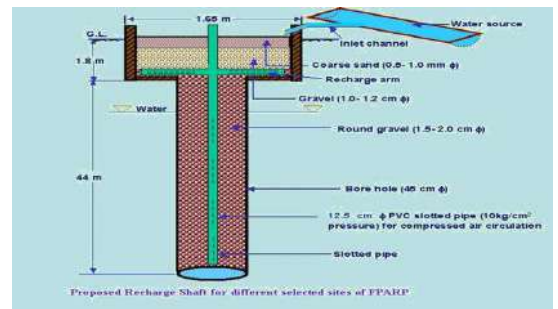
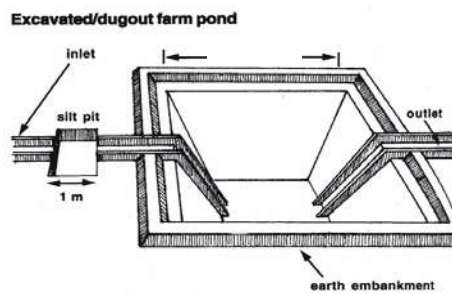




CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES,
RIVER DEVELOPMENT & GANGA REJUVENATION
GOVERNMENT OF INDIA



**ARTIFICIAL RECHARGE TO GROUND WATER AND WATER
CONSERVATION PLAN OF MANDORE BLOCK,
DISTRICT JODHPUR, RAJASTHAN**

Western Region, Jaipur
April 2016

**ARTIFICIAL RECHARGE TO GROUND WATER AND WATER CONSERVATION
PLAN BLOCK MANDORE,
DISTRICT JODHPUR**

Plan at a Glance

1.	Area of the Mandore Block	1260.96 Sq.Km.
2.	Area identified for Artificial Recharge	1165.19 Sq.Km.
3.	Dynamic Ground Water Resources (as on 31.03.2011)	
	Net Ground Water Availability	26.34 MCM
	Annual Ground Water Draft	44.40 MCM
	Stage of Ground Water Development	168.54 %
4.	Volume of water to be harnessed	0.5142 MCM
	Volume of water available for recharge	0.5142 MCM
	Volume of water available for conservation by other interventions	-
5.	Volume of unsaturated aquifer zone available for recharge	550.183 MCM
6.	Total number of structures to be proposed	
	Recharge structures	
	Existing village pond with recharge shaft/ well	17 shafts in 17 Nos. of existing village ponds
	Water Conservation	
	Farm pond	-
	Expected Annual GW recharge	0.362 MCM
	Provision for supplemental irrigation, thus reducing GW withdrawal for irrigation	-
	Total recharge/ saving of ground water	0.362 MCM
7.	Estimated Cost	0.6216 crore
	Artificial Recharge Plan	0.49 crore
	Piezometer construction	0.102 crore
	Operation and maintenance	0.0296crore

ARTIFICIAL RECHARGE TO GROUND WATER AND WATER CONSERVATION PLAN BLOCK MANDORE, DISTRICT JODHPUR

1 INTRODUCTION

The demand of fresh water for agriculture, drinking and industrial uses etc. has significantly increased due to population growth and socio-economic development. As surface water resources in the State of Rajasthan are meagre, the dependability on ground water resources in the State has increased substantially. This has resulted in over exploitation of ground water resources vis a vis depletion of ground water levels in various parts of the State.

The **Mandore Block, district Jodhpur** is one of the over exploited blocks of Rajasthan and is under severe stress, as evident from the stage of ground water development, which has attained an alarming level of **168.54%**. In view of over exploitation of ground water resources in the block, ground water resources in the area are under continuous depletion. Thus there is urgent need for taking up suitable water management interventions based on integrated approach, which on one hand includes augmentation of ground water resources through appropriate techniques, and on the other hand requires the adoption of suitable water conservation measures, such as ensuring water use efficiency through creation of additional water storage facility, maintenance/renovation of existing water bodies etc. Water awareness and capacity building of the stakeholders are also the important attributes of water management interventions as envisaged in the National Water Policy.

Artificial recharge to ground water is one of the most efficient, scientifically proven and cost effective technology to mitigate the problems of over exploitation of ground water resources. The technology serves as a means for restoring the depleted ground water storage, ameliorate the ground water quality problems and also enhance the sustainability of wells in the affected areas. A detailed knowledge of geology, hydrogeology, land use pattern, geomorphology and hydro-meteorological features are however, essential for selection of appropriate artificial recharge techniques as well as design and sites of ground water recharge structures.

As per directions of Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India and in pursuance to letter no 16-24/M(SML)/CGWB/ARP- OE Blocks/2015-6957, dated 13.7.2015 & 3.8.2015 & letter no 39(43)/TC/CHN/CGWB/2015-7929, dated 4.9.2015 from Central Headquarters, Central Ground Water Board, **the preparation of Artificial Recharge and Rainwater harvesting Plan for the Over exploited blocks in the State of Rajasthan has been taken up** on priority by the Western Region, Central Ground Water Board, Jaipur. Each Plan discusses the broad framework of ground water situation in the block, status of water availability (both surface and ground water), identification of feasible areas for interventions, feasibility of artificial recharge and other water conservation structures, their design considerations, numbers and cost estimates. The expected outcomes of the proposed interventions have also been elucidated in the report

The GIS layers used in the Plan include administrative (upto village level), Hydrogeology, Depth to Water level (pre and post monsoon), geomorphic, drainage, water bodies and the map of tentative locations of proposed interventions.

Methodology:

As per Ground Water Department, Government of Rajasthan direction the basin wise availability of surplus run off is calculated after taking into account 75 % dependability on the rain water for all uses. In furtherance, the sub basins with surplus run off available for recharge were taken into consideration. The block area falling in particular sub basin was taken into account and a proportionate area of the sub-basin draining the block was calculated. Based on this area of sub-basin draining the block, proportionate surplus run off, in the block by the sub basin, for recharge was calculated. Thus was calculated the final amount of surplus run off available for recharge in particular block by one particular sub-basin. The available run off was considered for Recharge through Recharge Shaft (@ 0.03 MCM) and Percolation tank (@ 0.2 MCM). If after allocating water for Recharge through Recharge Shaft, large amount of surface run off was left then the Water conservation through Farm Ponds, along with recharge through Percolation Tanks, was also taken into account. Besides the available run off the Average Water Level for the time span of ten years (Nov., 2005 to Nov. 2014) and the Decadal Water Level trend (Nov., 2005 to Nov. 2014) were also taken into account. The blocks showing average water level more than 5 m bgl and declining water level trend were considered suitable for Artificial Recharge Plan.

1.1 Location of the block

The Mandore Block covering an area of 1260.96 Sq. Km. falls in south central part of Jodhpur District and is located between North latitudes 26°12' & 26°30' and East longitudes 72°40' & 73°23'. As per 2011 census, the total population of the Block is 210758 persons consisting of 109425 males & 101333 females. Location map is shown in fig 1.

1.2 Source wise Irrigated Area

Out of total area of 1260.96 Sq.Km., an area of 93.08 (7.38%) falls under irrigation. The dug wells/ Tubewells are the only major source of irrigation in Mandore Block. There is no area that falls under canal & pond irrigation. The wells irrigate total 93.08 Sq.Km. area in this Block.

