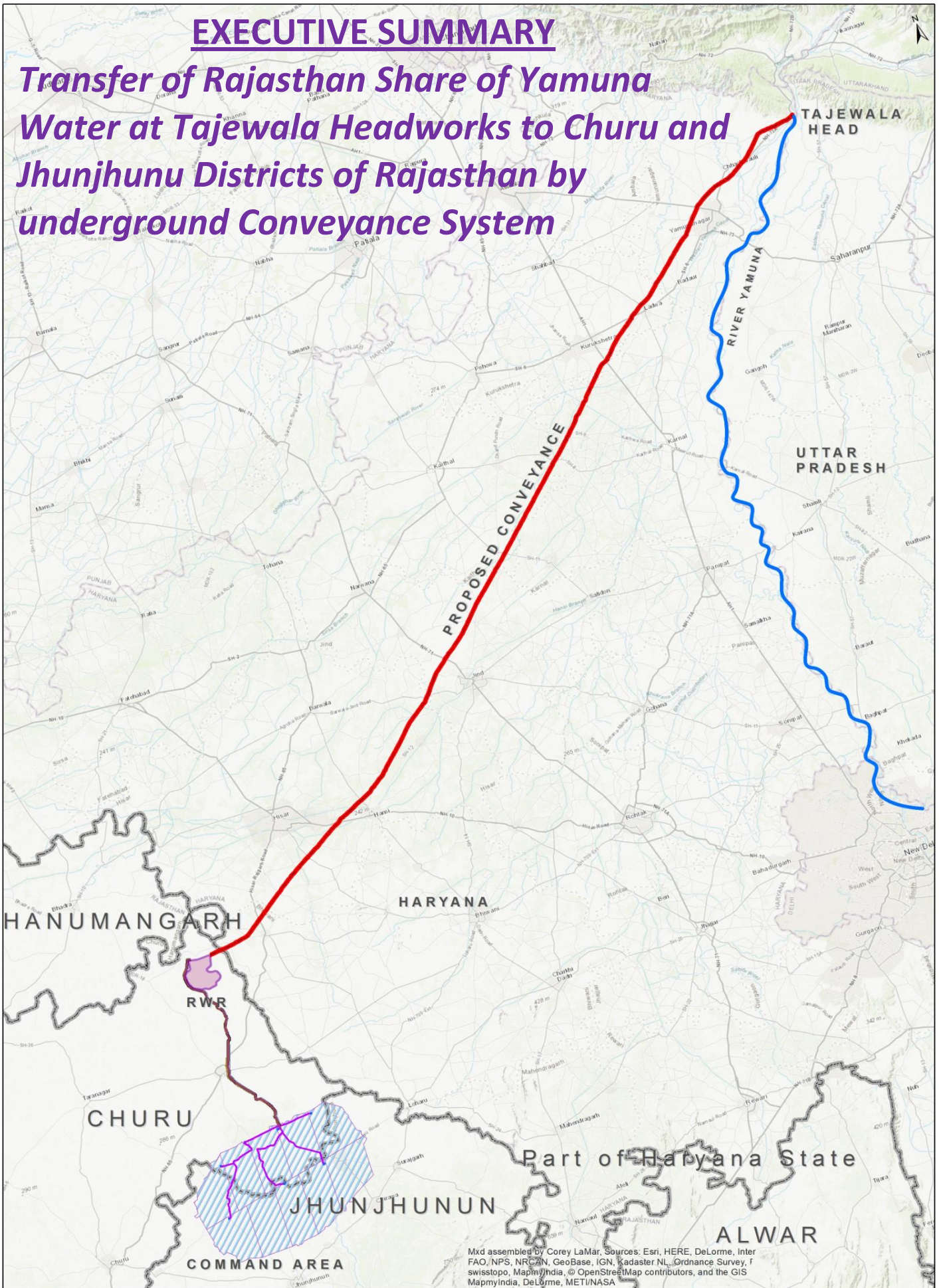


EXECUTIVE SUMMARY

Transfer of Rajasthan Share of Yamuna Water at Tajewala Headworks to Churu and Jhunjhunu Districts of Rajasthan by underground Conveyance System



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A. SALIENT FEATURES

Particulars	Details
Project Name	Transfer of Rajasthan share of Yamuna Water at Tajewala Headworks to Churu and Jhunjhunu districts of Rajasthan by underground conveyance system.
Location	Interstate (Haryana & Rajasthan) Main Pipeline: Haryana RWR & Distribution system: Rajasthan
Promoter	Water Resource Dept. Govt. of Rajasthan
Type & Category of Project	New Project (Drinking water cum irrigation project) Category-A : 1(c) River & Valley Projects (CCA >50,000 ha) as per EIA Notification, 2006 & its subsequent amendment dated 14.08.2018.
General Condition as per EIA Notification	Yes, (i) Protected Areas notified under the Wild Life (Protection) Act, 1972 area as follows: a. Kalesar National Park b. Kalesar Wildlife Sanctuary <i>Above mentioned protected area are located at Head works near Tajewala.</i> (ii) Notified Eco-sensitive areas: ESZ area of Kalesar National Park & Kalesar Wildlife Sanctuary (iii) Inter-State Boundaries : Haryana-Rajasthan Interstate Boundary
Project Capacity	Total transfer of water : 671 MCM Gross Command Area (GCA) : 121695 ha Culturable command area (CCA) : 105000 ha
Project Cost	Rs. 23965.845 cr

B. BRIEF DETAILS OF PROJECT

S.N.	PARTICULARS	VALUE
1	WATER AVAILABILITY	
i	Total Water allocation to Rajasthan	1119 MCM
ii	Allocation from Tajewala Head	671MCM
iii	Periodic allocation by UYRB :	
a	July- Oct	577 MCM or 58.30 Cumec (1917 cusecs)
b	Nov- Feb	42 MCM or 4.05 Cumec (143 cusecs)
c	Mar- June	52 MCM or 4.90 Cumec (173 cusecs)
vii	Periodic allocation after construction of 3 dams (presumed)	
a	July- Oct	550 MCM or 51.75 cumec (1827 Cusecs)
b	Nov- Feb	60.5 MCM or 5.78 cumec (204.12 Cusecs)
c	Mar- June	60.5 MCM or 5.78 cumec (204.12 Cusecs)

S. No.	MAIN COMPONENT	SUB COMPONENT	PARTICULARS	DETAILS
1	Intake Structure on Western Yamuna Canal at Tajewala Head, Haryana	Inlet Canal	Bed Level at Starting Point	328.865 m
			Slope in Canal Bed	1:18
			Width of Inlet Canal	24.00 m
			FSL Of Inlet Canal	333.425 m
		Coarse Screen	Design Discharge Of Canal	51.75 cumec/sec.
			Coarse screen each panel size	11.500 m X 2.800 m
			No of sets required	2x2 sets
			Sill level	328.532 m
			Canal level	333.425 m
			Water head	4.893 m
		Fine Screen	Spacing of trash bars	15 cm
			Fine screen each panel size	11.500 m X 3.100 m
			No of sets required	2x2
			Sill level	328.078 m
			Canal level	333.425 m
			Water head	5.347 m
		Inlet Gates	Spacing of trash bars	5 cm
			Location	At Entry of Canal
			Sill Level	328.865 m
			Canal Level	333.425 m
			Type of gates	MS Vertical lift fixed wheel type
			No of gates	5 sets
		Outlet Gates	Size	3200 x 3500 mm
			Operation by	Rope drum hoist- Electrically/manual
Location	At Entry of Pipes			
Sill Level	325.865 m			
Canal Level	333.425 m			
Type of gates	MS Vertical lift fixed wheel type			
No of gates	5 sets			
Size	3200 x 3200 mm			
Operation by	Rope drum hoist- Electrically/manual			
	Mcc, Scada & Duty Rooms	MCC Room, SCADA Room, Duty Room, Store, Pantry & Wash Room provided in the campus.		
2	Transmission	Main Pipe Line	Total Length of TR. Mains	265.00 km

S. No.	MAIN COMPONENT	SUB COMPONENT	PARTICULARS	DETAILS
	Main From Tajewala to Main Reservoir at Rajgarh, Churu		Total Design Discharge	51.75 cum/sec
			No. of Pipes	5 Nos
			Material of Pipes	MS
			Design Discharge in each pipe	10.35 cum/sec
			Size of Pipes as per Design	3200 mm Dia. (15 mm thick) up to 200 km
				3000 mm Dia. (14 mm thick) from 200 km to 265 km
		Line to work as	Gravity Main	
		Valves and Appurtenances on Each Pipeline	Sectionalizing Valves- Butter Fly Valves- Electrically Operated	28 Nos. (At 10 Km Spacing) 2500 mm size-21 Nos. 2400 mm size-07 Nos.
			Scour Valves- Sluice Valves	75 Nos. of 600 mm size, at lower levels in alignment
			Kinetic Air Valves with Isolating Gate Valve	482 Nos. of 300 mm size at peaks, at 500 m interval or as per design of air release system.
			Vacuum Release Valve	45 Nos.
		Civil Works on each Pipe Line Alignment	Vacuum Breaker	163 Nos.
			BF Valve/ Scour Valve Chambers	103 Nos.
			Air Valve Towers/ Pillars	482 Nos.
			Thrust Blocks- common for all 5 pipelines	92 Nos. as per Angle & Pressure at different chainages.
		Below Ground Crossings of Pipe Lines Proposed by Trenchless Method	Above ground Crossing Structures at Rivers/ Streams	13 Nos. at different chainages.
			Railway Track Crossings	7 Nos.
			NH/SH/MDR Crossings	25 Nos.
		Open Cut Crossing	Canal Crossings	31 Nos.
			Other Roads Crossings	134 Nos.
		Inlet Chamber At Entry Of Main Rwr At Rajgarh, Churu	RCC Inlet Chamber	Chamber Provided
		Instrumentation	Flow Meter at Initial Point and Terminal Point	Ultrasonic Insertion Type- 5x2 Nos.
			Level & Pressure Instruments at Intake Structure and Inlet Chamber of RWR	2 Sets

