



केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga

Rejuvenation

Government of India

Report on

AQUIFER MAPS AND MANAGEMENT PLAN

Mendarda, Junagarh District, Gujarat

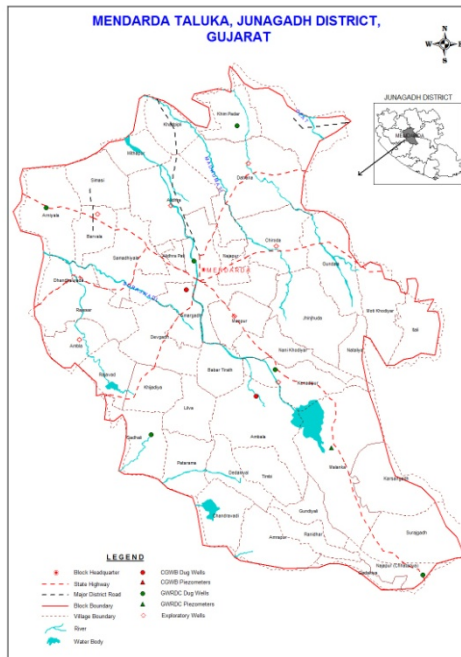
पश्चिमी मध्य क्षेत्र, अहमदाबाद

West Central Region, Ahmedabad



भारत सरकार
जल संसाधन, नदी विकास एवम् गंगा संरक्षण मंत्रालय
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GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND
GANGA REJUVENATION



**REPORT ON
AQUIFER MAPS & MANAGEMENT PLANS
MENDARDA, JUNAGADH DISTRICT, GUJARAT STATE**

**CENTRAL GROUND WATER BOARD
WEST CENTRAL REGION
AHMEDABAD**

**REPORT ON
AQUIFER MAPS & MANAGEMENT PLANS
MENDARDA TALUKA, JUNAGADH DISTRICT, GUJARAT STATE**

1. SALIENT FEATURES

1	Name of the TALUKA & Area, Location(Fig-1)	Mendarda - 363.86 Km² 21°10'29" to 21°25'15" N 70°20'48" to 70°34'27" E																																																																																		
2	No. of Town, villages	0, 66																																																																																		
3	District/State	Junagadh/Gujarat																																																																																		
4	Population (2011 Census)	Male- 35440, Female- 33091, Total- 68,531																																																																																		
5	Normal Rainfall (mm)	858.78 mm- Monsoon Rainfall (IMD) (in mm) (Long Term) 50 969.60 mm -Average Monsoon Rainfall (in mm) (2003-12)																																																																																		
6	Agriculture (20015-16)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2">Kharif Crops</th> <th colspan="2">Rabi Crops</th> </tr> <tr> <th>Crop</th> <th>Area in Hact</th> <th>Crop</th> <th>Area in Hact</th> </tr> </thead> <tbody> <tr> <td>Groundnut</td> <td>22100</td> <td>Wheat</td> <td>500</td> </tr> <tr> <td>Tal</td> <td>0</td> <td>Juvar</td> <td>0</td> </tr> <tr> <td>Castor</td> <td>0</td> <td>Castor</td> <td>0</td> </tr> <tr> <td></td> <td></td> <td>Gram</td> <td>20</td> </tr> <tr> <td>Bajri</td> <td>0</td> <td>Bajri</td> <td>15</td> </tr> <tr> <td>Tuver</td> <td>45</td> <td>Tuver</td> <td>0</td> </tr> <tr> <td>Mug</td> <td>65</td> <td>Mug</td> <td>80</td> </tr> <tr> <td>Udad</td> <td>130</td> <td>Mustered</td> <td>0</td> </tr> <tr> <td>Cotton</td> <td>300</td> <td>Isabgol</td> <td>10</td> </tr> <tr> <td>Sugarcane</td> <td>0</td> <td>Sugarcane</td> <td>0</td> </tr> <tr> <td>Vegetables</td> <td>70</td> <td>Vegetables</td> <td>40</td> </tr> <tr> <td>Fodder</td> <td>750</td> <td>Fodder</td> <td>150</td> </tr> <tr> <td>Gam Guvar</td> <td>0</td> <td>Jira</td> <td>10</td> </tr> <tr> <td>Soyabin</td> <td>40</td> <td>Onion</td> <td>40</td> </tr> <tr> <td></td> <td></td> <td>Coriander</td> <td>3900</td> </tr> <tr> <td></td> <td></td> <td>Garlic</td> <td>30</td> </tr> <tr> <td></td> <td></td> <td>Methi</td> <td>10</td> </tr> <tr> <td>Total</td> <td>23500</td> <td>Total</td> <td>4805</td> </tr> </tbody> </table>		Kharif Crops		Rabi Crops		Crop	Area in Hact	Crop	Area in Hact	Groundnut	22100	Wheat	500	Tal	0	Juvar	0	Castor	0	Castor	0			Gram	20	Bajri	0	Bajri	15	Tuver	45	Tuver	0	Mug	65	Mug	80	Udad	130	Mustered	0	Cotton	300	Isabgol	10	Sugarcane	0	Sugarcane	0	Vegetables	70	Vegetables	40	Fodder	750	Fodder	150	Gam Guvar	0	Jira	10	Soyabin	40	Onion	40			Coriander	3900			Garlic	30			Methi	10	Total	23500	Total	4805	
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7	Existing and future water demands (MCM)	Sector	Existing (MCM)	Future (MCM) (Year 2025)																																																																																
		Domestic and Industrial	1.99	2.68																																																																																
		Irrigation	52.43	31.38																																																																																
8	Water level behaviour (2015)(Fig-2 & 3)	12.98-17.00 m (Pre-monsoon)																																																																																		