Fig: 1

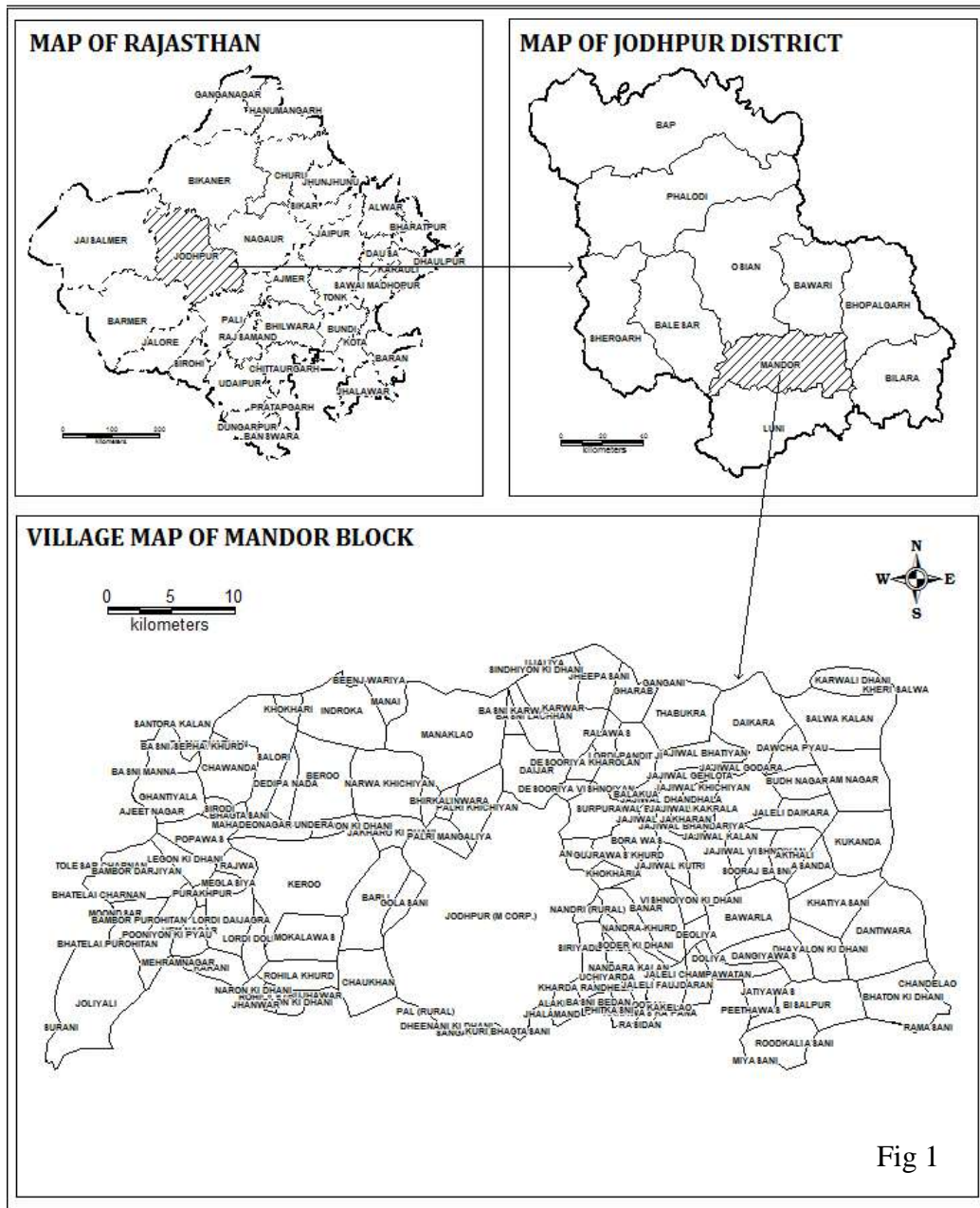


Fig 1

1.3 Physiography & Drainage

Physiographically (Fig 2), the block is characterized by presence of sandy plains of aeolian origin, dune valley complexes, eolian plains. The minimum and maximum elevation of Block is 165.1 m. amsl and 395.6 m. amsl, respectively.

The south eastern part of block is drained by Jojri river and falls under Luni basin. The map showing drainage and water bodies in the Mandore block is shown in fig 3.

Fig: 2

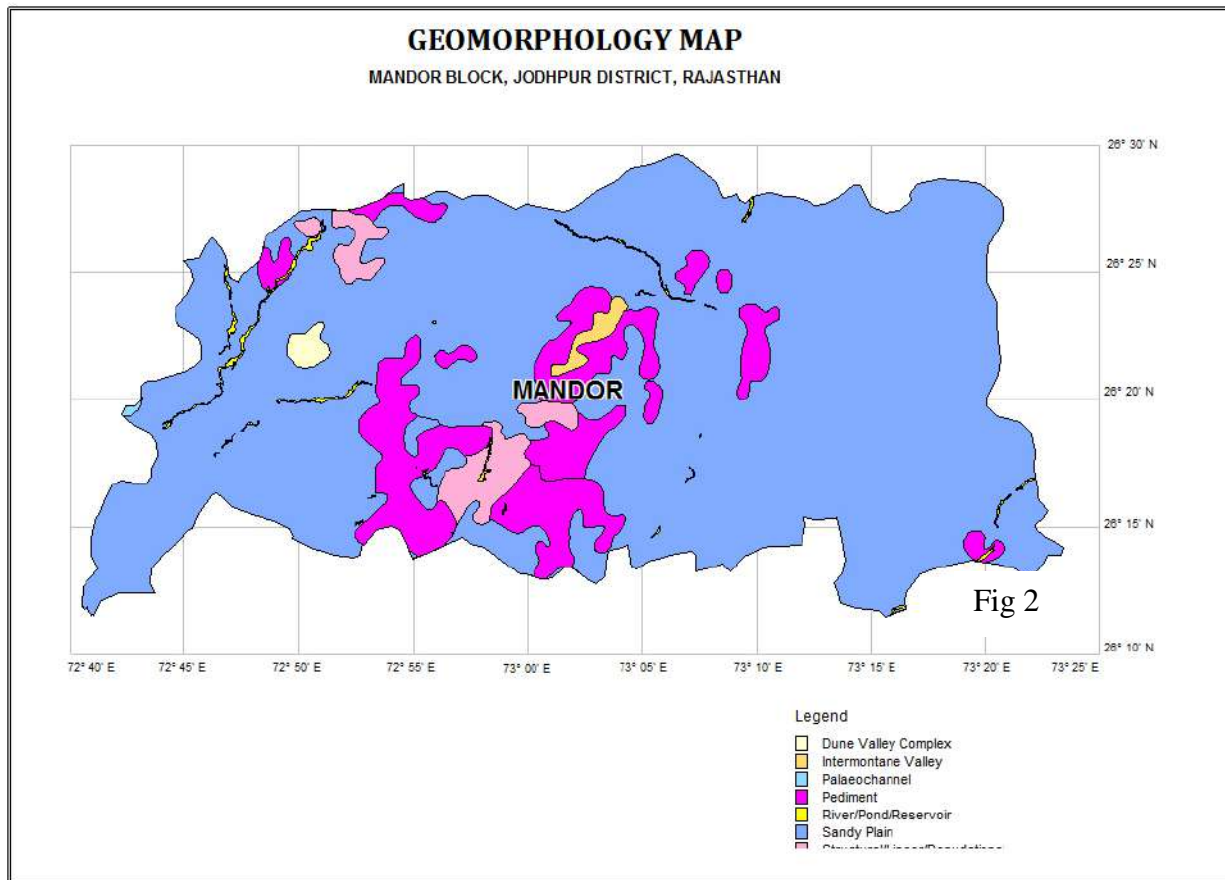
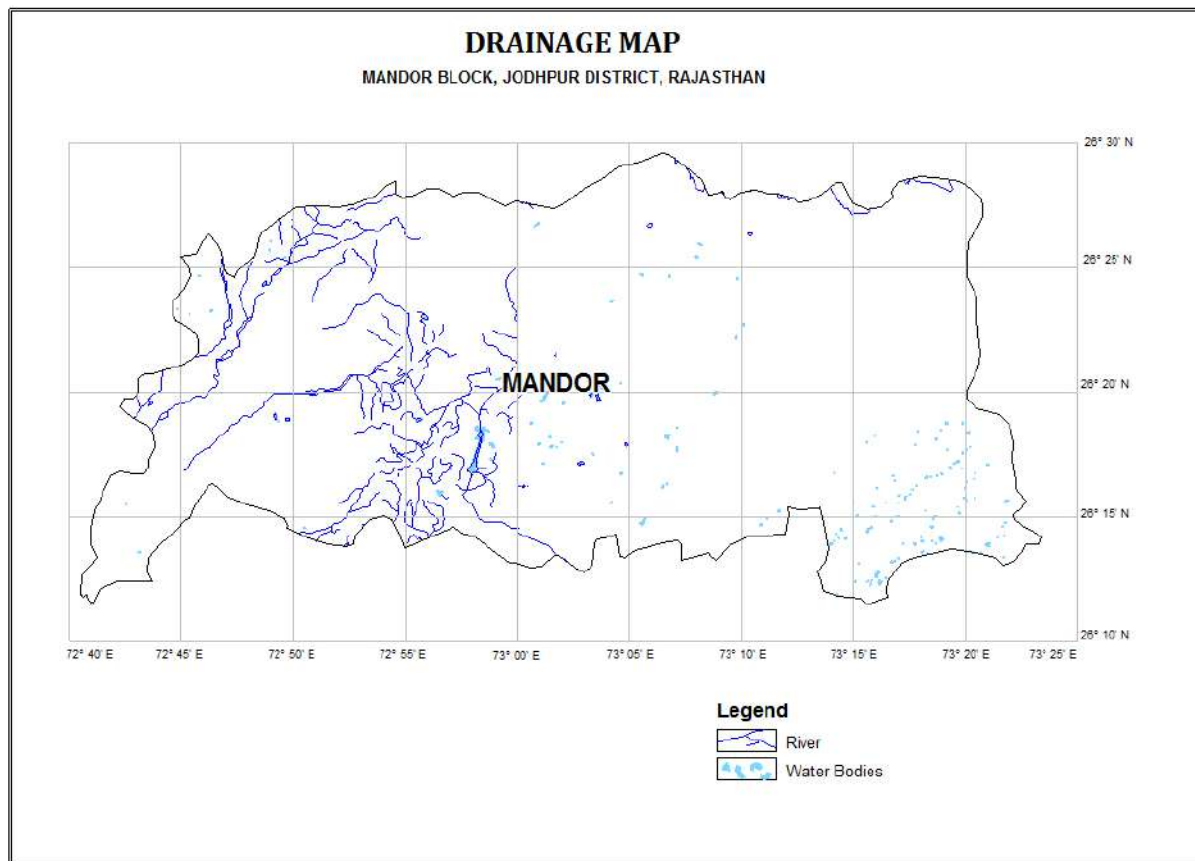