S.N.	PARTICULARS	VALUE
2	DETAILS OF CONVEYANCE MAINS FROM TAJEWALA TO RAJASTHAN	
i	Off take point of pipe lines for Rajasthan	RD 900 M of western Yamuna canal off taking from Tajewala head
ii	Mode of conveyance of water from Tajewala to Rajasthan	Underground pipe line
iii	No of rows and dia of pipes from Tajewala	5 nos 3200 mm dia ms pipe up to 200km and 3000 mm dia MS pipe from 200 km to 265 km
iv	Discharging capacity of pipe lines from Tajewala to Rajasthan	51.75 cumec
v	Total length of Transmission mains pipe line from Tajewala to main storage reservoir	265 km
vi	FSL of off take point (WYC)	RL 333.425 M
vii	Function of pipe line	As Gravity mains
3	DETAILS OF MAIN STORAGE RESERVOIR IN RAJASTHAN	
i	Location of main storage reservoir at Rajasthan	Between village Thambahera and Hansiyawas of Rajgarh tehsil of Churu district
ii	Storage capacity of main reservoir	333 MCM plus 5% siltation total 349.65 MCM
iii	Bottom RL of reservoir	205 M
iv	Minimum draw down level	208 M
v	FRL at main storage reservoir	319.50 M
vi	Free Board	1.50 M
vii	Top level of main reservoir	321.00 M
viii	Water spread area at FRL of main reservoir	46 sq km
ix	No of villages under submergence	7 of Rajgarh Tehsil of Churu district
x	Total land required for reservoir including embankment	50 sq km
4	DETAILS OF EARTHEN EMBANKMENT AROUND STORAGE RESERVOIR	
i	Max height	16 M at deepest ground level
ii	Total peripheral length of main reservoir	30.6 Km
iii	Total volume of earth work	70.61 Lac cum
iv	u/s and d/s slopes	4:1 and 2:1
v	Top width	6 M
vi	Type of embankment	Zoned with impervious core and cut off trench filled with IP soil, stone pitching on u/s slope and grass turfing on d/s slope
vii	Internal drainage provided	Chimney filter, d/s horizontal filter and rock toe
viii	Measures to prevent seepage from reservoir bed	Clay grouting all around the periphery up to bottom RL 190 M
5	BLOCK RESERVOIRS	
i	Inner & Outer Slopes	1.5:1
ii	Total Depth of Water	3.00 m
iii	Free Board	0.50 m
iv	Capacity excl. Dead Storage	26200 Cum
v	Area of Land required	1.25 ha
6	DIGGIES	
i	Inner & Outer Slopes	1.5:1 m
ii	Total Depth of Water	3.00 m
iii	Free Board	0.50 m
iv	Capacity excl. Dead Storage	500 Cum
v	Area of Land required	625 sqm
7	MAIN PUMPING STATION AT RAJGARH	
i	Size of Sump	2600 Sqm

S.N.	PARTICULARS	VALUE
ii	Overall Size of Pump House	2500 Sqm
iii	No. of Pump Sets Proposed	39 sets
iv	Pumps for PM- 01	12 Sets (8 W + 4 S)
v	Discharge & Head	2419.20 Cum/hr. at 110.00 m Head
vi	Pumps for PM- 02	15 Sets (10 W + 5 S)
vii	Discharge & Head	2628 Cum/hr at 107.00 m Head
viii	Pumps for PM- 03	12 Sets (8 W + 4 S)
ix	Discharge & Head	2462.40 Cum/hr. at 113.00 m Head
x	PMCC Room, SCADA Room, Office /Duty Room, Store, Pantry & Wash Room	Provided
8	PUMPING STATION AT BLOCK RESERVOIRS	
i	Size of Sump	150 Sqm
ii	Overall Size of Pump House	360 Sqm
iii	No. of Pump Sets Proposed	9 Sets
iv	Configuration	6 W + 3 S
v	Average Discharge & Head	6572.20 Cum/hr. at 40-58 m Head
9	PUMP HOUSE AT DIGGIES	
i	Sump	Direct suction from Diggi
ii	Overall Size of Pump House	120 Sqm
iii	No. of Pump Sets Proposed	2 Sets
iv	Configuration	1 W + 1 S
v	Discharge & Head	270 Cum/hr. at 55 m Head
10	PUMPING MAINS FROM MAIN RESERVOIR TO BLOCK RESERVOIRS	
i	Pumping Main - 01	Total length - 78008 m, Sizes - 2500/2400/2200/1000/900 mm Feed to Block reservoirs- E/F/G
ii	Pumping Main - 02	Total length - 77823 m, Sizes - 2800/2300/2200/700 mm Feed to Block reservoirs- C/D/H/I
iii	Pumping Main - 03	Total length - 91906 m, Sizes - 2400/2200/2100/1700/1000/900/700/500mm Feed to Block reservoirs- B/A/J
11	RISING MAINS FROM BLOCK RESERVOIRS TO DIGGIES (10 BLOCKS)	
i	Type of pipe	MS/DI
ii	Pipe sizes	1400 mm MS to 100 mm DI, K-7
iii	Total length	416395 m
12	DISTRIBUTION PIPE LINES FROM DIGGIES TO INDIVIDUAL FARMS	
i	Type and class of pipe	HDPE, PN-6/10
ii	Size of pipe	315 mm- 90 mm Total Length 4630 km
iii	Average length in 1 chak area	18300 m
iv	Total length in all chak areas	4630.00 km
13	ELECTRICALLY OPERATED BUTTER FLY VALVES ON PIPELINES	
i	2000 mm Dia	15 Nos
ii	1800 mm Dia	25 Nos
iii	1500 mm Dia	12 Nos
iv	1200 mm Dia	4 Nos
v	900 mm Dia	11 Nos
vi	800 mm Dia	02 Nos
vii	600 mm Dia	03 Nos
viii	500 mm Dia	73 Nos
ix	300 mm Dia	08 Nos
14	SLUICE VALVES FOR SCOURING	
i	1200 mm Dia	6 Nos
ii	500 mm Dia	82 Nos

S.N.	PARTICULARS	VALUE	
iii	400 mm Dia	23 Nos	
iv	300 mm Dia	46 Nos	
v	200 mm Dia	295 Nos	
vi	150 mm Dia	27 Nos	
vii	100 mm Dia	24035 Nos	
15	KINETIC AIR VALVE with ISOLATING GATE VALVE		
i	300 mm Dia	184 Nos	
ii	250 mm Dia	56 Nos	
iii	200 mm Dia	17 Nos	
iv	150 mm Dia	118 Nos	
v	100 mm Dia	161 Nos	
vi	50 mm Dia	233 Nos	
16	CIVIL WORKS ON PIPE LINE ALIGNMENT		
i	BF Valve Chambers	78 Nos	
ii	Scour Valve Chambers	24521 Nos (RCC-118 and 24403 Brick masonry)	
iii	Air Valve Tower / Pillars	769 Nos	
iv	Thrust Blocks	88 Nos	
17	PIPE LINE CROSSINGS (BELOW GROUND CROSSINGS OF PIPE LINES PROPOSED BY TRENCHLESS METHOD)		
i	Railway Track Crossings	01 No	
ii	NH/SH/MDR Crossings	01 No	
18	INLET CHAMBER AT ENTRY OF BLOCK RESERVOIRS AND DIGGIES		
i	RCC Inlet Chambers (Total)	263 Nos	
19	ELECTRICAL AND POWER SYSTEM FOR PUMPING STATIONS		
i	At Main Reservoir PS	Transformer-20 MVA (4 nos) 33/6.6 KV	Transformer-200 KVA (2 nos) 33/0.415 KV
ii	At Block Reservoir PS	Transformer-2 MVA to 3.5 MVA (2 nos) 33/6.6 KV	Transformer-100 KVA (2 nos) 33/0.415 KV
iii	At Diggies (Reservoirs) PS	Transformer-315 KVA (2 nos) 33/0.415 KV	
20	COMMAND AREA DETAILS		
i	Gross command area (GCA)	121695 ha	
ii	Cultivable command area (CCA)	1,05,000 ha	
iii	Gross Command area in Churu district	39523 ha	
iv	Gross Command area in Jhunjhunu district	82171 ha	
v	Name, number of blocks and villages in Churu	One Rajgarh block-46 villages	
vi	Name, number of blocks and villages in Jhunjhunu district	1 Malsisar -65 2 Surajgarh -36 3 Chirawa -41 4 Jhunjhunu-9	
vii	No of blocks in command area	Ten	
vii	Average CCA of each block command	About 10500 ha	
21	IRRIGATION PLANNING		
i	Average size of chak	400 ha	
ii	Average storage capacity of diggi at each chak	500 cum	
iii	Av land required for diggi	175 sq m	
iv	Proposed Cropping Pattern in Rabi		
a	Mustard	45%, 47250 ha	
b	barley	10%, 10500 ha	
c	Gram	25% 26250 ha	

S.N.	PARTICULARS	VALUE
v	Intensity of irrigation in Rabi and annual irrigation in rabi	80%, 84000 ha
vi	Proposed Cropping Pattern In Kharif	
a	Soyabean	35% 36750
b	Bajra	45% 47250
vii	Intensity of irrigation in kharif and annual irrigation kharif	80% 84000
viii	Total intensity of irrigation and total annual irrigation	160% 168000 ha
ix	Base period forRabi	120 days
x	No of watering and interval	8 waterings of 15 days each
xi	Base period for kharif	30 days
xii	No of watering and interval	2 waterings of 15 days each
xiii	Total irrigation days in a year	150 days
xiv	Water allowance	0.216 cumec/1000 ha of ICA or 3.08 cusec/1000 acre of ICA or 2.464 Cusecs per thousand acre of CCA
xv	System of irrigation	Sprinkler

EXECUTIVE SUMMARY

1. BACKGROUND

Rajasthan is considered as one of the 6 basin states for Yamuna River as Chambal River which flows through Rajasthan is a major tributary to Yamuna. Other 5 states are Haryana, Himachal Pradesh, Delhi, Uttar Pradesh and Uttarakhand. The Government of India has constituted 'Upper Yamuna River Board' (UYRB), 'Upper Yamuna River Committee' (UYRC) and a steering committee for its management. Rajasthan, along with other basin states, is striving for its share in Yamuna water since 1955. Therefore, UYRB took up the task of allocating water to various basin states.

