required for the NGO staff to spend in a village and other necessary office work. These calculations are conducted on the basis of the plan shown in the

Table 9.2.1. According to the required effort level, the number of NGO staff to be engaged will be adjusted.

Table 9.2.3 Proposed NGO Staff Deployment

Source: JST based on the information from PHED

9.2.3 Guidance to NGO Staffs

Once the procurement of NGOs is completed, orientation and training programs of the field staff of the NGOs will be conducted. Through these opportunities, the NGO staffs will not only understand and be familiarized with the concept of JJM, the project and its specific modalities, VWSC's role and responsibilities, and in-village water supply O&M, but also gain the skills and knowledge to effectively support VWSCs and the communities. The programs will adopt a cascade system in order to complete them in a timely manner. The master facilitators/trainers will be engaged from the resource organizations, WSSO or PHED, who will then be guided by the consultants hired for the project. These experts will serve as trainers in the training programs for the NGO staff who would thereafter provide training programs for the VWSCs and other beneficiaries. In addition, instructors from other organizations will also be dispatched as trainers. The indicative outline of the training program for the NGO staff is given in the table below.

Table 9.2.4 Training Outline for NGO Staffs

Item Code	Training Title	Content	Participants	Trainer/ Resource Person(s)	Timing
TOT-1	Training of Trainers	• The project • JJM and VWSCs • VWSC supporting activities, including VAP preparation, household survey, social audit, impact assessment, etc. • Operation and maintenance • Financial matters • Records keeping • Communication with stakeholders and mobilization of communities • Gender considerations • Education programs • Water-related health issues • Capacity development of VWSCs	NGO Staff	Trainers from WSSO/PHED/ Consultants/ Other Training Institutions	Preparation Stage
TOT-2	Health and WASH	• Education on diseases caused by unsafe/contaminated water and unhygienic environment • Prevention measures for the diseases • Awareness-raising on the current situation of the diseases • Safe disposal of gray water and solid waste	NGO Staff	Trainers from Health Department/ Consultants	Preparation Stage

Source: JST

The required materials for the NGO training will be developed prior to the training, using the budget estimated under the IEC activities. PMU/PIU will work closely with resource organizations including WSSO, relevant PHED offices and the consultants.

9.2.4 Workshops for Related Organizations in each District

Before the project starts, the information workshop will be conducted in each district, inviting relevant government offices and organizations at district level and block level. The participants will gain understanding of JJM and the project. This workshop will be conducted by PMU/PIU and the consultants.

9.2.5 Sensitization of Stakeholders - Creating an Enabling Environment for the Project

The stakeholders in the villages also will need to be informed of JJM, the project, VWSC establishment, roles and responsibilities of Gram Panchayat, VWSCs and villagers in the project, and health and WASH in general in the O&M activities. Thus, sensitization session for the Panchayat leaders and secretaries will be conducted before the project starts by PMU/PIU and the consultants prior to the establishment of VWSCs. The outline of the sensitization sessions is shown in Table 9.2.5. Related activities such as providing brochures may be jointly carried out by the PMU/PIU/the consultants with the assistance of NGOs engaged in the project.

Table 9.2.5 Outline of Sensitization Sessions for Panchayat Leaders and Secretaries

Item Code	Training Title	Content	Trainer/ Resource Person(s)	Timing
Tehsil Level	Guidance and Training for Panchayat Leaders and Secretaries	• JJM and the project • VWSC establishment • Operation and maintenance • Financial matters • Communication with stakeholders and mobilization of communities • Gender considerations • Roles and responsibilities of Panchayats	PMU/PIU/ Consultants	Preparation Stage

Source: JST

9.2.6 Selection and Trainings of Village Facilitators

In addition to NGOs, village level facilitators (one in each village) will be hired by NGOs and engaged in the village activities together with NGOs. The village facilitators will be selected from the village residents or persons who are close to the village at Gram Sabha. Their tasks are mostly to facilitate communication among VWSC, NGO staff, and PIU. Their responsibilities also include the provision of continuous support for the VWSCs, to secure the sustainability of the project as they will stay in the project area even after NGOs have left the villages.

Table 9.2.6 Training Outline for Village Facilitators

Item Code	Training Title	Content	Trainer/ Resource Person(s)	Timing
VF	Training for Village Facilitators	• The project and JJM • Roles and responsibilities of VWSCs • Operation and maintenance • Financial matters • Records keeping • Communication with stakeholders and mobilization of communities • Gender considerations	Trainers from Resource Organizations/ Consultants	Preparation Stage

Source: JST

9.2.7 Household Survey

The household survey will be conducted by NGO prior to the in-village construction in order to examine the current water supply systems in the village and to confirm the location and number of households who are willing to connect to the in-village water supply scheme provided by the project. This information will be used for the preparation of the Village Action Plan (designing the registration system, tariff /O&M fund/contribution system, etc.) and for the collection of security/connection deposit.

9.2.8 Capacity Development of VWSCs

(1) (Re)Activation of VWSCs

Although GOR issued an order to constitute the VWSCs in the villages in May 2020, some of the villages in the project area have not yet been able to select new members, while others have not started their activities. WUG as described in Figure 9.1.1 is suggested to be newly established in each village with the assistance of NGOs.

In the project, NGO will provide VWSCs with assistance programs to start functioning as a village institution and developing its capacity. The assistance includes training programs, exposure visits, social auditing and hand-holding support by regular follow-up visits. NGOs will also assist VWSCs to motivate village communities to actively participate in the water supply scheme O&M and health promotions related to FMP and WASH. The NGOs will provide assistance to VWSCs for a period of 12 months after the handover of the facilities to the VWSCs. Major activities that are to be provided for the capacity development of VWSCs through the project are explained in this section.

(2) Preparation of Village Action Plan (VAP)s

One of the VWSC's tasks is to prepare a VAP together with its rules and regulations. The VAP includes the following:

- Baseline information and maps of existing water supply and drainage systems in the village;
- Information and map of the project facility;
- Village household information and prospective customers;
- Tariff systems, billing systems, security deposit, O&M fund, contributions, salaries of employees, etc.;
- Potential locations of Public Stand Posts (PSPs);
- Plan for community education programs;
- Plan for construction of sanitation facilities, extension of the distribution networks, etc.;
- Short-term (first year) and long-term (next five years) financial plans

The VAP will be prepared by each VWSC with the assistance of the NGO staff during the preparation stage. It will be presented and approved at Gram Sabha.

(3) Trainings for VWSCs

VWSCs have to gain knowledge and skills in order to fulfil their responsibilities as a key party to operate and maintain the in-village water supply schemes. The indicative training activities, including orientation sessions, are outlined in the Table 9.2.7.

Table 9.2.7 Capacity Development Activities at the Village Level

Item Code	Training Title	Contents	Target/ Participants	Trainer/ Resource Person(s)	Timing
VW-1	Orientation and Management of VWSC	• JJM and in-village water supply scheme with FHTC and its operation • Maintenance • Registration, connection, distribution, adjustment, etc. • Fees, funds and tariff setting and collection, village contributions, other incomes and expenditures, etc. • Records keeping • Repair of minor breakage and leakage • Complaints handling • Gender mainstreaming • Communications with other stakeholders, etc.	8 per VWSC (Head, Secretary, Rep. of SHG, Arganwadi Worker, Rep. SC/ST, Rep. OH, Health Worker, other members)	NGOs Observed by the Consultants/ PHED Officer	Preparation Stage
VW-2	Financial Matters and Record Keeping	• Tariff, O&M fund, connection fee, etc. setting • Bill preparation and collection of fees and funds • Maintain accounts, cash books, etc. • How to make payments to PHED • What and how records should be kept by VWSCs, etc.	2 per VWSC, (Secretary, Valve Operator or other VWSC member)	NGOs Observed by the Consultants/ PHED Officer	Implementation Stage /Operational Stage
VW-3	Community Mobilization and Awareness Education	• Importance of community participation • Concept and method of IEC activities • Gender issues • Health and sanitation issues • Effective communication methods	5 per VWSC (Head, Secretary, SHG rep., Teacher, other 2 VWSC members)	NGOs	Implementation Stage /Operational Stage
VW-4	Health & WASH	• Importance of community participation • Improvement of knowledge for water-related health issue such as FMP, WASH, waste and drainage management • Concept and method of IEC activities, especially for awareness-rising and behavior changes for health issues	5 per VWSC (ASHA, ANM, Arganwadi worker, etc., VWSC members of related to WASH issues)	NGOs Observed by the Consultants/ PHED Officer	Implementation Stage /Operational Stage
VW-5	Operation & Maintenance (Technical)	• How to address technical issues, such as examination, repair, maintenance, etc. • Reporting to and consulting with the contractor and PUC	2 per VWSC (One VWSC member and Valve Operator or Local mechanic)	NGOs	Implementation Stage /Operational Stage

Source: JST

(4) Exposure Visits

Exposure visits will be organized by PMU/PIU within or outside the state for VWSC members and the stakeholders to gain insights on how to manage VWSCs and water supply facilities. Some of the beneficiaries may also be included in the exposure visits. The details of the exposure visits may be proposed by the consultants in consultation with PMU/PIU. In case other Japanese ODA Loan project is located nearby the project area, it is recommended to visit there.

(5) Social Audit

The social audit provides transparency, accountability, and opportunity for the beneficiaries to keep track of the activities and effectiveness of the VWSCs. Once a year, at Gram Sabha, the social audit will be held by the beneficiaries to see the revenue and expenditure of the VWSCs and to raise issues that need to be resolved. The necessary assistance in conducting the social audit will be provided by the NGO staff and village facilitators along with the PMU/PIU and the consultants.

(6) Hand-holding Support

The NGO staff will provide regular hand-holding to VWSCs through regular site visits, for a period of 12 months after the handover of the facilities to the VWSCs. During this stage, the in-village water supply scheme will operate on a full scale, and the NGO's assistance will be critical in all aspects of the VWSCs' activities. However, the principle "learning by doing" will be maintained. Then, towards the end of this period, the inputs from the NGO will gradually recede for the independence of VWSCs.

(7) Facilitation for Convergence

The primary objective of the project is to establish water supply facilities to provide adequate water to concerned areas. Moreover, it is also the project's goal to build the capacity of VWSCs to sustainably operate and maintain the facilities even after project completion. To further maximize the benefits of the project, other departments, schools, research institutions, and universities can be called to converge in awareness creation and education activities concerning water and sanitation. The PMU/PIU will facilitate the networking of the stakeholders and identify the areas in which convergence can be effective. As described in Section 9.2.9, a public awareness-raising campaign is one of the areas that can be effectively done through convergence.

9.2.9 Community Education Activities

Community Education Activities or so called "Information Education and Community (IEC) Activities" have a very important role for the successful implementation of the project. It is expected that IEC activities will maximize the benefits of the in-village water supply schemes as well as enhance community participation in other activities.

The main objectives of the IEC activities for the communities are:

- Gain understanding of JJM and the project as well as roles of VWSC, communities, and users;
- Generate sense of ownership and responsibility to manage, operate, and maintain their water supply systems and facilitate an active participation of the community;
- Understand the system of FHTC and its benefit including gender related issues;

- Create awareness and drive positive behavior changes of people to take action for the protection and conservation of water resources and promote the judicious use of water;
- Increase awareness and drive positive behavioural changes among stakeholders to take action for various health issues such as FMP, health and WASH, and waste and drainage management.
- Ensure participation of women and people with weaker social status in the decision-making processes of the community;
- Promote payment for water tariff, O&M fund, and other fees incurred by FHTS.

The IEC activities include various forms such as conducting educational rallies, meetings, campaigns, distribution of brochures, putting-up posters or banners, drama plays, utilizing various forms of media, and the like. The possible topics for IEC activities will be related to: 1) Orientation on the JJM and the project/ In-village Water Supply Scheme and Introduction of VWSCs, 2) Operation & Maintenance of Water Supply Schemes, 3) Conservation and Judicious Usage of Water, 4) Gender Considerations in Water Supply, and 5) Health & WASH. The proposed IEC activities are summarized in Table 9.2.8.

Table 9.2.8 Community Education Activities

Item Code	Title	Content	Objectives	Modality	Resource Person	Timing
IEC-1	Orientation on the Project/Water Supply Scheme and Introduction of VWSC	• Dissemination of information on the project • Dissemination of information on JJM and FHTC • Education on benefits of clean drinking water • Dissemination of information on process of VWSC formation and its roles, responsibilities and importance versus community's and users' roles and responsibilities • Water connection and payment	To inform villagers about the project (village water supply scheme), VWSC establishment, and community's and users' roles and responsibilities	• Holding information meetings /workshops • Posters /banners • Distribution of brochures • Local newspapers	NGOs Observed by PHED officers and the consultants	Preparation Stage
IEC-2	Gender Considerations in Water Supply	• Different roles, responsibilities and needs related to gender in water management in communities and households • Women in the community/home: as change agents • Importance of women's participation in community activities	To educate villagers about gender issues related to water supply and the importance of women's participation in decision making and community activities	• Rallies • Drama plays • Posters	NGOs	Preparation Stage
IEC-3	Operation & Maintenance of Water Supply Schemes	• Roles and responsibilities of VWSCs and community residents • How to solve potential technical problems and conflicts regarding water	For villagers to gain a sense of ownership of the water supply scheme	• Meetings • Brochures	VWSCs NGOs	Implementation Stage

		supply schemes				
ICE-4	Conservation and Judicious Usage of Water	• Judicious water usage • Utilization of traditional water preservation method • Water conservation • Illegal connection • Proper water handling • Diseases caused by unsafe/contaminated water	To educate the villagers on the importance of safe water and water conservation	• Rallies • Drama plays • Posters /banners • Radio broadcasting	VWSCs NGOs	Impleme ntation Stage
IEC-5	Health and WASH	• Education on the diseases caused by unsafe/contaminated water and unhygienic environment • Awareness-raising on the current situation of the diseases • Prevention measures for the diseases • Importance of regular toilet usage by all family members • Safe disposal of gray water and solid waste	To raise awareness among villagers and students about Health and WASH To change the behavior for the issues	• Rallies • Drama plays (in the village and at schools) • Posters/bann ers • Radio broadcasting • Clean-up exercise • Peer education	VWSCs NGOs	Impleme ntation Stage

Source: JST

At least one educational rally/meeting for each topic in the village will be held for the dissemination of information. Several sessions may be necessary at different locations, depending on the population. In addition, awareness raising campaigns will be carried out for the topics listed in Table 9.2.8 together with distributing brochures, putting up posters and/or banners, and/or conducting educational drama plays in public spaces. Among these activities, some of them, especially those related to Health & WASH (IEC-5), will be conducted at schools. This is very effective and important, as it will not only contribute to promoting the wellness of children and to reduce the risk of their dropping out, but will also allow the knowledge and information to be diffused to their household members. Details will be determined and included in the VAP. In planning these activities, sufficient attention should be given to the communication tools and methods such as using audio visual presentations effectively. In addition, it is important to ensure that these activities will be inclusive of all villagers considering the different social status of the participants, providing an environment where people can freely express their opinions.

The implementation of these activities will be carried out by the NGO with VWSC members. The contents of the materials to be used for the activities will be developed in consultation with the district PHED offices/DWSM. The monitoring of the IEC activities through visiting selected villages will be carried out by PMU/PIU.

9.2.10 Assessment of the Capacity Development of the Community Component and Mid-term Evaluation

An assessment of the component will be conducted during the project period by setting the baseline and conducting an end line survey to assess the positive and negative changes before and after the project. The baseline and end line survey will be conducted with approximately 2% of the total households in the project area. The participating households will be randomly selected from the project beneficiaries, considering the situation of the villages and households, such as location of the villages, the level of the income and the caste of the households, so as not to have the sample selection bias.

Case studies in which success stories are collected and documented, including making videos will also be conducted during the mid-term evaluation at the selected locations and will be disseminated among the stakeholders.

9.3 Activities Against Water-related Diseases including Fluorosis

9.3.1 Main Issues of Water-related Diseases in the Area

According to the investigation conducted by Ministry of Health, main issues of the water-related diseases in the area are Acute Diarrhea Disease, Basically Dysentery, Enteric Fever (Tyohoid), and Jaundice, as described in Section 3.4.1. Due to the limited resources for accurate diagnosis, there seems to be a lot of suspected and unreported cases as well. In addition, fluorosis is also detected in some of the area. As mentioned in Section 3.4.3, safe water distribution and education activities promoting the villager's behaviour change are recognized as the essential countermeasure for water-related diseases. In this regard, the activities for health and WASH (water, sanitation, and hygiene) are planned as described in Table 9.2.7 (VW-4: Health and WASH) for VWSCs and in Table 9.2.8 (IEC-5: Health and WASH) for villagers.

Prevention of water-related diseases highly relies on the combination of safe water supply and daily proper behaviour related to the diseases at individual, household, community, and institutional levels. In order to encourage the behaviour changes, it is crucial for the villagers and communities to increase the knowledge of both risks and benefits caused by their own behaviours. Effective health promotions such as IEC activities are planned and will be implemented targeting for major water-related diseases so that villagers' knowledge and motivation will be driven up.

9.3.2 Expected Behaviour Changes from Project Activities

Through the IEC activities, villagers will learn the knowledge of the fluorosis and major water-born diseases, which expects to promote the behaviour changes as shown in Table 9.3.1.

Table 9.3.1 Expected Behavior Changes from the Project Activities

Disease	Expected Behavior Changes
Fluorosis	-Increase the percentage of residents expanding the knowledge of fluorosis (What is fluorosis, what is the cause, how to prevent, etc.) -Increase the percentage of residents drinking safe water and eating safe food -Increase the percentage of residents visiting health facility and dentist for the suspected fluorosis case
Major Water-	-Increase the percentage of residents expanding the knowledge of major water-borne diseases in the area

born diseases	-Increase the percentage of residents conducting hygienic practice such as drinking safe water, wash their hands, keep the surroundings clean etc. to prevent the diseases -Increase the percentage of residents visiting health facility for the suspected cases

Source: JST

9.4 Gender Consideration

9.4.1 Policies Related to Gender and Water Supply

India’s Constitution guarantees basic human rights and gender equality. However, there is a wide gap between women's rights guaranteed by the Constitution, other laws, systems, policies, etc., and women’s actual status. The National Policy for Empowerment of Women (2001) was formulated in order to narrow the gap and to empower women by strengthening legal systems, creating supportive policies, and changing social attitudes and community practices through the active participation and involvement of both men and women. The National Policy for Women 2016 was drafted by the Ministry of Women and Child Development in order to “guide transformative shifts” required for addressing existing gender issues and positioning women as equal partners to sustain the development that the county is experiencing. The Policy states the importance of safe drinking water and sanitation as critical for women’s health as well as for mitigating women’s water burden.

The National Rural Drinking Water Program (NRDWP), the Government of India’s efforts to provide drinking water to rural populations, launched in 2010, recognizes rural women’s burden in securing water for their family’s daily lives and emphasizes the importance of the empowerment of women. NRDWP was restructured and subsumed as Jal Jeevan Mission (JJM) by the Modi Government in 2019, which aims to provide FHTC to every rural household by 2024. It succeeded the NRDWP’s strategy for promoting women’s participation and empowerment. The JJM operation guideline states that household water connection will further promote women's empowerment. In this way, women will be released from the burden of spending extensive time and effort in fetching water and will have more control over the decisions related to water usage. Ensuring the active participation of women at all levels of institutional arrangement, especially at the village level, is key to the success of JJM.

9.4.2 Gender Mainstreaming Efforts at Rajasthan PHED

There is a room for improvement as to the gender mainstreaming activities by PHED. Although the importance of gender considerations in water supply is recognized, there is not much expertise on gender issues in the department, and there is very limited chance for PHED engineers to participate in training programs that include gender considerations. Currently, sufficient attention has not been paid to mitigate gender inequality in design and in implementation of piped water supply schemes. Thus, promoting women’s participation in the community level activities will be the NGO’s important role in Capacity Development of Community.

As for employment, there is a norm[8] that there must be a reservation rate of 30% for women employment in government offices in Rajasthan. However, only a small number of women are working at PHED offices, especially in regional and circular offices. One of its reasons are low application rate (less than 30%) from women for PHED. It may also be associated with the fact that many positions in some of the circular offices, especially in Barmer District, are vacant, regardless of gender.

9.4.3 Women's Conditions in Project Area

It is known that females in India have less access to social services than males. It is particularly notable in the education sector. Females have been expected to stay at home and to take care of households rather than to work outside. Thus, it is considered that education is not needed for females. These trends are still persistent in rural areas. Table 9.4.1 shows the literacy rate of males and females in the target CD blocks in Jhunjhunu and Barmer districts. In all CD blocks, there are large gaps between male and female in literacy rates. In Jhunjhunu District, the disparity is larger than the national average, ranging between 24.26% in Surajgarh Block and 27.41% in Buhana Block. It is between 23.1% in Dhorimanna Block and 25.93% in Barmer Block in Barmer District, which is smaller than Jhunjhunu. However, this is not because of a high literacy rate for women but simply because males have a much lower literacy rate in that sample. The female literacy rate itself in Barmer is very low; it is only 22.17% in Chohthan Block, and even the highest rate in Sindhari Block is only 33.38% as compared with the female literacy rate in Rajasthan State of 52.12% on average.

Table 9.4.1 Literacy Rates of Males and Females in the Project Areas

	Literacy Rate (%)			Gap between Male and Female
	Persons	Male	Female	
India	74.04	82.14	65.46	16.68
Rajasthan State	66.11	79.19	52.12	27.07
Jhunjhunu District	76.53	87.39	65.03	22.36
Chirawa Block	73.53	86.99	59.94	27.05
Surajgarh Block	74.22	86.13	61.87	24.26
Buhana Block	75.64	88.99	61.58	27.41
Udaipurwati Block	71.89	85.30	58.14	27.16
Barmer District	56.53	70.86	40.63	30.23
Sindhari Block	46.14	57.82	33.38	24.45
Barmer Block	43.62	55.75	29.82	25.93
Dhorimanna Block	44.25	55.27	32.17	23.10
Chohthan Block	34.52	45.61	22.17	23.44

Source: JST based on Census 2011

[8] Women reservations were introduced in 1993 by the 73rd Constitutional Amendment Act, 1993 for position in Gram Panchayat, where one third of the seats were to be held by women. These reservations did not extend to employment or education, as many states deemed it unconstitutional. However, some states chose to implement reservations in government employment as a way to increase female participation rates and empowerment. So far, there is no documentation found that proves Rajasthan is one of these states.

9.4.4 Gender Issues Related to Water Supply

It is broadly discussed that the lack of safe water supply is causing hardships and losses for Indian women. Many domestic tasks that use water such as cooking, washing utensils, laundry, etc. as well as the care for livestock and home gardens are part of the many tasks done by women; thus, securing water for these activities is also considered to be a part of a woman's job. Securing water for domestic needs is time consuming if there is no household connection, and it hinders opportunities for women to be involved in various other activities such as gaining income and taking better care of their children and family. Girls who help their mother/family are often late for school or miss classes. In addition, girls also skip classes due to lack of water at school toilets as it is very difficult and embarrassing for them not to properly take care of themselves during menstruation. This situation is preventing girls from receiving proper education.

Information obtained through the interviews with female residents during field visits[9] confirmed the abovementioned women’s and girl’s situation. According to the residents, the main persons[10] who collect water are women or children where household water connection is not available. They said that fetching water is a hard work, carrying 15 to 20 kg for 10 to 30 minutes at a time between the water source and house, especially in the hot season. They go multiple times, depending on the household’s situation.

As for the girls’ situation, it varies by areas. A few girls in Nokhra Village in Barmer District where the Public Stand Post (PSP) is located more than 20 minutes walking distance from their houses said that they are late for school a few times a week due to fetching water in the morning. On the contrary, at a public high school in Sahar Village, in Jhunjhunu District, female students reported a different situation. They said that attending to school is considered to be more important by their families and they make sure that girls go to school without delay. In terms of the toilet situation, no girls interviewed in Jhunjhunu District or Barmer District revealed such problems.

The results of the social condition survey shows similar results. The main family members who are responsible for securing water for domestic use are female. They spend considerable time and energy in fetching water, which is a hard work and may hinder their potential for being involved in more meaningful activities, such as conducting economic activities or caring their children. Table 9.4.2 and Table 9.4.3 show the family members and the daily frequency of collecting water from different sources outside the house in Barmer District and Jhunjhunu District, respectively. Among those households (HHs) that need to fetch water from the water sources[11] outside the

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[9] 5 villages in Jhunjhunu District and 3 villages in Barmer District.

[10] Other family members as well, except old people, are involved in fetching water.