Fig: 3



1.4 Rainfall

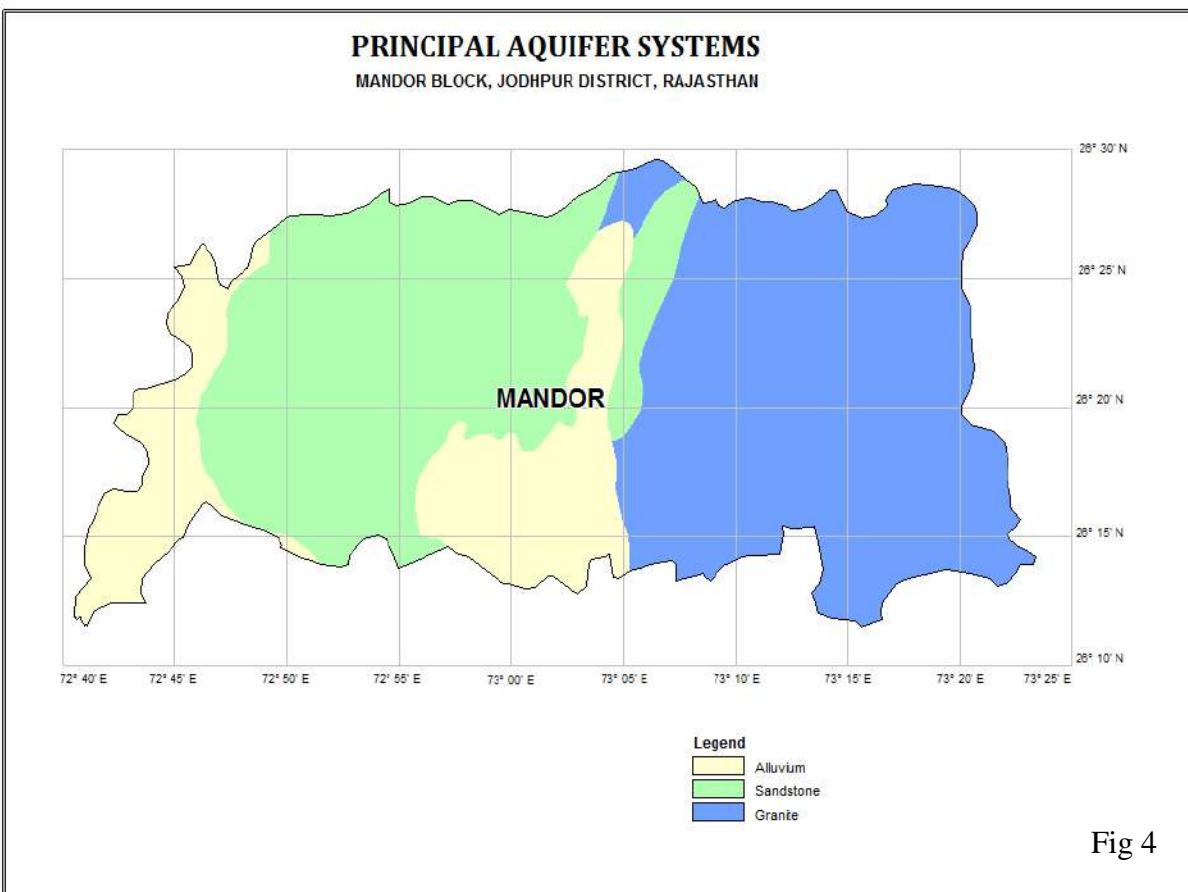
The climate of the block is semi arid. The Normal annual rainfall of block is 333.38mm. Failure of rains has observed several times. The available data of rainfall indicates that larger part of annual rainfall is received through SW monsoon during July to September. In March, there is transition to summers. The summer months of April to June are the hottest months and temperature upto 48°C is reached. From end of June to September, south western monsoon is received. The months of July and August are the wettest months, receiving about 70% of total annual rainfall. Winter season starts from November and lasts upto February. Average temperature during these months remains between 15° to 18°C, however from end of December to mid January, temperature remains in the range of 5° to 10°C.