After considering the report of Central Water Commission on availability of water in Yamuna River up to Okhla Barrage, UYRB has allocated the water to various basin states. A Memorandum of Understanding (MoU) was signed on 12.05.1994 among the Chief Ministers of 5 basin states namely- Haryana, UP, Rajasthan, HP and Delhi in the presence of Union Minister for Water Resources. A total water of 11.983 BCM has been allocated amongst the 5 basin states, out of 13.00 BCM virgin flow of Yamuna up to Okhla, considering their irrigation and consumptive water requirements. The basin states agreed on following allocation for utilizable water resources of River Yamuna assessed on mean year availability:

Table 1: Basin states agreed allocation of water from River Yamuna

S. No.	State	Allocation of Yamuna water
1	Haryana	5.730 BCM (6417 Cusecs)
2	Utter Pradesh	4.032 BCM (4515 Cusecs)
3	Rajasthan	1.119 BCM (1253 Cusecs)
4	Himachal Pradesh	0.378 BCM (423 Cusecs)
5	Delhi	0.724 BCM (811Cusecs)
	TOTAL	11.983 BCM (13419 Cusecs)

Para no 7(1) of MoU further contemplates that till storage in the upper reaches of Yamuna River (Kishau Dam, Renuka Dam, Lakhwar-Vyasi Projects) are created, the seasonal allocations among the five basin states shall be as under:-

Table 2: Seasonal allocations among the five basin states

S. No.	States	cusecs (As per MoU)			
		July-Oct.	Nov-Feb	March-June	Annual
1.	Haryana	13647.88	2336.62	3139.25	6416.63
2.	Utter Pradesh	10687.01	1168.31	1584.70	4515.16
3.	Rajasthan	3198.00	238.43	288.12	1253.00

S. No.	States	cusecs (As per MoU)			
		July-Oct.	Nov-Feb	March-June	Annual
4.	Himachal Pradesh	631.38	367.87	268.03	423.30
5.	Delhi	1927.38	231.62	254.62	810.76
	TOTAL	30091.65	4342.15	5534.72	13417.85

Accordingly, Rajasthan has been allocated 3198 cusecs (0.963 BCM) seasonal allocation from July to October. Rajasthan can utilize Yamuna water through two systems:

- From Okhla Barrage through -Agra Canal, Bharatpur Feeder, Gurgaon Canal system to be used in Bharatpur district and
- From Tajewala Head (Hathnikund Barrage) through a conveyance system not yet finalized to Jhunjhunu and Churu districts.

The Upper Yamuna River Board in its twenty second meeting held on 21.12.2001 had approved the claim of Rajasthan for utilization of Yamuna Water through Ex-Tajewala and Ex-Okhla. Following allocations were made at these two points:

i.	Ex-Tajewala (Hathani-Kund Barrage) July -October	1917 cusecs
ii.	Ex-Okhla Barrage	1281 cusecs
	Total	3198 cusecs

These allocations of 1917 cusecs and 1281 cusecs are 60% and 40% of total 3198 cusecs to be drawn from Tajewala Head and Okhala Head respectively.

On the similar principle, the flows of 238.43 cusec and 288.12 cusec in other two seasons have been distributed in a ratio of 60:40 accordingly at Tajewala & Okhla Heads respectively. This is tabulated as below:

Table 3: Seasonal distribution ratio at Tajewala and Okhla heads

S. No.	Season/Months	Total Flow		At Tajewala		At Okhala	
		Cusecs	MCM	Cusecs	MCM	Cusecs	MCM
1	July - Oct	3198	963	1917	577	1281	386
2	Nov - Feb	238.43	70	143	42	95	28
3	March - June	288.12	86	173	52	115	34
	TOTAL		1119		671		448

2. RECENT DEVELOPMENTS

Recently, in the month of August 2018, an MoU has been signed among six partner states, Rajasthan, Himachal Pradesh, Haryana, Uttarakhand, Uttar Pradesh and Delhi for construction of Lakhawar Dam on upstream side of Tajewala Head on Yamuna River. Similarly, two more Dams are also expected to be constructed on upstream side of Tajewala Head. The capacities of these dams are as under:

Table 4: Capacities of Dams

S. No.	Dam	Capacity
1	Lakhawar Dam	330.66 M-CM

2	Renuka Ji Dam	498.00 M-CM
3	Kisau Dam	1324.00 M-CM

The total capacity of the dams, to be constructed on upstream side of Tajewala Head, is 2152.66 M-CM.

The share of Rajasthan in Yamuna Water is 09.34% of the total water, i.e. 671 MCM. It is assumed that 550 MCM of water will be available in 4 months from July to October at Tajewala Head. As 60% of total Yamuna Water is available at Tajewala Head, it can be assumed that 60% of the capacity of proposed dams will also be available here. Therefore, at the same percent rate, remaining 121 MCM of water will be available in a regulated manner from these upstream dams in 8 months from November to June.

As already approved by WRD in preliminary feasibility report (PFR). The total receipt is proposed to be utilized for Irrigation and domestic purpose in a ratio of 40:60. Accordingly net volume of water proposed to be utilized as under:

Table 5: Allocation of Water Available to Different Sectors

S.N.	Particulars	Volume of water in MCM
1	Total water available	671
2	Evaporation losses in storage reservoir @8%	53.68
3	Seepage losses through the reservoir@ 5%	33.55
4	Net water available after evaporation	583.77
5	Water proposed to be utilized for domestic use @60% (as per PFR)	350.26
6	Water proposed to be utilized for irrigation @40%	233.50

3. OBJECTIVES OF THE PROJECT

The share of water in Yamuna River is intended to be made available to Rajasthan from Tajewala Head. Considering conveyance of the water by gravity, geographically, it is feasible to bring it in Churu District of Rajasthan. Hence, it is envisaged that water be brought to Rajasthan in Rajgarh Block of Churu District. From this point, it can be further transmitted to adjoining districts for irrigation and drinking water purpose.

The project envisages extending benefits to following two districts for providing irrigation facilities in about 105,000 hectare area:

- (a) Rajgarh Block of Churu District
- (b) Part of Jhunjhunu District (Parts of Alsisar, Jhunjhunu, Chirawa & Surajgarh Blocks)

The project will also make water available for drinking water purpose in following districts:

- (a) Jhunjhunu District complete
- (b) Part of Sikar District

However, the present DPR comprises the works for transfer of water from Tajewala to

Rajasthan, its storage in a Raw Water Reservoir (RWR) within Rajasthan boundary and then its utilization for irrigation purpose only.

3.1 BRIEF DESCRIPTION OF WORKS PROPOSED

3.1.1 PROPOSED CONVEYANCE SYSTEM TO RAJASTHAN

It is proposed to convey water from Tajewala Head to Rajasthan territory through a system of underground pipelines. It is possible to bring water by gravity as per the available head. The data of RL are as under:-

FRL of western Yamuna canal at RD 900 m (Starting Point)	: 333.425 m
Ground Level at Starting Point near Yamuna Canal	: 331.00 m
Ground Level at End Point near Main Reservoir	: 205.00 m
Finished Min Ground Level at End point	: 208.00 m
FRL of proposed Main RWR at Rajgarh (Raj)	: 219.50 m
Top level of main reservoir	: 221.00 m

There is a static fall of 123.00 m, in the ground level in a total distance of 265 km and a fall of 113.925 m in the water free surface at W Y C at Tajewala Head and Proposed Main RWR at Rajgarh, Churu, Rajasthan. Therefore, the system has been designed as a gravity system with the available head as above.

3.1.2 INTAKE STRUCTURE AT TAJEWALA HEAD

At Tajewala Head, two main canals are off taking, i.e. Western Yamuna Canal and Eastern Yamuna Canal. For Rajasthan, the off take is found suitable from Western Yamuna Canal, which has been remodeled to carry the discharge for 3 of the partner states up to its RD 900 m, having full supply level as 333.425 m. It is proposed to construct an intake structure at this point, with provision of electrically operated steel gates.

3.1.3 CONVEYANCE MAINS

It is proposed to provide 5 rows of 3.2 m / 3.0 m dia. MS pipes with Liquid Epoxy lining on its inner side and Fusion Bonded Epoxy Coating on its outer side to carry discharge of 1827 cusecs (550 M-CUM in July to October) under gravity. The pipe will be laid underground with a clear cover on top of pipe as 2 meters. Two meter space will be left between each row of pipe. A provision of gravel road of 12 meter width on one side of trench has also been kept for facilitating carriage of pipes and other materials and laying and jointing process. Hence, in all about 60 m wide strip of land shall be required, which will be acquired temporarily by compensating for one season crop.