[11] These are public stand posts, public hand pumps, and dug wells and the HHs with these sources are only 8.5%, 1.9%, and 4.7% of the total 364 HHs, respectively, in Barmer District. In Jhunjhunu, these are only stand posts and dug wells, and 3.6% and 4.6% of the 304 HHs, respectively.

house for their domestic needs, the wives or mothers of the HHs go most frequently in both Barmer and Jhunjhunu Districts. It should be noted, however, that all family members, except those who are too young or too old, are also involved in collecting water more or less, and the husbands/fathers are more involved than daughters. The average distance to the water source from the house is shown in Table 9.4.4. The average distance varies depending on the water source, and it is around between 229 and 326 meters. Moreover, the average amount of time required for one trip takes between 46 and 71 minutes in Barmer District. In Jhunjhunu District, the average distance is between 129 and 236 meters, and the average time required is between 31 and 50 minutes.

Table 9.4.2 Family Members and Frequency to Collect Water per Day in Barmer District

Water Source	Husband/ Father	Wife/Mother	Son	Daughter	Daughter in law
Stand Post	1.2	2.7	1.1	0.3	1.2
Hand Pump	7.9	9.4	2.1	4.3	0
Dug Well	0.8	4.8	1.4	1.5	0.7

Source: Social Condition Survey

Table 9.4.3 Family Members and Frequency to Collect Water per Day in Jhunjhunu District

Water Source	Husband/ Father	Wife/ Mother	Son	Daughter	Daughter in law
Hand Pump	2.6	4.5	2.9	1.6	1.5
Dug Well	2.4	5.4	0.1	1.6	1.6
Dug Well	0.8	4.8	1.4	1.5	0.7

Source: Social Condition Survey

Table 9.4.4 Distance to the Water Point and Times Required to Collect Water per Trip in Barmer and Jhunjhunu Districts

District	Jhunjhunu		Barmer	
Water Source	Distance (m)	Time Taken per Trip (min.)	Distance (m)	Time Taken per Trip (min.)
Stand Post	N/A	N/A	289	46
Hand Pump	123	50	229	51
Dug Well	236	31	326	71

Source: Social Condition Survey

To know the girls' situation, mothers of the above HHs[12] were asked whether or not their daughters have ever been late for school due to the collection of water. Only one mother in each district answered that her daughter had been late for school often. The vast majority of mothers, (89% in Barmer and 82% in Jhunjhunu) answered "never". In addition, in the school survey,

[12] 49 HHs.

teachers were asked whether they recognize that there are female students who skip school/classes because they are busy collecting water at home. In response to the question, 12 schools in Barmer and 17 schools in Jhunjhunu answered “Never heard of it,” and six schools in Barmer and one school in Jhunjhunu answered "I have heard about it, but not in our school".

As for the girls’ situation at school, the same result as the field survey was seen. Mothers were asked whether or not their daughters ever expressed their feelings of not wanting to go to school because there is no toilet or no water available for flushing toilets at schools. Among those who have daughters, 96% of the mothers in each district answered “never”. In addition, in the school survey, teachers were asked whether they recognize that there are female students who did not come to school because there was no water in the toilet or that the toilet was broken. In response to the question, 12 schools in Barmer District and 17 schools in Jhunjhunu District answered “Never heard of it” and six schools in Barmer District and one school in Jhunjhunu District answered "I have heard about it, but not in our school". Neither “girls skipping school for collecting water” nor “girls not going to school because there is no toilet or water at toilets in school” is a common phenomenon in the sample villages. Girls in the sample villages may be in better positions in the above situations than in other parts of India.

Nonetheless, the household water connections to be brought by the project will release women, and men, from the burden of spending extensive time and effort in fetching water. It will give opportunities for women to be involved in various activities such as gaining income and taking better care of their children and families, which will further promote women's empowerment.

9.4.5 Gender Issues in Water Supply and Needs to be Addressed

The main gender issues and needs identified from the current situation in the project area and to be addressed through the project are summarized in Table 9.4.5 below.

Table 9.4.5 Gender Issues and Needs to be Addressed through the Project

Gender Issues	Needs to be Addressed in the Project
Many households in the project area do not have water connections or wells at home, and family members, mainly women, spend considerable time and efforts for collecting water daily.	Enable many people, especially women, to utilize their time and efforts for other economic and productive activities by implementing this project and supplying safe water to each household.
Rajasthan PHED has not reached the quota of 33% for the employment of women. The same situation applies to the district and block offices.	Secure women's participation in decision making and implementation of the project.
PHED does not have sufficient gender expertise. Gender considerations are included in staff training programs but are very limited.	Improve the awareness and knowledge of stakeholders regarding gender considerations.
Women’s participation in decision making in water and sanitation should be secured at the community level. However, the literacy rate of	Secure women’s participation not only in terms of numbers but also regarding substantive matters. Carefully choose communication tools and

Gender Issues	Needs to be Addressed in the Project
residents of Barmer District, especially females, is much lower than the national average, and the gap between males and females is large.	methods giving consideration to women's literacy rate and education levels in the capacity development of VWSCs and the educational programs implemented in the villages.

Source: JST

9.4.6 Gender Action Plan

The following gender action plan is suggested in order to maximize the benefits of the project and to ensure that women will receive an equal portion of these benefits through their participation and involvement in decision making during the preparation, implementation, and operation and maintenance activities. The gender action plan corresponds to the needs identified in Table 9.4.5 to be implemented within the project framework. Suggested actions, expected outputs, and indicators as well as responsible parties and timeframes are summarized in Table 9.4.6

Table 9.4.6 Gender Action Plan

Action	Outputs/Indicators	Responsible Parties	Time Frame
Provide household water connections in target villages: this will enable both men and women in the project area to save time for collecting water, and thus they will be able to use time for other productive activities.	• About 2 million people in the project area (in [redacted]), nearly 50% of those being women, will be provided with household water connections. • Average time spent for collecting water in dry season by a family will be reduced by at least 50%.	PHED, PMU	Operation Phase
Create an organizational structure that ensures sufficient gender considerations throughout all phases of the project under the responsibility assigned to the PMC.	• Gender consideration is included in the TOR of PMC. • More than one female member is assigned to the PMC and PIU.	PHED PMU	Preparation-Operation Phase
Assign “Director (Community Development)” who has knowledge in community participation and gender considerations in PIUs’ positions and add "to ensure gender consideration in project implementation" to her/his TOR.	• An officer with expertise on gender considerations is assigned at each PIU.	PMU	Preparation-Operation Phase
Add subjects of gender consideration to the project orientation and capacity development programs for PIU members and Gram Panchayat leaders.	• More than 75% of participants of the programs in all levels understand the need for gender considerations in the project.	PMU, PIU	Preparation-Construction Phase

Action	Outputs/Indicators	Responsible Parties	Time Frame
Ensure equal employment opportunities and compensation for women who engage in project activities, including within PIU, the consultants, contractors, labors, NGO staff members, etc.	• Women who are involved in the project activities are given equal opportunities with men in terms of employment and compensation.	PMU, PIU, Contractors	Preparation-Operation Phase
Specify in the tender documents and contracts that gender considerations will be extended in the implementation and O&M of the village water supply schemes. In particular, women's opinions are to be sufficiently reflected in complaint management (grievance redress).	• Gender considerations are understood and acted upon by the contractor and NGOs and taken into consideration in O&M of village water supply schemes.	PMU, PIU	Preparation-Operation Phase
Include more than 33% of female members in the Ward-level User Group (WUG), and assign one male and one female representatives from each WUG as members of the association of WUGs. One male and one female representatives of WUG association will serve as village water subcommittee members in order to reflect female user's views equally.	• More than 90% of wards or other habitations have more than 33% female members in WUG.	PMU, PIU, VWSC	Construction-Operation Phase
Consider women not only as beneficiaries, but also as change agents, and encourage them to participate in any community activities in the target villages.	• More than one women's group is involved as an active agent in the community activities in each village. • At least 50% of participants in village education programs are women.	VWSC NGO PMU Consultants	Construction-Operation Phase
Include gender considerations as a subject in the capacity building program for VWSC members and village education programs. Use female resource persons, including ASHA and ANM, as much as possible.	• Gender-sensitive training materials are prepared and gender consideration subjects are included in VWSC capacity development programs and village education programs.	PMU, PIU	Preparation-Operation Phase
Carefully choose communication tools and methods giving consideration to women's low literacy rates and education levels in the capacity development of VWSCs and village educational programs. As necessary,	• Over 80% of female participants say they understand the content of the village education programs.	PIU, VWSC	Operation Phase

Action	Outputs/Indicators	Responsible Parties	Time Frame
separate programs for female residents may be set up to promote women’s understanding.			

Source: JST

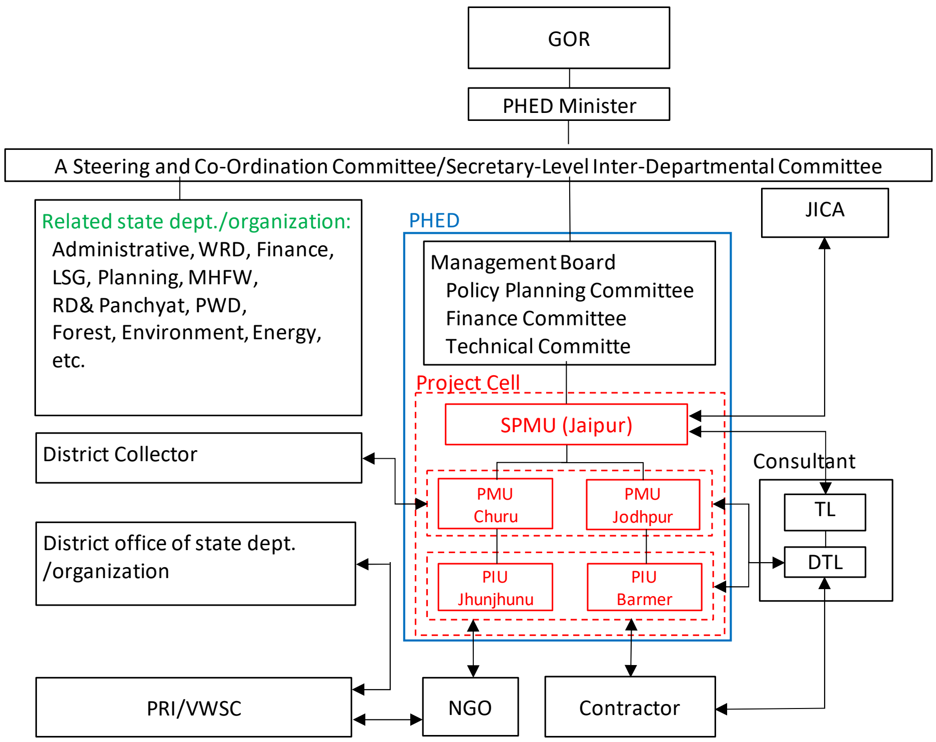
Chapter 10 Project Implementation Plan

10.1 Organization for Project Implementation

The organization for project implementation is proposed by PHED and JICA/JST as described hereunder.

10.1.1 Overall Implementation System

Figure 10.1.1 shows the proposed overall implementation system of the project.



Source: JST based on discussion between PHED and JICA

Figure 10.1.1 Proposed Overall Implementation System of the Project

The Management Board of PHED is a decision-making body of PHED. For implementation of the project, PHED will establish a separate and independent Project Cell, which assumes full responsibility for implementing the project. Project Cell will consist of one State Project Management Unit (hereinafter referred to as "SPMU") in Jaipur, two Project Management Units (hereinafter referred to as "PMU") respectively in Churu for Jhunjhunu scheme and in Jodhpur for Barmer scheme, and two Project Implementation Units (hereinafter referred to as "PIU") respectively in Jhunjhunu for Jhunjhunu scheme and Barmer for Barmer scheme. Project Cell will employ the consultant who will assist Project Cell in project management and communication with JICA. The proposed TOR of the consultant is presented in Appendix-10.1.

10.1.2 Organization in PHED for Project Implementation

(1) Management Board

The Management Board of PHED, RWSSMB: Rajasthan Water Supply and Sewerage Management Board, is the supervising, guiding, and decision-making authority for the water supply sector on behalf of GOR. RWSSMB is chaired by the PHED Minister and composed of the following members:

- Principal Secretary, PHED
- Secretary, Finance Department
- Secretary, Local Self Government Department (LSGD)
- Secretary, Planning Department
- Director, Rural Development and Panchayat Raj Department
- Technical Members
- Finance Advisor and Chief Accounts Officer (FA&CAO)
- Chief Engineer (HQ), PHED
- Chief Engineer (Rural), PHED
- Chief Engineer (Project), Jodhpur, PHED

The Board is assisted by the following committee as presented in Table 10.1.1. The Board delegates powers to these committees from time to time.

Table 10.1.1 Function and Member of Committees in the Management Board

	Policy Planning Committee	Finance Committee	Technical Committee
Function / Member	Administrative Sanction	Financial Sanction	Technical Sanction
Minister, PHED	Chairman		
Principal Secretary, PHED	Member	Chairman	
Secretary PHED	Member	Vice Chairman	
Pr. Secretary/Secretary, Finance Dept.	Member	Member	
Technical Members, PHED	Member		Chairman
FA&CAO, PHED	Member	Member	Member
Chief Engineer (HQ), PHED Jaipur	Member	Member	Member
Chief Engineer (SP), PHED Jaipur	Member		Member
Chief Engineer (Rural), PHED Jaipur	Member	Member	Member
Chief Engineer (Project), PHED Jodhpur	Member	Member	
Chief Engineer, WRD, Jaipur	Member		
Joint Director, Industries Dept.		Member	
Secretary of the Board	Secretary	Secretary	Secretary
Joint Secretary, Rural Development and Panchayat Raj Dept.	Special Invitee		

Source: JST based on information from PHED

(2) Project Cell

Project Cell consists of SPMU, two PMUs and two PIUs. SPMU will be chaired by Chief Engineer (Special) as Project Director of the whole Project and manage the whole scheme as the highest authority of the Project cell and as a nodal organization to Consultant/JICA/GOR. PMUs in Churu and Jodhpur will be chaired by Additional Chief Engineer and Chief Engineer (Jodhpur) respectively as Additional Project Director. PIUs will be headed by Superintendent Engineers in each region. PIUs will be the organization to monitor the progress, evaluate results and identify and resolve constraints progress and take actions under the direction of PMUs at the ground level and it also will function as the counter-part of contractors.

The staffing of Project Cell is proposed as presented in Table 10.1.2.

Table 10.1.2 Staffing of Project Cell

State PMU (Jaipur)		
Position	Nos. of staff	Remarks (Class)
Project Director	1	Chief Engineer
Chief Accounts Officer	1	Chief Officer
Director (Community Participation)	1	Director of WSSO
Secretary	1	Officer
Supporting staff	TBC	

PIU (Jhunjhunu and Barmer)			
Position	Nos. of staff		Remarks(Class)
	Jhunjhunu	Barmer	
Chief of PIU	1	1	Superintending Engineer
Manager (Technical)	2	2	Executive Engineer
Engineer	10	10	Assistant Engineer
Manager (Community Participation)	1	1	Executive Engineer (PHED)
Deputy Manager	2	2	Assist. Engineer
Chief Accounts Officer	1	1	Chief Officer
Accountant	1	3	Officer
Secretary	1	1	Officer
Supporting staff	TBC	TBC	

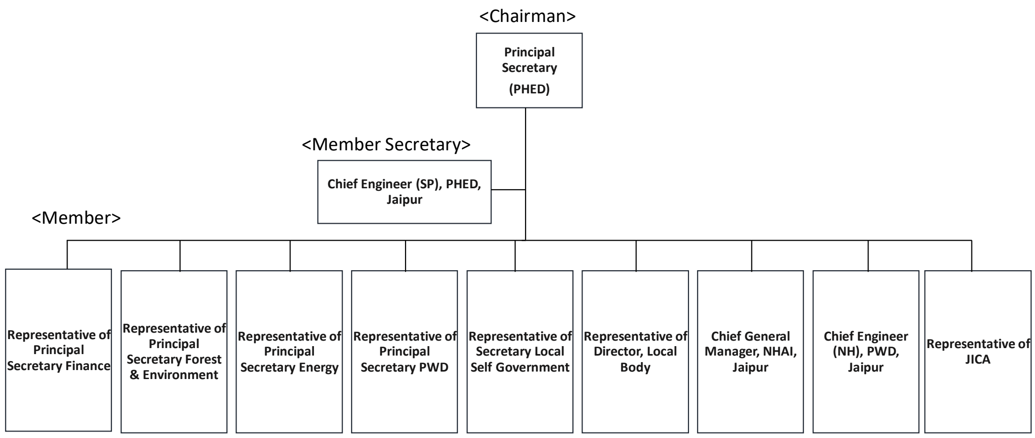
PMU (Churu and Jodhpur)			
Position	Nos. of staff		Remarks (Class)
	Churu	Jodhpur	
Additional Project Director	1 (ACE)	1 (CE)	
Deputy Additional Project Director		1	Additional Chief Engineer (exclusive)
Manager (Technical)	1	1	Executive Engineer
Engineer	1	1	Assist. Exec. Engineer
Manager (Community Participation)	1	1	Executive Engineer (PHED)
Chief Accounts Officer	1	1	Chief Officer
Accountant	1	1	Officer
Secretary	1	1	Officer
Supporting staff	TBC	TBC	

Source: JST based on discussion between PHED and JICA

SPMU will be established before signing of the L/A of the project. PMUs and PIUs will established soon after signing of the L/A.

10.1.3 Coordination with Related Department for Project Implementation

In GOR, a "Steering and Co-ordination Committee" under chairmanship of Chief Secretary has been constituted for time bound implementation of major infrastructure projects. In addition, it is proposed that a "Secretary-Level Inter-Departmental Committee" chaired by Principal Secretary of PHED with participation of Secretary-Level Officers no below than Joint Secretary of relevant departments is to be formed exclusively for the project in order to provide a platform to timely monitor and address the inter-departmental issues. The structure of the committees is as shown in Figure 10.1.2.



Source: JST based on discussion between PHED and JICA

Figure 10.1.2 Structure of Secretary-Level Inter-Departmental Committee

It is proposed that the role demarcation for implementation of the project would be as shown in Table 10.1.3.

Table 10.1.3 Roles of Each Organization for Project Implementation

Source: JST based on information from PHED

10.1.4 Lessons Learnt from Phase-I Project

(1) Outline of Phase-I Project

The loan agreement for Rajasthan Rural Water Supply & Fluorosis Mitigation Project (Nagaur), hereinafter referred to as Phase-I Project, was signed in September 2012. The outline of the project is as follows:

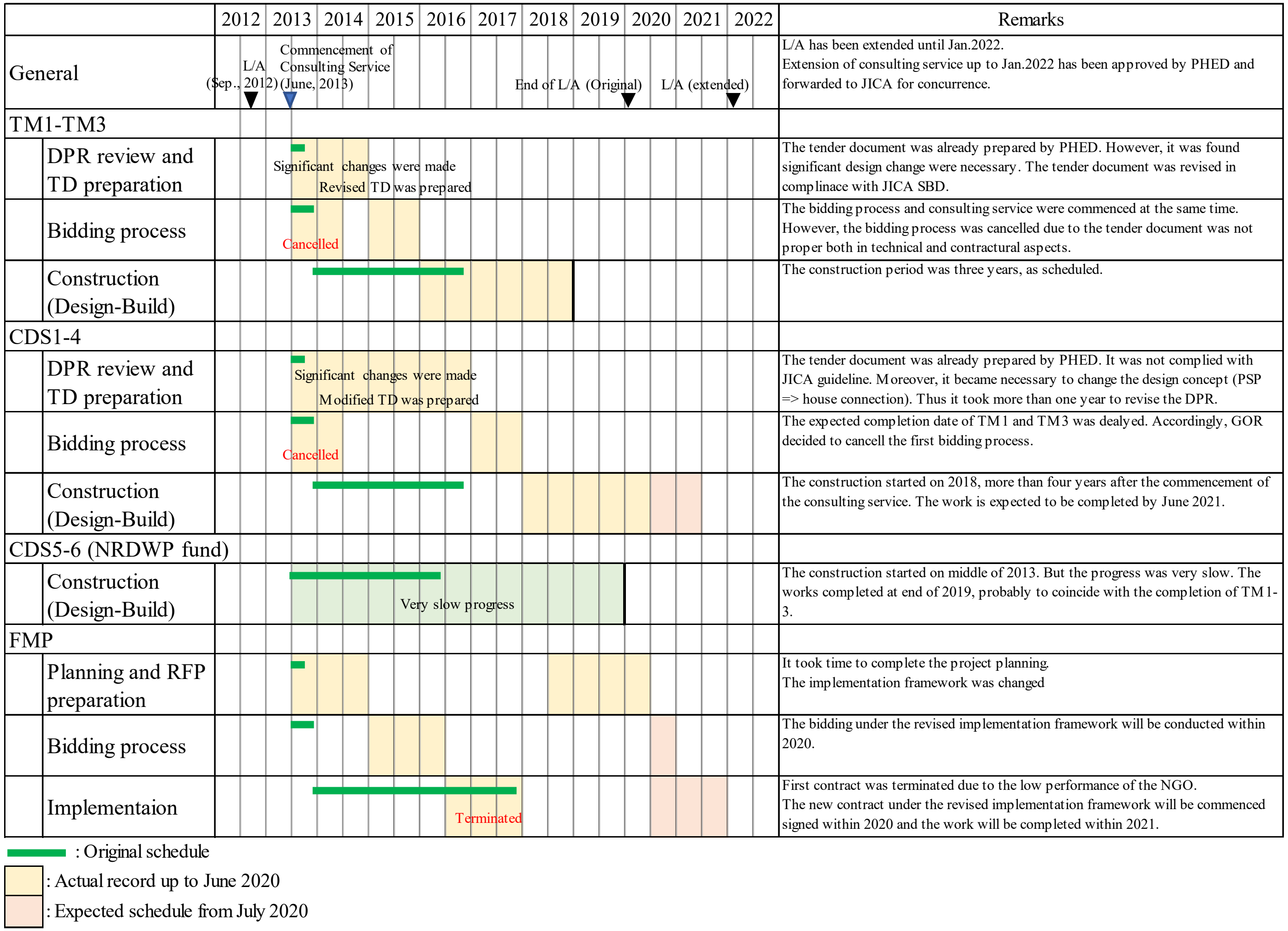
- Target supply area: Nagaur District (768 villages, 6 towns)
- Project component consisting of ten packages:
  - Trunk Main Facility (Intake - WTP - Transmission PS): TM-1, TM-2, TM-3 packages
  - Cluster Distribution System: CDS-1, 2, 3, 4, 5 packages
  - Fluorosis Mitigation Program: FMP package

(2) Progress Record of Phase-I Project

The implementation schedule was as follows:

- L/A signature: September 2012
- Commencement of Consulting Service: June 2013
- End of L/A (Original): January 2020, L/A extension: up to January 2022

The project was originally scheduled to be completed in 2017. However, the schedule was significantly delayed due to the delay of procurement of the contractor. The TM packages were completed in 2018 and the CDS packages and FMP are scheduled to be completed by the end of 2021. Figure 10.1.3 shows the progress record of the Phase-I Project.



Source: JST based on Monthly Project Report prepared by Project Monitoring and Supervision Consultant (PMSC) of Phase-I Project

Figure 10.1.3 Progress Record of Phase-I Project

(3) Reason for Delay in Progress

The PQ documents and tender documents for all ten packages had been prepared by PHED prior to commencement of the consulting service. Thus, the procurement of the contractor of TM and CDS packages and NGO of FMP started immediately after commencement of the consulting service. However, it took quite long period to sign the construction contracts after commencement of consulting service for signing the construction contracts as follows:

- TM 1, 2, 3 packages:	Two and half years
- CDS packages:	Four and half years
- FMP package:	Not yet signed

The reasons were as follows:

<u>TM Packages (Intake -WTP- Transmission PS)</u>

- The DPR design was not properly prepared. Significant changes on the pipeline route were made.
- The PQ condition of the PQ documents was not properly set. Thus, improper applicants participated in the bidding.
- Due to the situation above, the bidding process was cancelled. Moreover, the design and preparation of tender documents were re-stated, which took more than one year.
- It took long time to get the sanction of technical committee and finance committee of PHED for the revised design and cost estimate.

<u>CDS packages (Cluster Distribution System)</u>

- The state policy on water supply service was changed from PSP to house connection. Thus, it was necessary to revise the DPR design.
- Due to the delay of TM packages, it became impossible to start the water supply service even if the CDS packages were already completed. Thus, it was decided to postpone the construction of cluster distribution system
- Due to the situation above, the bidding process was cancelled. The design and preparation of tender documents were re-stated, which took more than two years.
- Due to the change of the design, the estimated construction cost was increased. Thus, the total construction cost exceeded the L/A amount and government funding was needed.
- It took time to get sanction of the revised design and cost estimate

<u>FMP Package</u>

- Original implementation framework was not suitable for implementation by the NGO. That is, there were no capable NGOs which could conduct the activities described in the TOR.

- Thus, the implementation framework was re-built incorporating WSSO and the tender documents are being finalized.

Moreover, it was reported that it took long period to obtain the permission of pipe laying from the concerned authorities.

