Draft Report

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

Kutiyana, Porbandar District, Gujarat

पश्चिमी मध्य क्षेत्र, अहमदाबाद

West Central Region, Ahmedabad

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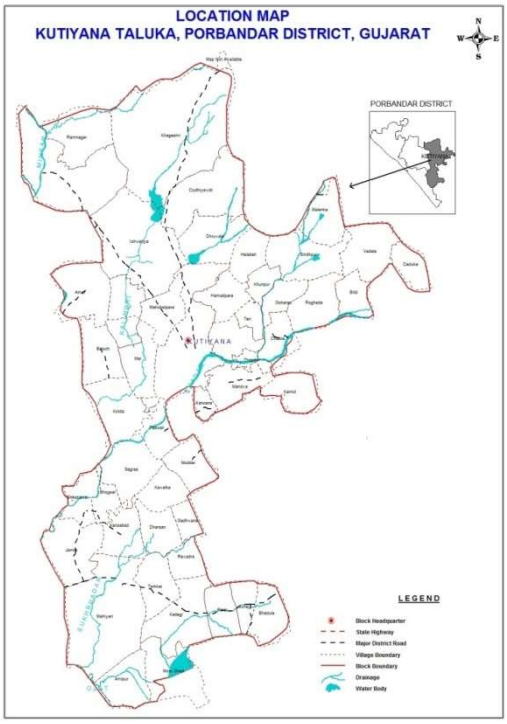
GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND
GANGA REJUVENATION



REPORT ON

AQUIFER MAPS & MANAGEMENT PLANS
KUTIYAN, PORBANDAR DISTRICT, GUJARAT STATE

CENTRAL GROUND WATER BOARD
WEST CENTRAL REGION
AHMEDABAD

MANAGEMENT PLANS OF
KUTIYANA TALUKA, PORBANDAR DISTRICT, GUJARAT STATE

1. SALIENT FEATURES

<table>
<tr><td>1</td><td>Name of the TALUKA & Area Location (Fig-1)</td><td>:</td><td>KUTIYANA - 566 Km^2
21°23’39” to 21°48’29” N
69°51’56” to 70°08’53” E</td></tr>
<tr><td>2</td><td>No. of Town, villages</td><td>:</td><td>1, 47</td></tr>
<tr><td>3</td><td>District/State</td><td>:</td><td>Porbandar/Gujarat</td></tr>
<tr><td>4</td><td>Population (2011 Census)</td><td>:</td><td>69640</td></tr>
<tr><td>5</td><td>Normal Rainfall (mm)</td><td>:</td><td>657.08 mm- Monsoon Rainfall (IMD) (in mm) (Long Term) 50
918.40 mm -Average Monsoon Rainfall (in mm) (2003-12)</td></tr>
<tr><td>6</td><td>Agriculture (20015-16)</td><td>:</td><td>
<table>
<tr><td colspan="2">Kharif Crops</td><td colspan="2">Rabi Crops</td></tr>
<tr><td>Crop</td><td>Area in Hact</td><td>Crop</td><td>Area in Hact</td></tr>
<tr><td>Groundnut</td><td>9700</td><td>Wheat</td><td>360</td></tr>
<tr><td>Castor</td><td>350</td><td>Gram</td><td>100</td></tr>
<tr><td>Cotton</td><td>13400</td><td>Jira</td><td>400</td></tr>
<tr><td>Vegetables</td><td>50</td><td>Coriander</td><td>320</td></tr>
<tr><td>Fodder</td><td>2750</td><td>Mug</td><td>50</td></tr>
<tr><td></td><td></td><td>Juvar</td><td>540</td></tr>
<tr><td></td><td></td><td>Vegetables</td><td>20</td></tr>
<tr><td></td><td></td><td>Fodder</td><td>3170</td></tr>
<tr><td>Total</td><td>26250</td><td>Total</td><td>4960</td></tr>
</table>
</td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">Existing and future water demands (MCM)</td><td rowspan="3"></td><td>Sector</td><td>Existing (MCM)</td><td>Future (MCM) (Year 2025)</td></tr>
<tr><td>Domestic and Industrial</td><td>2.51</td><td>3.36</td></tr>
<tr><td>Irrigation</td><td>44.44</td><td>24.11</td></tr>
<tr><td>8</td><td>Water level behaviour (2015) (Fig-2 & 3)</td><td></td><td colspan="3">10-40 m (Pre-monsoon)</td></tr>
</table>