The alignment of the pipelines has been decided keeping in view the shortest possible route cross country avoiding the existing habitations and major installation/developments. The pipelines from Tajewala Head will pass through Yamuna Nagar,

Ladwa, Taraori, Nissing, Rajound, Hissar Cantt, Chaudhariwas and finally enter Rajasthan near village Hansiyawas of Rajgarh Block of Churu District. The total length of the route is about 265 km. Thus, a total of 671 MCM water will be brought through 5 rows of pipelines annually to Rajasthan.

3.2 STORAGE OF WATER AT TERMINAL POINT

Water from Yamuna River shall ultimately reach Rajgarh Block of Churu (Rajasthan) and the same will be stored in an artificial reservoir. The water will be, mainly, received during the period of Monsoon from July to October (four months) and much less quantity in remaining 8 months also, but its utilization will be done throughout the year. Almost 60% of water shall be used for drinking purpose uniformly throughout the year and remaining 40% of water for irrigation purpose in the months of September and November to February. Since there is no significant river system or drainage system available in the area where a dam can be constructed, it will have to be stored in artificially constructed reservoir. It is therefore proposed to construct a reservoir near village Hansiyawas in Rajgarh Block of Churu District, to accommodate volume of water received during different months less drawl for drinking and irrigation and water evaporated from the reservoir during the period,

3.2.1 SITE SELECTION

The water received from Tajewala shall have to be stored in a reservoir; the site of the reservoir is selected at a place where the levels are lowest, so that maximum difference in head is available for the pipe line coming from Tajewala, which is designed as gravity line. Such a suitable site is found in Rajgarh block of Churu district between Hansiyawas village and Thambahera village.

Total 7 no of villages are coming under its submergence; the list of villages is as under:

3.2.2 COMPUTATION OF STORAGE CAPACITY

As mentioned above before computing storage capacity of reservoir, its operation table shall have to be prepared, which can be prepared after monthly drawl for irrigation and domestic use is finalized.

For this purpose, cropping pattern and crop water requirement and CCA shall have to be finalized, which are discussed below

(a) Proposed Cropping Pattern

While selecting cropping pattern, care has to be taken that since water is being brought from Haryana from about 300km distance at a very high cost, the cropping pattern selected is such that it covers maximum area with available water.

(b) Water Allowance

Water Allowance :

Rabi	0.216	cumec/1000 ha	3.08	cusec/1000 acre of ICA	2.46	cs/1000 acre of CCA
Kharif	0.209	cumec/1000 ha	2.98	cusec/1000 acre of ICA	2.39	cs/1000 acre of CCA

The irrigation will be provided by 8 waterings of 15 days each during Rabi period and 2 waterings of 15 days each in kharif period. In all there would be ten watering in 150 days period.

(C) Monthly Drawl

For the purpose of preparing reservoir operation table, monthly drawl shall have to be computed. The monthly drawl for September works out to be 45.68 MCM, and for October to February it is 46.99 MCM. Drawl for PHED would be uniform as 29.18 MCM.

(D) Storage Capacity

Accordingly storage capacity of reservoir works out to be 335 MCM which is available at RL 219.5 M adding 1.5 M free board the top RL works out to be 221M.

3.2.3 EARTHEN EMBANKMENT AROUND RESERVOIR

The earthen embankment around the reservoir is proposed to be 6m wide at top side slopes for u/s and d/s are proposed to be 4:1 and 2:1 respectively. The top RL is proposed to be kept at RL 221m i.e one and half meter above the FRL of reservoir. The overall length of embankment is likely to be 30600 m. The embankment is proposed to be a zoned earthen dam, having a impervious core in centre with top width of 3 m and 0.5:1 side slopes, all types of internal drainage such as 0.9 m thick chimney filter, 1 m thick d/s horizontal filter and 2 m wide and 2 m high rock toe etc. are also proposed. A positive cut off in the form of a cut off trench filled with impervious soil is proposed up to a depth of half of water column to increase the length of seepage line below the foundation. It is apprehended that impervious soil may not be available in near vicinity, hence a lead of 25 km is also proposed. The u/s face would be protected by 23 cm thick stone pitching where ever the depth of water is more than 5 m. The length of embankment where pitching is proposed and cut off trench is proposed would be 20700 mtr. i.e from RD 3000 to 23700 mtr. The d/s slope is proposed to be protected by grass turfing.

3.3 COMMAND AREA PLANNING

The CCA of the project as per availability of water and proposed cropping water works out to be 105000 ha. It is proposed to provide irrigation facility in Jhunjhunu and Churu both districts preferably in a ratio of 67:33. Accordingly the command area is selected in such a way that about 70000 ha is in Jhunjhunu and 35000 ha is in Churu district respectively, adjacent to each other so as to have continuity. While computing CCA out of GCA, areas covered by habitation, Charagah (grazing land), forest area, roads, water bodies etc have

been deducted. For ease in distributing water within command area it is proposed to divide the entire command area of 105000 ha into ten blocks, each block comprising of about 10500 ha CCA. Each block will have a small reservoir. Water from main reservoir will be pumped to block level reservoirs through pipe lines. Each block is proposed to be further divided into chaks having an area of approx. 400 ha. Where a diggi (small reservoir) is proposed to be provided. Water will be pumped to diggies through pipe lines, from where water will be further pumped to cluster of farms having area of 5-8 ha through pipe lines. The terminal of pipes within the chaks will be connected to sprinkler systems to be procured and maintained by farmers. The distribution of pipes within the cluster of 5-8 ha blocks will be maintained by farmers. While fixing boundaries of each block/chak /cluster care has been taken that an individual farm is not divided. Command area is divided in 10 blocks. Each block is named as A, B, C, D, E, F, G, H, I & J.

3.3.1 DISTRIBUTION OF WATER FROM STORAGE RESERVOIR TO COMMAND AREA

(A) Main pump house at storage reservoir

As per Lidar survey conducted it has been observed that the reservoir is located between RL204m to 221-m, whereas the command area is located between RL 274 m to 295 m, as such water from reservoir shall have to be lifted to command area. A pump house shall have to be constructed which will be equipped with requisite number of pumps and motors as per design. The pump house is proposed to be a RCC building, layout plan of the building showing layout of pumps and other accessories etc is attached in drawing volume. The pumps will lift the requisite quantity of water per day and distribute it to each block, where a small block level reservoir is proposed to be constructed. The water from main pump house will be transmitted to each block level reservoir

(B) Transmission mains from MAIN Pump house to block reservoir

The crop water requirement at table above states that the peak requirement is in Rabi season, when total 187.9 MCM water is to be distributed in 120 days, i.e 1.566 MCM per day which works out to be 18.14 cumec. Such huge water cannot be transmitted in one single pipe line. Hence for ease in distribution of water, three main distribution lines are proposed. Two lines will serve three blocks and one line will serve four blocks. These pipe lines will be laid underground. Layout of these main lines is shown in drawing above. Block wise CCA, Discharge required of each block has been decided accordingly and listed below. Discharge requirement for each block. Discharge requirement in each main distribution line shall be computed accordingly, which has been done in next chapter.

(C) Storage reservoir at blocks:

A small sized reservoir is proposed for each block. The storage capacity for each block reservoir is proposed to be equal to four hours pumping capacity, as it is presumed that further lifting of water to chak level daggies would be simultaneous. The storage capacity for each block has been computed and listed below along with their sizes assuming a trapezoidal section having 1.5:1 side slope and 3 m depth of water and plus 0.5 m free board.. The entire reservoir is proposed to be lined with cement concrete in bed and sides

(D) Pump house at Block level reservoirs:

A suitable sized pump house is proposed to accommodate required number of pumps, motors and other accessories, details of which is given in subsequent chapters. The size of pump house building is likely to be 360 sqm, The pump house would be located near to reservoir, most likely in Govt. land, so that no land acquisition is needed for this purpose.

3.3.2 TRANSMISSION OF WATER FROM BLOCK RESERVOIRS TO DIGGIES :

As stated above, each block is proposed to be further divided into chaks having CCA of 400 ha approx. where a small sized diggi (small reservoir) shall be provided. Water from block level reservoir shall be pumped through underground pipe lines to these doggies. Each block will have 25 chaks and 25 diggies. Each chak is named A-1 to A -25 & so on for each block. The discharge required in each diggi will be equal to CCA of the chak multiplied by water allowance. The pipe network is designed accordingly. A small pump house shall be provided at each block reservoir to pump the water further to diggies. Number of pumps required along with motors their capacity and design of pipe network is discussed in next chapter. The pump house building will be RCC building. All the pumps will be electrically operated. Drawing of each block showing chaks and pipe net work is shown in drawing volume of the report. Diggi wise discharge required for each block is as under:

3.3.3 TRANSMISSION OF WATER FROM DIGGIES TO CLUSTER OF FARMS**(A) CONSTRUCTION OF DIGGIES:**

A small sized diggi is proposed to be constructed in each chak of CCA having CCA of approx 400 ha. The storage capacity of each diggi is proposed to be equal to 2 hours discharge. The volume required for each diggi is computed and placed in table below. The diggi is proposed to be trapezoidal in shape having depth as 3 mtr. And side slopes as 1.5:1. The area required for one sample diggi is computed and tabulated below.

(B) PUMPING AND PIPE NETWORK FROM DIGGIES TO CLUSTER OF FARMS:

Water from chak level diggi shall have to be lifted and carried in underground laid pipe line network to serve a cluster of 5-8 ha. Within 5-8 ha cluster the farmer will carry the water to his farm at his level, which will be finally connected to sprinkler network laid within the farm of farmer. Cost of laying pipe network within the cluster of 5-8 ha and within their farm, shall have to be borne by the farmers within the cluster. The pipe network at Govt. Cost will end at 5-8 ha cluster. The discharge of the total chak will be distributed in 13-14 groups/branches. Each branch pipeline will carry discharge proportionate to their area, on average it may vary between 5-6 lps of the total discharge. Hence, 13-14 groups will be served at a time. Each group will serve 5-6 clusters of 5-8 ha. All the clusters with in group will be served by rotational method (warabandi) Drawing showing layout of pipe network up to 5-8 cluster is enclosed in drawing volume. Each individual farotaiona with in a cluster. A small pump house shall be constructed at diggi with electrical connection and solar system of power supply both. A dedicated

power line for providing connections to diggi level pump house shall have to be erected. (Details of which are given in subsequent chapters). It is further proposed that Govt. will bear the capital cost of installing pumps and pipe network up to cluster of 5-8 ha, but entire O &M shall have to be borne by the WUAS to whom the system will be handed over after completion of the project. The cost of providing sprinkler systems and O&M of sprinkler systems within 5-8 ha block will be borne by group of farmers within the clusters.