(4) Key for Smooth Implementation of the Project

Considering the above reasons, the key points for the smooth implementation of the project are:

1) Preparation of the proper design documents, PQ documents, and tender documents
2) Prompt sanction for the procurement activities
3) Prompt permission for pipe laying works

1) Preparation of proper design documents, PQ documents, and tender documents

Review of DPR and preparation of PQ and tender documents need to be conducted by the experienced consultant hired by PHED strictly in accordance with the JICA procurement guideline.

The consultant should have the experience of preparing tender documents based on the JICA standard bidding documents.

2) Prompt sanction of the procurement activities

The sanction/approval of procurement activities should be obtained in a timely manner to avoid unnecessary delay of project

3) Prompt permission for pipe laying works

It is recommended that sufficient staff be assigned in the PIU office to prepare the application for the work permission of the pipe laying work across/under the road, as well as under the farmland

10.2 Procurement Plan

The procurement plan for project implementation is proposed by PHED and JICA/JST as described hereunder.

10.2.1 Procurement Process

The procurement of consultant and contractors need to be conducted in compliance with the “Guideline for the Employment of Consultants under Japanese ODA Loans” and the “Guidelines for Procurement under Japanese ODA Loans.” The procurement process for the project is described hereunder.

(1) Employment of the Consultant

PHED will employ a consultant who will conduct consulting service for pre-construction service (review of DPR, preparation of PQ document, PQ evaluation, preparation of bidding document and bid assistance), construction supervision, and assistance in capacity development.

The selection procedure of the consultant (preparation of RFP and its concurrence by JICA) can be commenced after the notification of the pledge. The selection process takes approximately twelve months, which starts with the issuance of the Request for Expression of Interest (Request for EOI), evaluation of the proposals, contract negotiation, and ends with the conclusion of the agreement. Prior concurrence of JICA is required in sending the Request for Proposal (RFP) to consultants that are on the shortlist prepared in advance. Results of the selection of consultant and signed contracts also require JICA's concurrence. Examination period for JICA concurrence is approximately one month.

(2) Procurement of the Contractor

The consultant will perform:

- Preparation of the bidding documents including pre-qualification and technical requirements
- Preparation of the cost estimate
- Assistance in bid evaluation including pre-qualification

Bidding documents, bidding evaluation results, and the signed contract require the concurrence of JICA and the examination period required for the concurrence is approximately one month.

10.2.2 Contract Packaging

It is proposed that the project will be implemented by contract packages (CPs):

10.2.3 Type of Construction Contract

There are two types of construction contract:

- Design-Build type contract : Detailed design is prepared by the contractor
- Design-Bid-Build type contract : Detailed design is provided by the employer

It is also proposed that the procurement method shown in Table 10.2.2 will be applied.

Table 10.2.2 Procurement Method and Applicable Bidding Documents

Source: JST based on discussion between PHED and JICA

It should be noted that the O&M cost will not be included in the project cost. The contract price for O&M will be classified into non-eligible portion.

10.3 Permission Relevant to the Project Implementation

10.3.1 Permission for Construction Works

The construction site are currently controlled and maintained by various authorities. Before starting the construction works by the contractor, permissions from related authorities need to be obtained. The procedure of getting permission from the authority is as follows:

1) The contractor requests the permission from the authority to PHED by submitting related documents and drawings.
2) PHED prepares and submits a request letter of permission to related authority.
3) PHED receives the permission letter from the authority and gives the contractor a copy of the letter.

Necessary permissions, related authorities, and approximate time for getting permission are shown in Table 10.3.1.

Table 10.3.1 Permissions for Construction Works

Permission	Approved/Authorized by	Tentative Period from Application to Getting Approval
Water Rights	Water Resources Department, GOR	Upon approval by GOR
Works in the forest area	Forest Department, GOR	6 months
Land transfer of government land from Revenue Department	District Collector, Public Relations Department, GOR	3 months
Land transfer of government land from Water Resources Department	Chief Engineer of Water Resources Department, GOR	3 months
Land transfer of private land	District Collector, Public Relations Department, GOR	9 months
Railway crossing	Divisional Railway Manager, Ministry of Railways	3 months
Road occupancy (national highway)	National Highway Authority of India, Ministry of Road Transport and Highways	6 months
Road occupancy (state highway)	Rajasthan Road Development Corporation	3 months
Road occupancy (district road)	Public Works Department, Rajasthan State	3 months
Road crossing (rural road)	Rajasthan Rural Road Development Authority	1.5 months

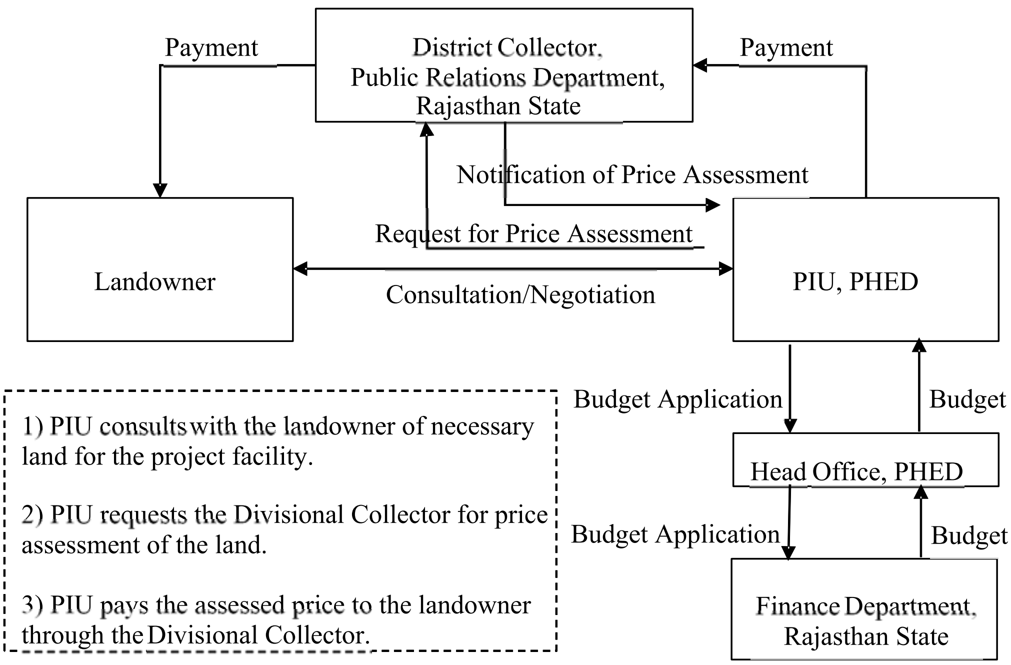
Source: JST

10.3.2 Procedure for Land Acquisition

The project facilities are basically planned on government land and the pipeline is planned to be installed within the right of way (ROW) of the road. Thus, only a few land acquisition of private land will be required.

In case the acquisition of any private land is necessary, a consultation and negotiation with the land owners, including surveying the official registered records called cadaster, will be conducted by PIU. Payment will be carried out directly by the District Collector Section, Public Relations Department, Rajasthan State. The budget of payment will be sourced by the Finance Department, Rajasthan State. At present, only one site (1,620 m^2) for pumping station (cluster pumping station at Goliyar) has been identified as the private land.

The detailed procedure for the land acquisition is shown in Figure 10.3.1.



Source: JST

Figure 10.3.1 Procedure for Land Acquisition of Private Land

In case the necessity of crop compensation arises, the same procedure will be taken. It should be noted the procedure prescribed in JICA guidelines for environmental and social consideration also need to be followed.

10.4 Security Measure in Barmer District

10.4.1 Threat Analysis

(1) Domestic and Transnational Terrorism Threats in India and Project Areas

Nationwide Threats

According to "Annual Report 2018-2019" of the Ministry of Home Affairs, four primary security issues are identified:

1) Terrorism in the hinterland of the country
2) Left wing extremism in certain areas
3) The security situation in Jammu & Kashmir
4) Insurgency in the Northeastern states

The report also indicates:

1) All Foreign Terrorist Organizations (FTOs) who attempted to carry out attacks in India's hinterland were thwarted by law enforcement agencies of India.
2) The Ministry also confirmed that Left Wing Extremism (LWE) related violence and its geographical spread have declined over the years.
3) Jammu & Kashmir saw significant improvements in the situation relating to terrorism.
4) Security in the northeastern states has improved significantly since 2014. The number of rebellions, civilian deaths, and security casualties all decreased by more than 70% in 2019 compared to 2013.

Threats in the Project Area

1) In Rajasthan State, no terrorist activity has occurred since the bombing in Jaipur in May 2008 that killed 71 people and left 200 injured in the city.
2) However, the Ministry of Home Affairs has informed the Parliament in September 2020 that Islamic State (IS) has been active in at least a dozen states throughout India including Rajasthan.
3) In recent years the Border Security Force (BSF) identified several border intrusions throughout Rajasthan, including the Barmer District. The BSF is to stay vigilant along the western frontiers.
4) The Barmer District is a border region, and intruders from the neighbouring country have been detained in the region. However, no major incidents have occurred in the past. It is important to avoid approaching the border because of the possibility of land mines. In terms of general crime, general crime rates of Barmer District such as of robbery and theft are lower than the average for Rajasthan and other cities.

(2) Impact of COVID-19 on Terrorism and Crime

1) A paper titled "The impact of the COVID-19 pandemic on terrorism, counter-terrorism and countering violent extremism" (June 2020), by the Counter-Terrorism Committee Executive Directorate (CTED) of the United Nations provides a concise analytical overview of the impact of COVID-19 on terrorism. The paper indicates that a wide variety of terrorist groups have integrated COVID-19 into their narratives and

propaganda, and raises an alert over the fact that the global population, including over 1 billion students, is spending more time online; giving terrorist groups an opportunity to expose a greater number of people to their ideas.

2) The COVID-19 pandemic has threatened economic losses around the world. Due to the increase in unemployment, many people are turning to criminal activities after authorities have begun easing lockdowns, including India.

(3) General Crime Situation of the Region in 2019

Regarding the criminal tendencies in Rajasthan state, the following observations can be made from the statistics data 2019 of the National Crime Records Bureau of the Union Government.

1) There has been a slight increase in homicide cases in the state over the past few years, but homicide rates are about the same as the national average (National level: 2.2 & Rajasthan: 2.1: The number represents the number of victims per 100,000 person).
2) The rate of Water Dispute-Motivated homicides is higher in the area and more than double the national average.
3) Gang Rivalry (6 cases) and murders by Class Conflict (10 cases) have occurred.
4) According to media reports several new gangs have emerged, and as a response the State Police Department announced last year that it will set up District Special Teams (DSTs) across the state to fight organized crime.
5) Kidnapping and abduction cases have also taken place. Crime rates are also higher than the national average (National level: 7.9 & Rajasthan: 10.4).
6) There have been no major incidents of riots or labor disputes in the region in the recent years.

From the above mentioned, there are no serious security issues in the project area. However, attention should be paid to the characteristics of the region.

(4) Construction Theft

1) According to interviews with private security companies in the region, theft at construction sites is very common, and a growing problem. These thefts are both opportunistic, or carefully planned in nature. Construction theft leads to both violent incidents and work delays.

10.4.2 Environment of Construction Sites

A majority of the construction sites are situated in isolated rural areas, and in the event of security related emergencies, prompt response by law enforcement agencies should not be expected. Thus, it is vital that construction sites appear as Hard Targets (highly defended), as opposed to Soft Targets (relatively unprotected or vulnerable).

10.4.3 Overview of Proposed Physical Security Measures

There are no significant security concerns in the project area, so it is recommended to exercise standard security precautions. Details are shown in Appendix-10.2, and the main points are as follows.

- The following facilities are the security priorities. Other facilities do not require special security measures, since their scale are very small, unless the engineers stay for an extended time.

HR-1 and HR-2 Sub-scheme:	Peeprali Headworks (RWR and WTP)
	Intake pump station at RD55 of Narmada Canal
Chohtan-1 Sub-scheme:	Aleti Headworks
	Intake pump station at RD74 of Narmada Canal
Chohtan-2 Sub-scheme:	Pump station at Dhanau

- It is recommended to deploy common and typical physical protection practices including: barriers, lighting, access control, doors and windows of facilities, along with security personnel for the above facilities. Making security appear and be formidable, is necessary to deter any criminal attempt.

Since above measures are proposed based on "as is" analysis without prediction of the future, the threat analysis needs to be reviewed on a regular basis.

10.4.4 COVID-19 Prevention Measures at the Construction Sites

Although the project area is not an infection hotspot so far, it is possible that cluster infections will occur due to workers gathering from surrounding villages and local cities. At present there are no special regulations regarding construction workplaces, but construction sites must comply with the various governmental guidelines, e.g., “Guidelines for Workplace of COVID-19 case” issued by the National Centre for Disease Control, Ministry of Health & Family Welfare.

10.5 Project Implementation Schedule

10.5.1 Construction Schedule

(1) Construction Method

The construction method to be applied for the construction work of the project facility will be the conventional civil construction method.

(2) Required Construction Period

The mean annual rainfalls (2007-2016) are 538 mm and 329 mm in Jhunjhunu and Barmer districts, respectively. 90% of rainfalls are from the southwest monsoon from June to September.

Considering the monsoon season and several national holidays, the annual number of working days is set at 280 (workable day ration = 280/365= 0.77).

The construction work of each package includes huge amount of works of distribution pipeline and this is the dominant factor for determining the construction period.

Considering the work efficiency and mobilizing/controlling capability of the contractors, the required construction period of the distribution pipeline for each package has been worked out as shown in Table 10.5.1.

Table 10.5.1 Required Construction Period for Distribution Pipeline

[redacted]

10.5.2 Overall Implementation Schedule

The contractor’s contract period is composed of [redacted]. The overall project implementation schedule including the procurement of consultant and implementation of [redacted] has been worked out as summarized in Figure 10.5.1.

Source: JST

Figure 10.5.1 Overall Project Implementation Schedule

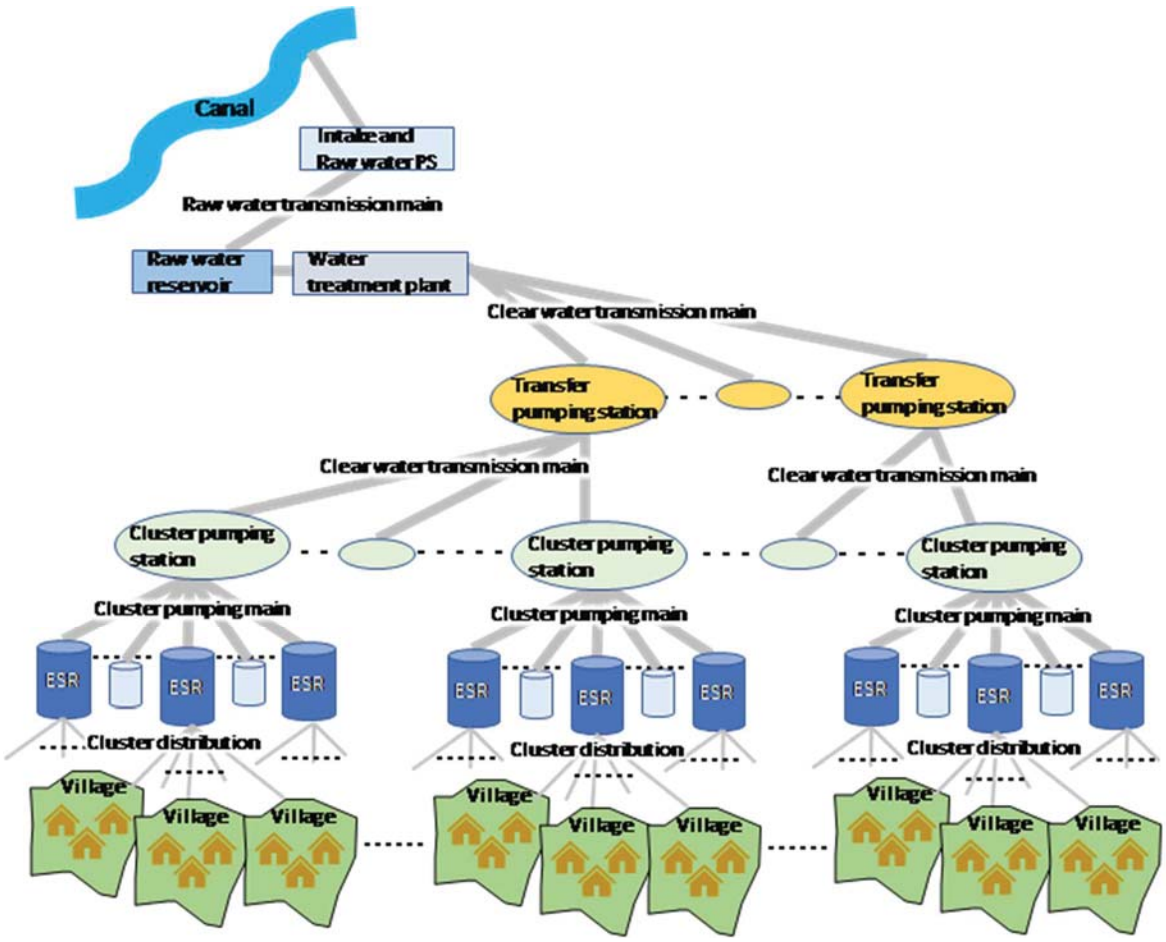
The detailed schedule is shown in Appendix-10.3.

Chapter 11 Cost Estimate

Chapter 12 Environmental and Social Considerations

12.1 Project Description

In the project, water supply facilities from intake and raw water pumping station (PS) to house connection are constructed in Jhunjhunu District and Barmer District as shown in Figure 12.1.1. In this chapter, the impact is assessed for relatively large scale facilities that from intake up to Elevated Service Reservoir (ESR). In Jhunjhunu District, facilities from transfer pumping station to house connection will be constructed and number of target village/town is 284 villages and 2 towns. In Barmer District, facilities from intake to house connection will be constructed and number of target village is 889 villages. Intake and Raw water PS will be constructed near canal and some of facilities will be located in forest area. Pipeline (Raw water transmission main, Clear water transmission main, and Cluster pumping main) will be constructed along existing road.



Source: JST

Figure 12.1.1 Facilities to be Constructed in the Project

12.2 Environmental and Social Condition

12.2.1 Living Environment

(1) Air Quality, Noise Level

Baseline of air quality and noise level were measured in Peeprali and Aleti, where WTP and raw water reservoir are planned to be constructed. Survey Location is shown in Figure 12.2.1. Result of air quality and noise level survey are shown in Table 12.2.1 and Table 12.2.2.

The overall means of 24-hourly average values of PM 10 and PM 2.5 in Peeprali are 62.48 μg/m^3 and 28.37 μg/m^3, respectively, while in Aleti, these values are 71.79 μg/m^3 and 38.59 μg/m^3, respectively. In Peeprali location, no specific pollution source was observed so the values of PM 10 and PM 2.5 are less than in Aleti location, where some construction activities were observed.

At the Peeprali site, 51.7 dB Leq. noise level was observed in the daytime and 42.2 dB in the nighttime while at the Aleti site, 53.4 dB in the daytime and 42.5 dB in the nighttime. At both locations, noise level was observed within the limit of the Central Pollution Control Board (CPCB) standards for ambient noise level.

Table 12.2.1 Air Quality Survey Results of Peeprali and Aleti

Location Name	Geotag Location	Parameter	Observed Value	CPCB Standard*	Max. & Min. Temp. During Survey
Peeprali	25° 08' 27.6" N	PM10	62.48 μg/m^3	100 μg/m^3 (24 hours)	Max: 32°C
	71° 36' 49.6" E	PM2.5	28.37 μg/m^3	60 μg/m^3 (24 hours)	Min: 27°C
Aleti	25° 00' 29.9" N	PM10	71.79 μg/m^3	100 μg/m^3 (24 hours)	Max: 32°C
	71° 33' 21.8" E	PM2.5	38.79 μg/m^3	60 μg/m^3 (24 hours)	Min: 27°C

* Ambient Air Quality Monitoring Guidelines 2009

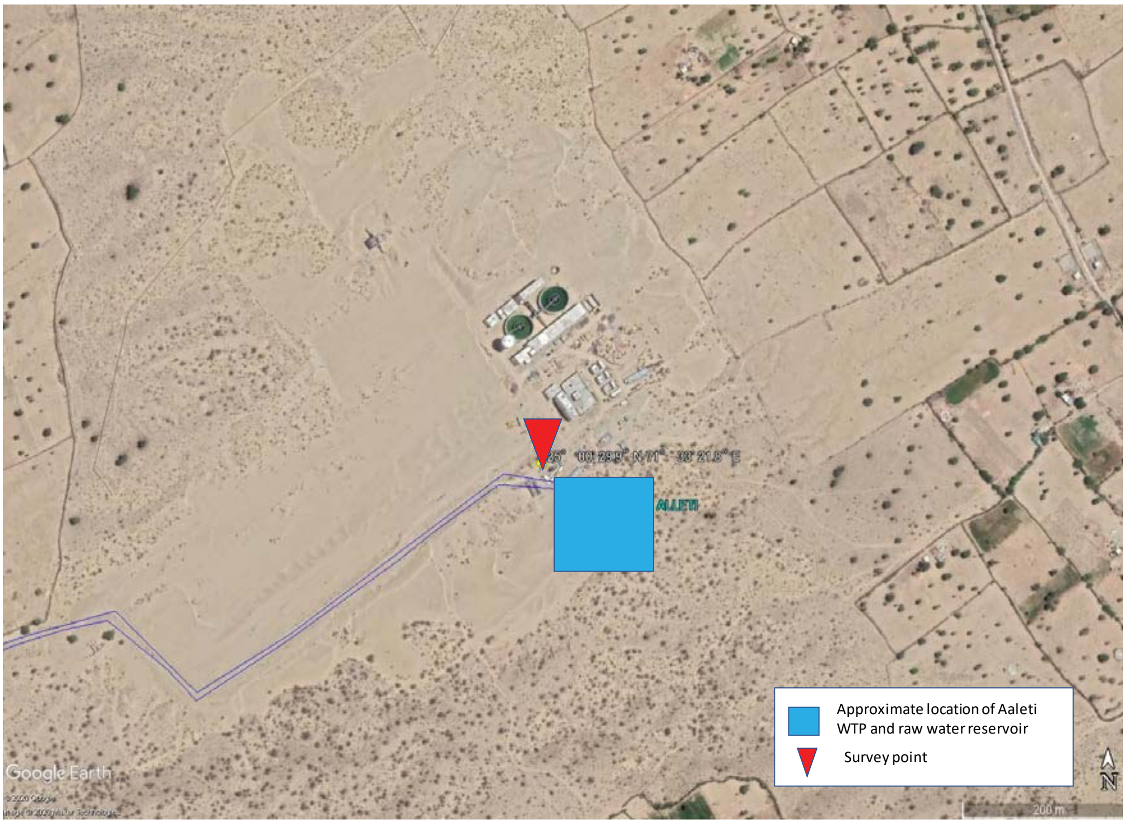
Source: Sampling and Analysis taken by JM Environet Private Limited 2020

Table 12.2.2 Noise Level Survey Results of Peeprali and Aleti

Location		Category of Area	Daytime Noise Level (dB)			Nighttime Noise Level (dB)		
Name	Coordinate		Max.	Min.	Leq.	Max.	Min.	Leq.
Peeprali	25° 08' 27.6" N, 71° 36' 49.6" E	Residential	64.2	40.6	51.7	56.1	35.1	42.2
Aleti	25° 00' 29.9" N, 71° 33' 21.8" E	Residential	64.3	42.6	53.4	55.8	36.2	42.5
CPCB Standard*		Residential	-	-	55	-	-	45

* The Noise Pollution (Regulation and Control) Rules, 2000

Source: Sampling and Analysis taken by JM Environet Private Limited 2020.



Source: JST

Figure 12.2.1 Survey Location for Air Quality and Noise Survey

(2) Water Quality

Water samples were collected at nearby locations of the proposed water reservoir, pumping stations, and ESR locations in Gudhamalani and Chohtan Tehsils, and intake point on Narmada Main Canal in Barmer District. The number of samples are nine for groundwater and four for surface water (canal). Contamination of chlorine, turbidity, and E-Coli in groundwater and chlorine, turbidity, $CaCO_3$, and E-Coli in surface water were detected. Details of the sampling locations and their results are given in Table 12.2.3, Table 12.2.4, Table 12.2.5, and Table 12.2.6.

