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

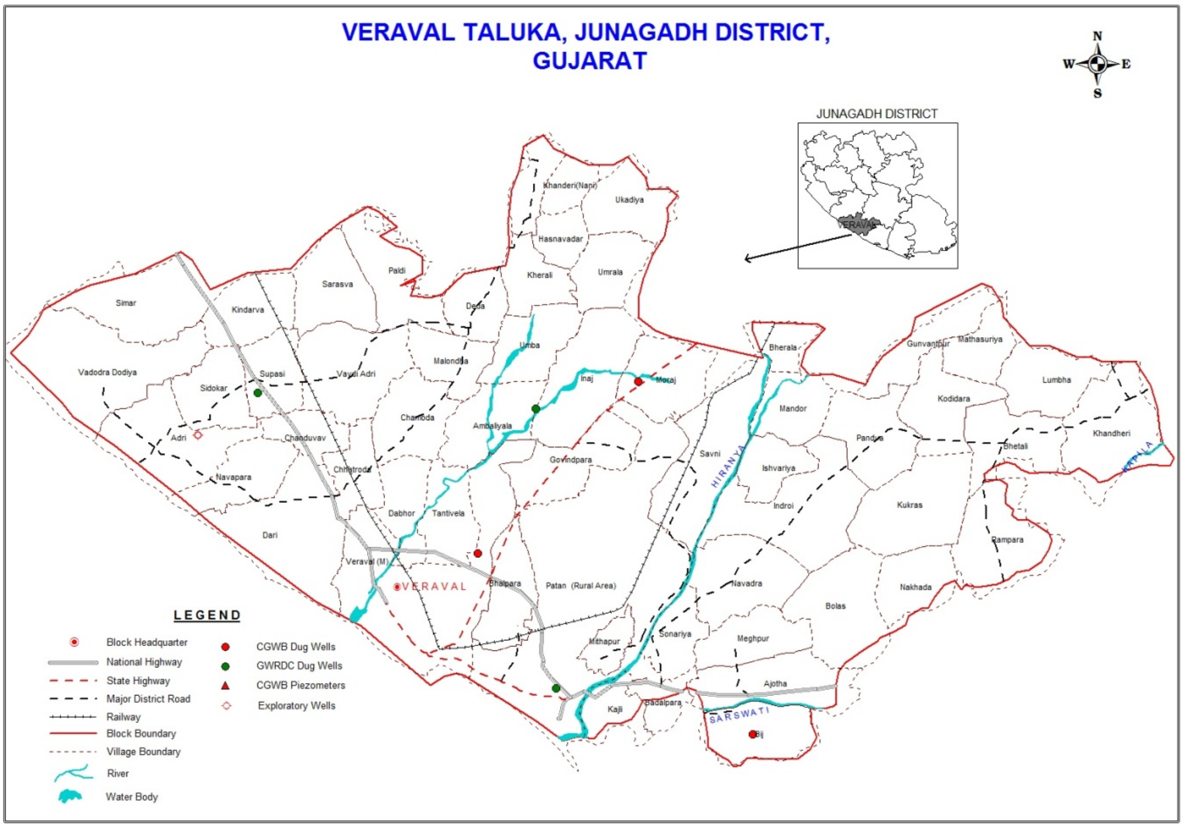
**Veraval, Junagarh District, Gujarat**

पश्चिमी मध्य क्षेत्र, अहमदाबाद

West Central Region, Ahmedabad

भारत सरकार
जल संसाधन, नदी विकास एवम् गंगा संरक्षण मंत्रालय
केंद्रीय भूमि जल बोर्ड

GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION




# REPORT ON

## AQUIFER MAPS & MANAGEMENT PLANS
## VERAVAL TALUKA, JUNAGADH DISTRICT, GUJARAT STATE

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

**AHMEDABAD**

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

## 1. SALIENT FEATURES

<table>
<tr><td>1</td><td>Name of the TALUKA& Area, Location(Fig-1)</td><td colspan="3">Veraval - 321.02 Km²<br>20°52’24” to 21°03’09” N<br>70°14’35” to 70°35’47” E</td></tr>
<tr><td>2</td><td>No. of Town, villages</td><td colspan="3"></td></tr>
<tr><td>3</td><td>District/State</td><td colspan="3">Junagadh/Gujarat</td></tr>
<tr><td>4</td><td>Population (2011 Census)</td><td colspan="3">Male- 85938, Female- 81918, Total- 167,856</td></tr>
<tr><td>5</td><td>Normal Rainfall (mm)</td><td colspan="3">766.76 mm- Monsoon Rainfall (IMD) (in mm) (Long Term) 50<br>1057.50 mm -Average Monsoon Rainfall (in mm) (2003-12)</td></tr>
<tr><td>6</td><td>Agriculture (20015-16)</td><td colspan="3">
<table>
<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>
<tr><td>Groundnut</td><td>19000</td><td>Wheat</td><td>1650</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>100</td></tr>
<tr><td>Bajri</td><td>450</td><td>Bajri</td><td>200</td></tr>
<tr><td>Tuver</td><td>350</td><td>Tuver</td><td>0</td></tr>
<tr><td>Mug</td><td>350</td><td>Mug</td><td>0</td></tr>
<tr><td>Udad</td><td>400</td><td>Mustered</td><td>0</td></tr>
<tr><td>Cotton</td><td>200</td><td>Isabgol</td><td>0</td></tr>
<tr><td>Sugarcane</td><td>500</td><td>Sugarcane</td><td>100</td></tr>
<tr><td>Vegetables</td><td>1300</td><td>Vegetables</td><td>500</td></tr>
<tr><td>Fodder</td><td>2450</td><td>Fodder</td><td>3000</td></tr>
<tr><td>Gam Guvar</td><td>0</td><td>Jira</td><td>0</td></tr>
<tr><td>Soyabin</td><td>250</td><td>Onion</td><td>50</td></tr>
<tr><td></td><td></td><td>Coriander</td><td>5550</td></tr>
<tr><td></td><td></td><td>Garlic</td><td>50</td></tr>
<tr><td></td><td></td><td>Methi</td><td>0</td></tr>
<tr><td>Total</td><td>25250</td><td>Total</td><td>11200</td></tr>
</table>
</td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">Existing and future water demands (MCM)</td><td>Sector</td><td>Existing (MCM)</td><td>Future (MCM) (Year 2025)</td></tr>
<tr><td>Domestic and Industrial</td><td>7.42</td><td>9.95</td></tr>
<tr><td>Irrigation</td><td>34.56</td><td>17.34</td></tr>
<tr><td>8</td><td>Water level behaviour (2015)(Fig-2 & 3)</td><td colspan="3">35.70 m (Pre-monsoon)</td></tr>
</table>