(C) ROTATIONAL METHOD OF SUPPLY (WARABANDI)

Water from diggi to individual cluster of farms will be supplied by rotational method i.e the entire water carried by the pipe will be delivered to one cluster of farms at a time. Stop valves shall be provided for each cluster of farms. To begin with all the valves shall remain closed, at a time only one valve will be opened for a cluster, which will be closed after his time is over, then the next valve will be opened and so on till entire clusters within the chak are served, but his time duration will be fixed which will be so calculated that entire clusters within the chak are served in 15 days, so as to complete one cycle of watering. During the base period of 120 days, there would be eight watering during Rabi season and two watering during kharif season in a base period of 30 days. The warabandi will be managed by the WUAs.

3.4 PUMPING STATIONS:

It is proposed to install pumping sets at Main Reservoir to pump water to Block Reservoirs in the command area in Churu and Jhunjhunu Districts. Also the pumping sets are to be installed at Block Reservoirs (10 No's) and at Diggies (total 253 No's). The details of the pump sets are as under:-

Table 6: Proposed Pumping System

S No	Location	Type of pump set	Discharge Q (LPS)	Head m	No's W + S = Total	KW of each pump
1	Main Reservoir					
1.1	PM-01	Sub. centrifugal	5379	110.00	12.00	925
1.2	PM-02	Sub. centrifugal	7296	107.00	15.00	975
1.3	PM-03	Sub. centrifugal	5469	113.00	12.00	960
2	Block Reservoir- A	Sub. centrifugal	1826	58	9	315
3	Block Reservoir- B	Sub. centrifugal	1792	51	8	315
4	Block Reservoir- C	Sub. centrifugal	1800	51	8	315
5	Block Reservoir- D	Sub. centrifugal	1841	45	6	315
6	Block Reservoir- E	Sub. centrifugal	1762	40	6	315
7	Block Reservoir- F	Sub. centrifugal	1813	40	6	315
8	Block Reservoir- G	Sub. centrifugal	1787	50	8	315
9	Block Reservoir- H	Sub. centrifugal	1834	62	9	315
10	Block Reservoir- I	Sub. centrifugal	1858	48	8	315
11	Block Reservoir- J	Sub. centrifugal	1837	41	6	315
12	Diggies (253 Nos)	HSC	75	55	2 x 253	75

3.5 PUMPING MAINS:

The water of Rajasthan share from Yamuna River will be received near Hansiyawas village in Rajgarh Block of District Churu and same would be stored in an artificial Reservoir of capacity 333 M-Cum. For utilization of this water for Irrigation purpose, it will be pumped to the Cultivable Command Area up to the farms through pipe lines as under :-

- A. Pumping Mains from Main Reservoir to Block Reservoirs
- B. Pumping Mains from Block Reservoirs to Diggies
- C. Pumping Line from Diggies to Farms for application in crops

The detailed planning, design and other aspects of these pumping mains has been narrated in the below mentioned paragraphs.

3.5.1 PUMPING MAINS FROM MAIN RESERVOIR TO BLOCK RESERVOIRS:

As discussed in previous chapters, the command area is about 60 Kilometers away from the location of Main Reservoir in Rajgarh Block. The total command area of 1,05,000 hectare has been divided into 10 blocks of about 10,500 hectare each. These blocks have been named as - A, B, C, D, E, F, G, H, I, J. It has been planned to lay three pumping mains from Main Reservoir to Block Reservoirs. Two pipe lines will provide water to 3 Block Reservoirs each and third pipe line to 4 Block Reservoirs. The data has been tabulated as under:-

Table 7: Detail of Pumping Mains from Main Reservoir to Block Reservoirs

S. N.	Name of Pumping Main	Pumping Main		Length (M)	Discharge (KLD)	Discharge (LPS)	Levels	
		From	To				Start Point (M)	End Point (M)
1	PM- 01	Main Reservoir	JN- 1	37253	464753.56	5379.09	211.00	247.00
		JN- 1	JN-2	16542	464753.56	5379.09	247.00	268.00
		JN- 2	JN-3	6535	153777.28	1779.83	268.00	267.80
		JN- 3	BR- E	1665	153777.28	1779.83	267.80	267.00
		JN- 2	BR- F/G	16013	310976.28	3599.26	268.00	291.00
2	PM- 02	Main Reservoir	JN- 4	54664	630408.71	7296.40	211.00	267.00
		JN- 4	BR- C/D	483	314925.23	3644.97	267.00	262.50
		JN- 4	JN- 5	18863	315483.48	3651.43	267.00	270.53
		JN- 5	BR- H/I	3813	315483.48	3651.43	270.53	288.00
3	PM- 03	Main Reservoir	JN- 6	63216	472549.16	5469.32	211.00	271.00
		JN- 6	JN-7	167	155345.95	1797.99	271.00	266.50
		JN-7	BR- B	299	155345.95	1797.99	266.50	264.00
		JN-6	JN-8	5943	317203.21	3671.33	271.00	268.72
		JN-8	JN-9	3646	317203.21	3671.33	268.72	265.00
		JN-9	JN-10	2550	157233.88	1819.84	265.00	267.96
		JN- 10	BR- A	751	157233.88	1819.84	267.96	278.00
JN-9	BR- J	15334	159969.33	1851.50	265.00	286.00		

S. N.	Name of Pumping Main	Pumping Main		Length (M)	Discharge (KLD)	Discharge (LPS)	Levels	
		From	To				Start Point (M)	End Point (M)
TOTAL				247737	5016423.43			
Design Discharge in Each Line is as below :								
1	PM- 01	4,64,753.56	KLD					
2	PM- 02	6,30,408.71	KLD					
3	PM- 03	4,72,549.16	KLD					

3.6 DESIGN PARAMETERS

The following parameters have been considered in the design of the pumping mains from Main Reservoir to Block Reservoirs:-

- Formula for Head Loss Modified Hazen William's Formula
- Value of C for MS Pipes 1
- Design Period 50 Years
- Rate of Interest 10 %
- Life of MS Pipe line More than 50 Years
- Life of Pumping Sets 25 years
- Rate of Pipes per metre Enclosed
- Rate of Pumping Sets- Present Rs. 8,000 per KW

3.7 DESIGN OF PUMPING MAINS

On the basis of above parameters and the assumptions the economical sizes of pumping mains have been worked out as under:-

Table 8: Pumping Mains from Main Reservoir to Block Reservoirs

Name of Pumping Main		Pumping Main		Length (M)	Discharge (KLD)	Pipe Line Sizes		
		From	To			Type	Diameter (mm)	Thickness (mm)
PM-01	1	Main RES.	JN-1	37253	464753.56	MS	2500	18/15/13/12
	2	JN-1	JN-2	16542	464753.56	MS	2400	11
	3	JN-2	JN-3	6535	153777.28	MS	1000	5
	4	JN-3	BR-E	1665	153777.28	MS	900	4
	5	JN-2	BR-F/G	16013	310976.28	MS	2200	10
PM-02	1	Main RES.	JN-4	54664	630408.71	MS	2800	21/18/16/13
	2	JN-4	BR- C/D	483	314925.23	MS	700	4
	3	JN- 4	JN-5	18863	315483.48	MS	2300	11
	4	JN-5	BR-H & I	3813	315483.48	MS	2200	10

Name of Pumping Main		Pumping Main		Length (M)	Discharge (KLD)	Pipe Line Sizes		
		From	To			Type	Diameter (mm)	Thickness (mm)
PM-03	1	Main RES.	JN-6	63216	472549.16	MS	2400	18/16/14/11
	2	JN-6	JN-7	167	155345.95	MS	700	4
	3	JN-7	BR- B	299	155345.95	MS	500	4
	4	JN-6	JN-8	5943	317203.21	MS	2200	10
	5	JN-8	JN-9	3646	317203.21	MS	2100	10
	6	JN-9	JN-10	2550	157233.88	MS	1000	5
	7	JN-10	BR- A	751	157233.88	MS	900	4
	8	JN-9	BR- J	15334	159969.33	MS	1700	8
TOTAL					5016423.43			

3.8 PUMPING MAINS FROM BLOCK RESERVOIRS TO DIGGIES

The Block of about 10,500 Hactare area has been divided into 25 Chaks of about 400 Hactares areas. For storage of water for the Chak area, a Diggi has been proposed in each Chak area. Pumping Main to Chak Reservoirs (Diggies) has been designed with the assumption of 24 Hr supply to Diggies and most economical sizes of pipe sections have been selected. The details of pipe sizes and lengths for all Blocks are as under:-

Table 9: Detail of Pumping Mains from Block Reservoirs to Diggies

S. No.	Name of Block	Details of Pipes		Total Length (m)	Remarks
		Type	Size (mm)		
1	Block- A	DI & MS	100 mm - 1200 mm	37645	
2	Block- B	DI & MS	150 mm - 1200 mm	36974	
3	Block- C	DI & MS	100 mm - 1200 mm	38310	
4	Block- D	DI & MS	150 mm - 1200 mm	43394	
5	Block- E	DI & MS	150 mm - 1200 mm	43808	
6	Block- F	DI & MS	150 mm - 1200 mm	45181	
7	Block- G	DI & MS	150 mm - 1200 mm	40564	
8	Block- H	DI & MS	150 mm - 1200 mm	46105	
9	Block- I	DI & MS	150 mm - 1200 mm	48174	
10	Block- J	DI & MS	100 mm - 1000 mm	36240	
TOTAL				416395	

3.9 PUMPING MAINS FROM DIGGIES TO INDIVIDUAL FARMS:

Pipe Lines have been proposed from Diggies to individual farms of Farmers in the command area for watering of the particular crops in each month in rotational manner.