Table 12.2.3 Survey Location for Water Quality Survey

Sample No.	Source	Location
Groundwater		
No. 17	Tube Well	Chohtan Town Tehsil Chohtan Gram Panchayat Chohtan
No. 18	PHED Water Supply Tank	Chohtan Town Tehsil Chohtan Gram Panchayat Chohtan
No. 19	Open Well	Villages Marcharon Ka tala Tehsil Chohtan Gram Panchayat Bijrar
No. 20	Tube Well	Sayed Mojali Ka Tala Tehsil Chohtan Gram Panchayat Agnishah ki dhani
No. 21	Tube Well	Villages-Khardaya Tehsil Gudha Malani Gram Panchayat Mangta
No. 22	Open Well	Villages-Champa bari Tehsil- Chohtan Gram Panchayat Champa bari
No. 23	Tube Well	Villages-Gudha Malani Town Tehsil Gudha Malani Gram Panchayat-Gudha Malani
No. 24	PHED Water Supply Tank	Villages-Gudha Malani Town Tehsil Gudha Malani Gram Panchayat-Gudha Malani
No. 25	PHED Water Supply	Villages-Gudha Malani Town Tehsil Gudha Malani Gram Panchayat-Gudha Malani
Surface Water		
No. 26	Canal km 55	Narmada Main Canal km 55
No. 27	Canal km 55	Narmada Main Canal km 55
No. 28	Canal km 74	Narmada Main Canal km 74
No. 29	Canal km 74	Narmada Main Canal km 74

Source: JST

Table 12.2.4 Result of the Groundwater Quality Survey

Parameter	Cl (mg/L)	F (mg/L)	NO3 (mg/L)	NO2 (mg/L)	NH3 (mg/L)	Turbidity (NTU)	E-Coli (MPN)	Fe (mg/L)	Mn (mg/L)	As (mg/L)
Sample No. 17	297.86	1.1	75	11.4	0.2	0.03	Nil	Nil	Nil	Nil
Sample No. 18	304.95	0.45	80	12.1	0.1	Nil	Nil	Nil	Nil	Nil
Sample No. 19	1595.7	1.3	35.44	7.9	0.2	10	Nil	Nil	Nil	Nil
Sample No. 20	309.2	1.3	80	12.15	0.4	Nil	Nil	Nil	Nil	Nil
Sample No. 21	1453.8	1.1	33.22	7.8	0.2	Nil	Nil	Nil	Nil	Nil
Sample No. 22	49.64	0.45	0.36	0.1	Nil	Nil	43	Nil	Nil	Nil
Sample No. 23	49.64	Nil	0.1	Nil	Nil	Nil	43	Nil	Nil	Nil
Sample No. 24	21.27	0.5	0.1	Nil	Nil	1	210	Nil	Nil	Nil
Sample No. 25	28.36	0.5	0.12	Nil	Nil	0.3	210	Nil	Nil	Nil
Acceptable Limit*	250	1	45	-	45	1	N.D. (100 ml	0.3	0.1	0.01

Parameter	Cl (mg/L)	F (mg/L)	NO3 (mg/L)	NO2 (mg/L)	NH3 (mg/L)	Turbidity (NTU)	E-Coli (MPN)	Fe (mg/L)	Mn (mg/L)	As (mg/L)
Permissible Limit*	1000	1.5	No Relaxation	-	No Relaxation	5	sample)	No Relaxation	0.3	0.05

Note: Result which are exceeding permissible limit is highlighting in yellow

Source: JST (*Indian standards for drinking water quality ;IS 10500 – 2012 Bureau of Indian Standards in May 2012)

Table 12.2.5 Result of the Surface Water Quality Survey (1)

Parameter	pH	Temp.	Color	Odor	TOC	Jar Test- Alum Dose Maximum Settling in Sample
	-	ºC	Hz	-	mg/L	
Sample No. 26	7.2	32.0ºC	Nil	Agreeable	42	At 3 ppm
Sample No. 27	7.2	32.5ºC	Nil	Agreeable	42	At 3 ppm
Sample No. 28	7.6	31.0ºC	1	Agreeable	38	At 3.5 ppm
Sample No. 29	7.5	31.5ºC	Nil	Agreeable	38	At 3.5 ppm
Acceptable Limit*	6.5 to 8.5	-	5	Agreeable	-	-
Permissible Limit*	No Relaxation	-	15	Agreeable	-	-
Parameter	Before Dosing Turbidity	After Dosing Turbidity	NH_3	NO_3	NO_2	Zn
	NTU	NTU	mg/L	mg/L	mg/L	mg/L
Sample No. 26	7	Nil	0.1	75	2.8	Nil
Sample No. 27	7	Nil	0.04	70	1.1	Nil
Sample No. 28	7.5	Nil	0.01	0.9	Nil	Nil
Sample No. 29	7.5	Nil	0.1	17.73	1.1	Nil
Acceptable Limit*	1	1	-	45	-	5
Permissible Limit*	5	5	-	No Relaxation	-	15
Parameter	Fe	Mn	CI	F	$CaCO_3$	P Alkalinity
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample No. 26	Nil	Nil	2056.6	1.15	880	245
Sample No. 27	Nil	Nil	2262.3	0.8	600	315
Sample No. 28	Nil	Nil	177.3	0.6	140	100
Sample No. 29	Nil	Nil	751.14	0.75	140	130
Acceptable Limit*	0.3	0.1	250	1	200	-
Permissible Limit*	No Relaxation	0.3	1000	1.5	600	-

Note: Result which are exceeding permissible limit is highlighting in yellow

Source: JST (*Indian standards for drinking water quality ;IS 10500 – 2012 Bureau of Indian Standards in May 2012)

Table 12.2.6 Result of the Surface Water Quality Survey (2)

Parameter	M Alkalinity	Cu	Chlorine Acid	Cyanide	T.S.S.	Cr
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Sample No. 26	Nil	Nil	Nil	Nil	0.15	Nil
Sample No. 27	Nil	Nil	Nil	Nil	0.1	Nil
Sample No. 28	Nil	Nil	Nil	Nil	0.15	Nil
Sample No. 29	Nil	Nil	Nil	Nil	0.15	Nil
Acceptable Limit	200	0.05	-	0.05	2000	0.05
Permissible Limit	600	1.5	-	No Relaxation	No Relaxation	No Relaxation
Parameter	Pb	Hg	Al	Cd	E-Coli	Residual Chlorine
	mg/L	mg/L	mg/L	mg/L	MPN	mg/L
Sample No. 26	Nil	Nil	Nil	Nil	43	Nil
Sample No. 27	Nil	Nil	Nil	Nil	43	Nil
Sample No. 28	Nil	Nil	Nil	Nil	55	Nil
Sample No. 29	Nil	Nil	Nil	Nil	55	Nil
Acceptable Limit	0.05	0.001	0.03	0.003	Will not be detected in any 100 mL sample	0.02
Permissible Limit	No Relaxation	No Relaxation	0.02	No Relaxation		1

Note: Result which are exceeding permissible limit is highlighting in yellow
Source: JST (*Indian standards for drinking water quality ;IS 10500 – 2012 Bureau of Indian Standards in May 2012)

12.2.2 Natural Environment

(1) Geomorphology

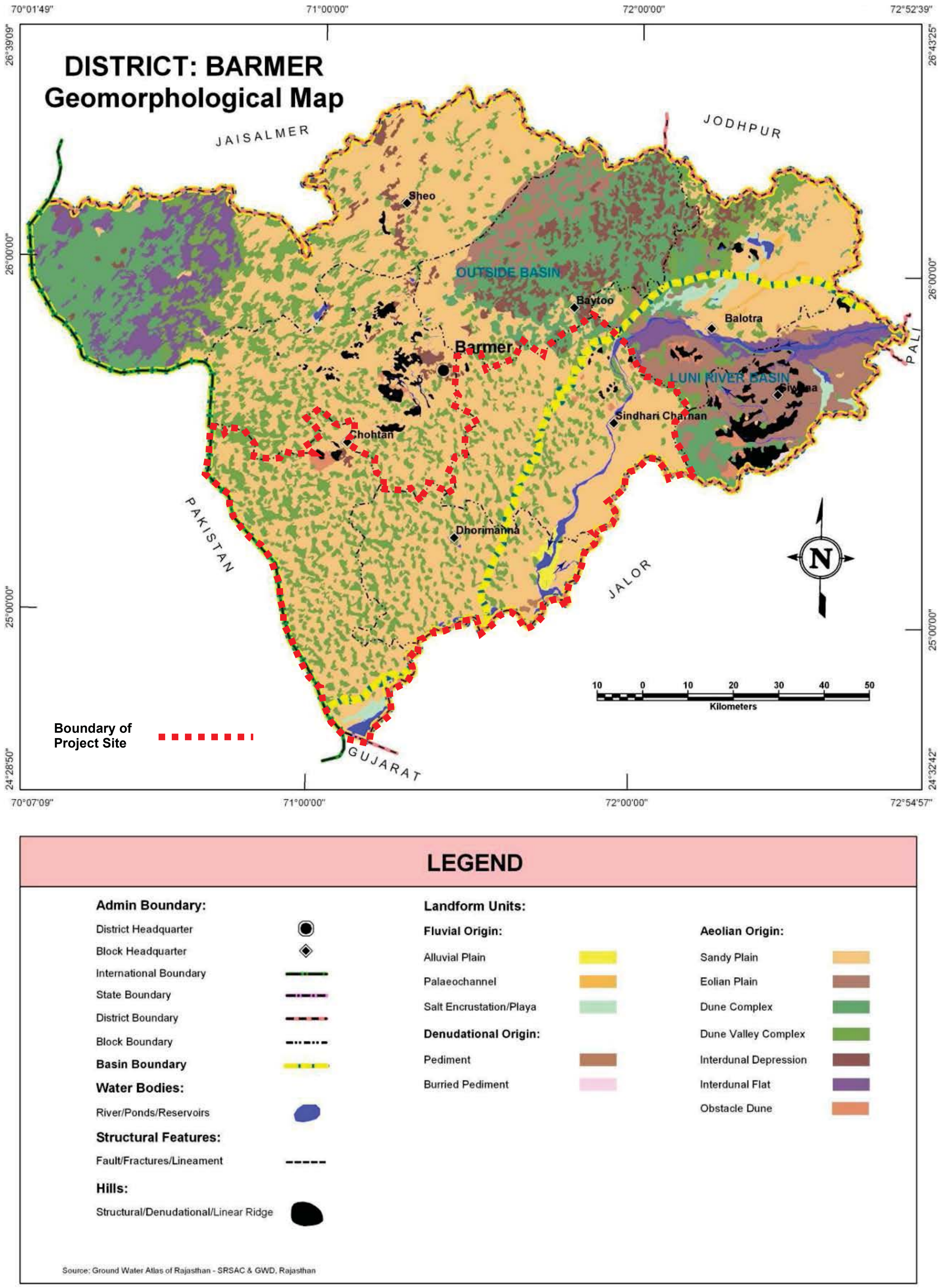
Geomorphology maps of Barmer District and Jhunjhunu District are shown in Figure 12.2.1 and Figure 12.2.2.

1) Barmer

Most parts of the district come under the Great Indian Desert. In the eastern part of the district and to the west of Barmer City, exposures of hill ranges are seen trending in the east-west direction. The district is actually a vast sandy tract. The only major drainage course in the area is the Luni River, which flows from Balotra and Sindhari Charnan Block towards Jalor District. Salt lakes are found in the northeast and northwest parts of the district. The general topographic elevation in the district is between 125 m and 250 m above mean sea level. Elevation ranges from a minimum of 0.00 m above mean sea level in Chohtan Block in the southwest part of the district to a maximum of 931.8 m above mean sea level in Siwana Block in the eastern part of the district, which is part of the Aravalli Range.

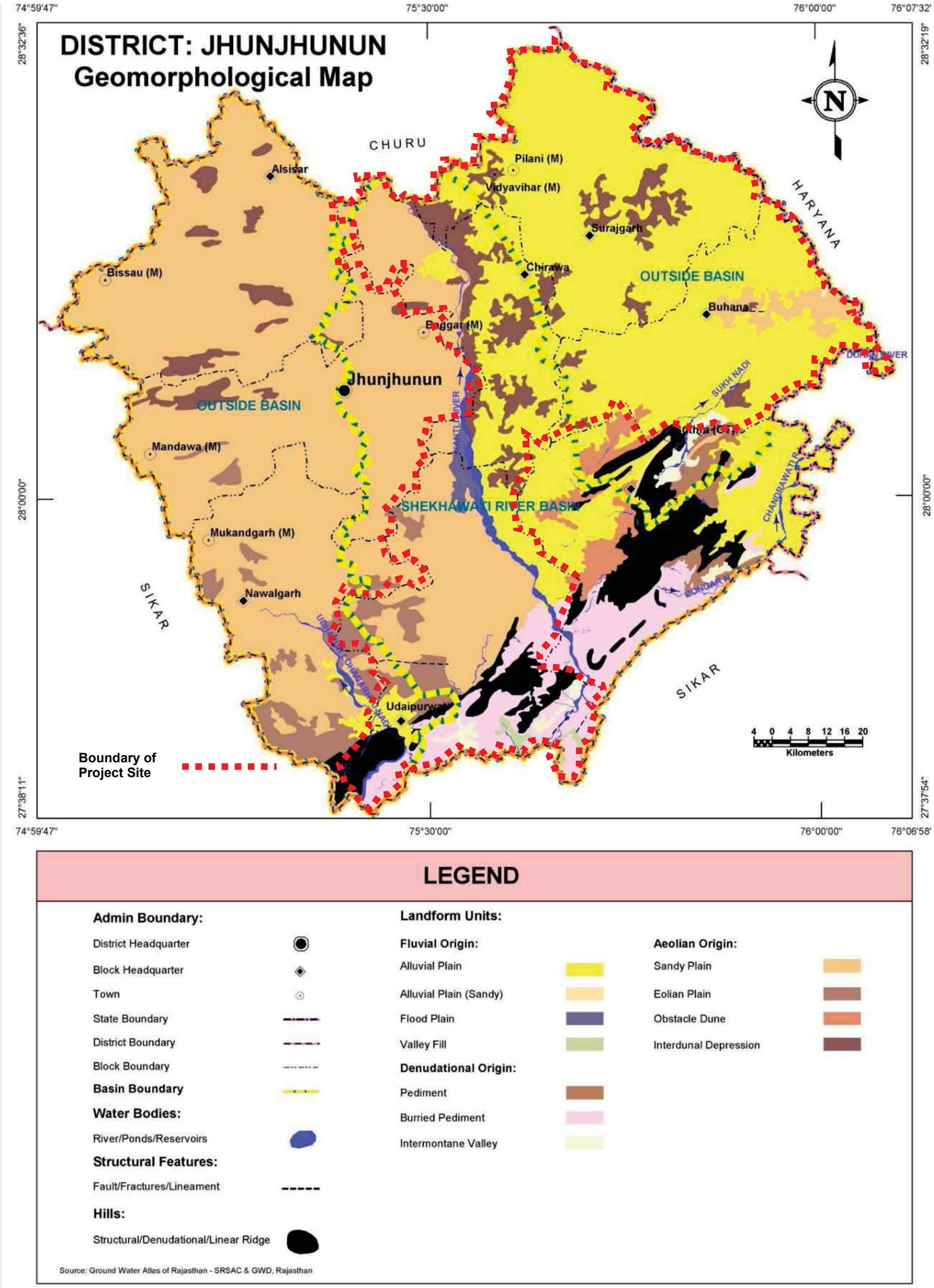
2) Jhunjhunu

The topography of the district displays a hilly area in the eastern and southeastern parts, which belong to the Aravalli Range, running in northeast-southwest direction. The rest of the district has broad undulating plains. The general slope of the terrain in the district is from southeast to northwest. The area is drained mainly by Shekhawati, Kantli and by the Chandrawati rivers with their tributaries like Udhapur Ohagarh, Dongar, Sukh, etc. The general topographic elevation in the district is between 250 m and 500 m above mean sea level in most of the blocks. Elevation ranges from a minimum of 259.6 m above mean sea level in Surajgarh Block in the northeast part of the district to a maximum of 1,035.0 m above mean sea level in Nawalgarh in the southwest part of the district.



Source: Ground Water Atlas of Rajasthan – SRSAC and GWD, Rajashtan

Figure 12.2.2 Geomorphological Map of Barmer District



Source: Ground Water Atlas of Rajasthan – SRSAC and GWD, Rajashtan

Figure 12.2.3 Geomorphological Map of Jhunjhunu District

(2) Geology

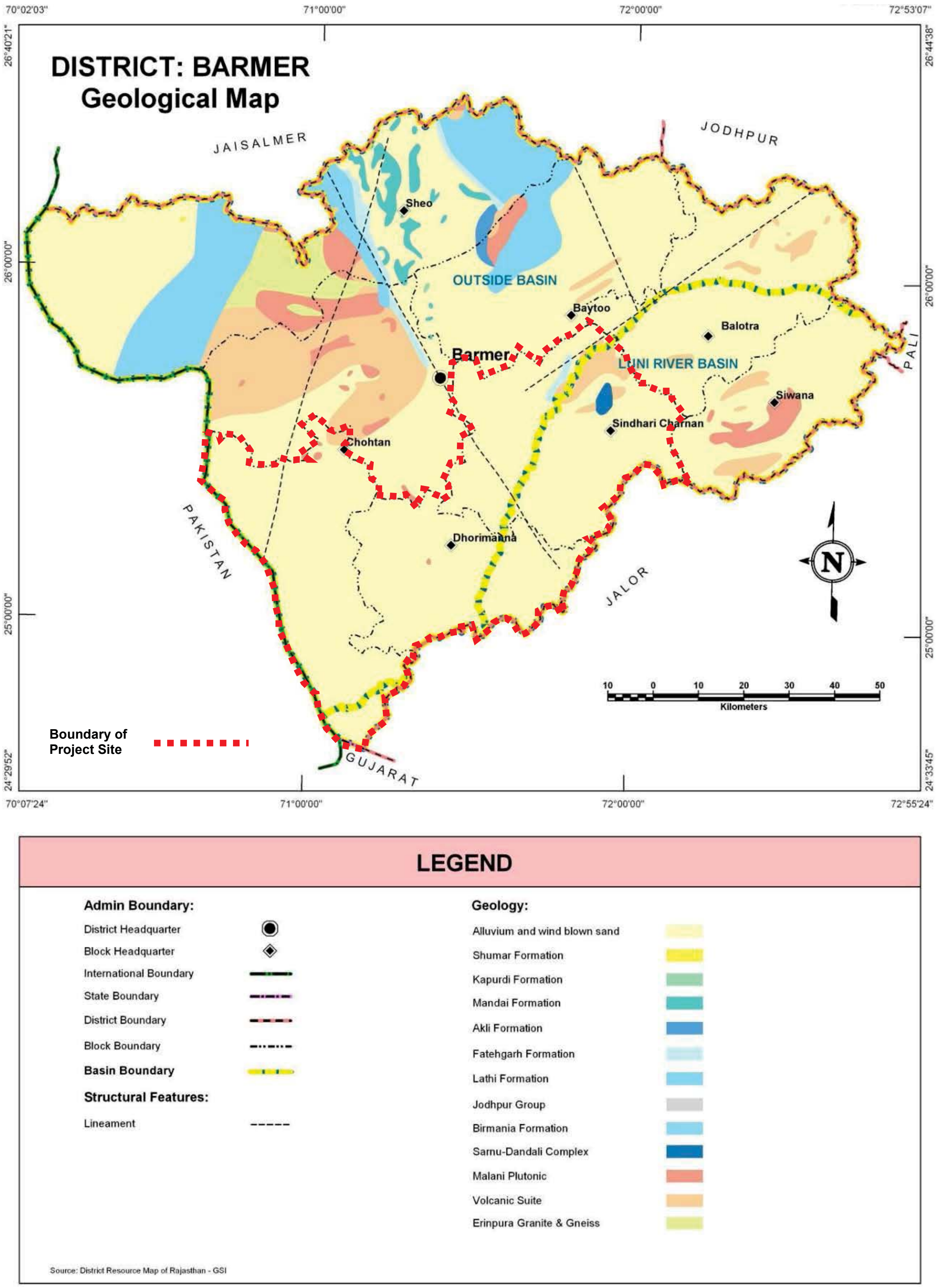
Geological maps of Barmer District and Jhunjhunu District are shown in Figure 12.2.3 and Figure 12.2.4.

1) Barmer

Most parts of the district are covered by desert sand and sand dunes. The rock formation occupies the area in patches. The Malani igneous suits of rocks are most extensive and oldest in the area, consisting of volcanic rocks, rhyolites granites and associated intrusives like basic dykes aplites and quartz veins. Besides these igneous rocks, other rocks exposed in the area are sandstone belonging to Lathi, Fatehgarh and Mandai formations, and Akli and Kapurdi formations constituted by bentonite.

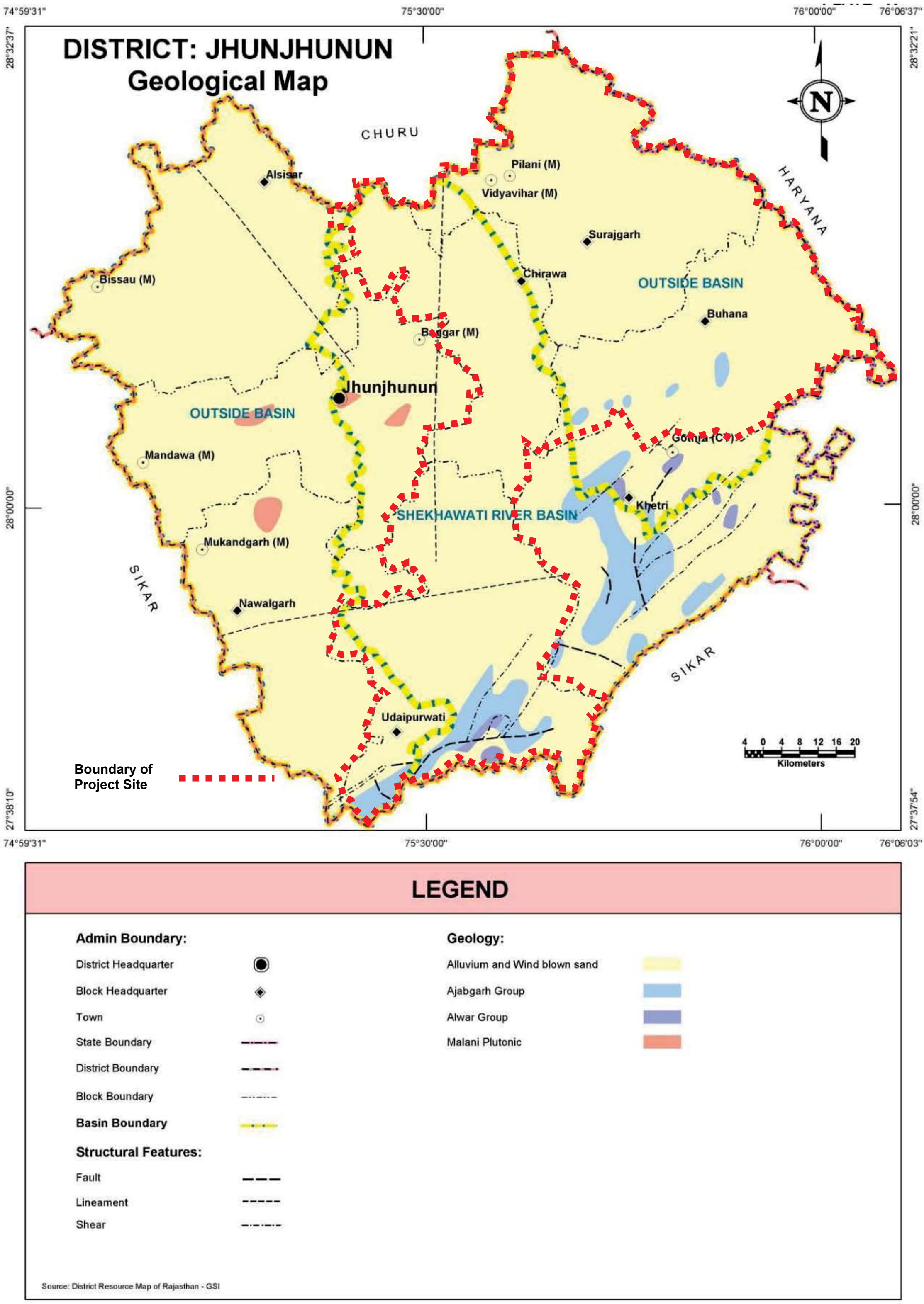
2) Jhunjhunu

Geologically, this district is mostly covered by brown sand. Apart from this, small isolated outcrops of rocks of Delhi super group and Malani igneous suite are found in Khetri, Udaipurwati, Buhana and Jhunjhunu blocks of the district. The Alwar groups of rocks are exposed in the southeastern part (around Udaipurwati) and northeastern part (around Khetri), with Ajabgarh group of rocks, but here they are thin and narrow outcrops only. The Alwar groups are represented by quartzite, schist, grit, arkose, etc. These have been intruded by Post Delhi intrusives such as amphibolites, granite, pegmatite, quartz veins, etc. The Ajabgarhs are represented by phyllites, biotite schists, calc gneisses intruded by Post Delhi intrusives viz. amphibolite, granite, albitites, pegmatites, epidiorite, quartz veins, etc. The basic intrusives include epidiorite, diorite amphibolite, etc.