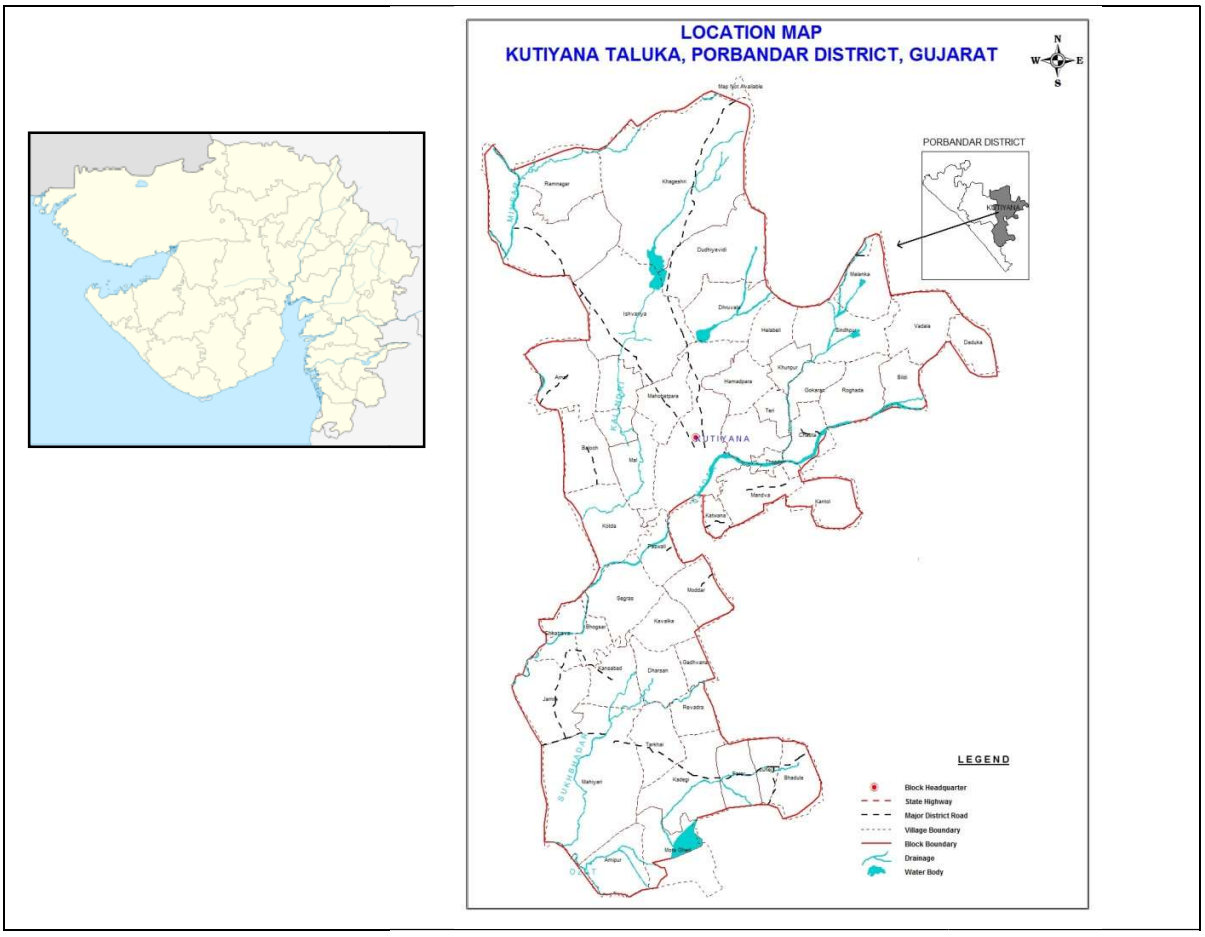


Fig-1: Location Map

2. Hydrogeology:

Mainly three formations form aquifers in the area (Fig.2) namely Basalt, Limestone and Alluvium. The limestone constitute both Miliolitic limestone and Gaj limestone, however the quality of water is saline in Gaj limestone at depths. Alluvium is surficial features and does not forms good aquifer though the quality of ground water is also saline at depth. In upstream area the basaltic aquifer is only aquifer 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. 4.