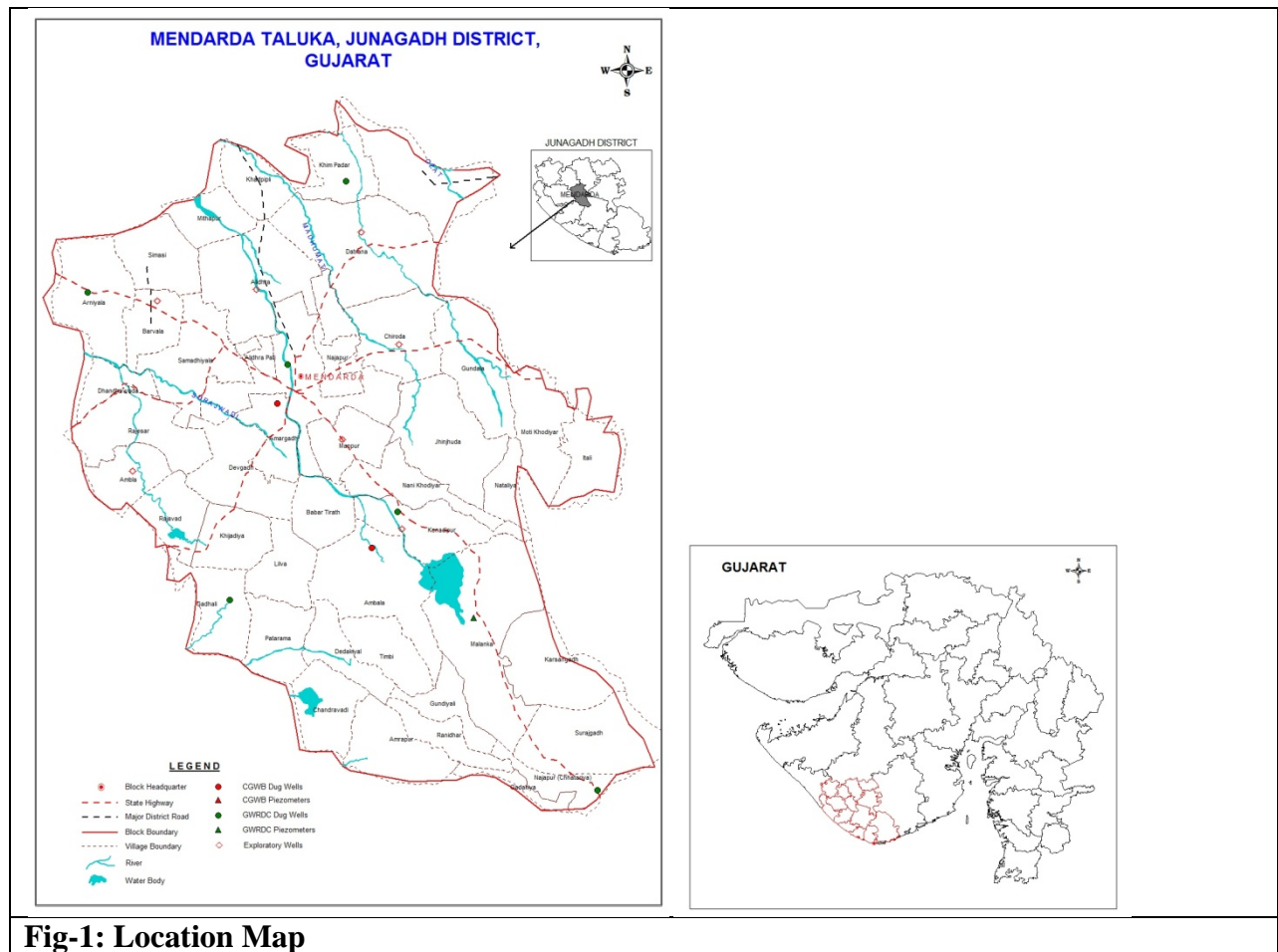


Fig-1: Location Map

1. Hydrogeology:

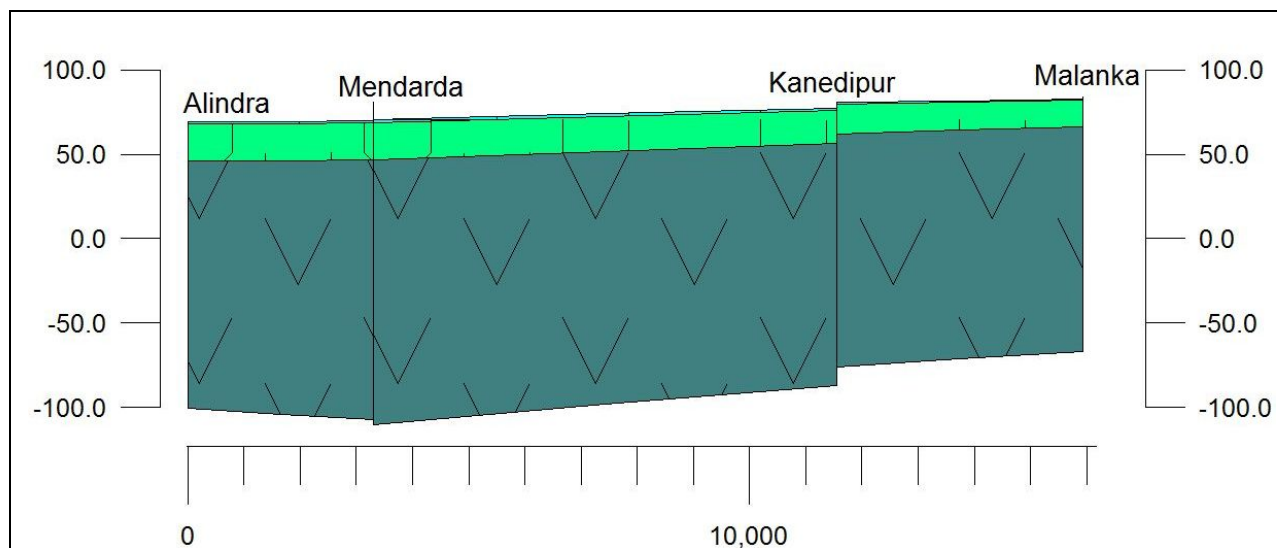
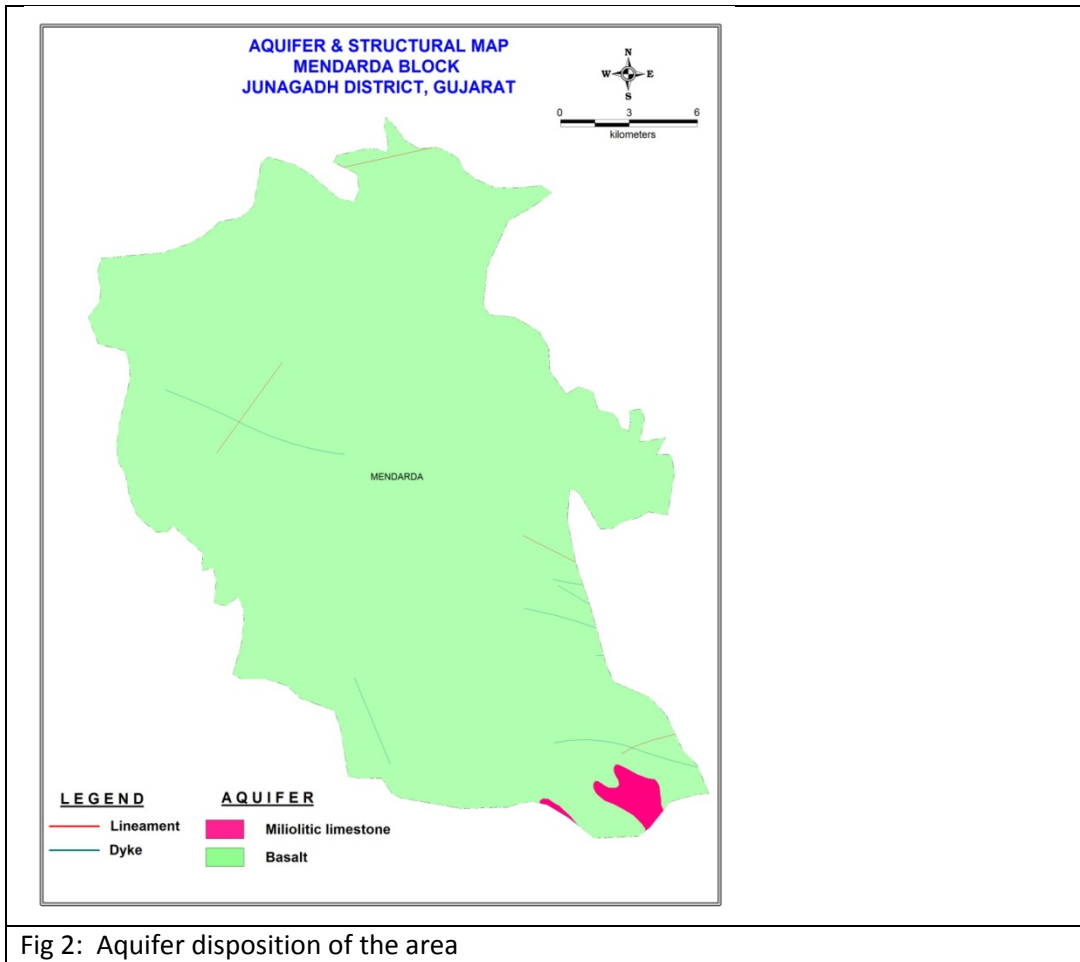
Main aquifer in the areas basaltic aquifer (Fig. 2) where the ground water exists upto the depth of weathering and in the fracture zones wherever encountered in the depth. Two hydrogeological Cross sections are given in Fig. 3.