Source: Ground Water Atlas of Rajasthan – SRSAC and GWD, Rajashtan

Figure 12.2.4 Geological Map of Barmer District



Source: Ground Water Atlas of Rajasthan – SRSAC and GWD, Rajashtan

Figure 12.2.5 Geological Map of Jhunjhunu District

(3) Hydrology

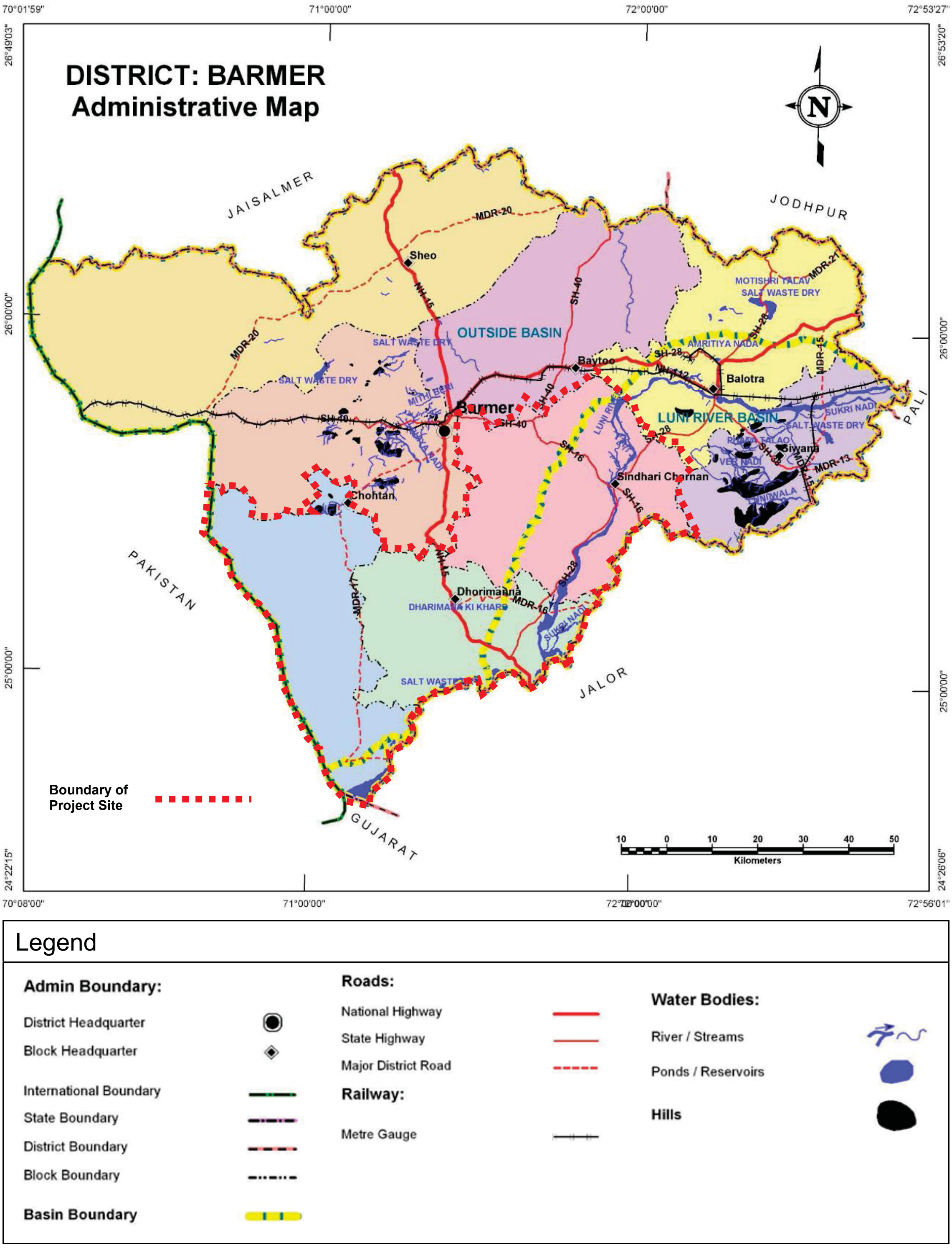
Administrative maps, which also show the location of rivers, are shown in Figure 12.2.5 and Figure 12.2.6.

1) Barmer

In Barmer District, the only river from any survey consequence is the Luni (salt river), which has headstream in the hills southwest of Ajmer City. After flowing through Nagaur, Pali and, Jodhpur districts, it enters this district near Village Rampur in Pachpadra Tehsil and flows westward till just beyond Tilwara, where it alters the course to southwest; in the years of heavy rains, which, however, are rare, the river overflows (known as Rel) when crops of wheat, gram, and barley become possible. After flowing into Jalor District, it finally loses itself in marshy ground at the head of the Rann of Kutch. Another river is Sukri, which enters Barmer Tehsil of the district from Jalor District, flows through a small portion and then joins the Luni River near Samdari. Other rivers of the district are Mitri and Sukri.

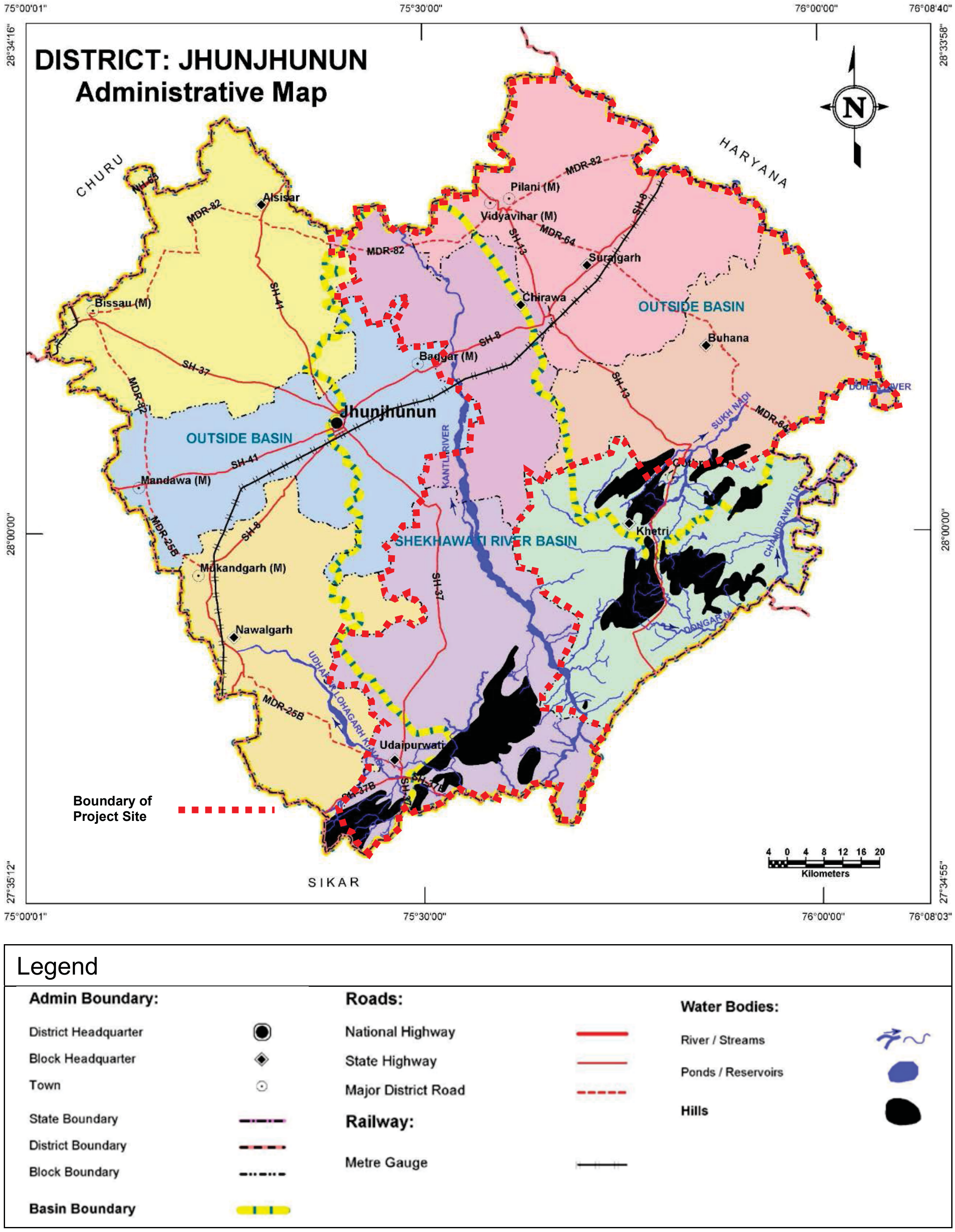
2) Jhunjhunu

In Jhunjhunu District, Katti River originates from Khadela Hillsides of Shrimadhopur Tehsil and enters near southwest of Udaipurwati Tehsil running towards the northwest direction and ultimately disappears in the sandy tracks of Churu District. This river divides the district almost into two parts. Similarly, the Dohan River also originates from Shrimadhopur Hills and flows to the northeastern direction passing through some eastern part and ultimately disappears in the sandy tracks of Mahendragarh District of Haryana. Major streams of Udaipurwati are Lohagarh Ki Nadi Chandrawati and Sukh Nadi. There is no lake in the district; however, small reservoirs are in existence in some areas. There are only four reservoirs used for irrigation purposes.



Source: Prepared by JST based on Hydrogeological Atlas of Rajasthan Barmer District 2013

Figure 12.2.6 Administrative Map of Barmer District (With Location of Rivers)



Source: Prepared by JST based on Hydrogeological Atlas of Rajasthan Jhunjhunu District 2013

Figure 12.2.7 Administrative Map of Jhunjhunu District (With Location of Rivers)

(4) Ecology

Species of flora and fauna in Jhunjhunu and Barmer were confirmed by literature survey. Regarding flora, in the proposed project area, 34 species are listed as rare, endangered, and threatened flora[1] and 5 tree species, 10 shrub species, and 12 herb species are existing[2]. Regarding fauna, in the proposed project area, 3 species of mammals and 3 species of birds are listed as rare, endangered, and threatened animals while 10 species of mammals are recognized as important mammal species and 11 species of birds are also recognized as important bird species. Twenty-eight species of reptile and amphibian are existing in the proposed project area.

(5) Wildlife Sanctuary and Forest Area

The project areas are neither in core zone nor in eco-sensitive zone of any protected areas conserved under the Wildlife Conservation Act, 1972. The nearest protected area is Desert National Park, which is approx. 122 km far from Peeprali and approx. 130 km from Aleti.

12.2.3 Social Environment

(1) Population and Density, Indigenous People

Population information of Barmer District and Jhunjhunu District is shown in Table 12.2.7 and Table 12.2.8.

Table 12.2.7 Population Information of Barmer District

		Barmer District		
		Total	Rural	Urban
Population (Subdistrict)	Barmer	370,721	269,893	100,828
	Baytoo	253,350	253,350	0
	Chohtan	485,344	485,344	0
	Gudha Malani	453,911	447,398	6,513
	Pachpadra	422,784	348,288	74,496
	Ramsar	108,001	108,001	0
	Sheo	237,080	237,080	0
	Siwana	272,560	272,560	0
	Total	2,603,751	2,421,914	181,837
Children (0-6 years)		501,522	475,218	26,304
Literacy		56.53%	54.79%	78.22%
Sex Ratio		902	902	899
Scheduled Caste		16.80%	16.90%	15.30%
Scheduled Tribe		6.80%	7.10%	2.20%

*Project area is highlighted with color.

Source: Census 2011

1 Source: Endemic and Threatened Taxa: ENVICS Centre on Floral Diversion Hosted by Botanical Survey of India, Kolkata, West Bengal Sponsored by the Ministry of Environment, Forest and Climate Change, Government of India

2 Source: H.G. Champion and S. K. Seth (2005). Revised Survey of the Forest Types of India. Natarj Publisher, Dehradun

Table 12.2.8 Population Information of Jhunjhunu District

		Jhunjhunu District		
		Total	Rural	Urban
Population (Subdistrict)	Buhana	223,405	212,033	11,372
	Chirawa	476,087	365,083	111,004
	Jhunjhunu	538,174	328,886	209,288
	Khetri	277,946	232,184	45,762
	Nawalgarh	326,663	244,246	82,417
	Udaipurwati	294,770	265,534	29,236
	Total	2,137,045	1,647,966	489,079
Children (0-6 years)		288,470	222,519	65,951
Literacy		74.13%	73.42%	76.53%
Sex Ratio		950	956	932
Scheduled Caste		16.90%	17.30%	15.30%
Scheduled Tribe		1.90%	2.20%	1%

*Project area is highlighted with color.
Source: Census 2011

As per the Ministry of Law and Justice Notification G.S.R. 466(E) 19th May 2018 "C.O.270", The Scheduled Areas (State of Rajasthan) Order, 2018, there are no scheduled tribe area and indigenous people living in Barmer and Jhunjhunu districts.

The population of scheduled caste and scheduled tribute in Barmer District and Jhunjhunu District is shown in Table 12.2.9. Scheduled caste constitutes 16.8% while scheduled tribe represents 6.8% of the total population in Barmer. Scheduled caste constitutes 16.9% while scheduled tribe represents 1.9% of the total population in Jhunjhunu.

Table 12.2.9 Population of Scheduled Caste and Scheduled Tribute

Population	Barmer District			Jhunjhunu District		
	Total (% for total population of the district)	Male	Female	Total (% for total population of the district)	Male	Female
Scheduled Caste	436,414 (16.80%)	228,431	207,983	360,709 (16.90%)	185,879	174,830
Scheduled Tribe	176,257 (6.80%)	92,610	83,647	41,629 (1.90%)	21,380	20,249

Source: Census 2011

(2) Gender

In 2011, the total population of Barmer District was 2,603,751 in which male and female were 1,369,022 and 1,234,729, respectively. Sex ratio was 902. Male and female literacy rates were 70.86% and 40.63%, respectively. The average literacy rate was 56.53%. In Jhunjhunu District, the total population was 2,137,045 in which male and female were 1,095,896 and 1,041,149, respectively. The sex ratio was 950 and literacy rate was 73.13%. Male literacy rate was 86.90% while female literacy rate was 60.95%.

(3) Economy, Land Use, Social Infrastructure, Transportation

Information regarding economy, land use, social infrastructure, and transportation are stated in

Section 2.2.

12.3 Institution and Organization for Environmental and Social Considerations in India

12.3.1 Regulation Related to the Project

The summary of environmental regulations applicable to the project is presented in Table 12.3.1.

Table 12.3.1 List of Environmental Regulations

Regulation	Organization
EIA Notification 2006	MoEFCC
Water (Prevention and Control of Pollution) Act of 1974, Rules of 1975, and Amendments.	MoEFCC
Air (Prevention and Control of Pollution) Act of 1981, Rules of 1982 and Amendments.	MoEFCC
Environment (Protection) Act, 1986 and CPCB Environmental Standards.	MoEFCC
Noise Pollution (Regulation and Control) Rules, 2000 amended up to 2010.	MoEFCC
Ancient Monuments and Archaeological Sites and Remains Act, 1958 and Ancient Monuments and Archaeological Sites and Remains (Amendment and Validation) Act, 2010	Ministry of Culture
Rajasthan State Environment Policy, 2010 including And Rajasthan Environment Mission and Climate Change Agenda for Rajasthan (2010-14).	Government of Rajasthan
The Rajasthan Monuments, Archaeological Sites and Antiquities Act, 1961; the Rajasthan Monuments, Archaeological Sites and Antiquities (Amendment) Act 2007	Government of Rajasthan
The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	Ministry of Rural Development
Labor Laws	Ministry of Labour and Employment
Biological Diversity Act of 2002	MoEFCC
Wildlife Protection Act, 1972	MoEFCC
Forest (Conservation) Act, 1980	MoEFCC
Rajasthan Forest Act, 1953 and Rajasthan Forest Rules, 1962	Government of Rajasthan
Right to Information Act, 2005	MoPPGP

Note:
MoEFCC: Ministry of Environment, Forest and Climate Change
MoPPGP: Ministry of Personnel, Public Grievances and Pensions
Source: JST

(1) EIA

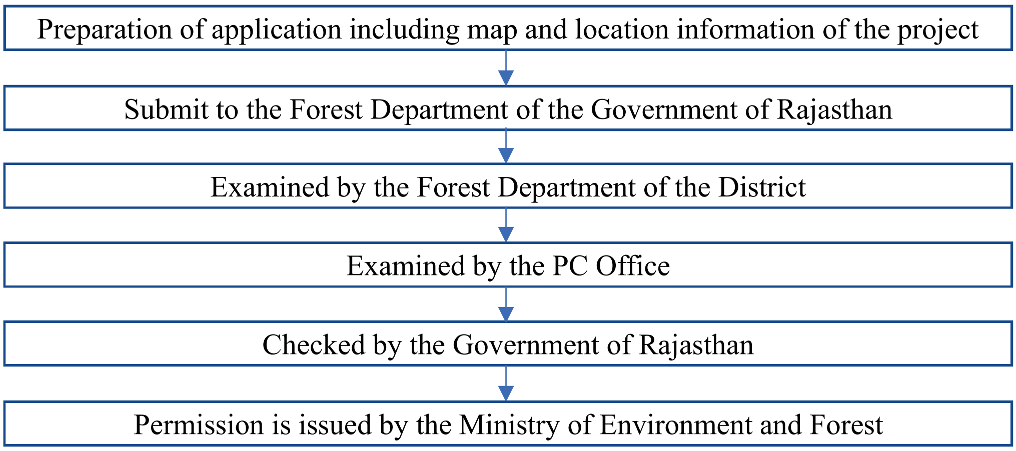
Requirement of EIA is stipulated in Environment (Protection) Act and EIA Notification 2006. Water supply project is not listed in the Schedule of the EIA Notification 2006. Thus, EIA approval is not necessary in accordance with EIA Notification for implementation of the project. EIA procedure is shown in Figure 12.3.1.

Source: Environment Protection Act, 1986 (https://www.drishtiias.com/to-the-points/paper3/environmental-impact-assessment-1)

Figure 12.3.1 EIA Procedure

(2) Forest Land Use

If forest land is used for non-forest purpose, forest land use permission is required in accordance with Forest (Conservation) Act, 1980. To obtain forest land use permission, compensatory afforestation is requested to compensate the loss of 'land by land' and loss of 'trees by trees'. Normally, compensatory afforestation is to be raised on suitable non-forest land, equivalent to the area proposed for diversion, at the cost to be paid by User Agency. Amount of compensatory afforestation cost is informed by the Divisional Forest Officer as a demand note in the procedure of approval.



Source: JST

Figure 12.3.2 Assumed Procedure for Issuance of Permission for Forest Land Use

(3) Protection of Flora and Fauna

Wildlife Protection Act, 1972 stipulates specified species of flora and fauna to be protected and requirement of permission for activities in sanctuary. Biodiversity Act 2002 stipulates requirement of permission for biological resource use. In Rajasthan state, State Wildlife Board is in charge of effective implementation of wildlife projects and efficient management of protected areas.

(4) Information Disclosure

Regarding Information disclosure, national of India has right to access information from government that stipulated in Right to Information Act, 2005. The Act also requires every public authority to computerize their records for wide dissemination and to proactively publish certain categories of information, thus the citizens need minimum recourse to request for information formally.

(5) Grievance

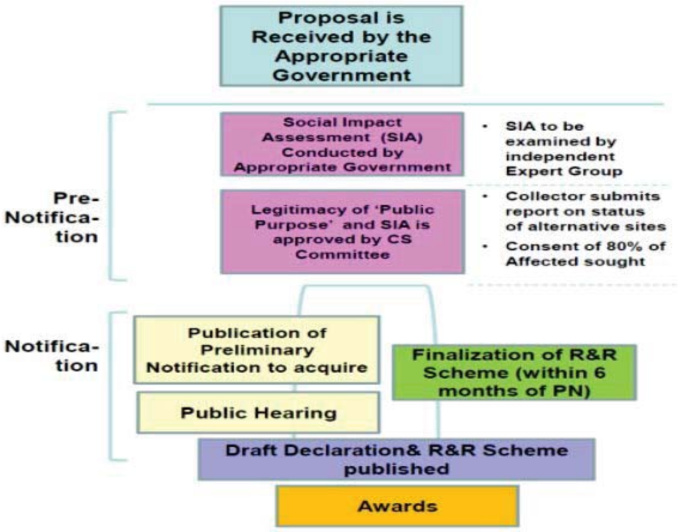
Regarding complaints from surrounding communities in the project sites, "Rajasthan Sampark" receive complains from citizens and reach the departments of the State Government for their queries and concerns. Rajasthan Sampark is a single point of contact for addressing and readdressing various citizen queries and grievance related to government services. Citizens can lodge their grievances against any government department/ office through this portal and the grievance will further be sent to the respective office/ department for redressal. Citizens also can call number 181 (free of charge) and clam their complaints. Grievance mechanism is shown in Figure 12.3.3.

Source: Rajasthan Sampark Getting Started Guide & User Manual

Figure 12.3.3 Grievance Mechanism in Rajasthan

(6) Land Acquisition

Land acquisition procedure is stipulated in Right to Fair Compensation and Transparency in Land Acquisition, rehabilitation and Resettlement Act. Land is acquired with social impact assessment study and compensation is calculated based on market value of the land. Land Acquisition procedure flow is shown in Figure 12.3.4.



Source: Right to Fair Compensation and Transparency in Land Acquisition, rehabilitation and Resettlement Act ("Indian Economy towards a Pragmatic Land Acquisition Policy for Industrial Use" by Ministry of Rural Development)

Figure 12.3.4 Land Acquisition Procedure Flow

12.3.2 Gap Analysis between the National Laws and JICA Guidelines

The gap analysis between the JICA Guidelines and the Indian Law is presented in Table 12.3.2.

Table 12.3.2 Gap Analysis between the Indian Regulation and the JICA Guidelines on EIA Study

JICA Guidelines for Environmental and Social Considerations 2010	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 in the earliest possible planning stage. Alternatives 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 shall have the power to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution.	No major gap between the JICA Guidelines and Indian Law. Water supply project is not listed in the Schedule of the EIA Notification 2006.
Disclosure of information		
- EIA reports (which may be referred to differently in 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 projects to 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 EIA reports are always required to be available for perusal by project stakeholders such as local residents and copying must be permitted.	<u>EIA Notification, 2006</u> For public hearing, the Summary Environment Impact Assessment Report are prepared in English in the local language and they are disclosed in select offices or public libraries or panchayats etc.	No major gap between the JICA Guidelines and Indian Law. EIA for the project is not requested in EIA Notification 2006. Therefore, project proponent is necessary to follow JICA Guidelines.
Social acceptability		
- For projects with a potentially large environmental impact, enough consultations with local stakeholders, such as local residents, must be conducted via disclosure of information at an early stage, at which time alternatives for project plans may be examined. The outcome of such consultations must be incorporated into the contents of project plans. - In preparing EIA reports, consultations with stakeholders such as the residents, must take place after sufficient information has been disclosed. Records of such consultations must be prepared. - Consultations with relevant stakeholders, such as residents, should take place if necessary, throughout the preparation and implementation stages of a project. Holding consultation is highly desirable, especially when the items to be considered in the EIA are being selected, and when the draft report is being prepared.	<u>EIA Notification, 2006</u> - Public Consultation refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity are ascertained with a view to taking into account 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 the material environmental concerns expressed during this process, and make appropriate changes in the draft EIA and EMP. - Public hearing at, or in close proximity to, the site(s) in all cases shall be conducted by the State Pollution Control Board (SPCB) or the Union territory Pollution Control Committee (UTPCC) concerned in the specified manner	No major gap between the JICA Guidelines and Indian Law. EIA for the project is not requested in EIA Notification 2006. The project authorities is necessary to 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 at the time of consultation to locals, in which enough information were collected from the locals. After public consultations, record of consultation is prepared.