Water Table map (Fig 5) shows water table are high around Barda hill in the north and have steep slope, the elevation of water table reduces almost to sea level along the sea. Flow direction is in general towards south and south west.

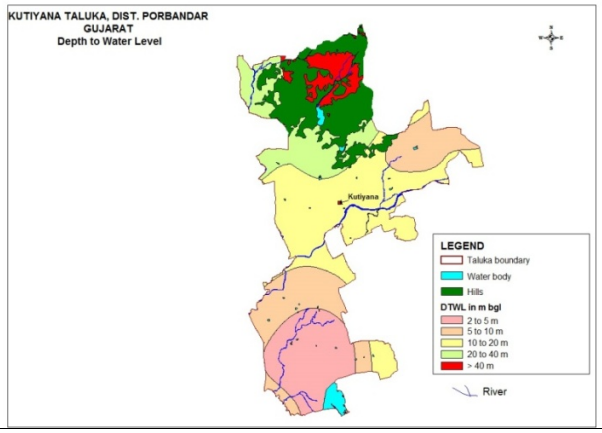


Fig 2: DTW Map (Pre monsoon)

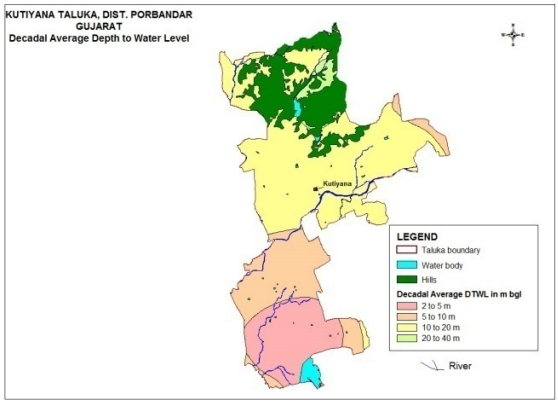


Fig 3: Decadal Average Depth to Water Level

Subsurface Hydrogeology

As inferred from borehole data of the Kutiyana Taluka, Miliolitic limestone and weathered and fractured Basalt forms the principal aquifer in the Taluka. The depth of drilling ranges from 53.9 to 150 mbgl and the average discharge ranges from 0.83 to 14.67 lps. The quality of water has Salinity problem particularly area close to vicinity of sea, Ghed area. Transmissivity value is observed 130 m^2/day.