The pipe lines from Diggies to Farms have been designed for one chack area in each Block (10 No's). An average length of each size of the pipe lines has been adopted for estimating the total pipe lines of all the 253 No's of Chack Areas in complete Command Area. Following are the main points / assumptions in the design of pipe lines from Diggies

to Farms:-

1. Each diggi covers an average area of 400 Ha. The set of pumps will pump the water to entire pipe network in the chak area. The layout of pipe line network has been so planned that a group of farmers in an average area of 25-30 Ha will be provided continuous 24 hrs water supply at the rate of full demand of this group i.e. $27.5 \times 0.8 \times 0.216 = 4.752$ lps or 5 lps water . These groups have been shown in different colors in the drawing.
2. The Head at most distant terminal point has been kept as 30 m so as to keep at least 30 m terminal pressure in the pipes, to be laid in the farms of individual farmers.
3. The farmers in each group will be provided water on rotation basis with a time period depending upon their area of farms.
4. The farmers have to use their own pipes of 90 mm dia of HDPE from the nearest passing network up to the hydrant in his farm.
5. The HDPE PN6 PE100 pipes have been used and the internal diameters for design purpose has been used as per specifications of HDPE Pipes as per relevant IS.
6. There are about 253 diggies in 10 chaks of 400 Ha. Out of these 1 diggi network of each chak has been hydraulically designed i.e. 10 Diggi area network have been analyzed. The details of pipe length and pump head & discharge requirement is as below :-

Table 10: Average Pipe Length in meter

Outer Dia	Internal Dia	A01	B11	C20	D15	E06	F18	G25	H06	I07	J01
90mm	81.10	3666	1704	238	3003	193	119	475	598	990	2478
110mm	99.30	11826	9832	8406	9738	9893	7653	6113	10762	12016	9055
160mm	144.40	1629	953	2826	1993	934	2550	2458	2735	1306	2111
200mm	180.60	0	2075	3045	1103	1763	1288	1906	362	1829	2549
250mm	225.80	1439	1026	316	1055	834	225	2055	614	795	1432
315mm	284.50	1004	977	156	126	652	1192	915	516	421	386
Grand Total		19564	16567	14987	17018	14269	13027	13922	15587	17357	18011

Table 11: Pump Duty condition

Diggi	A01	B11	C20	D15	E06	F18	G25	H06	I07	J01
Head m	47.05	53.71	41.30	44.30	51.27	41.91	54.85	42.71	50.01	50.89
Discharge lps	69.18	71.40	71.55	70.04	69.78	72.14	71.60	72.79	73.60	72.29

7. In view of the above analysis for estimating purpose of cost of pipe lines for chaks following quantities have been adopted

Table 12: Average quantities of pipelines adopted for chaks

Outer Dia	Average length (m)	Adopted Quantity(m)
90mm	1346	1500
110mm	9529	10000

160mm	1949	2000
200mm	1592	1600
250mm	979	1000
315mm	634	1000
	16030	16100

8. The Pump duty condition may also be taken as 75 lps and 55 meter head for all 253 diggies. The details of pipe sizes and lengths etc are as under :-

Table 13: Detail of pumping mains from Diggies to Farms

S. No.	Name of Block	Total No. of Diggies in Blocks	Details of Pipes		Total Length (Km)	Remarks
			Type	Size (mm)		
1	Block- A to J (10 Nos)	253	HDPE, PN- 6/10	315	253	
				250	253	
				200	405	
				160	506	
				110	2530	
				90	380	
			Total		4327.00 Km	

4. SURGE PROTECTION SYSTEM:

The Pumping and Rising Mains will have to be provided with proper surge protection devices to keep the pipe and valves protected against any damaging surges in water pressure at the time of sudden closure of pumping stations.

4.1 DESIGN OF CONTROL SYSTEM

4.1.1 SURGE PROTECTION & AIR RELEASE SYSTEM (FOR GRAVITY MAINS)

Being a Gravity pipeline, the surge/ water hammer shall not be a critical feature in the Transmission Mains from Tajewala Head to Main RWR in Rajasthan. However, the Transmission Line shall behave in a very different manner at the time of its initial filling with water during commissioning and every time after its closure due to any reason. This phenomenon shall take place due to huge amount of air to be released at the time of water filling and entry of huge quantity of air at the time of closure of the system.

Design of the surge protection and air release system has been done and accordingly following surge control devices have been proposed in the project. Additional air valves have been proposed in the alignment of Transmission Main for protection of surge and safe release/ entry of air.

Table 14: Provisions for Surge Protection & Air Release system

Vacuum Release Valve	45 Nos.
Vacuum Breaker	163 Nos.

4.1.2 SURGE PROTECTION SYSTEM FOR PUMPING MAINS:

Surge analysis for the Pumping and Rising Mains and design of the surge control systems is to be done so as to ensure that:

- the maximum residual surge shall be restricted to 10% of the maximum surge which would have developed without the surge control devices at any point in the pipeline or 10% of the design pump head, whichever is more; and
- the vacuum pressure developed in the pipeline at any place shall be restricted to -3 m (minus 3 meters); and
- The surge protection system provides adequate protection against damage for the valves, pipe delivery systems and pumps.

The work of Surge analysis and recommendations for protection system has been assigned to M/s Shridhan International Pvt Ltd Bangalore. The report shall be submitted separately. A tentative provision of Rs. 10.00 Cr has been taken in the estimated cost for the same.

5. CATHODIC PROTECTION SYSTEM:

All underground MS pipelines for this project shall be protected by impressed current Permanent Cathodic Protection system using Hi Silicon anodes and Rectifier units. All the anodes shall be connected with tail cables to an Anode Junction box and the Rectifier positive terminal by a header cable from the junction box common bus bar. Test Stations installed along the entire route of the pipeline during Temporary CP system shall be utilized for monitoring of the pipeline potential. Permanent CuSo_4 reference cells shall be installed near the cathode drainage point and connected to the Rectifier unit control circuit for automatic control of the system. Pipe to cable connection shall be made by Thermal Welding as per approved procedure. The underground section of delivery pipes from pumps and the raw water header pipes shall be protected by a separate sacrificial anode system. Insulation flanges shall be provided at the entry point of underground section of the five nos. carrier pipes from the Intake Structure at Tajewala Head and at the above ground portions at the River/ Stream Crossings of the pipes. The permanent C.P. system shall be commissioned as per the above criteria.

The work of CATHODIC PROTECTION SYSTEM and recommendations for protection system has been assigned to M/s CEEPEE TECHNICAL SERVICES, MUMBAI. The report shall be submitted separately. A tentative provision of Rs. 10.00 Cr has been taken in the estimated cost for the same.

6. POWER SUPPLY SYSTEM:

The supply of uninterrupted/tripping free power to the system is essential and the supply system has been designed accordingly. The issue of power supply has been discussed with the local JDVVNL/AVVNL & RVPNL to identify the GSS and Power line feeders. As per discussions with JDVVNL/AVVNL & RVPNL authorities and the power map available on web site, the following system seems to be feasible and likely to be adopted; this however will depend upon the final feasibility from JDVVNL/AVVNL & RVPNL authorities.

Table 15: Proposed Demand at Pumping Stations

S. N.	Pumping Station	Location	Installed Load (KW)	Operating Load (KW)	Demand (KVA)	Demand (MVA)
					(Tentative)	(Tentative)
1	Pump House at Main Reservoir	Near Village Ramsara Teeba, Rajgarh, Churu	37645	25030	40000	40.00
2	Block Reservoir- A	Village- Vijayapura, block- Rajgarh, Churu	3035	1990	3150	3.15
3	Block Reservoir- B	Village- Khabarpura, block- Rajgarh, Churu	2720	1675	2500	2.50
4	Block Reservoir- C	Village- Neema, block- Rajgarh, Churu	2720	1675	2500	2.50
5	Block Reservoir- D	Village- Neema, block- Rajgarh, Churu	2090	1360	2000	2.00
6	Block Reservoir- E	Village- Bhainsali, block- Rajgarh, Churu	2090	1360	2000	2.00
7	Block Reservoir- F	Village- Jherli, block- Surajgarh, Jhunjhnu	2090	1360	2000	2.00
8	Block Reservoir- G	Village- Jherli, block- Surajgarh, Jhunjhnu	2090	1360	2000	2.00
9	Block Reservoir- H	Village- Alsisar, block- Malsisar, Jhunjhnu	2090	1360	2000	2.00
10	Block Reservoir- I	Village- Tigiyas, block- Chirawa, Jhunjhnu	3035	1990	3150	3.15
11	Block Reservoir- J	Village- Tigiyas, block- Chirawa, Jhunjhnu	2090	1360	2000	2.00
12	At Diggis (253 No's)	In all 10 Blocks	180	90	250	

Table 16: Proposed Power Feeder from Nearest Source

S.N.	Location of Block Level Pump Houses	Nearest Sub Stations	Distance in Km
1	Main Reservoir (Near Village Ramsara Teeba, Rajgarh, Churu)	220/132 KV GSS at Bhadra	40
2	Block level Reservoir -A (Village- Vijayapura, block- Rajgarh, Churu)	Malsisar	10
3	Block level Reservoir -B (Village- Khabarpura, block- Rajgarh, Churu)	Chand Gotni	15
4	Block level Reservoir -C+D (Village- Neema, block- Rajgarh, Churu)	Chand Gotni	8.5
5	Block level Reservoir -E (Village- Bhainsali, block- Rajgarh, Churu)	Chand Gotni	9
6	Block level Reservoir -G+F (Village- Jherli, block- Surajgarh, Jhunjhnu)	Chand Gotni	7
7	Block level Reservoir -J (Village- Alsisar, block- Malsisar, Jhunjhnu)	Malsisar	5
8	Block level Reservoir -H+I (Village- Tigiyas, block- Chirawa, Jhunjhnu)	Chand Gotni	7.5

S.N.	Location of Block Level Pump Houses	Nearest Sub Stations	Distance in Km
9	At Diggis (253 No's)	Nearest Source to diggi	

*The above description is based on power map available and subject to submission of feasibility report and cost estimate by RVPNL.