JICA Guidelines for Environmental and Social Considerations 2010	Relevant Law in India	Gap between JICA Guidelines and Government Law/ Actions to be Taken
	and forward the proceedings to the regulatory authority concerned within 45(forty five) of a request to the effect from the applicant.	
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 on the natural environment, that are transmitted through air, water, soil, waste, accidents, water usage, climate change, ecosystems, fauna and flora, including trans-boundary or global scale impacts. These also include social impacts, including migration of population and involuntary resettlement, local economy such as employment and livelihood, utilization of land and local resources, social institutions such as social capital and local decision-making institutions, existing social infrastructures and services, vulnerable social groups such as poor and indigenous peoples, equality of benefits and losses and equality in the development process, gender, children's rights, cultural heritage, local conflicts of interest, infectious diseases such as HIV/AIDS, and working conditions including occupational safety. - In addition to the direct and immediate impacts of projects, their derivative, secondary, and cumulative impacts as well as the impacts of projects that are indivisible from the project are also to be examined and assessed to a reasonable extent. It is also desirable that the impacts that can occur at any time throughout the project cycle should be considered throughout the life cycle of the project.	<u>EIA Notification, 2006</u> <u>Following items is requested to be assessed in EIA.</u> - Land Environment (including soil, waste) - Water Environment - Vegetation - Fauna - Air Environment - Aesthetics - Socio-Economic Aspects - Building Materials - Energy Conservation	Regarding social aspects, detailed point of view is not described in EIA Notification 2016. Derivative, secondary, and cumulative impact and indivisible project are also not described. EIA for the project is not requested in EIA Notification 2006. Thus, impact is assessed referring JICA Guidelines.
Monitoring, Grievance		
- Project proponents should make efforts to make the results of the monitoring process available to local project stakeholders. - When third parties point out, in concrete terms, 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 with a view to resolving problems.	<u>EIA notification, 2006,</u> - It shall be mandatory for the project management to submit half-yearly compliance reports in respect of the stipulated prior environmental clearance terms and conditions in hard and soft copies to the regulatory authority concerned, on 1st June and 1st December of each calendar year. - All such compliance reports submitted by the project management shall be public documents. Copies of the same shall be given to any person on application to the concerned regulatory authority. The latest such	Detailed procedure/method to consider measures for concerns which are pointed by third parties is not described. 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 pointed out issues under the Environmental Management Plan.

JICA Guidelines for Environmental and Social Considerations 2010	Relevant Law in India	Gap between JICA Guidelines and Government Law/ Actions to be Taken
	compliance report shall also be displayed on the website of the concerned regulatory authority.	
Ecosystem and biota		
Projects must not involve significant conversion or significant degradation of critical natural habitats and critical forests.	<u>Forests (Conservation) Act, 1980 and Rules 1981 as amended 2004.</u> The Forest Conservation Act (FCA) was adopted in 1980 to protect and conserve forests. The Act restricts the powers of the State in respect of de-reservation of forests and the use of forestlands for non-forest purposes. <u>Wildlife (Protection) Act 1972</u> The 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

12.4 Comparison of the Alternative Measures (including "Zero Option")

(1) Without Project Scenario

In the project site, groundwater is used as the water source for their daily life. However, ground water is contaminated with fluorine and it might cause Fluorosis. The current situation of water use in the project site is not safe. Thus, the project for development of rural water supply with surface water is essential for the improvement of public water supply.

(2) Options of Alternatives on Location of WTP

A comparison analysis was made qualitatively between Option 1: Government land far from intake pumping station and Option 2: Private land next to the intake pumping station. As shown in Table 12.4.1, the Option 1 is evaluated as more feasible as a result of the comparison analysis..

Table 12.4.1 Results of Comparison of Options

Plan	Option-1 (Far from intake pumping station in government land)	Option-2 (Next to intake pumping station in private land)	Without project Scenario
Construction cost Advantage (+)/ Disadvantage (-)	(+) Cost for land acquisition is not necessary (-) Length of pipeline is longer and construction cost is higher than option-2	(-) Cost for land acquisition and resettlement is necessary (+) Length of pipeline can be minimized and cost of construction is lower than option-1	No construction work is implemented
Environmental and Social Impact	No significant impact on environment and social aspects	Impact during construction is bigger than option-1 because intake pumping station is located near canal and households also located around intake pumping station. Impact on social aspect is bigger than option-1 because land acquisition and involuntary resettlement is required and measures should be considered and taken.	No negative impact and positive impact
Overall Evaluation	Priority option	-	

Source: JST

12.5 Scoping and TOR of Survey for Environmental and Social Considerations

In order to assess the likely significant environmental and social impacts, conceivable environmental and social impacts by the project implementation were identified based on the project description and present environmental and social conditions in and around the project sites.

The result of scoping for environmental and social impact assessment is shown in the table below. Scoping was conducted at three stages (i.e., before construction (BC) stage, construction stage (CS), and operation stage (OS)).

Table 12.5.1 Results of Scoping for Environmental and Social Impact Assessment

No.	Impacts	Ratings BC/CS	OS	Brief Description (Reasons for Scoping Evaluation)
Pollution control measures				
1	Air quality	✓		(BC/CS) Impact on air quality due to operation of construction machineries and traveling of construction vehicles is expected. (OS) No activity is planned that will cause air pollution.
2	Water quality	✓		(BC/CS) Impact on water quality from muddy water due to construction of the intake and raw water pumping station is expected. (OS) No activity is planned that will cause water pollution.
3	Waste	✓	✓	(BC/CS) Construction waste will be generated such as excavated soil. (OS) Sludge due to water treatment process will be generated.
4	Soil contamination			(BC/CS, OS) No activity is planned that will cause soil contamination.
5	Noise and vibration	✓		(BC/CS) Increase of noise and vibration levels due to construction machineries and traveling of construction vehicle would temporarily occur. (OS) No activity is planned that will result in the increase of noise and vibration level. Regarding operation of pump station, noise and vibration will not be significant negative impact because pump station is installed in the building and operated in the closed environment.
6	Ground subsidence			(BC/CS, OS) No activity is planned that will cause ground subsidence.
7	Offensive odor			(BC/CS, OS) No activity is planned that will cause offensive odor.
8	Bottom sediment			(BC/CS, OS) No activity is planned that will cause pollution to river sediment.
Natural environment				
9	Protected area	✓		(BC/CS) The project site is not located within the protected area. If facilities are constructed in protected area, required procedure for construction in the site should be complied. (OS) No activities are planned to have impact on the protected area.
10	Flora/fauna and biodiversity	✓		(BC/CS) The project site is not located within the protected area. In case some species are found in the proposed project site, the species might be affected by the project. (OS) Impact on the ecosystem due to operation is not expected.
11	Hydrology			(BC/CS, OS) No activity is planned that will result in the increase of rainwater discharge.
12	Topography and geology			(BC/CS, OS) No activity that will adversely affect the topography and geographical features is expected.
Social environment				
13	Involuntary resettlement/land acquisition			(BC/CS, OS) Involuntary resettlement and land acquisition are not planned for the proposed project because the project is implemented within the land owned by the government.
14	Poverty			(BC/CS, OS) Information of poor people who live in the surrounding project area is not found. However, positive impacts such as creation of local employment are predicted.
15	Ethnic minorities and indigenous peoples			(BC/CS, OS) Ethnic minority and indigenous people are not found in the proposed project area.
16	Local economy (Employment)			(BC/CS, OS) Positive impacts such as creation of local employment are predicted.
	(Livelihood)			(BC/CS, OS) Positive impacts such as creation of local employment are predicted.
17	Land use and utilization of local resources			(BC/CS, OS) Impacts on land use and local resources are not expected because government land will be used for this project.
18	Water usage	✓		(BC/CS) If muddy water is discharged to the river during construction of intake and raw water pumping station, impact on water use is expected. (OS) No activity is planned that will impact on water usage.
19	Existing social infrastructure and service	✓		(BC/CS) Traffic of construction vehicles and trucks, and construction machine may cause traffic jam. (OS) No activity is planned that will impact on social infrastructure and service.
20	Social institutions			(BC/CS, OS) No activity is planned that will affect the social and local

No.	Impacts	Ratings		Brief Description (Reasons for Scoping Evaluation)
		BC/ CS	OS	
	such as social infrastructure and local decision-making institutions			institutions.
21	Maldistribution of damage and benefit			(BC/CS, OS) No activity is planned that will cause maldistribution of the damage or benefit.
22	Local conflict of interest			(BC/CS, OS) No activity is planned that will cause local conflict.
23	Cultural heritage			(BC/CS, 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			(BC/CS, OS) No activity is planned to have impact on landscape.
25	Gender			(BC/CS, OS) No activity is planned to have impact on gender.
26	Children’s rights			(BC/CS, OS) No activity is planned to have impact on children’s rights.
27	Infectious disease and HIV/AIDS	✓		(BC/CS) Inflow of construction workers may increase the risks on communicable diseases. (OS) No activities are planned that will increase the risk of communicable diseases.
28	Occupational health and safety	✓	✓	(BC/CS) Impact on the working conditions of construction workers is expected. (OS) Impact on the working conditions of workers of the WTP is expected.
Others				
29	Accident	✓	✓	(BC/CS, OS) Impact of construction vehicles to the local community is predicted.
30	Cross-border impact, climate change			(BC/CS, OS) Emission of greenhouse gases (GHGs) due to construction is not expected.

Source: JST

12.6 Survey Result of the Environmental and Social Considerations

12.6.1 Living Environment (Pollution Control Measures)

(1) Air Quality, Noise and Vibration

Construction machinery which will be used for the project is shown in Table 12.6.1. During construction, construction vehicles such as large cars and trucks for traveling of works and transportation of construction materials will be used.

Table 12.6.1 Construction Machineries

Type of Work	Name of Machinery	Function
Land preparation, levelling	Excavator	Excavating soil
	Bulldozer	Land levelling
Excavation	Excavator	Excavating soil
	Ramming machine	Excavating soft and hard rock
Facility construction	Crane	Construction materials lifting
	Bending machine	Steel bar bending
	Concrete mixer machine	Concrete mixing
	Concrete pump	Concrete placing
	Submersible pump and Generator	Pumping water
	Clamshell bucket excavator	Soil and rock lifting
Equipment installation	Crane	Construction materials lifting
Reinstatement	Tampa	Compacting roadbed

Source: JST

Operation of construction machineries and traveling of construction vehicles have impacts on air quality, noise, and vibration. Especially, the large-scale construction works, such as WTP and raw water reservoirs, can generally have grater environmental and social impacts. However, they will not be significant on the project because the construction site for such facilities are isolated from residential area as shown in Figure 12.6.1. In general, the noise and vibrations are sufficiently attenuated at a distance more than 200 m from the construction sites.

Regarding the pipelines, the pumping stations and the ESRs, some of the facilities are in the urban areas that houses are located near the construction sites. During their constructions, mitigation measures shall be taken against the air pollution, noise, and vibration.

Source: JST

Figure 12.6.1 Location of Construction Site of WTP and Raw Water Reservoir

(2) Water Quality

Only one water body (canal) is located near the intake and raw water pumping stations. Therefore, the generated muddy water due to the construction works of the facilities will flow into the canal near the construction sites, and it can deteriorate the water quality. Location of the construction site is shown in Figure 12.6.2. The impact of the muddy water will be mitigated by installing a silt screen and sedimentation tank.

(3) Waste

The contractors will be responsible for collection, segregation and storage of construction waste generated separately and also deposit at collection centre or handover it to the authorised processing facilities in accordance with Construction and Demolition Waste Management Rules, 2016. According to Rajasthan State Solid Waste Management Policy and Strategy, 2019, there are 40 operational plants to manage and process the generated solid waste in Rajasthan including 4 Centralized and 36 Decentralized Plants with a total capacity of 613 t/day and 256 t/day respectively. Therefore, construction waste should be transported to these plants and properly managed and processed. According to Rajasthan state pollution control board, there are secured landfill and incinerator in Rajasthan as shown in Table 12.6.2, thus generated waste by project should be proceeded/treated in these facilities.

Table 12.6.2 List of Secured Landfill and Incinerator in Rajasthan

S.No.	District	Name of the Industry	Facility
1	Alwar	Lords Chloro Alkalied Ltd	SLF
2	Alwar	Ranutrol India Ltd (Connected with CTDF also).	SLF
3	Alwar	SRF Ltd	SLF
4	Chittorgarh	Hindusthan Zinc Ltd. (Chanderia)	SLF & Jarosite disposal facility
5	Udaipur	Hindustan Zinc Ltd.(Debari)	SLF & Jarosite disposal facility
6	Udaipur	Hindustan Zinc Ltd.(Dariba)	SLF & Jarosite disposal facility
7	Kota	Shri Ram Chemical & Fertilizers	SLF
8	Udaipur	Rose Zinc Ltd. (Presently not in operation)	SLF
9	Alwar	Continental Petroleum Ltd., Behror(Connected with CTDF also)	Common Incinerator
10	Alwar	Seigwerk India Pvt. Ltd (Connected to common Incinerator also)	Incinerator
11	Dholpur	Rajasthan Explosive & Chemical	Incinerator
12	Jaipur	Indomax Chemicals(Connected with CTDF also)	Incinerator
13	Jaipur	Mahandra & Mahendra (Connected to common Incinerator also)	Incinerator
14	Jodhpur	Penta Capsules Ltd. (Unit closed)	Incinerator
15	Alwar	Gillette India Ltd. (Connected to common Incinerator also)	Incinerator
16	Barmer	Cairn Energy India PTY Ltd.	SLF and Incinerator

Note: SLF: Secured Landfill Facility, CTDF: Common Hazardous Waste Treatment and Disposal Facility
Source: Action Taken Report of the Rajasthan State Pollution Control Board as on 30.6.2015

Regarding excavated soil, it will be used for land elevation in the project sites, thus it will not be disposed outside the project sites and the disposal site for surplus soils is not necessary. During the WTP operation, generated sludge is collected and suitably disposed of in an environmentally-friendly manner, which will be evaluated and finalized as per site conditions in the sludge handling system.

Source: JST

Figure 12.6.2 Location of Construction Site of Intake Pumping Station

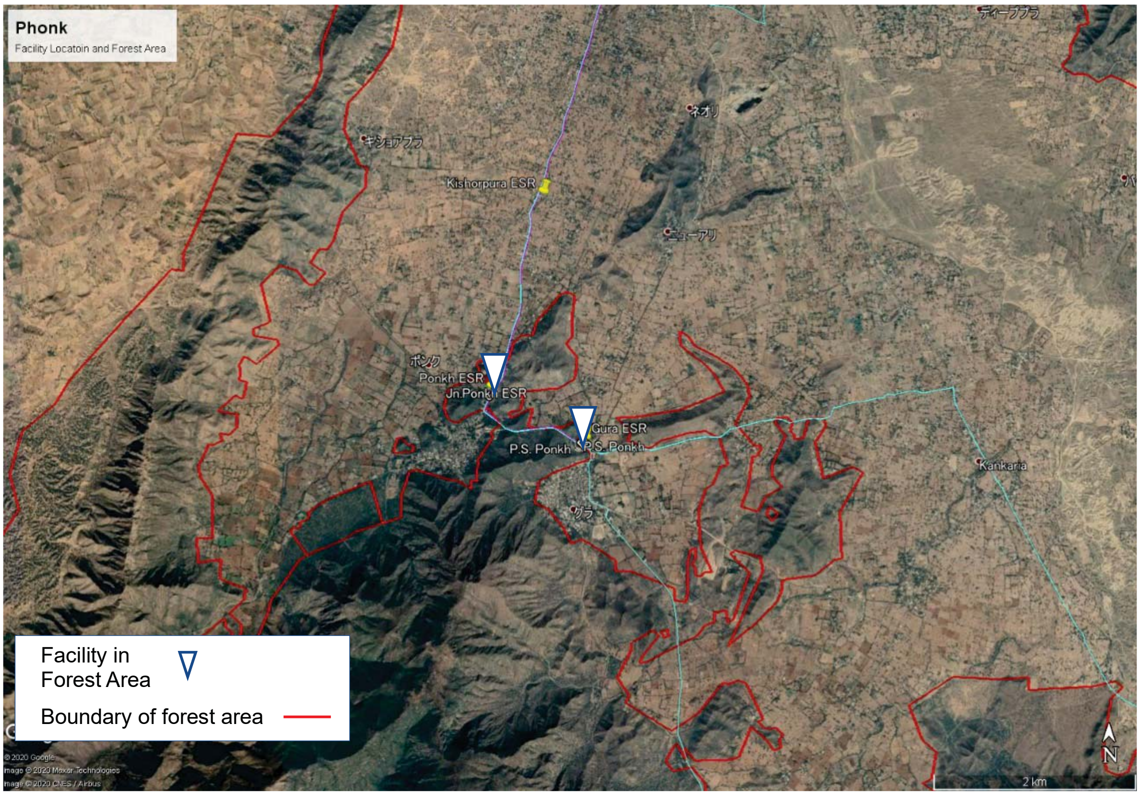
12.6.2 Natural Environment

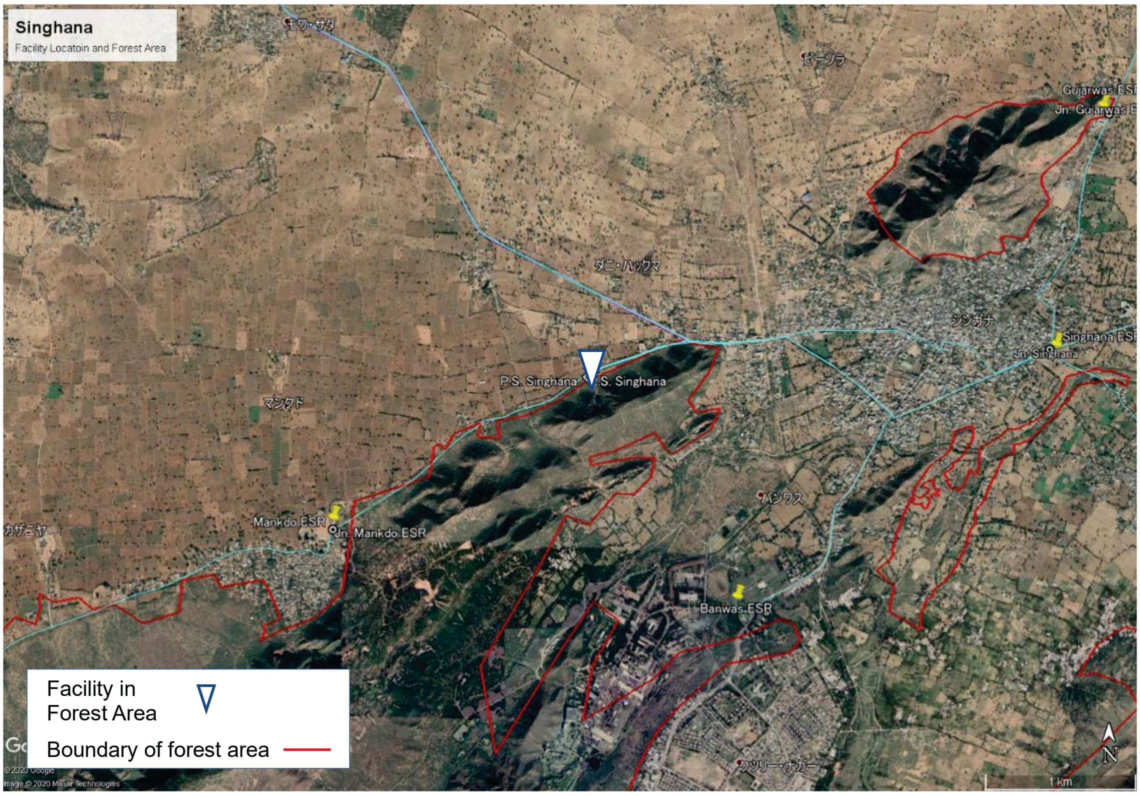
(1) Protected Area

There is a possibility that one pumping station and one ESR in Phonk, and one pump station in Singhana are located in a protected forest area[3], and some parts of the pipeline are planned to be installed along the existing road within the protected forest area as shown in Figure 12.6.3. Location of these facilities will be fixed after the contractors conducted detailed design and then forest area also will be identified through the site survey. The project should obtain permission before the construction works in compliance with the legislative procedure as shown in Figure 12.3.2.

As stated in the sub-section 12.2.2 (5), no construction works in the project will be executed in the core zones nor eco-sensitive zones.

[3] Regarding the forest area, there are two types of forest area, i.e., reserved forest and protected forest. Reserved forests are under the direct supervision of the government and no public entry is allowed for collection of timber or grazing of cattle. Protected forests are looked after by the government, but the local people are allowed to collect fuel-wood/timber and graze their cattle without causing serious damage to the forests.





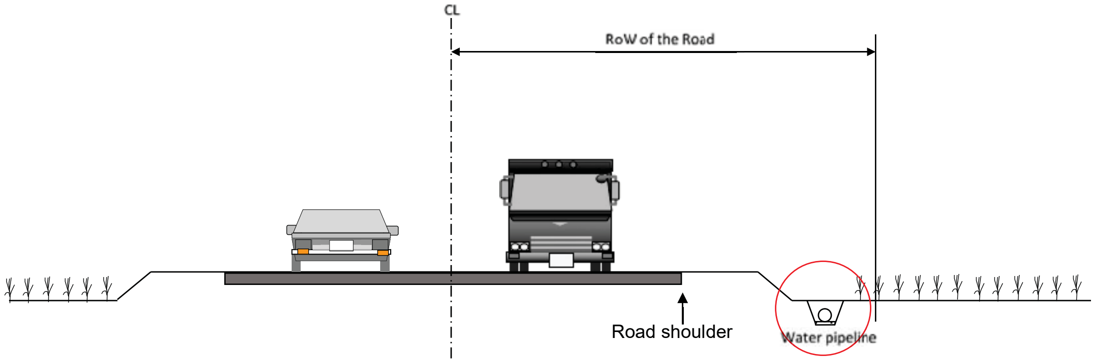
Source: JST

Figure 12.6.3 Location of Facilities in Forest Area

(2) Flora/Fauna and Biodiversity

Construction works in the forest area may have impacts on the ecosystems by the activities such as tree felling. On the other hand, the construction works of WTPs and raw water reservoirs would not cause significant impact on vegetation because the site is an arid area. The pipelines will also not cause significant impact on eco-systems because they will be installed under the right-of-way (RoW) of the road.

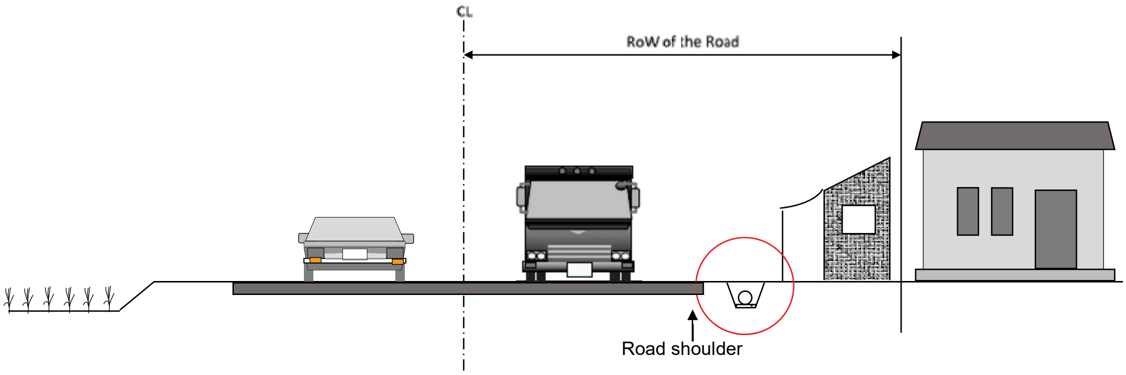
Basically, pipelines will be installed outside the road shoulder and inside the RoW as shown in Figure 12.6.4.



Source: JST

Figure 12.6.4 Pipeline Installation outside the Road Shoulder and inside the RoW

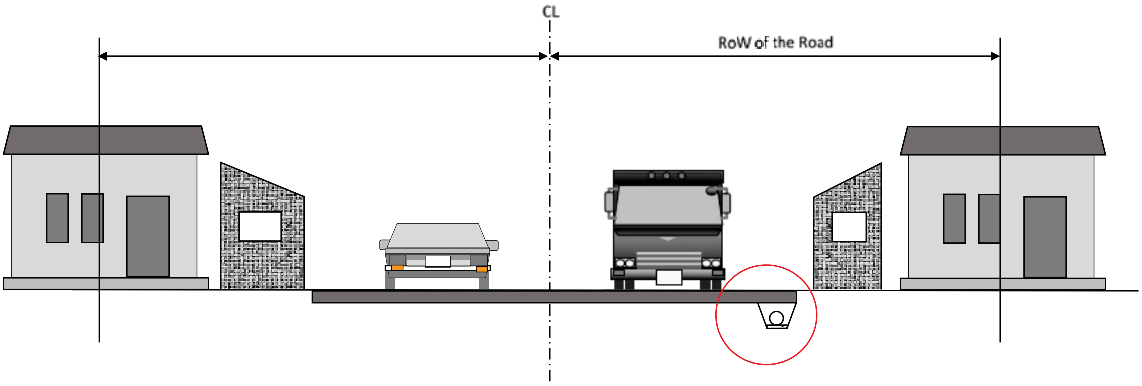
If an illegal hut/residence is existing within the RoW and outside the RoW continuously, pipelines will be installed on the road shoulder to avoid such obstruction as shown in Figure 12.6.5.



Source: JST

Figure 12.6.5 Pipeline Installation between Road Shoulder and Existing Hut/Residence

If there is no space to install the pipeline on both sides of the road shoulders, pipelines will be installed under the road pavement to divert the construction as shown in Figure 12.6.6.