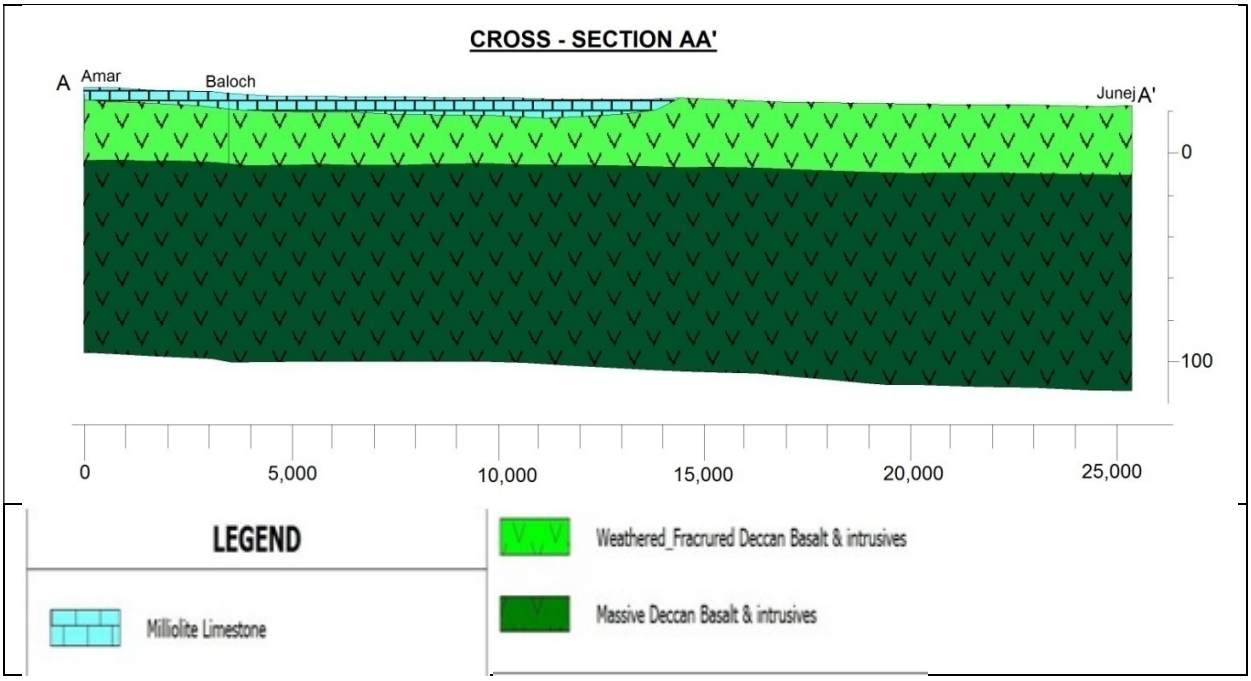


Fig-4: Stratigraphic Section

Table: 1 Aquifer characteristics

Name of aquifer	Aquifer material	Nature of aquifer	Thickness (m)		Nature of porosity	Average Yield m3/day	Quality
			Min.	Max.			
Miliolitic limestone	Limestone	Unconfined	2.27	46	Primary and secondary (Poreses, fractures and solution cavities)	210	Fresh at shallow depth and saline in depth in contact of Gaj formation
Deccan Trap	Basalt	Unconfined (Weathered and fractured)	1	65	Secondary (weathered & fracture)	182	Fresh
		Confined (Massive & amygdolidal)		Explore up to the depth of 350 m	Secondary (fractures, joints, shears and flow contacts)		Fresh

Large part of the taluka is having depth to water level between 10 to 20 m bgl. However in the north eastern part water levels are more than 20 m bgl, whereas in the south eastern part near the coast water levels are less than 5 m bgl (fig 5). The decadal average depth to water levels also depict almost similar picture, the 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, whereas, shallow water levels are observed on south eastern part of taluka (Fig.6).

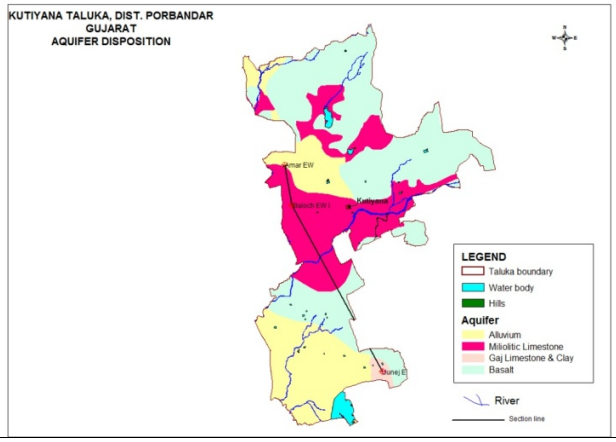


Fig 4: Aquifer disposition of the area

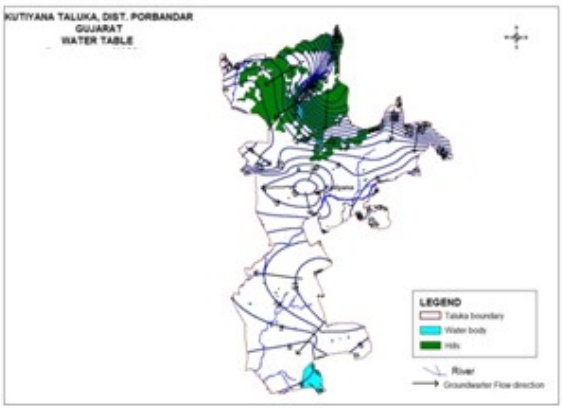


Fig 5: Water Table map with flow direction

3. Groundwater resource extraction, contamination.

Dynamic GW Resources in MCM

Total groundwater availability of the area is estimated in year 2013 is 65.29 MCM and total groundwater withdrawal for all purposes is 44.41 MCM. The stage of groundwater development is 65.29% and the taluka is categorized "Safe". Ground Water Resources upto 200 m depth are given below in table 2.