1.5 Hydrogeology of the Area

Nagaur & Jodhpur Sandstone, Malani Rhyolites & Granites and Quaternary Alluviums are the major aquifers in the block. Out of total geographical area of 1255.96 Sq. Km,

an area of 1165.19 Sq. Km. (92.77%) forms aquifer system (potential zone) in the block. Sandstones are generally hard and compact layered rocks with intermittent shale and clay layers. Softer and friable sandstone layers and patches do occur in these formations making it a good yielding aquifer tapped by open wells and bore wells. Sandstone is fine to medium grained, sometimes coarse to gritty and friable. In such formations, friable and soft nature often leads to formation of small cavities in saturated zones. This makes it a very good aquifer forming chief source of ground water in the area. A large number of light to medium duty bore wells have been constructed in such areas for irrigation and water supply purposes. Ground water in sandstone occurs under unconfined to semi-confined conditions. Granites and Rhyolites form poor aquifers. Ground water occurs under unconfined conditions in secondary spaces in weathered and fractured zones. The unconsolidated Quaternary sediments comprising of alluvium, valley fills and aeolian sands also form important aquifers in some parts. These sediments occur as thin blanket over the older sediments. In general yield of the wells tapping sandstone ranges from 0.35 to 2.08 and yield of wells tapping Malani Rhyolites & Granites vary from 0.12 to 0.93 lps. The yield of Quaternary alluviums ranges from 0.23 to 1.16 lps. The map showing aquifer system in the Mandore block is shown in