Source: JST

Figure 12.6.6 Pipeline Installation under the Road Pavement

12.6.3 Social Environment

(1) Poverty

BC/CS/OS: The impact on the affected villages will be positive in terms of employment generation, provision of facilities of drinking water, and others which will be provided by the project.

(2) Local Economy (Employment)

BC/CS/OS: Positive impacts such as creation of local employment are predicted.

(3) Local Economy (Livelihood)

BC/CS/OS: Economic effects by the purchases of the foods and commodities by the workers and plant operators that will come from outside the village for the project.

(4) Land use and utilization of local resources

BC: Current land use status for major facilities were confirmed as shown Appendix-12.1. One cluster pumping station is located in private land and the land is necessary to be acquired. In the land, currently nobody lives there, thus resettlement is not required. PHED had consultation with the land owner on the land acquisition and compensation at Goliyar on 13 December, 2020 and they explained that compensation is paid for land acquisition in accordance with The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 (compensation is calculated based on market value) and the owner agreed to the compensation policy and had no objections to the process of land acquisition. Summary of land acquisition and resettlement impacts is shown in Table 12.6.3[4].

Regarding the land for Elevated Service Reservoir (ESR)/Overhead Reservoir (OHR), they cannot be identified until the contractors conduct detailed design. In the location selection process of these facilities, the private land should be avoided as much as possible and the proper compensation shall be made in accordance with JICA guidelines for environmental and social considerations and The Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013 in case private land is required.

CS/OS: No activity is planned that will impact on land use and utilization of local resources

Table 12.6.3 Summary of Land Acquisition and Resettlement Impacts

Component	Area (m^2)	Land status	Number of land owner	Resettlement	Response from the Owner	Proposed Timing of Acquisition
Cluster Pumping Station in Goliyar	1,620	Private	1	zero	Consent to Land Acquisition	March, 2022

Source: JST

(5) Water Usage

CS: Around the construction sites of the raw water pumping stations, the impact of the muddy water will be mitigated by installing silt screen and sedimentation tank. Thus impact on water usage is temporary and not negative significant.

BC/OS: Project operation activity will not affect water usage for other purposes. The Indira Gandhi Canal and Narmada Canal are irrigation canal of which flow volume is under control by Water Resources Department (WRD). The inflow into the canal at the entrance point of the canal and intake flow from the canal at each intake point are controlled in a planned manner by WRD based on the agreed water allocation.

(6) Existing social infrastructure and service

BC/CS: The construction works including the traveling of construction vehicles are expected to cause traffic congestion and limitation of access to social infrastructure temporarily.

OS: No activity is planned that will impact on social infrastructure and services.

(7) Landscape

BC/CS, OS: No activity is planned that will impact on landscape.

[4] PHED had consultation with the land owner on the land acquisition and compensation at Goliyar on 13 December, 2020 and the policy of compensation was explained. The owner agreed to the compensation policy and had no objections to the process of land acquisition.

(8) Gender

BC/CS: No activity is planned that will impact on gender.

OS: Water supply pipeline will be connected to each house and burden of women who are the main bearers of water collecting 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 improvement of the status and right of women.

(9) Children’s Rights

BC/CS/OS: No activity is planned that will violate the children’s rights.

(10) Infectious Disease and HIV/AIDS

BC/CS: The workers will come to the construction sites and it is expected that the risk of infectious diseases such as HIV/AIDS will increase. The contractors should sufficiently educate the workers and the people in the local communities.

OS: No activities are planned that will increase the risk of communicable diseases.

(11) Occupational Health and Safety

BC/CS: The workers has risk of being affected by air pollution such as dust and gas emission due to construction works and risk of heat attack.

OS: There is a risk of chlorine gas inhalation for the workers in WTP.

12.6.4 Others

(1) Accident

BC/CS: Due to the use of construction machinery and vehicle, risk of accident is expected to be increased in and around the construction sites. The contractors should educate the workers and communities around the construction sites to minimize the risk of accident.

OS: The impact of accident from the operation is not expected.

(2) Cross-border Impact, Climate Change

BC/CS, OS: GHG emission from the construction works and facility operation would not cause any significant impact.

12.7 Impact Assessment

The results of the assessment on impacts from the proposed project are presented in the following table:

Table 12.7.1 Assessment of the Project

No.	Environmental Item	Scoping Result		Survey Result		Basis/ Reason for the Survey Result
		PC/ CS	OP	PC/ CS	OP	
Pollution control measures						
1	Air quality	✓		B-	D	BC/CS: The construction works near existing houses have impact on air pollution, thus mitigation measures should be taken. OS: No activity is planned that will cause air pollution.
2	Water quality	✓		B-	D	BC/CS: If generated muddy water flow into the canal near the construction sites of intake, it has impact on water quality, thus mitigation measures should be taken. OS: No activity is planned that will cause water pollution.
3	Waste	✓	✓	B-	B-	BC/CS: Generated waste should be managed and transported to waste management and processing plant and surplus soil can be stored near WTP or nearest government owned land for future construction of filling work. OS: The sludge would be collected and disposed by sludge handling system in WTP.
4	Soil contamination			N/A	N/A	BC/CS, OS: No activity is planned that will cause soil contamination.
5	Noise and vibration	✓		B-	D	BC/CS: The construction works near existing houses have impact on noise and vibration, thus mitigation measures should be taken. OS: No activity is planned that will increase noise and vibration level.
6	Ground subsidence			N/A	N/A	BC/CS, OS: No activity is planned that will cause ground subsidence.
7	Offensive odor			N/A	N/A	BC/CS, OS: No activity is planned that will cause offensive odor during construction.
8	Bottom sediment			N/A	N/A	BC/CS, OS: No activity is planned that will cause pollution to river sediment.
Natural environment						
9	Protected area	✓		B-	D	BC/CS: Some of the facilities are planned to be constructed in forest area and also some part of pipeline is installed along existing road within forest area. Forest area is prohibited to be developed without permission. Construction work should be started after appropriate legal procedure and issuance of permission of forest land use. OS: No activity is planned to have impact on protected area.
10	Flora/fauna and biodiversity	✓		B-	D	BC/CS: Pumping stations and ESRs which are planned to be constructed in forest area have impact on flora/fauna and biodiversity such as cutting trees. Mitigation measures should be taken. OS: Impact on the ecosystem due to operation is not expected.
11	Hydrology			N/A	N/A	BC/CS, OS: No activity is planned that will increase rainwater discharge.
12	Topography and geology			N/A	N/A	BC/CS, OS: No activity that will adversely affect the topography and geographical features is expected.
Social environment						

No.	Environmental Item	Scoping Result		Survey Result		Basis/ Reason for the Survey Result
		PC/ CS	OP	PC/ CS	OP	
13	Involuntary resettlement			N/A	N/A	BC/CS, OS: Involuntary resettlement or other impact on livelihood is not identified so far. However, if involuntary resettlement including illegal resident and agriculture etc. is required, compensation is necessary to be paid for them resettlement is executed in accordance with JICA's guideline and legislative procedure of India.
14	Poverty			B+	B+	BC/CS, OS: The impact on social or peoples of the affected villages will be positive in terms of employment generation, provision of facilities of drinking water, and others which will be created from the project.
15	Ethnic minorities and indigenous peoples			N/A	N/A	BC/CS, OS: There are no Scheduled Tribe Area and Indigenous Peoples in Barmer and Jhunjhunu districts.
16	Local economy (Employment)			B+	B+	BC/CS, OS: Positive impacts such as creation of local employment are predicted.
	(Livelihood)			B+	B+	BC/CS, OS: Economic effects by the purchases of the foods and commodities by the workers and plant operators that will come from outside the village for the project.
17	Land use and utilization of local resources			B-	N/A	BC/CS: Location of ESRs/OHRs will be considered in non-private land as much as possible. So far, land for 1 facility is confirmed to be acquired without resettlement. OS: No activity is planned that will impact on land use and utilization of local resources.
18	Water usage	✓		B-	D	BC/CS: If generated muddy water flow into the canal near the construction sites of intake, it has impact on water usage, thus mitigation measures should be taken. OS: No activity is planned that will impact on water usage.
19	Existing social infrastructure and service	✓		B-	D	BC/CS: The construction works including the traveling of construction vehicles are expected to cause traffic congestion and limitation of access to social infrastructure temporarily. OS: No activity is planned that will impact on social infrastructure and services.
20	Social institutions such as social infrastructure and local decision-making institutions			N/A	N/A	BC/CS, OS: No activity is planned that will affect the social and local institutions.
21	Maldistribution of damage and benefit			N/A	N/A	BC/CS, OS: No activity is planned that will cause maldistribution of the damage or benefit.
22	Local conflict of interest			N/A	N/A	BC/CS, OS: No activity is planned that will cause local conflict.
23	Cultural heritage			N/A	N/A	BC/CS, OS: No activity is planned that will affect the cultural heritage.
24	Landscape			D	D	BC/CS, OS: No activity is planned that will impact on landscape.
25	Gender			D	A+	BC/CS: No activity is planned that will impact on gender. OS: Women can save their time for activities other than water collection work and it is expected to contribute improvement of the status and right of women.
26	Children's rights			D	D	BC/CS, OS: No activity is planned that will violate the children's rights.

No.	Environmental Item	Scoping Result		Survey Result		Basis/ Reason for the Survey Result
		PC/ CS	OP	PC/ CS	OP	
27	Infectious disease and HIV/AIDS	✓		B-	D	BC/CS: During construction, construction workers will come to the construction site and it is expected that the risk of infectious diseases such as HIV/AIDS will increase. OS: No activities that will increase the risk of communicable diseases is expected.
28	Occupational health and safety	✓	✓	B-	B-	BC/CS: The workers has risk of being affected by air pollution such as dust and gas emission due to construction works and risk of heat attack. OS: There is a risk of chlorine gas inhalation for the workers in WTP.
Others						
29	Accident	✓	✓	B-	D	BC/CS: Due to the use of construction machinery and vehicle, risk of accident is expected to be increased in and around the construction sites. OP: The impact of accident from the operation is not expected.
30	Cross-border impact, climate change			D	D	BC/CS, OS: GHG emission from the construction works would not cause any significant impact.

Note: BC (Before-construction stage), 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 into D in the scoping phase
Source: JST

12.8 Mitigation Measures and Environmental Management Plan (EMP)

EMP is a list of mitigation measures against the possible environmental and social impacts identified in the section above. It will serve as a guidance to an eco-friendly implementation of the project by ensuring

(i) Efficient lines of communication between the project management consultants and contractors.

(ii) The activities are undertaken in a responsible non-detrimental manner; provide a pro-active, feasible and practical working tool to enable the measurement and monitoring of environmental performance on site;

(iii) Guide and control the implementation of findings and recommendations of the environmental assessment conducted for the subproject;

(iv) Detail specific actions deemed necessary to assist in mitigating the environmental impact of the subproject; and

(v) Safety recommendations are complied with.

Mitigation measures and implementing organization at each project stage are shown in Table 12.8.1 and Table 12.8.2.

12.9 Environmental Monitoring Plan

The Environmental Monitoring Plan (EMoP), which present monitoring items, location, frequency, and responsibility at each project phase is shown in Table 12.9.1 and Table 12.9.2.

12.10 Environmental Checklist

Environmental Checklist is shown in Table 12.10.1.

Table12.8.1 Summary of Identified Potential Negative Impacts and Mitigation Measures during the Construction Phase

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Relevant Component	Implementing Organization	Responsible Organization	Roughly Estimated Cost (USD)
Pollution control measures	Air quality	Emission from operation of construction machineries and traveling of construction vehicles for construction of WTP and raw water reservoir will cause air pollution.	Control dust by water sprinkling on exposed soil, stock stockpiled material on site. Barricade areas provide 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 machineries with air pollution control devices which are operating correctly; all the vehicles will meet the emission norms and will have valid pollution under control (PUC) certificate. Conduct air quality monitoring as per the monitoring plan.	Intake and raw water pumping station, WTP, raw water reservoir, pump station, pipeline, ESR	Contractor	PHED	Water sprinkling truck in WTP and raw water reservoir site USD 7,500 /1 unit
	Water quality	Flow of muddy water from the construction work site of intake and raw water pumping station to the river near the site will cause water pollution.	Install silt screen and sedimentation tank	Intake and raw water pumping station	Contractor	PHED	Silt Screen USD 7,500 /1 unit Sedimentation tank USD 22,500 /1 unit
	Waste	Excavated soil and rock from construction work has impact on waste.	Excavated soil and rock should be restored as properties of the contractor during construction.	Intake and raw water pumping station, WTP, raw water reservoir, pump station, pipeline, ESR	Contractor	PHED	-

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Relevant Component	Implementing Organization	Responsible Organization	Roughly Estimated Cost (USD)
	Noise and vibration	Impact of noise and vibration is expected from the construction works.	Conduct noise generating activities during the daytime. Minimize noise from construction equipment (by using vehicle silencers, fitting jackhammers with noise-reducing mufflers, and use portable street barriers to minimize sound impact to surrounding sensitive receptor. Consult local communities in advance to avoid working at sensitive times, such as religious and cultural festivals.	Intake and raw water pumping station, WTP, raw water reservoir, pump station, pipeline, ESR	Contractor	PHED	-
Natural environment	Protected area Flora/fauna and biodiversity	Impact on the ecosystem due to construction of facilities is expected.	Avoid removal of vegetation / tree cutting. If unavoidable, minimize as much as possible, and obtain tree-cutting permit (forest land use approval).	Intake and raw water pumping station, WTP, raw water reservoir, pump station, pipeline, ESR	Contractor	PHED	-
Social environment	Water usage	Impact on water usage is expected due to intake construction.	Install silt screen and sedimentation tank (Same as water quality)	Intake and raw water pumping station	Contractor	PHED	Silt Screen USDD 7,500 /1 unit Sedimentation tank USD 22,500/1 unit
	Existing social infrastructure and service	Temporary access limitation to social infrastructure and temporary traffic congestion due to construction works and increase of construction vehicles	Arranging pedestrian way to secure accessibility to social infrastructure as necessary. Inform contents of construction works and work schedule to the surrounding communities in advance.	Pipeline	Contractor	PHED	-
	Infectious disease and HIV/AIDS	During construction, construction workers will come to the construction site and it is expected that risk of infectious diseases	Educate workers and the surrounding communities on the risks, prevention, and available treatment of infectious disease.	Intake and raw water pumping stations, WTP, raw water, reservoir, pump	Contractor	PHED	-

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Relevant Component	Implementing Organization	Responsible Organization	Roughly Estimated Cost (USD)
		such as HIV/AIDS will increase.	Prevention of illness among workers by undertaking health awareness and education initiatives.	station, pipeline, ESR			
	Occupational health and safety	There is possibility to cause problem on occupational health and safety (OHS) such as asthma due to dust or gas emission from the construction works and heat attack.	Provide OHS training program and information of safe work practice and emergency procedure. Provide adequate healthcare facilities and first aid within the construction site.	Intake and raw water pumping station, WTP, raw water reservoir, pump station, pipeline, ESR	Contractor	PHED	-
Others	Accident	Due to the use of construction machinery and vehicles, risk of accident is expected to increase in and around the construction site.	Provide information and guidance on construction activities and safety to the surrounding communities. Secure all installations from unauthorized intrusion and accident risks.	Intake and raw water pumping station, WTP, raw water reservoir, pump station, pipeline, ESR	Contractor	PHED	-

Source: JST

Table12.8.2 Summary of Identified Potential Negative Impacts and Mitigation Measures during the Operational Phase

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Relevant Component	Implementing Organization	Responsible Organization	Roughly Estimated Cost (USD)
Pollution control measures	Waste	The generation of sludge from the dry bed in WTP is expected.	The sludge would be collected and disposed by sludge handling system in WTP.	WTP	Contractor	PHED	-
Social environment	Occupational health and safety	Impact on occupational health and safety which might occur during the operation phase of the project.	Provide appropriate PPE to workers and training on its proper use. Use fall protection equipment when working at heights. Maintain work areas to minimize slipping and tripping hazards. Prepare escape plans from areas where there might be a chlorine emission. Install safety showers and eye wash stations near the chlorine equipment and other areas where hazardous chemicals are stored or used. Prohibit eating, smoking, and drinking except in designated areas.	WTP, raw water reservoir	Contractor	PHED	-

Source: JST

Table 12.9.1 Frequency and Locations of Environmental Monitoring during the Construction Phase

Item	Monitoring Item	Monitoring Method	Monitoring Place	Frequency	Term	Package	Responsibility	Roughly Estimated Cost (USD)
1. Pollution								
Air quality	PM, SO_2, NOx and CO	Site measurement	Nearest village around the WTP and raw water reservoir	Quarterly	Entire construction phase	WTP and raw water reservoir	PHED/ Consultant	-
Water quality	SS, oil and grease, pH,	Site measurement	Nearest river around intake and raw water pumping station	Quarterly	Entire construction phase	Intake and raw water pumping station	PHED/ Consultant	-
Waste	Record of excavated soil and rock	Check records of amount of excavated soil and rock, Check amount of stored soil and rock by the contractor	Intake and raw water pumping station, WTP, raw water reservoir	Monthly	Entire construction phase	Intake and raw water pumping station, WTP, raw water reservoir	PHED/ Consultant	-
Noise and vibration	Sound level and vibration level	Site measurement	Nearest village around the intake and raw water pumping station, WTP, raw water reservoir	Quarterly	Entire construction phase	Intake and raw water pumping station, WTP, raw water reservoir	PHED/ Consultant	-
2. Natural environment								
Protected area, flora, fauna and ecosystem	Condition of the ecosystem	Sentinel surveillance of ecosystem (e.g., vegetation, reservoir)	Pump station, ESR, pipeline	Quarterly	Entire construction phase	Pipeline, pump station, ESR	PHED/ Consultant	-
3. Social environment								

Item	Monitoring Item	Monitoring Method	Monitoring Place	Frequency	Term	Package	Responsibility	Roughly Estimated Cost (USD)
Existing social infrastructure and service	Complaint from surrounding communities	Check complaint records	Whole project area	Monthly	Entire construction phase	Intake and raw water pumping station, WTP, raw water reservoir, pipeline, pump station, ESR	PHED/ Consultant	-
Infectious disease and HIV/AIDS	Record of awareness on infectious disease	Check record of awareness activities on infectious disease	Whole project area	Monthly	Entire construction phase	Intake and raw water pumping station, WTP, raw water reservoir, pump station, pipeline, ESR	PHED/ Consultant	-
Occupational health and safety	Record of accidents in the construction site	Check record of accidents in the construction site	Whole project area	Monthly	Entire construction phase	Intake and raw water pumping station, WTP, raw water reservoir, pump station, pipeline, ESR	PHED/ Consultant	-
4.Others								
Accident	Record of traffic accidents in the surrounding communities	Check record of traffic accidents in the surrounding communities	Surrounding area	Weekly	Entire construction phase	Intake and raw water pumping station, WTP, raw water reservoir, pump station, pipeline, ESR	PHED/ Consultant	-

Source: JST

Table 12.9.2 Frequency and Locations of Environmental Monitoring during the Operation Phase

Item	Monitoring Item	Monitoring Method	Monitoring Place	Frequency	Term	Package	Responsibility	Roughly Estimated Cost (USD)
1. Pollution								
Waste	Record of amount of generated sludge and recycled sludge	Check record of amount of waste	WTP	Monthly	2 years after the start of operation	WTP	PHED/ Consultant	-
Noise and vibration (If pumping station is located next to household)	Sound level and vibration level	Site measurement	Nearest village around the pump facility	Monthly	2 years after the start of operation	Pump Station	PHED/ Consultant	-
2. Social environment								
Occupational health and safety	Record of accidents in the WTP	Check record of accidents in the construction site	WTP	Monthly	2 years after the start of operation	WTP	PHED/ Consultant	-

Source: JST

Table 12.10.1 Environmental Check list

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) N (b) N (c) N (d) N	(a) EIA report is not required for water supply project in India (b) ditto (c) ditto (d) It is necessary to get approval for forest land use, however, not get it yet.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) Y	(a) Public consultation meeting has been conducted appropriately. (b) No critical comment to reflect the project design.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) 3 options including "without project scenario" were considered for location of WTP.
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Are any mitigating measures taken? (b) Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	(a) N (b) Y	(a) No activity is expected for air quality pollution due to leakage of chlorine. (b) Chlorine concentration should be complied with occupational health and safety standard of India.
	(2) Water Quality	(a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	(a) Y	(a) No activity is expected to generate wastewater due to facility operation.
	(3) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations?	(a) Y	(a) Sludge is treated in facility and disposed in an environmentally-friendly manner.
	(4) Noise and Vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a) Y	(a) Noise and vibration from facilities are acceptable level because source of noise such as pump is in the building and the building.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a) N	(a) Groundwater is not taken.
3 Natural Environment	(1) Protected Areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There is no protected area in the project site.
3 Natural Environment	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)?(b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions?(c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem?(d) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N(b) N(c) -(d) N	(a) There is no eco-sensitive zone or national park in the project site. (b) ditto (c) ditto (d) Because water will be taken from irrigation canal, no impact is expected to aquatic environment due to water intake.
	(3) Hydrology	(a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows?	(a) N	(a) Because water will be taken from irrigation canal, no impact is expected due to water intake.

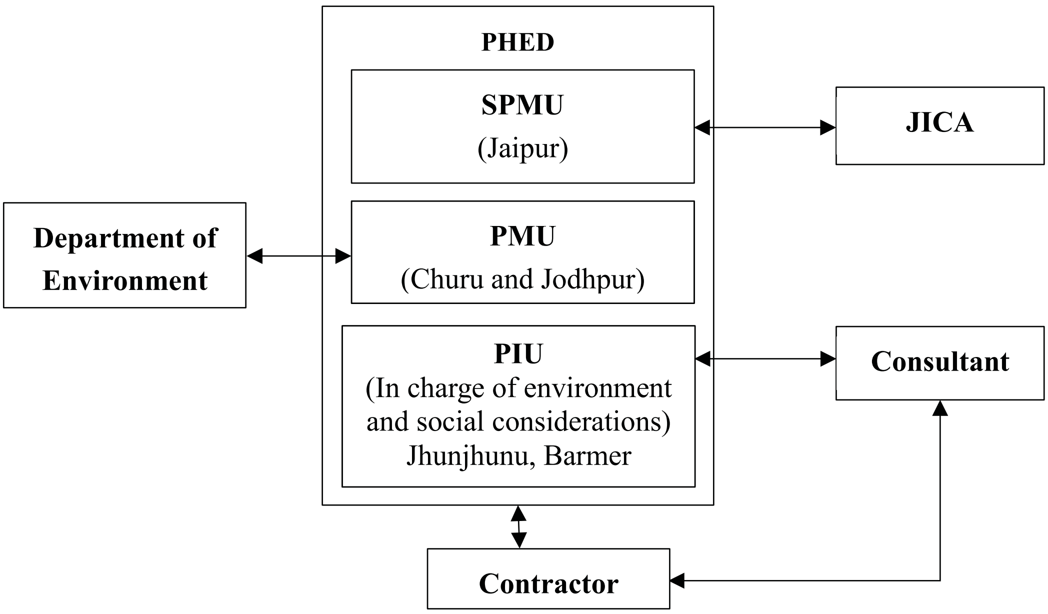
Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) N (b) - (c) - (d) - (e) - (f) - (g) - (h) - (i) - (j) Y	(a) Resettlement is not expected because project is implemented within government owned land (b) ditto (c) ditto (d) ditto (e) ditto (f) ditto (g) ditto (h) ditto (i) ditto (j) People can claim their complaints by call or online system.
4 Social Environment	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?	(a) N(b) N	(a) No activity is expected to affect living condition and livelihood negatively because project will create new job. (b) Project will not affect adversely their water use. Project can supply water source without Florine contamination.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) There is no heritage in project site
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) No activity is expected to affect landscape by the project.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N (b) N	(a) There are no ethnic minorities and indigenous people in the project site. (b) ditto
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) Y (b) Y (c) Y (d) Y	(a) Project proponent has to comply with Labor Laws (b) ditto (c) ditto (d) ditto
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a) Y (b) Y (c) Y (d) Y	(a) Mitigation measures are considered. (b) If forest land is developed, compensatory afforestation will be implemented (c) No adversely impact to social environment is expected during construction. (d) Arranging pedestrian way to secure accessibility to social infrastructure as necessary. Inform contents of construction works and work schedule to the surrounding communities in advance.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) - (c) Y (d) Y	(a) The consultant will implement the environmental monitoring during the construction stage as well as operation stage of WTP. (b) Monitoring plan is prepared based on result of environment and social consideration impact assessment. (c) PHED has responsibility to conduct monitoring and also submit monitoring report to JICA. (d) Monitoring report is shared with Department of Environment of Rajasthan.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked.	(a) -	(a) Not necessary to refer additional checklist items in other sectors.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) Y	(a) No activity is expected to have impact to transboundary or global issues.