Table: 2 Groundwater resources 2013

S No.	Item	Fresh	Saline	Total
1	Area	407.41	148.94	
2	Total GW Recharge	75.69	19.38	79.18
3	Net GW Availability	71.90	17.44	74.70
4	Gross Draft	46.95	7.75	50.33
5	Net Availability for Future Irrigation	24.11	9.69	23.56
6	Stage of GW Development	65.29	44.41	67.38

In Storage GW Resources

Typr of Rock Formation	Total Geographical Area (sq km)	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)
1	2	3	4	5	6	7	8	9	10	11	12
Alluvium & Miliolite		188.05	41.05	147	19.5	13.5	6		0.1	24.63	88.20
Tertiary-Gaj		6.25		6.25	51.1	9.14	41.96		0.08	0.00	20.98
Basalt-Weathered		281.15	186.28	94.87	25.35	14.99	10.36		0.02	38.60	19.66
Basalt-Massive-Fractured zone			186.28	94.87	93.42			9.342	0.002	3.48	1.77
Total	566	475.45	227.33	248.12						66.71	130.61

Chemical quality of groundwater

Ground water quality is major issue in the area. Salinity is expressed in terms of total dissolved solids (TDS). About 84% (476 sq. km) of area (Fig. 7) falls TDS more than 2000 mg/litre. Ground water quality is good in the upstream area, whereas, it deteriorates towards sea.

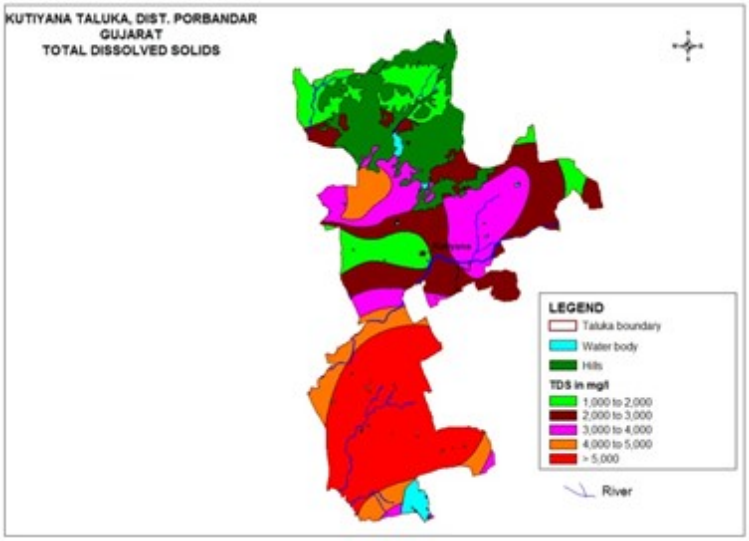


Fig 7: Ground Water Quality

Ground Water Issues

The Gaj aquifer underlying Miliolitic aquifer contains inherent salinity and development in this aquifer has to be very well coordinated as there are chances of up coning of salinity in case of over exploitation of overlying aquifer.

The main issues of water management are as detailed below:

- Salinity Ingress
- Inherent Salinity of Gaj Formation
- 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

Taluka	Aquifer	Volume of unsaturated zone avilable for artificial recharge	Specific yiled factor	Volume of water required for recharge MCM	Volume of available surplus surface water(90%) planned for Artificial recharge (MCM)
KUTIYANA	Basalt	415.96	0.03	12.479	1.05
	Limestone	100.47	0.15	15.071	0.25
KUTIYANA Total		516.43		**27.55**	1.31

Table: 4 Computation of Recharge structures.

Aquifer	Area feasible for artificial recharge Sq. km	Surplus surface water resources in Taluka MCM	Volume of surface 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	138.65		1.05	0.21	0.84	4	17
Limestone	33.49		0.25	0.05	0.20	1	4
Total	172.14	1.45	1.31			5	21

Financial Outlay of the Plan

The total estimated cost of the Plan is 242.13 lakh, which includes Rs 168 lakh for ground water recharge activities, Rs 50 lakh (Farm ponds), 12.6 lakh for ground water monitoring (Piezometer construction) and Rs 11.53 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)	Surface water 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		21	1.05	8	168	0.95
Sub total					168	0.95
Water Conservation Activities						
Farm Pond (3 fillings)	(30 m x 30m x 1.5 m) 900 sq.m or 0.1 ha	5	0.25	10	50	0.175
Impact assessment & Monitoring						
Piezometer	Up to 80 m bgl	21		0.6	12.6	
Impact assessment will be carried out by implemneting agency						
O & M - 5% of total cost of the scheme					11.53	
TOTAL					**242.13**	

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. 8 and Table 6.