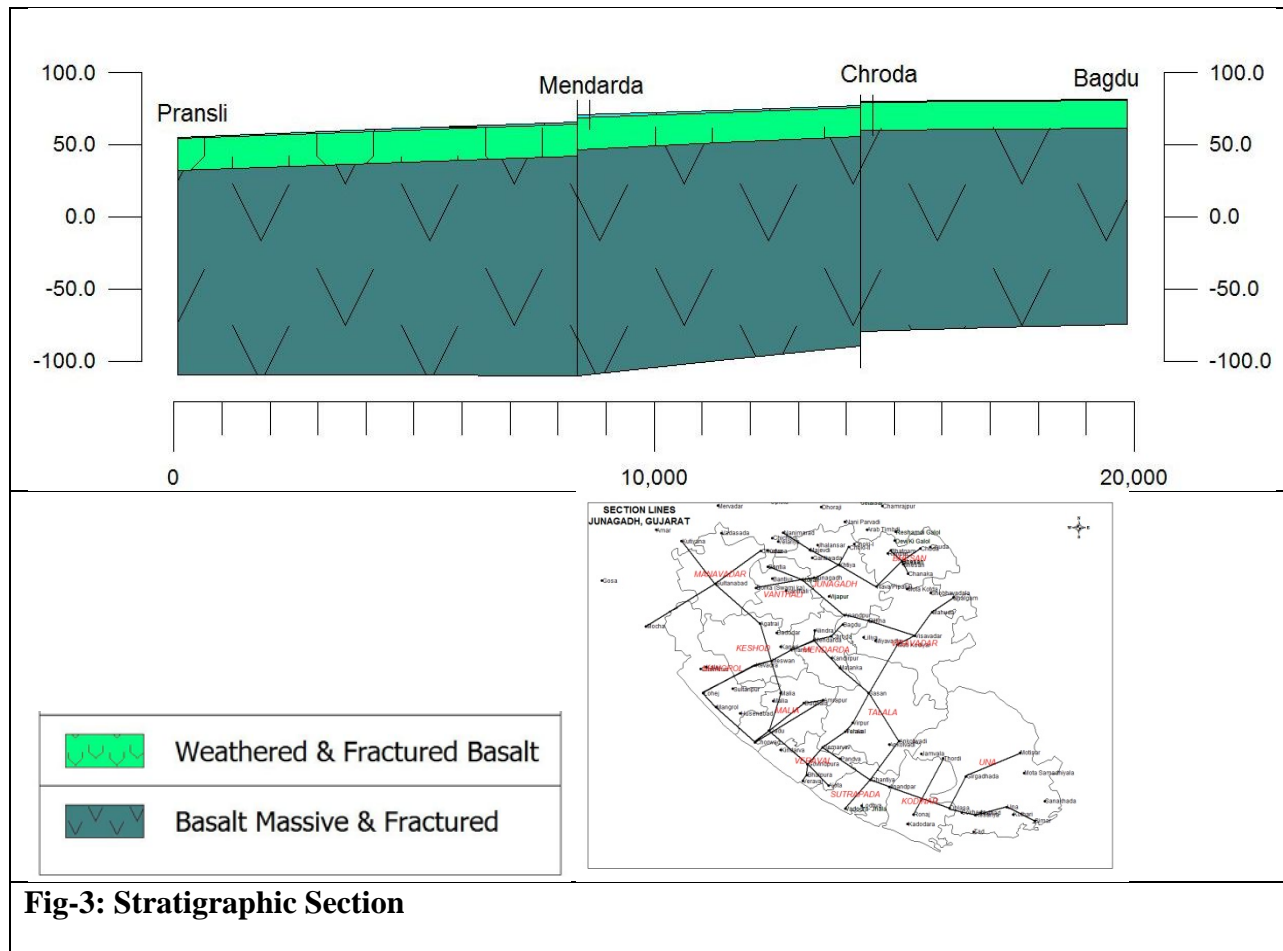
Subsurface Hydrogeology

As inferred from borehole data of the Mendarda Taluka, weathered and fractured Basalt forms the principal aquifer in the Taluka. Groundwater in this aquifer occurs under unconfined conditions and in the fractures encountered in the massive basaltic formation in the depth. The movement of groundwater is controlled by the extent of weathering, fracture and joints in the trap formation. Groundwater exploration has been done down to a max. depth of 437 mbgl and the average discharge ranges from 1 to 38 lps by compressor during drilling.

2. AQUIFER DISPOSITION

Name of aquifer	Aquifer material	Nature of aquifer	Aquifer depth and zone encountered (m)	Nature of porosity	Compressor discharge	Quality
Miliolitic Limestone	Limestone	Unconfined	0 to 7	Primary and secondary (Poreses, fractures and solution cavities)	-	-
Deccan Trap	Basalt	Unconfined (Weathered and fractured)	0 to 37	Secondary (weathered & fracture)	1 to 2 lps	Fresh
		Deep Fracture (Massive & amygdolidal)	Explore up to the depth of 437 m, zone encountered at 50, 77, 138, 174, 187, 214 & 429 m	Secondary (fractures, joints, shears and flow contacts)	Compressor discharge 10 to 38 LPS	Fresh





Depth to water level:

Large part of the taluka is having depth to water level mostly between 10 to 20 m bgl in the central part of the taluka whereas the South-Western and North –Eastern fringe observed water level 20 to 40 m bgl (Fig. 4). One isolated patch of water level > 40 is shown in the North –Eastern boundary of the taluka. Decadal average water level mostly between the period of May 2006 and 2015 ranges from 10.98 to 18.55m bgl. (Fig5). The decadal average depth to water levels also depict almost similar picture, except deepest water levels of more than 20 mbgl are on the North-Eastern parts and large area is occupied by water levels between 10 and 20 mbgl (Fig.5).

Long term groundwater fluctuation of water level for pre-monsoon and post- monsoon period are depicted in Fig. 6 & 7 for the period of 1987 to 2015. Ranges of the long-term fluctuation is given in Table below.

Pre-monsoon(1987-2015)				Post-monsoon(1987-2015)			
Rise		Fall		Rise		Fall	
Min	Max	Min	Max	Min	Max	Min	Max
2.54	3.60	-3.80	-10.20	0.40	15.88	Negligible	

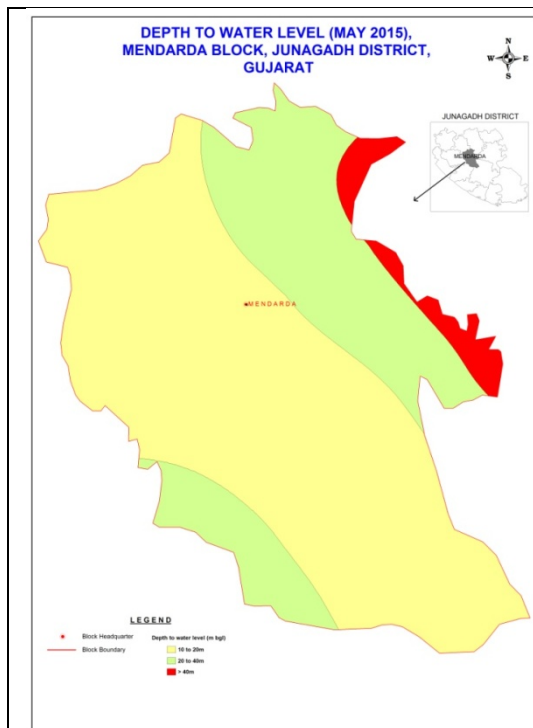


Fig 4: DTW Map (Pre monsoon)