12.11 Implementation Structure of the Environmental Management Plan

The environmental management structure is shown in Figure 12.11.1. The consultant will implement the environmental monitoring during the construction period as well as the first two years in operation stage. The environmental monitoring will be conducted by the consultant. The consultant will prepare the monitoring report and submit it to PIU of PHED. The PIU will review the environmental monitoring report and submit it to PMU. Then PMU will submit it to JICA through SPMU. PMU will also share the monitoring report with the Department of Environment of Rajasthan and if any significant impact is confirmed in the monitoring report, PMU will consult with the Department of Environment and PHED will conduct mitigation measures.



Source : JST

Figure 12.11.1 Environmental Management Structure

12.12 Stakeholder Consultation Meeting

(1) Outline of stakeholder meeting

Stakeholder meetings were held in tehsils of the project site to offer an opportunity for local people to express their concern and expectations to project proponent and share information of the project including environment and social matters.

In target villages of project site, date of meeting was informed to all villagers a week in advance at first and detailed information such as time and location was also informed to them in parallel with arrangement for the meetings. Information is announced by verbal communication by the Sarpanch who is a focal point of contact between government officers and the village community of Panchayat. Participants were selected considering diversity, thus not only representative person but also general villagers such as farmer were invited for the meeting. Considering situation of COVID-19, number of participants were adjusted depending on the size of venue for the meeting and participants were requested to wear mask, disinfect their hand by sanitizer, and windows/doors of meeting place were opened to let some fresh air in. Outline of the meeting is shown in Table 12.12.1.

Table 12.12.1 Outline of Stakeholder Meeting

Item	Description
Method of meeting	Face-to-face meeting
Language	Hindi
Organizer	PHED
Participants	Villagers in project site
Agenda	1. Project Introduction 2. Scheme Wise Project Details 3. Environmental Status 4. Socio-Economic Status 5. Question Answer with feedback

Source: JST

(2) Result of stakeholder meeting

10 stakeholder meetings were held in Barmer District and Jhujhunu District. Date, locations, and number of participants are shown in Table 12.12.2. Villages where main facilities such as pump stations are constructed and have relatively large population were selected as meeting location in order to invite local people as much as possible effectively.

Table 12.12.2 Date, Location, and Number of Participants of Stakeholder Meetings

Date	Location		Number of participants
	Tehsil	Village	
Barmer Disrict			
16 Dec. 2020	Gudhamalani	Dhoorimanna	24 people (Male: 22, Female: 2)
16 Dec. 2020		Peeprali	18 people (Male: 16, Female: 2))
16 Dec. 2020		Gudhamalani	26 people (Male: 25, Female: 1)
17 Dec. 2020	Chohtan	Chohtan	31 people (Male: 28, Female: 3)
17 Dec. 2020	Dhanova	Dhanova	38 people (Male: 37, Female: 1)
17 Dec. 2020		Gohad Ka Tala	19 people (Male: 19, Female: 0)
Jhunjhunu Disrict			
22 Dec. 2020	Udaipurwati	Udaipurwati	36 people (Male: 24, Female: 12)
22 Dec. 2020		Ponkh	24 people (Male: 20, Female: 4)
23 Dec. 2020	Surajgarh	Surajgarh	13 people (Male: 11, Female: 2)
23 Dec. 2020	Buhana	Buhana	17 people (Male: 17, Female: 0)

Note: Date of the meetings were informed 1 week in advance by verbal communication by the Sarpanch
Source: JST

Almost all comments from participants are that they expect the project to solve health problem due to current water use and lack of water supply. Negative opinion/comments to the project were not received from participants. Some of comments from participants are shown in Table 12.12.3. Minutes of meeting including all comments and answers is shown in Appendix-12.2.

Table 12.12.3 Comments from Participants

Comments from participants	Answer from PHED
Requests to employ local people preferentially for the project	PHED will give job for construction works of the project to local people.
Request to complete the project as soon as possible	PHED ensure to complete the project and supply treated water.
Request to supply water everyone including Scheduled Caste and Scheduled Tribute.	PHED ensure to supply water everyone including such communities

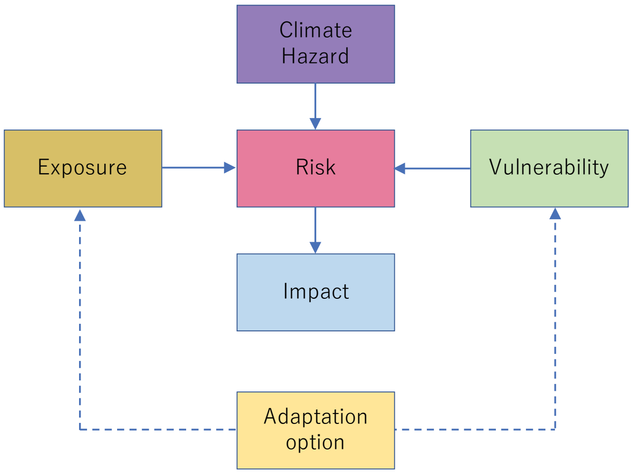
Source: JST

In order to include socially disadvantaged people, the meetings were facilitated in consideration for participants who are not well educated, and presenter interacted with participants in the middle of explanation and tried to promote their understanding. Moreover, information of the meetings were announced to all villagers including women by the Sarpanch and some women were invited to the meetings.

Chapter 13 Global Warming Impacts

13.1 Framework of Analysis of Adaptation Option

In this chapter, the exposure, climate hazard, vulnerability, and risks of the project due to anticipated climate change are analysed and adaptation options are studied in accordance with the JICA Climate Finance Impact Tool (FIT) for Adaptation. Magnitude of climate hazard and exposure and vulnerability for the climate hazard has been evaluated. Then, adaptation option for exposure and vulnerability has been studied. Frame work of adaptation option study is shown in Figure 13.1.1.



Source: JICA Climate-FIT (Adaptation)

Figure 13.1.1 Framework of Adaptation Option Study

13.2 Climate Hazard

The Government of Rajasthan drafted the Rajasthan State Action Plan on Climate Change (RAPCC) in 2012. In RAPCC, future climate change is projected by PRECIS (Providing Regional Climates for Impact Studies, a high-resolution modelling system developed by the Hadley Centre, UK). Based on observed climate trends and A1B SRES scenario of IPCC SRES (Special Report on Emission Scenarios), variation range of future temperature and precipitation of District wise by 2035 and State wise for 2071-2100 are projected. The projected data are shown in Table 13.2.1 and Table 13.2.2.

Table 13.2.1 Projected Rising Temperatuire and Precipitation by 2035

	Variation range by 2035			
	Maximum Temperature	Average Temperature	Minimum Temperature	Precipitation
Barmer District	+1.75-1.85 ºC	+2.0-2.1 ºC	+2.2-2.3 ºC	+5-10%
Jhunjhunu District	+1.45-1.55 ºC	+1.7-1.8 ºC	+2.0-2.1 ºC	+5-10%

Source: RAPCC

Table 13.2.2 Projected Rising Temperatuire and Precipitation for 2071-2100

	Variation range for 2071-2100	
	Temperature	Precipitation
Rajasthan State	+ 2-4 ºC	Decrease slightly, but extreme rainfall is projected to increase in frequency and intensity

Source: RAPCC

According to RAPCC, the increase in the evapotranspiration due to higher temperature and the increase in frequency and intensity of extreme rainfall is projected. Thus, climate hazardous such as drought and flood will be caused due to such climate changes.

13.3 Exposure and Vulnerability

Exposure and vulnerability regarding the flood and the drought are shown in Table 13.3.1.

Table 13.3.1 Exposure and Vulnerability for Climate Hazard

Climate hazard	Exposure	Vulnerability
Flood	Deterioration and breakdown of infrastructure due to the flood is assumed. Intake and raw pumping stations constructed by the project has high possibility to be damaged by the flood because it is located near water body (canal).	Because almost all project site is in arid area, frequency of flood is not high, thus measures against flood is not adequate in the project site.
Drought	Depletion of groundwater which are current main water resource for local people due to drought is also assumed. However, facilities to be constructed by the project might not be affected by drought.	Groundwater is used as main water resource for their daily life without sufficient management.

Source: JST

13.4 Risk

Facilities constructed by the project, especially intake and raw water pumping station, have risk of inundation due to flood however damage by drought is not assumed. Considering the risk in the whole project sites, restriction of daily activities and deterioration of health condition of local people by the flood and drought are assumed.

13.5 Adaptation Option

Placing of equipment at higher elevation than the flood level in facilities constructed by the project can be adaptation measures against the flood. Moreover, implementation of the project itself also can be considered as adaptation measures for the drought in the whole project sites because the project will provide managed and stable water supply.

Chapter 14 Economic and Financial Analysis

14.1 Economic Analysis

14.1.1 Methodology of Economic Analysis

Social and economic feasibility of the project is evaluated by comparing the economic benefits and costs under the “With” and “Without” cases of water supply project in the project area. Under the “With” case, water supply facilities are constructed by the project, whereas the project is not implemented under the “Without” case. The economic internal rate of return (EIRR), benefit-cost ratio (B/C), and economic net present value (ENPV) are calculated as the indicators for the evaluation.

14.1.2 General Assumptions of Economic Analysis

General assumptions of economic analysis are shown in Table 14.1.1.

Table 14.1.1 Assumptions of Economic Analysis

Items	Assumptions	Remarks
Discount Rate	10%	There is no guideline in India. Generally used figure for studies of international organizations such as JICA (2019) [1]
Project Period		
Price Level	As of December 2020	Inflation is not considered in the evaluation
Physical Contingency	5%	1) 5% of Construction Cost 2) 5% of Consulting Service Cost
Exchange Rate	USD 1 = INR 74.2 USD 1 = JPY 104.00	As of December 2020
Standard Conversion Factor (SCF)	0.9	There is no guideline in India. Generally used figure by international organizations. Also used in JICA (2019) [1] and World Bank (2014) [2].

Source: JST

14.1.3 Economic Benefits

After the project is implemented, the current water source is substituted by the newly constructed water supply system by household connection. Supplied water quantity and supply condition (time, pressure) will be improved from the current situation.

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[1] JICA (2019) “Republic of India, Preparatory Survey for Madhya Pradesh Rural Water Supply Project”

[2] The World Bank (2014) “MAHARASHTRA RURAL WATER SUPPLY AND SANITATION PROGRAM”

Quantified economic benefits of the water supply project are composed of (1) benefit of reduced water supply cost, (2) benefit of willingness to pay for water usage, (3) benefit of reduced water fetching time, and (4) benefit of cost reduction of waterborne diseases.

The project is assumed to be completed in [redacted] Half of the benefits are produced [redacted] assuming the water service is partially started from the previous year of project completion.

(1) Benefit of Reduced Water Supply Cost

Under the "With" case, the water system provided from the new WTP will be used instead of the current system. Therefore, the cost of current water system will be saved. The total benefit amount of reduced cost is calculated by multiplying "Number of Beneficiaries", "Water Consumption without Project" and "Alternative Water Supply Cost".

"Economic Benefit of Reduced Water Cost (INR/year)" =

"Number of Beneficiaries" x "Water Consumption without Project (m^3/day)"

x "Alternative Water Supply Cost (INR/m^3)" x 365 (days/year)

The water consumption of users without the project is surveyed through a social condition survey in the project area as described in Section 3.6. Average daily water consumption per person is calculated (based on the figures in summer and winter) at 41.9 Lpcd in Barmer and 44.9 Lpcd in Jhunjhunu as shown in Table 14.1.2 below. The average household sizes are 5.8 people in Barmer and 5.5 people in Jhunjhunu referring to the latest census in 2011.

Table 14.1.2 Average Water Consumption per Person per day Without the Project

Area	Daily Water Consumption per Person
Jhunjhunu	44.9 liters/person-day
Barmer	41.9 liters/person-day

Source: JST

The weighted average alternative water supply cost was estimated based on the estimated water supply cost and number of users of each water source. The water supply cost is estimated assuming the capital cost, life period, and number of users of each facility based on the past project experience of JST and interviews with PHED staffs. O&M cost is not included due to difficulty in estimation. The number of water usage is obtained from the result of the social condition survey. The cost of "8) Independent Residents/Colony Association Line Supply" is assumed to be the average cost of other sources due to difficulty of cost estimation.

The average alternative water supply costs are estimated at INR 48.7/m^3 in Barmer and INR 35.2/m^3 in Jhunjhunu.

Table 14.1.3 Combined Alternative Water Supply Cost

Main Water Source	Estimated Cost (INR/m^3)	Number of Samples in Barmer	Number of Samples in Jhunjhunu
1) Stand Post	27	31	0
2) Public Hand Pump	10	7	11
3) Own Hand Pump (Bore Well)	51	153	67
4) Water Tanker	60	169	7
5) Shared with Neighbor	26	17	14
6) Dug Well	10	17	144
7) Gram Panchayat Connection	27	14	14
8) Independent Residents/Colony Association Line Supply	-	0	83
Total		408	339
Average Alternative Water Cost* (INR/m^3)		48.7	35.2

* Weighted Average of Estimated Cost and Number of Samples
Source: JST

(2) Benefit of Willingness to Pay (WTP) for Water Usage

In the social condition survey, the expected duration of water supply and the amount of WTP in order to have the said improved situation are asked. After the project is implemented, the water supply time will be longer, and this benefit can be quantified by accumulating the WTP of total users. Survey result of WTP per person is shown in Table 14.1.4. The WTP of whole beneficiaries of the project is added as the benefit of the project.

"Benefit of WTP for Water Usage" = "Number of Beneficiaries" x "WTP (INR/person/month)" x 12 (month/year)

Table 14.1.4 Willingness to Pay for Water Supply Services

Unit：INR/month

Area	Average Monthly Willingness to Pay per Household	Average Number of Household (person/household)	Average Monthly WTP per person
Jhunjhunu	INR 109.0	5.5	INR 19.8
Barmer	INR 101.8	5.8	INR 17.6

Source: JST

(3) Benefit of Reduced Water Fetching Time

After implementation of the project, treated water is supplied to each household directly, and people who used to collect water from standposts, public hand pumps, and dug wells can use the saved time for other productive activities.

Therefore, the following benefit would be obtained from the saved time of water fetching:

"Economic Benefit of Saved Water Fetching Time" =
"Number of Beneficiaries (with household connection)" x "Average Saved Time (hour/person)"
x "Average GDP per hour (INR/hour)" x 1/2

According to the results of the social condition survey, the average time to fetch water per household per day are 54 minutes in Barmer and 40 minutes in Jhunjhunu. The net domestic product per capita of Rajasthan State in 2019-20 was INR 118,159. Assuming the total working hour per year is 1,920 hours (240 days/year x 8 hours/day), the average GDP per hour is calculated at INR 61.5/hour. Fifty percent of the saved time is assumed to be used for alternative economic works, and the total benefit is added in the calculation.

(4) Benefit of Reduced Waterborne Diseases

By supplying enough water by the project, medical cost for waterborne diseases in the project area could be reduced. This cost reduction is one of the benefits of the project. According to the World Bank (2017)[3], it is estimated that about 21% of communicable diseases in India are water-related, and the economic costs of these waterborne diseases are estimated at USD 600 million annually with 73 million days of lost labor. Since 700 million people are residing in rural India, the average economic cost of these waterborne diseases per person is assumed at INR 74.4 per year in 2020 applying inflation rate from 2017 to 2020. It is assumed that the current cost will be reduced by 50% due to the project implementation.

"Economic Benefit of Reduced Waterborne Diseases" = "Number of Beneficiaries"
x "Average Cost of Waterborne Diseases per Person" x 1/2

14.1.4 Economic Costs

Details of the cost estimate are described in Chapter 11. The economic cost includes physical contingency and cost borne by the Indian side such as administration cost and land acquisition cost. Price contingency is excluded. Tax is also excluded from the cost as the price distortion of a non-tradable commodity should be removed. Standard conversion factor of 0.9, which is generally used for economic analysis in India[4], is multiplied to the local currency portion. Economic costs of the initial construction cost and O&M cost of the project are shown in Table 14.1.5 below.

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3 Source: The World Bank (2017) "Waterlife: Improving Access to Safe Drinking Water in India"

4 The World Bank (2014) "MAHARASHTRA RURAL WATER SUPPLY AND SANITATION PROGRAM"

Table 14.1.5 Economic Costs of the Project

[redacted]

Source: JST

14.1.5 Results and Evaluation of Economic Analysis

(1) Results of Economic Analysis

Table 14.1.6 shows the results of the economic analysis of the project. The EIRR of the whole project is [redacted] which is higher than the social discount rate (10%). The B/C becomes [redacted] and the ENPV is INR [redacted]. Cash flow of the economic analysis is shown in Appendix-14.1 “Cash Flow of Economic Analysis”. From the results of economic analysis, this project is evaluated as economically feasible.

Table 14.1.6 Results of Economic Analysis

[redacted]

Source: JST

(2) Sensitivity Analysis

Sensitivity analysis with 10% cost increase and 10% benefit decrease are conducted. Results of the sensitivity analysis are shown in Table 14.1.7. The increase of costs and decrease of benefits have similar impacts on the EIRR.

Table 14.1.7 Results of Sensitivity Analysis

[redacted]

Source: JST

14.2 Financial Analysis

14.2.1 Methodology of Financial Analysis

The financial analysis is conducted to evaluate the feasibility of the project by estimating revenue and cost during the project period. The cost and revenue of the JICA loan project is focused, and those for managing VWSC is excluded from the calculation. Basic assumptions of the financial analysis, such as project life and exchange rates, are the same as those of the economic analysis. The indicators of financial internal rate of return (FIRR), B/C, and financial net present value (FNPV) of the project are calculated for the evaluation.

14.2.2 Financial Costs

The physical contingency and cost borne by the Indian side are included in the financial cost. Price contingency and tax are excluded. The financial costs are shown in Table 14.2.1 below.

Table 14.2.1 Financial Costs of the Project

Unit：million INR

Source: JST

14.2.3 Revenues

Revenue of this project is the tariff revenue from users. As of November 2020, the tariff level for special service (project implemented by international fund) is fixed at INR 1.65 for first 10 Lpcd, INR 3.85 for 10-40 Lpcd, and INR 4.95 for over 40 Lpcd. However, the no-tariff-policy is adopted in Rajasthan state for lower consumption users including special service area since March 2020. Standing on the conservative side, the collected revenue is assumed to be zero during a project period assuming the no-tariff-policy will be also applied to the project area.

14.2.4 Results and Evaluation of the Financial Analysis

The result of the financial analysis is shown in Table 14.2.2 below. The cash flow of the financial analysis is shown in Appendix-14.2 "Cash Flow of Financial Analysis". As no revenue is added, the FIRR of the whole project could not been obtained, and B/C becomes zero. The FNPV becomes INR It indicates the difficulty of the project without subsidy from the state government or the central government. To implement the project financially sustainable, provision of enough subsidy should be guaranteed from the GOR or central government.

Table 14.2.2 Results of Financial Analysis

Source: JST

Chapter 15 Project Evaluation and Indicators for Project Effects

15.1 Project Evaluation

15.1.1 Technical Evaluation

The facility plans of the project are described in Chapters 5 and 7. The JICA Study Team (JST) reviewed the facility plans described in the Detailed Project Report (DPR).

In February 2020, PHED decided to revise the DPR of Barmer District. PHED selected the target villages and population based on the 2011 Census. The revision work was conducted by the local consultants. The location of elevated service reservoirs (ESRs) and grouping of villages (which village belongs to which ESRs) were determined through the site visit.

In accordance with JJM policy, every household in the target village will be connected by household connection. However, the cost for certain number of PSP is included in the cost estimate. That is, there is a possibility that the PSPs are temporary installed in some villages. It will be determined by VWSC at the time of construction.

In conclusion, JST judged the project design and implementation plan to be reasonable.

15.1.2 Economic and Financial Evaluation

Economic and financial analysis was conducted in Chapter 14. The economic internal rate of return (EIRR) is estimated at and the benefit-cost ratio (B/C) is estimated at . The major economic benefits are: 1) reduced water supply cost, 2) Willingness to pay (WTP) for water usage, 3) reduced water fetching time, and 4) reduced waterborne diseases. In conclusion, the project is economically feasible.

The expected water tariff income cannot even cover the O&M cost of the project. Government subsidy is required for the O&M cost as well as the initial costs of the project.

15.1.3 Environmental Evaluation

The environmental and social considerations of the project are described in Chapter 12. Based on the Indian laws, the water supply project does not need to have an environmental impact assessment (EIA) approval. No serious environmental impacts have been found in the consideration. As for the social aspect, impact will be minimized by the basic policy of using government land for the installation of the facilities.

15.2 Operation and Effect Indicators

Operation and effect indicators with the target year of [redacted] project completion and start of operation, are set in Table 15.2.1.

Table 15.2.1 Operation and Effect Indicators of the Project

Indicators	Original (2020)	Target [redacted]	Remarks
Operation Indicators			
(1) Water supply amount by the project (m^3/day)	N/A	47,500 m^3/day (Jhunjhunu Scheme) 81,500 m^3/day (Barmer Scheme)	Water supply amount from WTP including non-domestic demand and distribution loss (90% of clear water demand at project completion year)
(2) Percentage of water samples at the tap in which residual chlorine is detected (%)	N/A	100%	
(3) Establishment of VWSC	N/A	270 (Jhunjhunu Scheme) 845 (Barmer Scheme)	95% of target villages of the project
(4) Female ratio of VWSC members (%)	N/A	50%	
Effect Indicators			
(5) Number of household connection (nos.)	N/A	108,900 nos. (Jhunjhunu Scheme) 228,600 nos. (Barmer Scheme)	85% of household in the project area at project completion year

Remarks:
(1) Daily water supply amount can be monitored via online, and it is metered at the exit point of WTP.
(2) A member of VWSC will check residual chlorine at house connection taps once a month. The record of water quality test will be kept in the VWSC office and it will be reported to the PIU office every month.
(3) List of VWSC will be kept in the PIU office
(4) The member list of each VWSC will be kept in VWSC office.
(5) VWSC will keep a list of house connections in VWSC office.
Source: JST

15.3 Risk Management Framework

Risk management framework of the project is shown in Table 15.3.1.

Table 15.3.1 Risk Management Framework

Potential Project Risks	Assessment	Probability* / Impact	Mitigation Measures
1. Stakeholder Risk			
Delay in project implementation due to conflicts with the land users of the project site	- The project facility is basically located in the government land, for which few conflict is expected to occur. - If land acquisition is necessary, PIU will take necessary procedure.	Low / High	- Site confirmation shall be conducted at an early stage of the project. - PIU shall have close communication with the panchayat to avoid conflicts

Delay in project implementation due to delay of setting up of VWSC	- Installation of house connection/PSP/CWT needs to be conducted with confirmation from VWSC - Setting up of VWSC is to be supported by the soft component of the project	Low / High	- PMU/PIU shall monitor the progress of setting up VWSC - If there are any problems, PIU shall discuss with panchayat to solve the problem
2. Executing Agency Risk			
2.1 Capacity Risk Delay in project implementation due to little coordination with relevant authorities	- PHED needs to take necessary procedure for obtaining timely permission from relevant authorities	Low (Middle) / Middle	- Sufficient staffing shall be provided in PIU - PIU, with the help of the consultant, shall have close communication with the contractor and relevant authorities
2.2 Governance Risk Delay in the project due to delay of approval/ sanction process in PHED	- Frequent personnel changes in critical positions may affect the approval/ sanction process	Low (Middle) / High	- A dedicated unit for the project, PMU/PIU, shall have certain authority of approval/ sanction - "Inter Departmental Committee" will address the inter-departmental issues in a timely manner.
2.3 Fraud and Corruption Risk Delay in the project due to occurrence of fraud and corruption	- If fraud and corruption occur, project implementation will be interrupted until the case is resolved	Low (Middle) / High	- All procurement process shall comply with the JICA Procurement Guidelines
3. Project Risk			
3.1 Design Risk Delay in project implementation due to change of design parameter/ conditions/ criteria	- If the GOR's policy of rural water supply changed, it may be necessary to change the design of the project	Low (Middle) / High	- Confirmation of the design parameter/ conditions/ criteria shall be conducted at an early stage of the project
3.2 Delivery Quality Risk (1) Delay in project implementation due to technical/ financial incapability of the contractors	- If capable contractor and NGO is not selected, unnecessary delay may happen which is attributable to the contractor	Low (High) / Middle	- Appropriate procurement process shall be conducted in accordance with the JICA Procurement Guidelines using JICA Standard Documents
3.2 Delivery Quality Risk (2) Lower project benefits than expected due to ineffective operation and maintenance by VWSC	- Proper O&M of the in-village facility by VWSC is required for the realization of the project effect	Middle (High) / High	- Capacity development of VWSC and the community shall be conducted by the soft component of the project

Probability in (　) is when the proposed mitigation measure is not taken or successful.
Source: JST