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

Sr. no.	Taluka_Name	Village_ Name
1	KUTIYANA	Khageshri
2	KUTIYANA	Roghada
3	KUTIYANA	Dhruvala
4	KUTIYANA	Khageshri
5	KUTIYANA	Sindhpur
6	KUTIYANA	Sindhpur
7	KUTIYANA	Roghada
8	KUTIYANA	Sindhpur
9	KUTIYANA	Dhruvala
10	KUTIYANA	Khageshri
11	KUTIYANA	Khageshri
12	KUTIYANA	Dhruvala
13	KUTIYANA	Ishvariya
14	KUTIYANA	Ishvariya
15	KUTIYANA	Devda
16	KUTIYANA	Ramnagar
17	KUTIYANA	Devda
18	KUTIYANA	Devda
19	KUTIYANA	Devda
20	KUTIYANA	Devda
21	KUTIYANA	Ramnagar

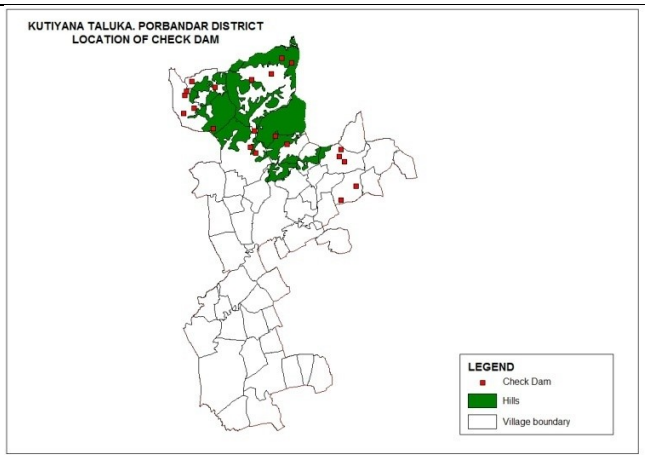


Fig. 8 Tentative location of Check Dams

5. 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	KUTIYANA
AMLA	29.84
BAJRA	1
Banana	0.39
BER	34.06
BOTTLE GUARD	15.88
BRINJAL	3.8
CASTOR	16.39
CHILLI	34.97
COTTON	582.11
GOURDS	2
GRAM	14.23
GREEN GRAM	79.35
GROUNDNUT	2479.37
GUAVA	8.01
LEMON	24.74
Mango	20.52
MUSK MEION	2
PAPAYA	30.76
Pomogranate	20.14
RIDGE-GOURD	1
WATERMELON	9.82
WHEAT	220.34
Grand Total	**3630.72**

Water use efficiency by Drip Irrigation in Rabi crop season:

An area of 3631 hectare is covered by micro-irrigation scheme (MIS) under different crops grown in the district (Table 7). In the taluka 1300 Ha.land (year 2015-16) is covered by the crop of Wheat, jira (cumin), onion castor and Juvar and out of which 220 Ha. area is irrigated by micro irrigation (Source GGRC, Vadodara, Gujarat). It is estimated the groundwater saving in the district by adopting the drip irrigation method in an area of 648 Ha. to the crop mentioned in the Table 8 is about 2 MCM during the Rabi crop season. It is estimated saving of groundwater through Drip irrigation to the Crop Groundnut and Cotton are 2.67 MCM and 5.91 MCM respectively (Table 9 to 12).

Table: 8 Water saving in MCM by application of Drip Irrigation in proposed 60% balance area left under micro irrigation during main Rabi corp.

Taluka	Crop Area in Ha.		Wheat	Jira	Onion	Castor	Juvar	Total
Kutiyana	Crop area		360	400	0	0	540	1300
	Under MIS		220.34	0	0	0	0	220
	Balance Area		139.66	400	0	0	540	1080
	Proposed 60% area to the balance for micro irrigation in Ha.		83.796	240	0	0	324	648
	Crop water requirements(mm)	Flood Irrigation	532	150	540	300	950	494
		Drip Irrigation	396	100	330	214	665	341
		water saving in mm	136	50	210	86	285	153
	water saving in MCM		**0.1899376**	**0.2**	**0**	**0**	**1.539**	**2**

Table: 9 Are under micro irrigation for Groundnut corp.