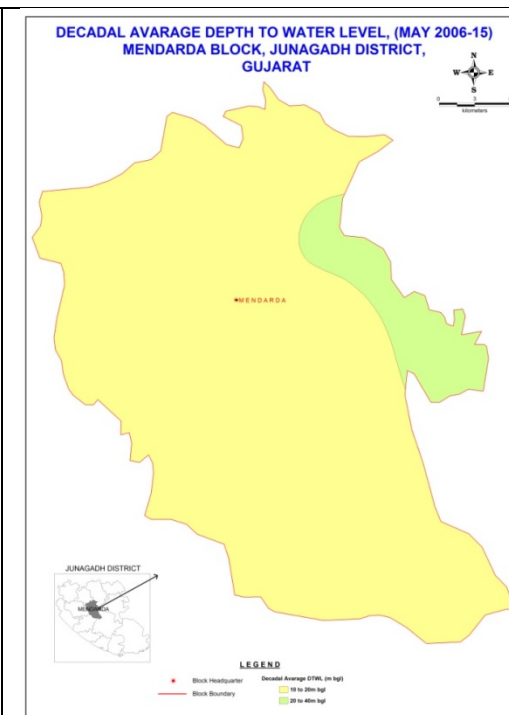


Fig 5: Decadal Average Depth to Water Level

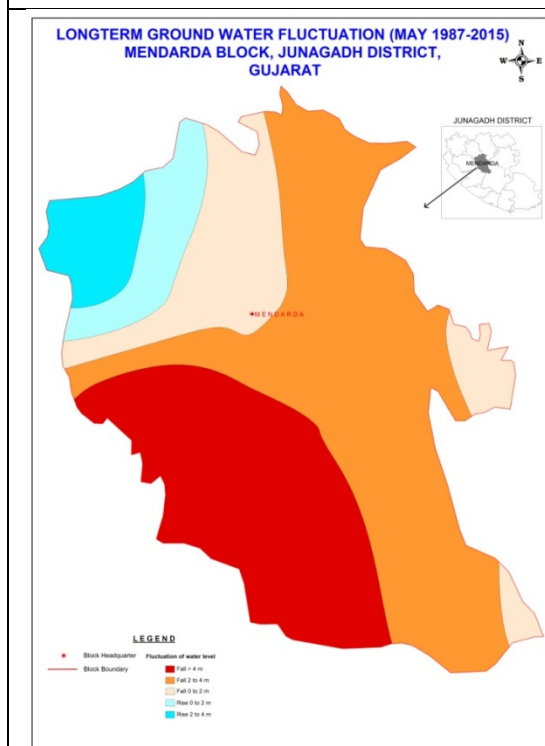


Fig.6 Absolute fluctuation Pre-monsoon

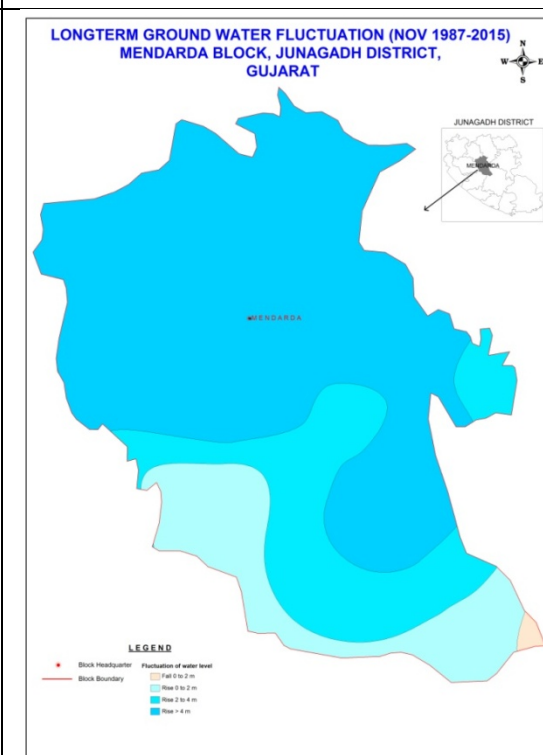


Fig. 7 Absolute fluctuation Post-monsoon

Water Table map (Fig 8) shows water table are ranges 62.42 m to 135.02 m above msl and groundwater flow direction is from South-East to North-West. A groundwater mount is shown in the South-Eastern side of the Taluka.