Fig. 4

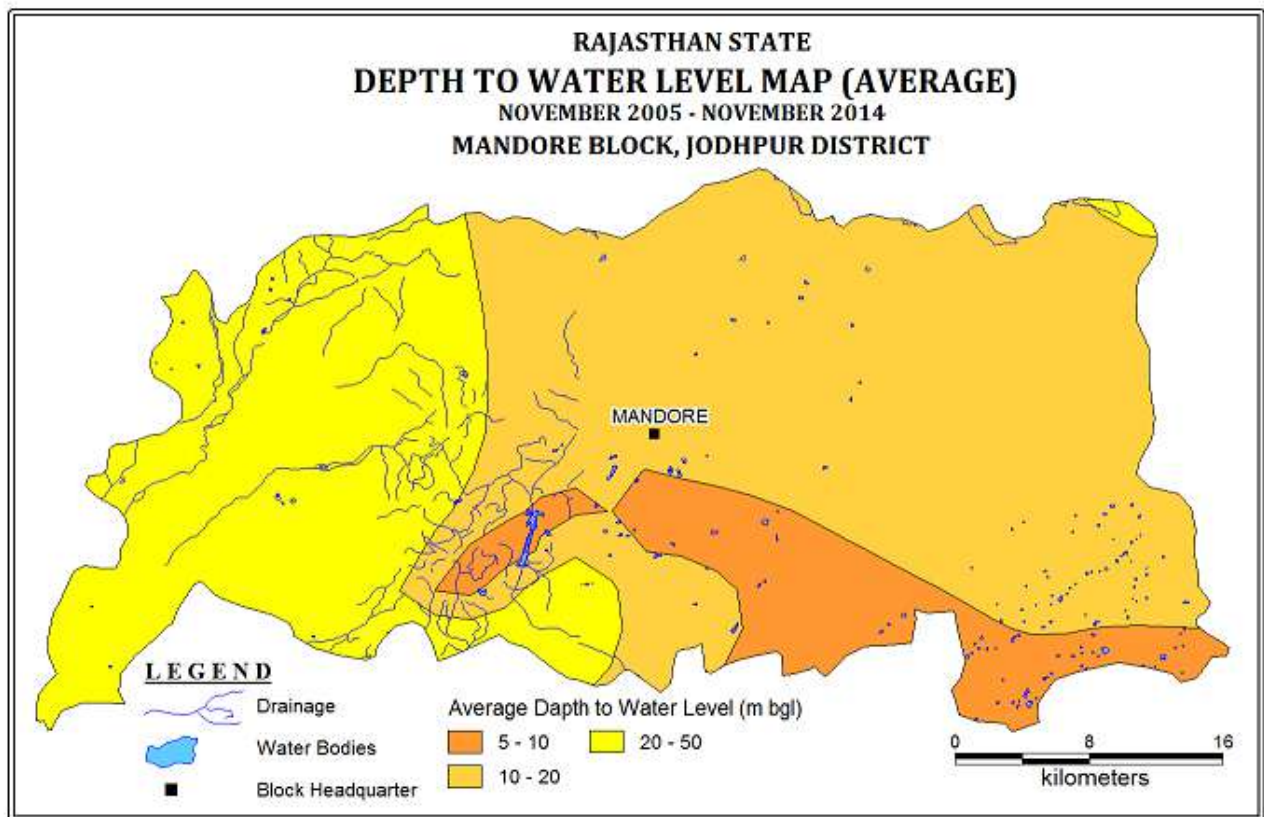


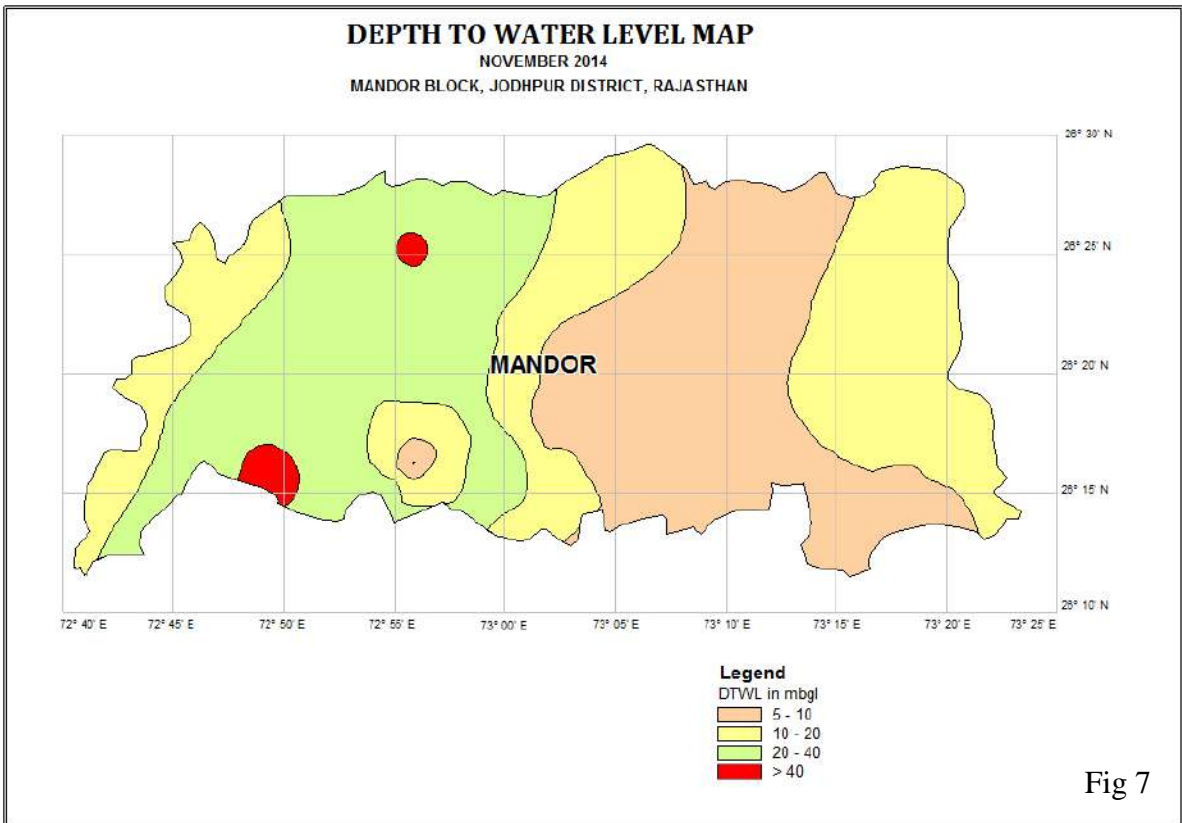
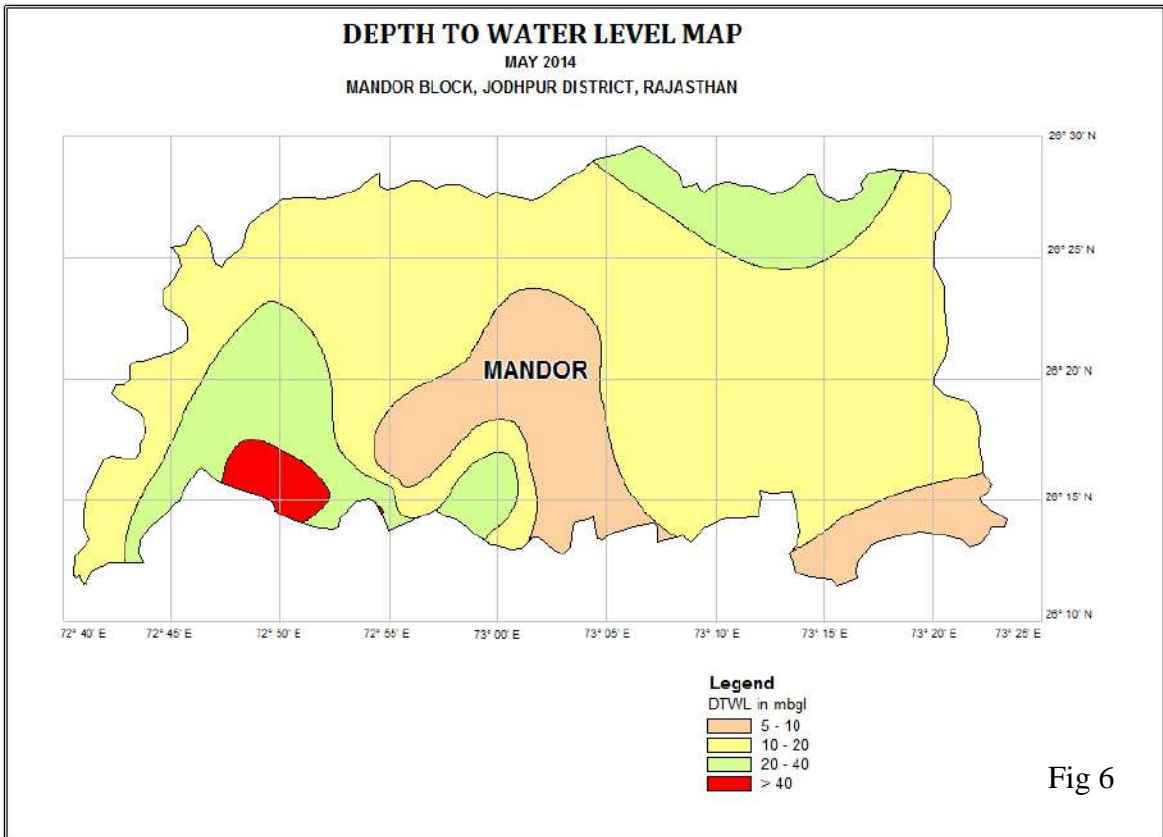
Ground Water Level

As per Average decadal depth to water level (from November, 2005 to November, 2014), the block majorly falls in water level range 20 - 50 m bgl range from west to east. (Fig 5)

The average decadal depth to water level is 24.61 m bgl for Pre monsoon & 22.02 m bgl for Post monsoon. According to depth to water level map of May 2014, water level ranges between 10 to 20 mbgl in major part, 20 to 40 mbgl & more than 40 mbgl in south western & north eastern parts and 5 to 10 mbgl in isolated pockets in southern part. According to depth to water level map of November 2014, water level ranges between 10 to 40 mbgl in major part, 5 to 10 mbgl in some parts situated in eastern half and more than 40 mbgl in isolated pockets. Depth to water level maps for May 2014 & November 2014 is shown in fig 6 & 7.

Fig: 5



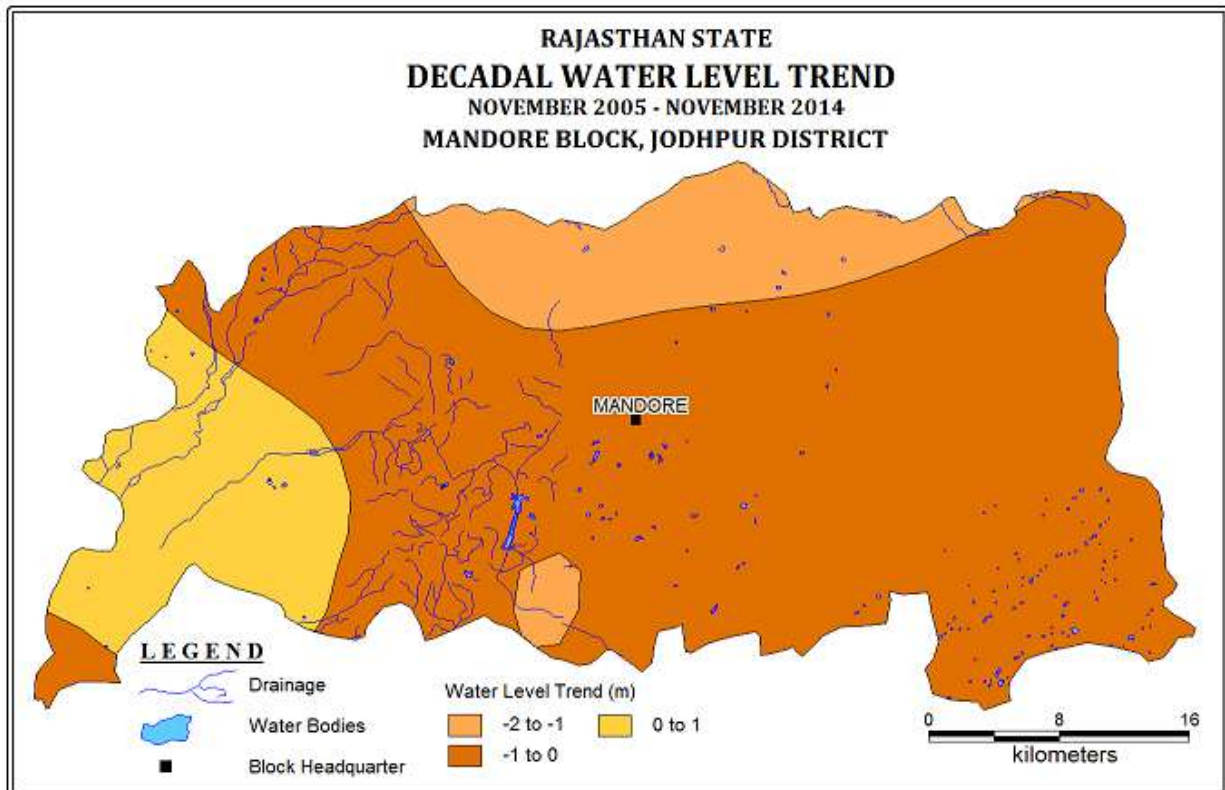


Water Level Trend:

All the hydrographs are showing declining water level trends over last 10 years. Water level trend shows average decline of 0.45 m/year during pre monsoon and 0.43 m/year during post monsoon has been observed.