Table 17: Details of pumping station equipments

SN	Particulars	Item Description
1	Main Pump House at RWR	
1.01	Motor Details	6.6 KV, Submersible Type
1.02	Quantities	PM-01 (8 Working+4 Standby)- 925 KW PM-02 (10 Working+5 Standby)- 975 KW PM-03 (8 Working+4 Standby)- 960 KW
1.03	Main Transformer Rating	20 MVA,33/6.6 KV,ONAN with OLTC
1.04	Quantities	4 Nos
1.05	Auxiliary Transformer Ratings	200 KVA, 33/0.433 KV,ONAN
1.06	Quantities	2 Nos
1.07	Connected Load	37.64 MW
1.08	Operating Load	25.03 MW
2	Block level Reservoir -A	
2.01	Motor Details	315 KW, 6.6 KV, Submersible Type
2.02	Quantities	6 Working+3 Standby
2.03	Main Transformer Rating	3.15 MVA,33/6.6 KV,ONAN with OLTC
2.04	Quantities	2 Nos
2.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
2.06	Quantities	2 Nos
2.07	Connected Load	3.035 MW
2.08	Operating Load	1.99 MW
3	Block level Reservoir -B	
3.01	Motor Details	315 KW, 6.6 KV, Submersible Type
3.02	Quantities	5 Working+3 Standby
3.03	Main Transformer Rating	2.5 MVA,33/6.6 KV,ONAN with OLTC
3.04	Quantities	2 Nos
3.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
3.06	Quantities	2 Nos
3.07	Connected Load	2.72 MW
3.08	Operating Load	1.675 MW
4	Block level Reservoir -C	
4.01	Motor Details	315 KW, 6.6 KV, Submersible Type
4.02	Quantities	5 Working+3 Standby
4.03	Main Transformer Rating	2.5 MVA,33/6.6 KV,ONAN with OLTC
4.04	Quantities	2 Nos
4.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
4.06	Quantities	2 Nos
4.07	Connected Load	2.72 MW
4.08	Operating Load	1.675 MW
5	Block level Reservoir -D	
5.01	Motor Details	315 KW, 6.6 KV, Submersible Type
5.02	Quantities	4 Working+2 Standby
5.03	Main Transformer Rating	2.0 MVA,33/6.6 KV,ONAN with OLTC
5.04	Quantities	2 Nos
5.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
5.06	Quantities	2 Nos
5.07	Connected Load	2.09 MW
5.08	Operating Load	1.36 MW

SN	Particulars	Item Description
6	Block level Reservoir -E	
6.01	Motor Details	315 KW, 6.6 KV, Submersible Type
6.02	Quantities	4 Working+2 Standby
6.03	Main Transformer Rating	2.0 MVA,33/6.6 KV,ONAN with OLTC
6.04	Quantities	2 Nos
6.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
6.06	Quantities	2 Nos
6.07	Connected Load	2.09 MW
6.08	Operating Load	1.36 MW
7	Block level Reservoir -F	
7.01	Motor Details	315 KW, 6.6 KV, Submersible Type
7.02	Quantities	4 Working+2 Standby
7.03	Main Transformer Rating	2.0 MVA,33/6.6 KV,ONAN with OLTC
7.04	Quantities	2 Nos
7.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
7.06	Quantities	2 Nos
7.07	Connected Load	2.09 MW
7.08	Operating Load	1.36 MW
8	Block level Reservoir -G	
8.01	Motor Details	315 KW, 6.6 KV, Submersible Type
8.02	Quantities	5 Working+3 Standby
8.03	Main Transformer Rating	2.5 MVA,33/6.6 KV,ONAN with OLTC
8.04	Quantities	2 Nos
8.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
8.06	Quantities	2 Nos
8.07	Connected Load	2.72 MW
8.08	Operating Load	1.675 MW
9	Block level Reservoir -H	
9.01	Motor Details	315 KW, 6.6 KV, Submersible Type
9.02	Quantities	6 Working+3 Standby
9.03	Main Transformer Rating	3.15 MVA,33/6.6 KV,ONAN with OLTC
9.04	Quantities	2 Nos
9.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
9.06	Quantities	2 Nos
9.07	Connected Load	3.035 MW
9.08	Operating Load	1.99 MW
10	Block level Reservoir -I	
10.01	Motor Details	315 KW, 6.6 KV, Submersible Type
10.02	Quantities	4 Working+2 Standby
10.03	Main Transformer Rating	2.0 MVA,33/6.6 KV,ONAN with OLTC
10.04	Quantities	2 Nos
10.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
10.06	Quantities	2 Nos
10.07	Connected Load	2.09 MW
10.08	Operating Load	1.36 MW
11	Block level Reservoir -J	
11.01	Motor Details	315 KW, 6.6 KV, Submersible Type
11.02	Quantities	5 Working+3 Standby
11.03	Main Transformer Rating	2.5 MVA,33/6.6 KV,ONAN with OLTC
11.04	Quantities	2 Nos
11.05	Auxiliary Transformer Ratings	100 KVA, 33/0.433 KV,ONAN
11.06	Quantities	2 Nos
11.07	Connected Load	2.72 MW
11.08	Operating Load	1.675 MW
12	Diggi's (253 No's)	

SN	Particulars	Item Description
12.01	Motor Details	75 KW, .415 KV, HSC Type
12.02	Quantities	1 Working+1 Standby
12.03	Main Transformer Rating	250 KVA, 11/0.415 KV, ONAN with OLTC
12.04	Quantities	2 Nos, at each Diggi Pump House
12.05	Connected Load	180 KW
12.06	Operating Load	90 KW

6.1 ELECTRICAL DISTRIBUTION SYSTEM

132/33 KV GSS shall be constructed near Bhadra. This GSS shall receive the Power from 220/132 GSS at Bhadra shall feed power to 33/6.6 KV sub station. 33/6.6 KV Partly Indoor/Partly Outdoor type substations shall be proposed to be constructed adjacent to all the Main Pumping Stations and from these substations power shall be fed to 6.6 KV Switchboard. The Fault Level at 6.6 KV system shall be 750 MVA.

6.1.1 MAIN PUMPING STATIONS

33 KV power shall be fed to 4 nos of 20 MVA, 33/6.6 KV transformers, which in turn shall feed the power to 6.6 KV Indoor type Switchboard. 100 % redundant transformers are proposed to feed an entire load of Main Pumping Station.

The 6.6 KV Switchboard shall have two Incomer VCBs with one coupler VCB. The switchboard shall have outgoing VCBs for Vacuum contactor panels for Main pump house motors. The transformers shall be selected in such a way that in normal operation each transformer shall have 50% load and bus coupler shall remain in open condition. In case of failure of one transformer the other transformer shall be able to cater entire load of the plant with bus coupler in close condition.

Two nos of 33/0.433 KV auxiliary transformers shall be provided to feed 415 Volts power supply to MOVs, EOT, Control & Instrumentation panel and lighting etc.

6.1.2 BLOCK LEVEL PUMP HOUSE

33 KV power shall be fed to 2 nos of 33/6.6 KV transformers (Details Given above **pumping station equipments**, table) which in turn shall feed the power to 6.6 KV Indoor type Switchboard. 100 % redundant transformers are proposed to take complete load of Main Pumping Station.

The 6.6 KV Switchboard shall have two Incomer VCBs with one coupler VCB. The switchboard shall have outgoing VCBs for Vacuum contactor panels for Main pump house motors. The transformers shall be selected in such a way that in normal operation each transformer shall have 50% load and bus coupler shall remain in open condition. In case of failure of one transformer the other transformer shall be able to cater entire load of the plant with bus coupler in close condition.

6.1.3 DIGGIES PUMP HOUSE

For each Diggi (253 No's) 11 KV Over Head Dedicated Transmission Line shall be laid along with 250 KVA, 11/0.433 KV Transformer and shall be connected to switch board panel of

the pump houses.

7. SOLAR POWER SYSTEM:

7.1 SITE ANALYSIS

Proposed site is based in Churu- Jhunjhunu districts of Rajasthan. Rajasthan is located in the sunny belt of India. As per Ministry of New and Renewable Energy (MNRE), Government of India (Gol), the country receives solar energy equivalent to more than 5,000 trillion kWh per year with a daily average solar energy incident over India which varies from 4.0 to 7.0 kWh/m² depending upon the location. Hot and Dry climatic regions have the best solar radiations in the country with around 300 sunny days; which makes this region very appropriate location for harnessing solar energy and with average Solar radiation for the site as 5.26 kWh/m²/day. It is, therefore, suggested that the proposed location is most appropriate for high yielding solar power project.

7.2 ESTIMATION OF SOLAR POWER PLANT

Annual average power required for the proposed pump house is 227844 MWh, for which annual electricity charges (cost) will be approximately Rs.109 Cr. To counter such heavy annual power charges, solar power plant of 150 MW capacity is proposed with an expected annual power generation as 263535 MWh.