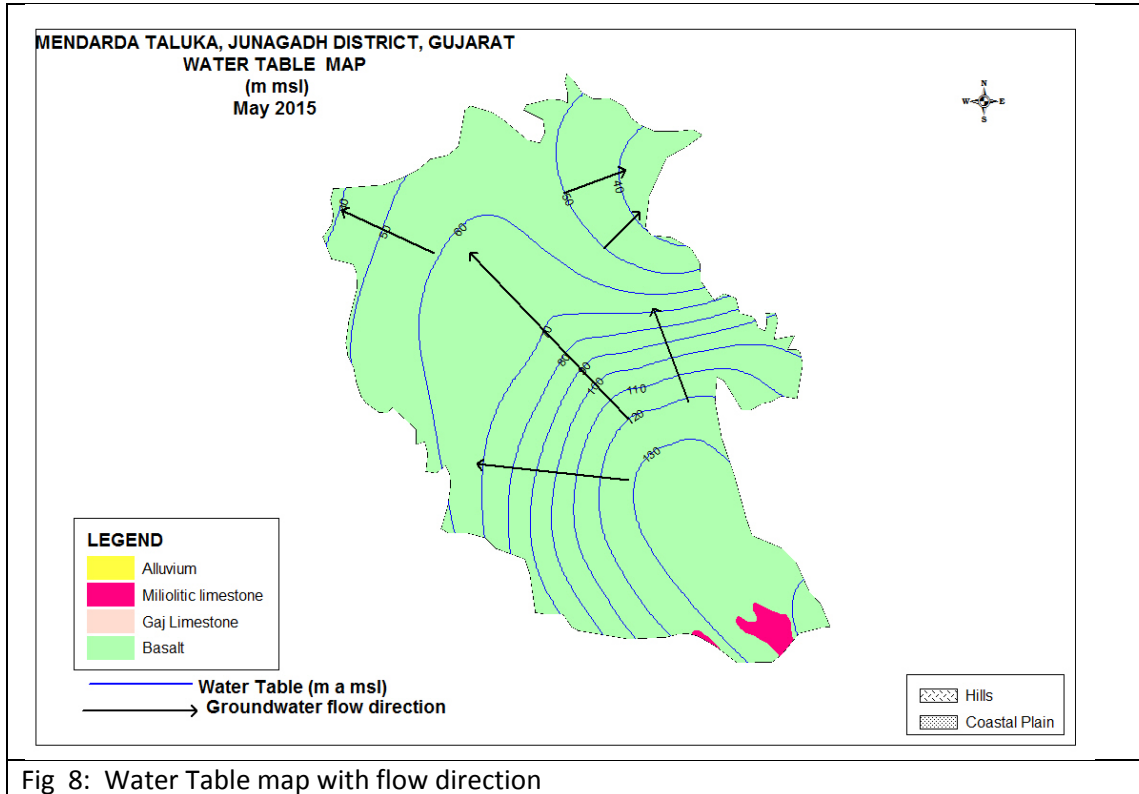


Fig 8: Water Table map with flow direction

3. Groundwater resource extraction, contamination.

Dynamic GW Resources in MCM

Total groundwater availability of the area is estimated in year 2013 is 86.49 MCM and total groundwater withdrawal for all purposes is 54.42MCM. The stage of groundwater development is 62.92% and the taluka is categorized “Safe” (Table 2).

Table: 2 Groundwater resources 2013

S No.	Item	Fresh	Saline	Total
1	Area	363.86	-	363.86
2	Total GW Recharge (MCM)	91.04	-	91.04
3	Net GW Availability (MCM)	86.49	-	86.49
4	Gross Draft (MCM)	54.42	-	54.42
5	Net Availability for Future Irrigation (MCM)	31.38	-	31.38
6	Stage of GW Development %	62.92 (safe)	-	62.92 (safe)

In Storage GW Resources

Name of Assessment Unit	Type of Rock Formation	Total Unit Area (sq km)	Fresh Area (sq km)	Saline/Brackish Area (sq km)	Depth of Bedrock(Soft Rock Areas/Depth upto which the aquifer is commonly Developed (HR Areas) (m)	Average Pre monsoon Water Level in (m)	Total saturated Thickness m	Thickness of the Granular Zone-Fracture zone/Productive Zone below Premonsoon WL(M)	Average Specific Yield (Sy) Fraction	FRESH In storage GW Resources (MCM)	BRACKISH/SALINE In storage GW Resources (MCM)
MENDARDA	Basalt Weathered	360.85	360.85	0	18.43	13.59	4.84		0.02	34.93	0.00
	Basalt-Massive-Fractured zone		360.85					22.9	0.01	82.63	0.00
	Milliolitic Limestone	3.53	3.52	0	21.79	14.96	6.83		0.1	2.40	0.00
MENDARDA Total		364.39	364.39	0						119.97	0.00

Chemical quality of groundwater

Groundwater quality in general is good. Salinity is expressed in terms of total dissolved solids (TDS). Most of the area in the taluka (Fig. 9) falls TDS ranges 400 to 1440 mg/litre. Min. & Max. ranges of some of the constituents is given in the following Table.

Taluka	Total dissolved solids		Cl		F		HCO ₃	
	Min	Max	Min	Max	Min	Max	Min	Max
Mendarda	400	1440	48	528	0	0.54	183	378