As per the Decadal Water level trend (from November, 2005 to November, 2014), the declining trend is visible in the block. The fall in the range of -2 to -1, -1 to 0 (major part) and 0 to 1m/ year in ground water level is prevalent in the block. The map of Decadal Water Level Trend is shown in **fig. 8**

Fig: 8



1.6 Subsurface Hydrogeology

As inferred from borehole data of the Mandore Block; Sandstone, Granite and Alluvium form the aquifers. However, the ground water in hard rocks only occurs in shallow weathered parts or fractures due to absence of primary porosity. The depth of drilling ranges from 37.0 to 230.5 mbgl and the average discharge ranges from 0.5 to 30.0 lps. The quality of water has 2 major problems, i.e., Salinity & Fluoride.

1.7 Dynamic Ground Water Resource

The Ground water Resources for the block are given in Table 1, as per 31.03.2011 Ground Water Resource Assessment. The Net Ground water Availability of Block is 2634.19 ham and Annual Ground water draft is 4439.60 ham. Due to this excessive draft over recharge, stage of Ground water development has reached 168.54%.

**Table 1: Ground Water Availability, Utilization and Stage of Development
Block Mandore, District Jodhpur**

Natural Discharge During Non Monsoon Period	292.68 ham
Net Ground Water Availability	2634.19 ham
Annual Ground Water Draft	4439.60 ham
Net Ground water Availability for Future Irrigation Use	193.58 ham
Stage of Ground Water Development	168.54%
<i>Source: Ground Water Resource Assessment 31.03.2011</i>	

Need for artificial recharge and water conservation plan

The present artificial recharge and water conservation Plan aims to mitigate the problems of continuous decline in water levels over the area through techniques of artificial recharge utilizing surplus rainwater based on scientific manner for optimal results. The broad scope of the recharge plan is as follows:

- Establishing efficacy of integrated approach through various artificial recharge and water conservation techniques. Intervention is proposed in cluster mode basis wherever feasible to have a better impact.
- Enhancing water use efficiency for controlling excessive ground water draft, especially for irrigation purposes.
- Ensuring sustainability of ground water abstraction structures and improvement in quality of ground water.

Surface water availability

As per the studies carried out by Water Resources Department, Govt of Rajasthan there is hardly any surplus water available for further development at 75% dependability. However, after taking into account the availability of source water in the

basins of Rivers flowing in the State proportionate amount of surplus runoff available in particular block by particular sub basin was calculated.

Accordingly about 0.5142 MCM has been considered for recharge plan in the block. Optimum utilization of rainwater runoff depends on availability of land, feasible conditions, etc. Surface water availability, allocation and number of structures are presented in table 2.

Table 2: Source water for artificial recharge and number of recharge structure

District	District code	Block	Block code	Area of Block (Sq.km.)	Potential area suitable for recharge (Sq.km.)	Type of Aquifer	Area feasible for artificial recharge (Sq km)
JODHPUR	RJ22	MANDORE	RJ2206	1260.96	1165.19	alluvium	53.77
JODHPUR	RJ22	MANDORE				hard rock	1111.42

Table 2 (contd): Source water for artificial recharge and number of recharge structure

Sp Yield	Average DTW (mbgl) NOV 2013	Thickness of unsaturated zone 3 m below ground level (m)	Volume of sub surface storage space available for artificial recharge (MCM)	Sub Basin	Type of Aquifer	Surplus available in the block (in Mm3)	Surplus water used in Recharge Shaft (RS)	No. of RS (0.03 MCM/RS)
0.080	32.72	29.72	127.844	Luni	Soft rock	0.0696	0.0696	2
0.020	22	19	422.340		Hard rock	0.3947	0.3947	13
				Jojri	Hard rock	0.0499	0.0499	2
			Total			0.5142	0.5142	17

Feasible Artificial Recharge and water conservation structures

A wide spectrum of techniques is in vogue, which are being implemented to recharge the ground water reservoir, conserve the utilizable rainfall and enhance the water use efficiency. Based on prevailing field conditions, out of total block area of 1260.95 sq km practically 1165.19 sq km area is feasible for implementing recharge measures. Based on available information about the area such as ground water scenario, hydrogeology, hydrology, topography, rainfall pattern, drainage, soil cover, utilizable rainfall etc. scope for various interventions has been studied and assessment of suitable areas, tentative design and costs of structures has been worked out in the present plan.

Identification of feasible areas

Mandore block is having ground water level about 40m below ground level and as per dynamic ground water resource estimation, the block is over exploited with stage of ground water development at 168.54 %. The Mandore block is feasible for recharge due to presence of permeable zone above water table, favorable land slope and availability of water from rainfall.

Generally the Artificial recharge structures suitable in this type of area are Check dams/ Anicuts/ Percolation tanks and Recharge Shafts/ Recharge wells. Since the ground water levels are quite deep in the block, the structures like ani-cuts and Check dams are not suitable and also their construction is regulated. Considering these aspect the proposal for Recharge Shaft/ Recharge wells have been firmed up in the present Plan as the most suitable structures in Mandore block.

Details of Ground Water Recharge Measures

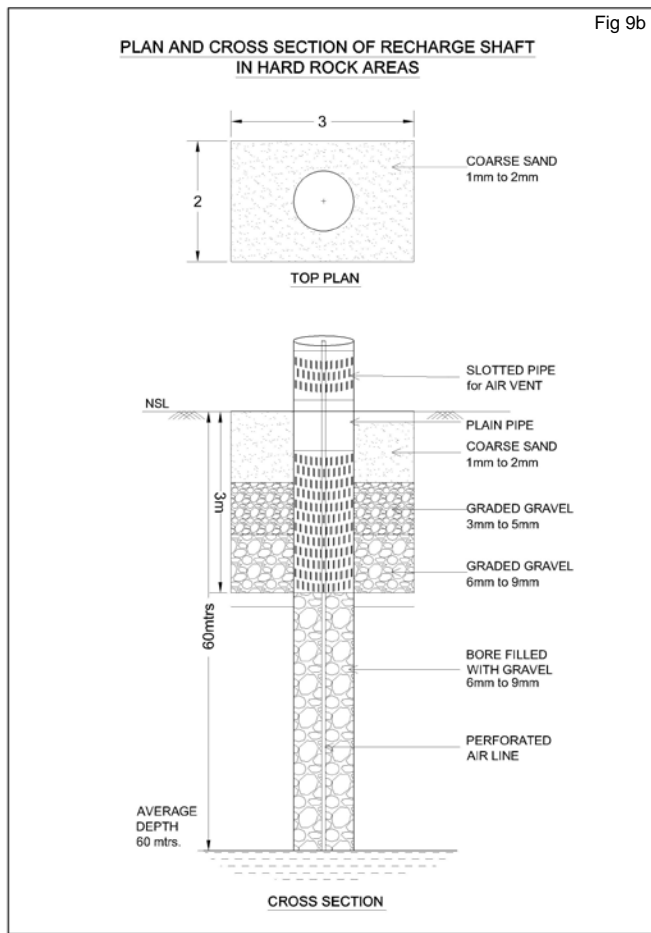
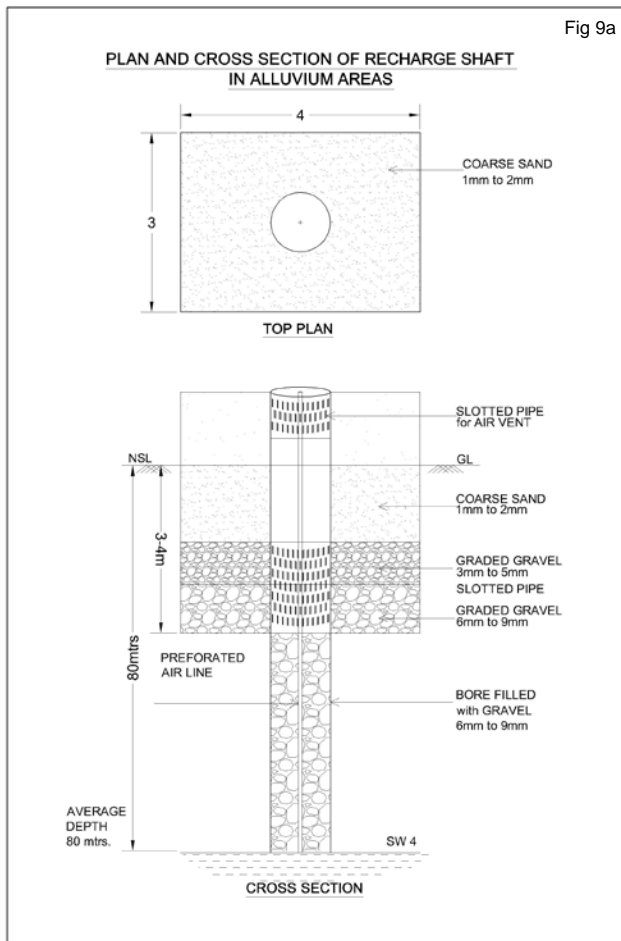
1. Existing Village Pond with recharge shaft/wells