7.3 PV TECHNOLOGY

The selected area for the proposed solar power generation shall be used to reduce overall power consumption charges on the pumping stations, reduction in the emission of carbon in the atmosphere and to minimize evaporation losses of water from reservoir. It has been noticed that the selected location satisfies most of the essential requirements for setting up a Solar power generation Plant to achieve above noted benefits.. Few advantage of using floating PV technology consists of no loss of valuable land space, reduces evaporation of water from reservoirs and solar panel perform better due to proper ventilation.

7.3.1 MAIN FEATURES OF PLANT

⇒ Plant capacity	: 150 MW
⇒ PV Module Type	: Si Poly modules
⇒ PV Modules Required (area)	: 8, 95,546 m ² or 0.895546 Km ²
⇒ Total Area Required**	:10,00,000 m ² or 1.0 Km ² (approx)
⇒ Annual Gross Output	: 263535 MWh
⇒ Annual Captive Consumption	: 96104 MWh
⇒ Annual Energy injected to Grid	:167430 MWh
⇒ Annual Energy From Grid	:131740 MWh
⇒ Miscellaneous PV array losses	:1-3 %

- ⇒ Miscellaneous power conditioning losses :1 %
- ⇒ Expected CUF :19-20 %
- ⇒ Project PR :80.75%

8. Field Instrumentation and SCADA

Supervisory control and data acquisition (SCADA) has been proposed for effective control and monitoring of the system during operation and maintenance period (O&M). SCADA is a combination of Hardware & Software and SCADA allows to monitor and gather-time data locally as well as from remote.

A Master Control Centre shall be established in the premises of Main Pump House and it shall receive the data/signals from various control centres. The various control centres shall have all the hardware and software to meet the requirements of SCADA along with all the field instruments.

The Master Control Centre (MCC) shall be subordinated by Zonal Control Centre (ZCC), Subsidiary Control Centre (SCC) and Local Control Centre (LCC).

Project Covers a length of about 325 km from Tajewala Head to Command Area with control points at Tajewala Head, Main RWR at Churu, Block Reservoirs (10 nos.) and 253 Diggies

8.1 FUNCTIONS OF MCC

- To monitor & the withdrawals of water from Tajewala source throughout the year
- To monitor the overall distribution of water demand

8.2 FUNCTION OF THE ZCC

- To control & monitor of Raw Water Pumps
- To control & monitor of water quantity/flow up to Block Level
- To implement cuts in water supply effectively as and when necessary

8.3 FUNCTIONS OF SCC

- To control & monitor of Block Level Pumps
- To control & monitoring of water quantity distributed from block level pump house to diggies
- Monitoring of pressure on trunk mains and inlet mains

8.4 FUNCTIONS OF LCC

- To control & monitor of pumps for Diggi

- To maintain the pressure

The project basically consists of following major subsystems

- Instrumentation System
- Telemetry System
- SCADA System

9. LAND ACQUISITION & R8R

According to subsection (1) of Section 2 of the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013, the Government can acquire land for its own use, hold and control, including for Public Sector Undertaking and for public purpose, and Public purpose includes **Infrastructure projects**.

The list of infrastructure projects, as notified by the Department of Economic Affairs, Ministry of Finance, Government of India (Notification No. F. No. 13/6/2009-INF dated 07.10.2013), includes both **Water Supply Pipelines & Irrigation (Dams, Channels, embankments etc.)** as one of the infrastructure sub-sectors under the Water & Sanitation category.

The Land area to be acquired is the bare minimum area to be acquired with Minimum displacement and minimum loss of crops and efforts are taken towards minimizing loss of Permanent structures. Therefore the Project Planning & Screening Stage aims to minimize the social impact by involving only the Land parcels.

The Scope of Land Acquisitions for Private Khatedari aims to propose land requirements either temporarily as per the Rights of Way or permanently as per the RFCTLARR Act 2013. There have been both the Government & Private Entitle holders as per the Rights of Records available. Largely all the Private entitle holders have a Joint Ownership.

The various sub-projects for which the displacements on the basis of time is given below:

Table 18: On the basis of the Duration of Land Displacement/Acquisition:

Temporary: One Crop Season	Permanent Acquisition
<p>1. State of Haryana: Temporary one crop season for Laying of the Underground Conveyance System for the 60.8 m width.</p> <p>2. State of Rajasthan: For laying of the Underground Conveyance System 60.8 m width.</p> <p>Rajasthan : For laying of the Main pumping lines (Before Command and within Command),</p>	<p>1. <u>Maintenance Roads :</u></p> <p>Haryana- Required permanently (approx. with a 7.5 m Width from the 60.8 m width) for Underground Conveyance System from Tajewala, Haryana to Churu District (for Maintenance & Laying Pipelines).</p> <p>Also Permanent requirement for Land spaces for components requiring permanent installation viz. the Butterfly, Scour, Air Valves within the 60.8 m width</p>

Temporary: One Crop Season	Permanent Acquisition
<p>Transmission Pipelines from Block Heads to Diggis & further Distribution Pipe line for the 253 <i>Chacks</i> spread across the Command Area.</p>	<p>along the linear project.</p> <p>Rajasthan-Required permanently (approx. with a 7.5 m Width from the 60.8 m width of temporary displacement) for Underground Conveyance System entering in Dhanothi Choti, District Churu (Approx. 3.0 km length required for Maintenance & Laying Pipelines) including Permanent Land spaces for components viz. the Butterfly, Scour, Air Valves within the 60.8 m width along the linear project.</p> <p>Required permanently (approx. with a 7.5 m Width from the 40.0 m width of temporary displacement) for Laying of Main Pumping Supply Line System from Pump House in Churu towards Command Point and further remaining Pumping Line Main from Command point to respective Block Heads the same 7.5 m width of Maintenance road is required from the 20.0 m width of Individual Pipeline within the Command Area.</p> <p>Also approx. a 3.5 m width of Road is required for maintenance and laying of the Transmission Lines from Block heads to Diggis from the 10.0 m width of temporary displacement.</p> <p>2. Reservoirs :</p> <p>Main Reservoirs & Pumphouse: Required for the Submergence Area in District Churu.</p> <p>Block Reservoirs & Offices with residential premises: Required for the Submergence Area in District Churu & Jhunjhunu within the Command Area.</p> <p>Diggis with WUA Offices: Required for the Submergence Area in District Churu & Jhunjhunu both within the Command Area.</p> <p>3. Offices & Residential Premises: Proposed at Government Lands Near Jhunjhunu City (Nayasar) & Sidhmukh, Churu for Superintending & Executive Engineer's, and their Staffs, Offices & Residential premise.</p>

The Basis of Calculations for Compensation towards proposed Land Acquisition have been undertaken as per the First Schedule of the RFCTLARR Act, 2013. The components that constitute the approximate package to be given to those whose land is proposed to be required for both temporarily & permanently as per Records of Rights are as follows:

- i. The Market Value of the Land: Although the Applicable (DLC rate/Average Sales price/ Consented amount, whichever is higher) Rate for land value to be incorporated as per Section 26 of the act, shall be on the date on which the notification has been issued under Section 11, However for calculations the Latest DLC rates were considered for the each village / nearest available village for reaching to an Estimated cost of Value of Land and therefore may differ as per the time & specifications during implementation.
- ii. The Factor: The applicable Factor for Main RWR Land Parcels & Pumphouse has been taken 3.5 as the Nearest Urban Habitation is Rajgarh located in Churu (Rajasthan), between 20-30 km from the Main RWR. The Factor for the Diggi & WUA Office Land parcels, is measured out to be 3.0 as per the nearest urban outer limits in reference to the towns of Pilani, Malsisar & Alsisar.
- iii. Solatium: Equivalent to 100% of the Compensatory Value of the Land, as per the Multiplying Factor, over the basis of the applicable latest DLC rates (Nov. 2018).
- iv. Only Private Entitle holders (including SC & ST) Land has been taken into consideration for the calculation of the Land acquisition. Government & Related entitle holders as per ROR have been listed separately. Therefore Subsistence grant has been accordingly given for the SC/ST with an additional 50,000 INR.
- v. The Value of Assets attached to Land for linear projects has been taken for Temporary Requirement as per Rights of Way. The Assets included are standing Crops for one season shall be reimbursed and Consideration shall be tkane for giving prior notice for available time towards cultivation. In Rajasthan & Haryana as per the Trend Analysis, farmers largely grow Wheat; One acre of land in a good year yields about 20 quintals of Wheat. And in One Hectare it equates to about 8 Quintal of Wheat. The Value of Wheat as per the Latest Minimum Support Price (released by Commission for Agricultural Costs and Prices) increase in Oct. 2018 to INR 1840.0 per Quintal is taken into consideration. Hence keeping one of the prevalent & valued Crops for calculation of, loss of standing crops during Laying of Pipelines for estimation purposes.
- vi. Around 2% of the total cost has been set aside for physical contingencies. Such type of contingencies may arise as a result of time overrun of the project or due to various other unforeseen circumstances.

The Sub-total budget of Underground Conveyance System (UCS) Chainage, under the part of State of Haryana & Rajasthan is taken as budgeted master total. The UCS is further calculated on the basis of Temporary requirements and Permanent acquisitions for laying of the Pipelines & Maintenance roads for the same, respectively. The Sub-total budget of the various Sub Projects in Rajasthan viz. Main Reservoir& Pump house , Main Pumping Lines , Block Reservoirs & Offices with residential premises, Block to Diggi Transmission Lines, Diggi Reservoirs & WUA Offices and further Distribution Transmission lines are under the part of State of Rajasthan and is taken as budgeted master total.