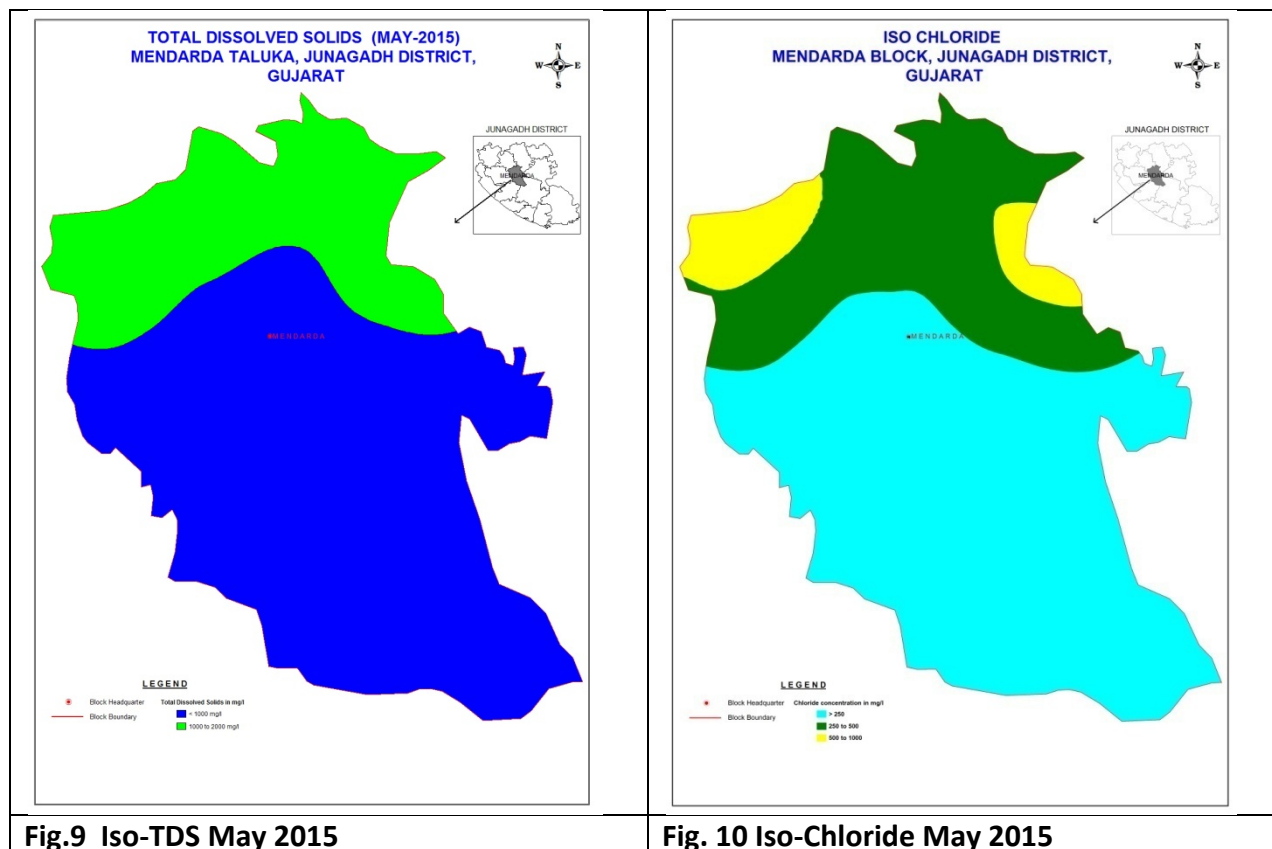


Fig.9 Iso-TDS May 2015

Fig. 10 Iso-Chloride May 2015

Ground Water Issues

- Sustainability of hard rock Aquifers
- Non Availability of sufficient Surface Water for Irrigation.
- Lack of awareness and involvement of stake holders in decision making.

4. Groundwater resource enhancement.

Table-3 Computation of volume (MCM) of water required for recharge

Aquifer	Volume of unsaturated zone available for artificial recharge	Specific yiled factor	Volume of water required for recharge MCM	Volume of rain water planned for Artificial recharge (MCM)
Basalt	345.66	0.02	6.91	0.59

Table: 4 Computation of Recharge structures.

Aquifer	Area feasible for artificial recharge Sq. Km	Volume of rain water planned for Artificial recharge (MCM)	Volume of water planned for conservation through Farm Pond	Volume of water planned for recharge through Check Dam	No of Farm Pond (Unit storage 0.05MCM)	No of Check Dam (Unit 0.05 MCM)
Basalt	98.44	2.58	1.98	0.59	39	11

Financial Outlay of the Plan

The total estimated cost of the Plan is 508.83 lakh, which includes Rs 88 lakh for ground water recharge activities, Rs 390 lakh (Farm ponds), 6.6 lakh for ground water monitoring (Piezometer construction) and Rs 24.23 lakh towards operation and maintenance charges. The tentative cost estimates of the various activities of the Plan are shown in Table 5.

Table: 5 Cost estimates of Recharge structures and monitoring well (Piezometers):

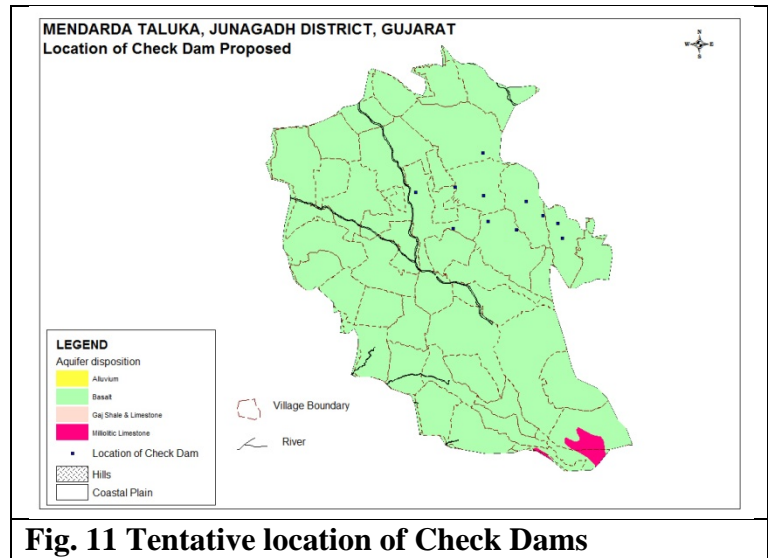
Feasible Artificial Recharge & Water Conservation structures/ activities	Tentative Design	Quantity (in nos. or area in sq. m)	Rainwater harvested (mcm)	Tentative unit cost (in Rs lakh)	Total tentative cost (in Rs lakh)	Expected Annual GW recharge/ conservation (mcm)
Recharge Structures/ Activities						
Check Dam		11	0.55	8	88	0.50
Sub total					88	0.50
Water Conservation Activities						
Farm Pond (3 fillings)	(30 m x 30m x 1.5 m) 900 sq.m or 0.1 ha	39	1.95	10	390	1.365
Impact assessment & Monitoring						
Piezometer	Up to 50 m bgl	11		0.6	6.6	
<i>Impact assessment will be carried out by implemneting agency</i>						
O & M - 5% of total cost of the scheme					24.23	
TOTAL					508.83	

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

The tentative location of villages for construction of Check Dams and their cost estimates are shown in Fig. 11 and Table 6.