Almost all the villages in the State of Rajasthan have one or two village ponds & other ponds. With time, these ponds get silted & hardly any water percolates downward. Also, any excess water coming into the pond goes away as a run off due to limited storage capacity. This surplus runoff can very well be utilized for recharging the ground water and also for enhancing conservation of water that can be further used for irrigation, thereby saving ground water withdrawal. Since natural recharge from these ponds is limited due to siltation and ground water levels are deep, the most effective ground water structure considered under the Plan is Recharge Shaft/ Recharge well constructed within the pond itself.

The above mentioned recharge well has been designed in a manner that maximum surplus water would likely to be utilized for recharge as well as sufficient water is retained in the pond for local use.

The model design of recharge well has been worked out in consultation with Ground Water Department, Government of Rajasthan and presented in Fig 9a & 9b. The major features required are:

1. The well should have sufficient diameter for recharge- 10 to 12 inch diameter well with bottom screen/ opening just above the highest ground water level.
2. The well should have screen/ opening at the top, which should be at least 1.5m above the bed level of the pond.
3. The upper opening should be surrounded with filter pack comprising graded filter media of medium, coarse sand & gravel, so that the Recharge well does not get silted.



The opening for inflow to the well has been proposed at 1.5m above Bed level of pond. This is necessary to ensure that the pond retains sufficient water for use by local consumers. However, this may necessitate further deepening of pond itself so that the pond is 3-4 m deep. A Single well as discussed above would be suitable for a pond upto area of about 5ha. Therefore, more number of such Recharge wells is envisaged for larger ponds.

Criteria for number of shafts

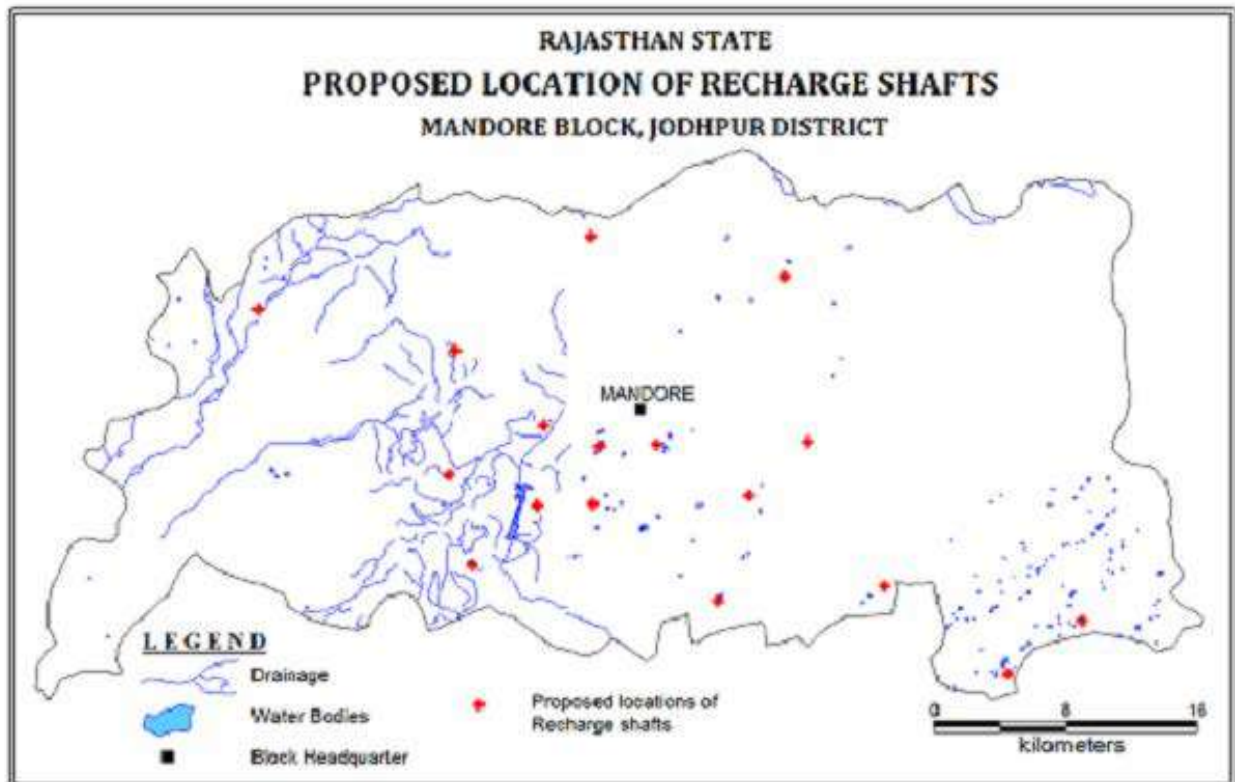
Village ponds having area <1 ha and > 25 ha has not been considered for construction of recharge shafts, one recharge shaft is proposed for pond area between 1 to 5 ha; 2 for 5 to 7.5 ha, 3 for 7.5 to 10 and 4 shafts for >10 ha.

The tentative location of villages for construction of recharge shaft/well in existing village pond and their cost estimates are shown in Fig 10 and Table 3. The plan proposes construction of 17 recharges shafts/ wells in 17 identified existing village ponds at an estimated cost of 49 lacs.