Taluka	Pre-Kharif Irrigated 4th week of May to 2nd week of June	Kharif - Rainfed 2nd week of June to 1st week of July	Total crop area in Ha.	Area covered Under MIS in Ha	Balance Area in Ha.	Proportnate Proposed MIS in 60% of balance area in sq. Km		
						Summer	Kharif	Total
Kutiyana	1200	**8500**	9700	**2479**	7221	5.36	37.97	43.33

Table: 10 Water saving in MCM by application of Drip Irrigation in proposed 60% balance area left under micro irrigation for groundnut corp.

Taluka	Flood Irrigation by groundwater in MCM		MIS Irrigation by groundwater in MCM		Water saving		
	Pre-Kharif season	Kharif (25% groundwater used to required water)	Summer (75% groundwater to required water)	Kharif (25% groundwater to required water)	Summer	Kharif	Total
Kutiyana	4.78	8.46	3.81	6.75	0.96	1.71	2.67

Table:11 Are under micro irrigation for cotton corp.

Taluka	Pre Kharif-Irrigated 4th week of May to 2nd week of June	Kharif-Rainfed 2nd week of June to 1st week of July	Total crop area in Ha.	Area covered Under MIS in Ha	Balance Area in Ha.	Proportionate Proposed MIS in 60% of balance area in sq. Km		
						Summer	Kharif	Total
Kutiyana	900	**12500**	13400	**582**	12818	5.17	71.74	76.91

Table:12 Water saving in MCM by application of Drip Irrigation in proposed 60% balance area left under micro irrigation for Cotton corp.

Taluka	Flood Irrigation by groundwater in MCM		MIS Irrigation by groundwater in MCM		Water saving		
	Pre Kharif	Kharif (25% groundwater used to required water)	Summer (75% groundwater to required water)	Kharif (25% groundwater to required water)	Summer	Kharif	Total
Kutiyana	3.62	12.55	2.29	7.97	1.32	4.59	5.91

Expected Benefits or outcome of the Plan

Ground water recharge and water conservation Plan of Kutiyana Taluka, Porbandar district envisages gainful utilization of 1.04 MCM of surplus non committed surface water for recharging of depleted aquifer system. Besides this, the proposed intervention would also lead to reduction of pre-existing ground water draft by 0.26 MCM annually through construction of farm ponds. By adopting the micro-irrigation area in the remaining area conserve the 10 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 50% from the existing 65%. The projected status of ground water resources and utilization scenario is presented in table 13.

Table :13 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. Developement (in %)**
Kutiyana	71.90	1.04	72.94	46.95	0.26	10.00	36.69	65	50

Projected irrigation potential:

It is estimated 4520 Ha additional irrigation potential may be created in the taluka on 70% of groundwater development Table 14.

Table: 14 Irrigation command area on 70% of development of groundwater

District	Stage	Net G.W. Availability (MCM)	Additional Recharge from Check Dam (mcm)	Total Net G.W. Availability after intervention (mcm)	Max GW avilable on 70% development MCM	Existing G.W Draft for all purpose (mcm)	Balance GW avilable on 70% development to Existing Draft	Saving of Ground water through Farm ponds (mcm)	**Saving of Ground water through MIS (mcm)**	**Net GW avilable for withdrawl after interventions (mcm)**	Average crop water requirement by Drip Irrigationm	Additional area may be Irrigate in sq. km	Additional area may be Irrigate in Ha
Kutiyana	70	71.90	1	72.85	50.3331	46.95	3	0	10	13.56	0.3	45	4520

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 21 check dam and 5 Farm ponds in the Taluka to recharge 1.04 MCM and conserve 0.26 MCM of non committed available surface water.
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. 648 Hectares area may brought under micro-irrigation to adopt Drip method to save about 2 MCM of water during the Rabi crop season.
5. 4333 Hectare Groundnut crop area during pre-Kharif season and last phase of Kharif season may brought under Drip irrigation to save 2.67 MCM of water.
6. 7691 Hectare Cotton crop area during pre-Kharif season and last phase of Kharif season may brought under Drip irrigation to save 5.91 MCM of water.
7. 4520 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.