Table-6 : TENTATIVE LIST OF VILLAGES WHERE ARTIFICIAL RECHARGE STRUCTURES CAN BE TAKEN UP

Sr no.	Village	Taluka
1	Chiroda	MENDARDA
2	Datrana	MENDARDA
3	Gundala	MENDARDA
4	Gundala	MENDARDA
5	Jhinjhuda	MENDARDA
6	Jhinjhuda	MENDARDA
7	Mendarda	MENDARDA
8	Mendarda	MENDARDA
9	Moti Khodiyar	MENDARDA
10	Moti Khodiyar	MENDARDA
11	Najapur	MENDARDA



1. Demand Side Management:

As the surface water is not available to improve the supply of water, demand side management is essential.

Table: 7 Crop wise area in Hectares covered under micro irrigation methods (source Gujarat Green Revolution Company, Vadodara, Gujarat).

CROP	Area in Ha.	CROP	Area in Ha.	CROP	Area in Ha.
Banana	4.22	GARLIC	4.01	PAPAYA	23.79
BITTER GUARD	77.77	GOURDS	4.2	PIGEONPEA	2.99
BOTTLE GUARD	121.93	GRAM	1.2	Pomogranate	25.52
BRINJAL	0.8	GREEN GRAM	19.56	RIDGEGOURD	14.68
CASTOR	20.23	GROUNDNUT	6136.33	ROSE	1.6
COCONUT	3.14	JOWAR	0.8	SESAMUM	7.73
COTTON	406.33	KANTOLA	5	WATERMELON	5.91
CUSTARD APPLE	10.73	LEMON	6.6	WHEAT	252.14
DRUMSTICK	1.17	Mango	222.27	Grand Total	7380.65

Water use efficiency by Drip Irrigation in Rabi crop season:

An area of 7380.65 hectare is covered by micro-irrigation scheme (MIS) under different crops grown in the district (Table 7). It is estimated the groundwater saving in the district by adopting the drip irrigation method to the main crop in Rabi season is about 0.22 MCM. It is estimated saving of groundwater through Drip irrigation separately to the Crop Cotton and Groundnut are 7.79 MCM and 2.18 MCM respectively (Table 8).

Table :8 Groundwater saving by Drip irrigation in MCM

Taluka	Rabi_Crops	Cotton crop		Grounut crop		Total
		Summer	Kharif	Summer	Kharif	
Mendarda	0.29	0.00	0.00	7.02	2.55	9.86

Expected Benefits or outcome of the Plan

Ground water recharge and water conservation Plan of Mendarda Taluka, Junagadh district envisages gainful utilization of 0.59 MCM of volume of rain water planned for recharging of depleted aquifer system. Besides this, the proposed intervention would also lead to reduction of pre-existing ground water draft by 1.98 MCM annually through construction of farm ponds. By adopting the micro-irrigation area in the remaining area conserve the 9.86 MCM of groundwater draft in the district.

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 49% from the existing 63%. The projected status of ground water resources and utilization scenario is presented in table 9.

Table :9 Projected Status of Groundwater Resource & Utilization on Recharge and Micro-Irrigation Interventions

Taluka	Net G.W. Availability (MCM)	Additional Recharge from RWH (mcm)	Total Net G.W. Availability after intervention (mcm)	Existing G.W. Draft for all purpose (mcm)	Saving of Ground water through conservation (mcm)	Saving of Ground water through MIS (mcm)	Net GW draft after interventions (mcm)	Present stage of G.W. development (%)	Projected stage of G.W. Development (in %)
Mendarda	86.49	0.59	87.08	54.416	1.98	9.86	42.57	63	49

Projected irrigation potential:

It is estimated 2842 Ha additional irrigation potential may be created in the taluka on 70% of groundwater development Table 10.

Table: 10 Irrigation command area on 70% of development of groundwater

District	Development %	Net G.W. Availability (MCM)	Additional Recharge from RWH (mcm)	Total Net G.W. Availability after intervention (mcm)	Max GW available on 70% development MCM	Existing G.W Draft for all purpose (mcm)	Balanced GW available on 70% development and Existing Draft	Saving of Ground water through conservation (mcm)	Net GW available for withdrawal after interventions (mcm)	Average crop water requirement by Drip Irrigationm	Additional area to be Irrigate in sq. km	Area can be Irrigate in Ha
Mendarda	70	86.49	0.59	87.08	60.96	54.42	6.54	1.98	8.53	0.30	28.42	2841.70

CONCLUSION AND RECOMMENDATION:

1. It is recommended to increase the recharge of groundwater from external surface water sources. It is also important to properly maintain and timely operate the existing recharge and salinity control structures.
2. Recommended to construct the 11 check dam and 39 Farm ponds in the Taluka to recharge 0.59 MCM and conserve 1.98 MCM of rainfall runoff.
3. During the electrification of well/ bore wells, the micro-irrigation through drip/sprinkler irrigation should be made mandatory, so as to minimize use of groundwater.
4. 209 Hectares area may brought under micro-irrigation to adopt Drip method to save about 0.29 MCM of water during the Rabi crop season.
5. 9578 Hectare Groundnut crop area during pre-Kharif season and last phase of Kharif season may brought under Drip irrigation to save 9.57 MCM of water.
6. 2842 Hectare land may additionally irrigated on 70% of groundwater development and observing all intervention proposed.

- **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.