Table 3: Tentative locations of village for village pond with recharge shaft

S.N	Village	Long	Lat	Pond Area (Ha)	No of Shaft	Formation	Unit cost (Rs in lac)	Cost of Shaft (Rs in lac)
1	Chawanda	72.811	26.406	2.085	1	Soft rock	5	5
2	Chaukhan	72.943	26.266	9.492	1	Soft rock	5	5
3	Narwa Khichiyan	72.932	26.383	3.769	1	Hard rock	2.6	2.6
4	Manaklao	73.015	26.446	6.757	1	Hard rock	2.6	2.6
5	Jodhpur (M Corp.)	72.986	26.342	3.217	1	Hard rock	2.6	2.6
6	Barli	72.929	26.316	6.094	1	Hard rock	2.6	2.6
7	Jodhpur (M Corp.)	72.982	26.298	6.989	1	Hard rock	2.6	2.6
8	Jodhpur (M Corp.)	73.020	26.331	13.080	1	Hard rock	2.6	2.6
9	Jodhpur (M Corp.)	73.016	26.299	3.318	1	Hard rock	2.6	2.6
10	Jodhpur (M Corp.)	73.055	26.332	4.061	1	Hard rock	2.6	2.6
11	Nandri (Rural)	73.112	26.304	9.265	1	Hard rock	2.6	2.6
12	Alakhdera	73.093	26.246	7.909	1	Hard rock	2.6	2.6
13	Jaleli Champawatan	73.195	26.254	3.760	1	Hard rock	2.6	2.6
14	Roodkali	73.270	26.206	7.347	1	Hard rock	2.6	2.6
15	Bisalpur	73.316	26.235	10.920	1	Hard rock	2.6	2.6
16	Lordi-Pandit Ji	73.133	26.424	3.712	1	Hard rock	2.6	2.6
17	Banar	73.147	26.333	3.318	1	Hard rock	2.6	2.6
					17			49

Fig: 10



Conservation Measures

As mentioned earlier the present Plan occurs on integrated approach of interventions, which includes both recharge measures as well as conservation of water while the recharge interventions have been discussed. The proposed conservation measures discussed below includes revival, repair of existing water bodies, etc.

A. Revival, repair of water bodies

The existing ponds and tanks in loose their storage capacity as well as the natural ground water recharge through these water bodies has also become negligible due to siltation and encroachment by farmers for agriculture purposes. There are several such

villages where ponds/ tanks are in dilapidated condition. These existing village tanks, which are normally silted and damaged, can be modified to serve as recharge structure in case these are suitably located to serve as percolation tanks. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structure.

Impact Assessment and Monitoring

Assessment of impact of the artificial recharge schemes implemented is essential to assess the efficacy of structures constructed. It helps in identification of cost-effective recharge mechanisms for optimal recharge into the ground water system. It also helps to make necessary modifications in site selection, design and construction of structures in future. The monitoring system should be designed judiciously to monitor impact of these structures individually as well as collectively. Demarcation of the zone of influence of the artificial recharge structure is one of the main objectives of monitoring.

It is proposed to utilize the existing data available with the Government of Rajasthan and CGWB baseline data. For assessment of the impact of proposed measures additional data will be generated by construction of the piezometer at suitable and strategic sites.

It is proposed to construct 17 piezometer, at suitable locations for monitoring of water levels, in the vicinity of proposed recharge structure. The depth of the piezometer may vary from 60 to 80 mbgl. This will help in assessing the impact of the project implementation.

Since the implantation of the Plan involves institutional framework, it is proposed to constitute State Level Technical Coordination Committee (SLTCC) and District Level Technical Coordination Committee (DLTCC) for proper monitoring and review of the implementation of the Plan.

Financial Outlay of the Plan

The total estimated cost of the Plan is 0.6216 cr, which includes Rs 0.49 cr for ground water recharge activities, 0.102 cr for ground water monitoring (Piezometer construction) and Rs 0.0296 cr towards operation and maintenance charges. The tentative cost estimates of the various activities of the Plan are shown in Table 4 & 5.

The tentative cost for different activities is given in table 5. The unit rates are as followed by the Govt. of Rajasthan (BSR). The total estimated cost of the project is **Rs 0.6216 Crores**.

Table 4: Cost of the recharge structures

Cost Recharge Shaft Rs in crs (Unit cost Rs 0.05 cr for alluvium and Rs 0.026 cr for hard rock)
Soft rock -0.10
Hard rock -0.39

Table 5: Tentative cost of different activities

Feasible Artificial Recharge & Water Conservation structures/ activities	Tentative Design	Quantity (in nos. or area in sq. m)	Rainwater harvested (mcm)	Tentative unit cost (in Rs lakh)	Total tentative cost (in Rs lakh)	Expected Annual GW recharge/ conservation (mcm)
Recharge Structures/ Activities						
Recharge shaft within the pond /tanks	Alluvium – Depth 80m, Dia: 10-12” with filter pit	2	0.0696	5	10	0.049
	Hard rock: Depth – 60m, Dia 10-12”with filter pit	15	0.447	2.6	39	0.313
Sub total					49	0.3619
Impact assessment & Monitoring						
Piezometer	Up to 80 m bgl	17		0.6	10.2	
<i>Impact assessment will be carried out by implemneting agency</i>						
O & M - 5% of total cost of the scheme					2.96	
TOTAL					62.16	

Note: Type, number and cost of structure may vary according to site after ground verification

Time Schedule

The project is to be implemented in two years, however impact assessment will be carried out for five years. A time schedule for different activities is given in table 6.

Table 6: Time Schedule

Steps	1 st Phase	2 th Phase	3 rd Phase	4 th Phase	5 th Phase	6 th Phase	7 th Phase	8 th Phase
Constitution of State Level Technical Coordination Committee (SLTCC) and District Level Technical Coordination Committee (DLTCC)								
Arranging meeting of SLTCC for provision available under the scheme, request to implementing agencies for submission of DPR								
Scrutiny, recommendations & approval of AR Projects / Schemes in DLTCC & SLTCC								
Forwarding the DPR to Central Ground Water Board (CHQ), New Delhi for approval and issuing of sanction from the Ministry								
Meeting of TCC(CHQ) and release of sanction of funds								
Construction of artificial recharge structures & Monitoring of water levels in the area locally								
Completion and Utilisation certificate								
Impact Assessment and submission of report								

Expected Benefits or outcome of the Plan

Ground water recharge and water conservation Plan of Mandore block, Jodhpur envisages gainful utilization of 0.362 MCM of surplus monsoon runoff for recharging of depleted aquifer system.

With the additional recharge and water conservation interventions as proposed in the Plan, it is anticipated that with enhanced recharge and reduction in ground water draft, the stage of ground water development will reduce to 166.25% from the existing 168.54%. The projected status of ground water resources and utilization scenario is presented in table 7.

Table 7 Projected Status of Groundwater Resource & Utilization							
Net G.W. Availability (Ham)	Additional Recharge from RWH & conservation (mcm)	Total Net G.W. Availability after intervention (mcm)	Existing G.W Draft for all purpose (mcm)	Saving of Ground water through projects (mcm)	Net GW draft after interventions (mcm)	Present stage of G.W. development (%)	Projected stage of G.W. Dev. (in %)
26.3419	0.362	26.7039	44.396	-	44.396	168.54	166.25

- The implementation of the project would result in additional recharge. The other tangible/ non-tangible benefits of the project are:
 - ❑ Recharging the ground water will help in arresting the rapid decline in ground water resources and will also ensure improvement in quality of ground water by way of dilution.
 - ❑ Proposed structures and measures will also enhance the ground water potential and would ensure sustainability of ground water resources.
 - ❑ Surface runoff water stored or harnessed can be used as supplemental irrigational resources and will reduce the stress on the ground water.
 - ❑ Besides, it will also help in reducing the amount and spate of storm water being drained by river and controlling soil erosion.