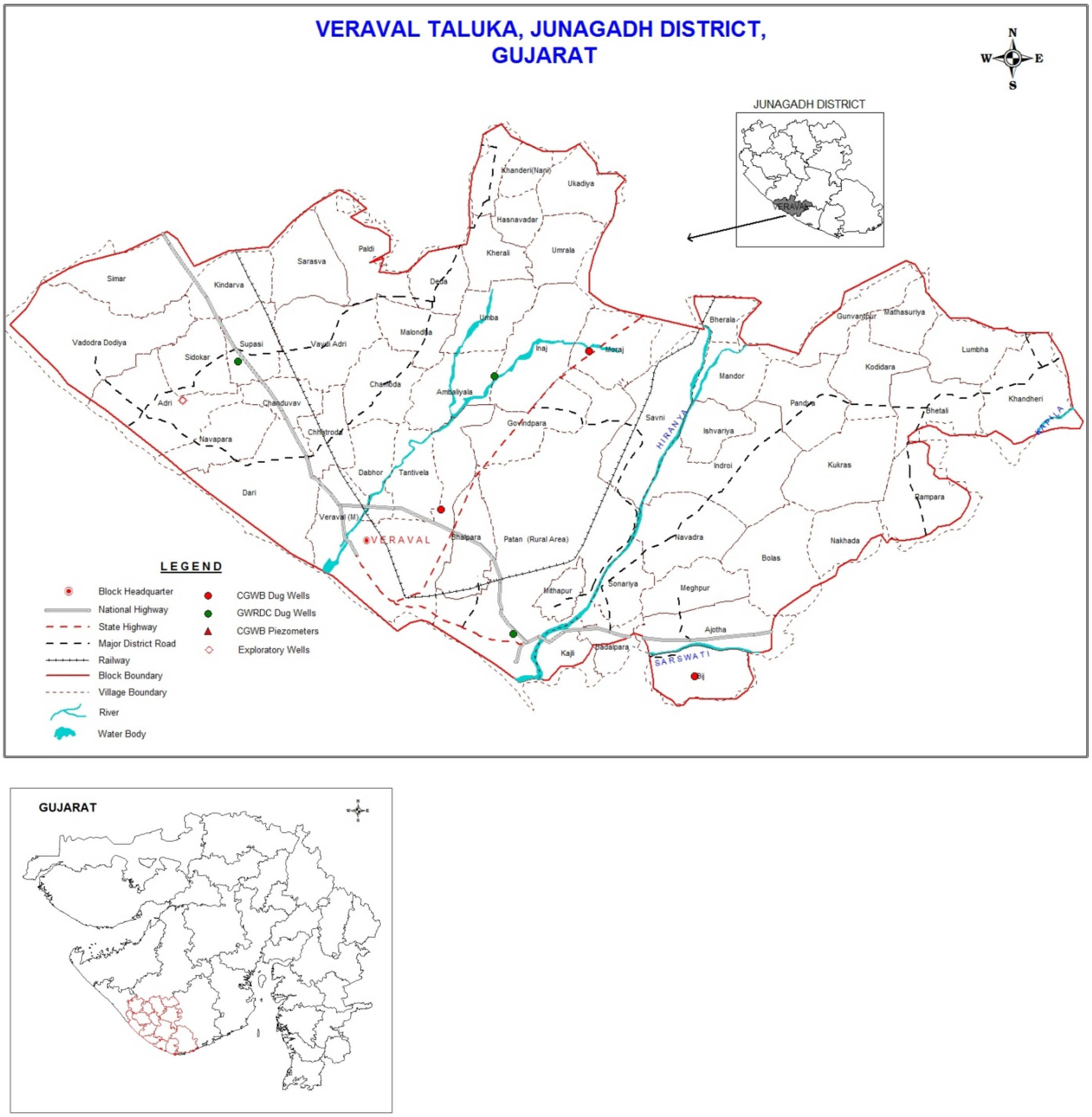



**Fig-1: Location Map**

1. **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. Miliolite limestone occupies major parts of the taluka. It also occurs as small outliers in Gaj and Trap country. The limestone is karstified at places. It is made of remains of foraminifers Miliolite around which calcite grain have formed (Krishnan, 1968). 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. 3.

### Subsurface Hydrogeology

As inferred from borehole data of the Veraval Taluka, Miliolitic limestone and weathered and fractured Basalt forms the principal aquifer in the Taluka. Top portion of Gaj formation is ocherous limestone with pockets of yellow clay and is easily distinguishable from the overlying Miliolite limestone. It is horizontally bedded and dip at small angle towards the sea. The lower part of Gaj formation is of marine origin whereas part is estuarine (Krishnan, 1968). Groundwater in aquifers 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 118 mbgl and the average discharge ranges from 2 to 5 lps by compressor during drilling. The quality of water has Salinity problem particularly area close to vicinity of sea, Ghed area.

## 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 65 | Primary and secondary (Poreses, fractures and solution cavities) | - | - |
| Gaj limestone | Limestone | Unconfined & confined | 18 to 101 | Primary and Secondary (Pores, Fractures and solution cavities) | Average yield 201m$^3$/day | Good to bad |
| Deccan Trap | Basalt | Unconfined (Weathered and fractured) | 56 to 109 | Secondary ( weathered & fracture) | yield 10 to 1370 m$^3$/day | Fresh |
| | | Deep Fracture (Massive & amygdolidal) | Explore up to the depth of 118 m | Secondary (fractures, joints, shears and flow contacts ) | Compressor discharge 2 to 5 lps | Fresh |

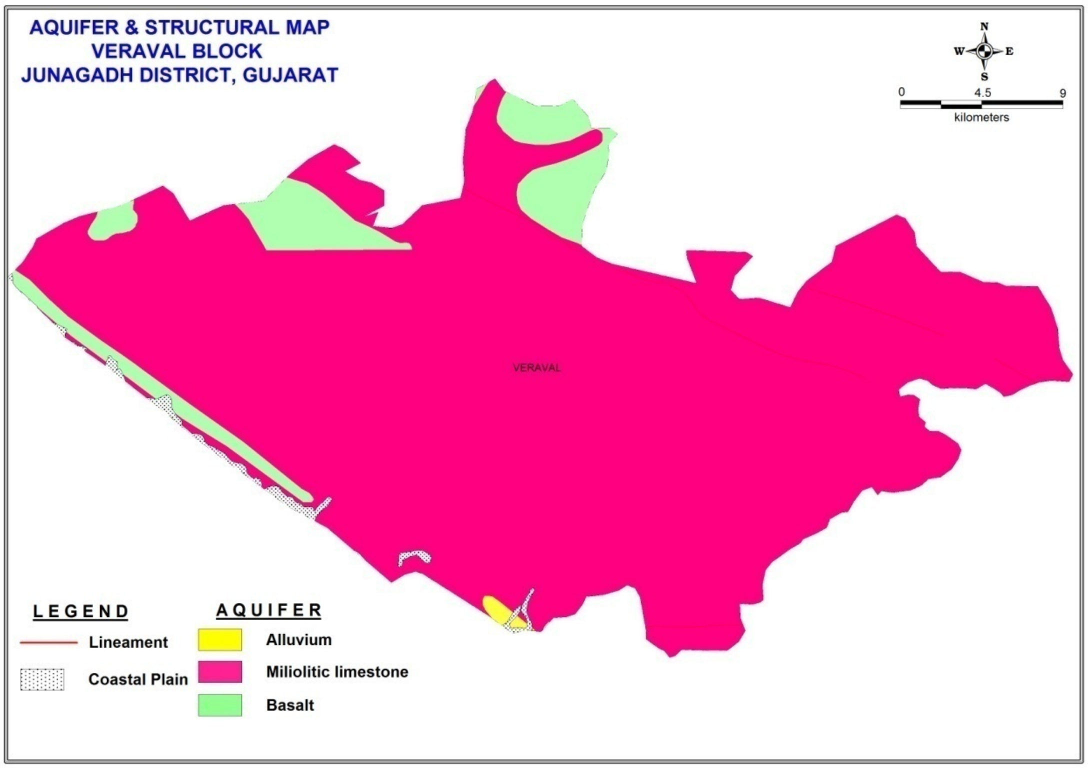
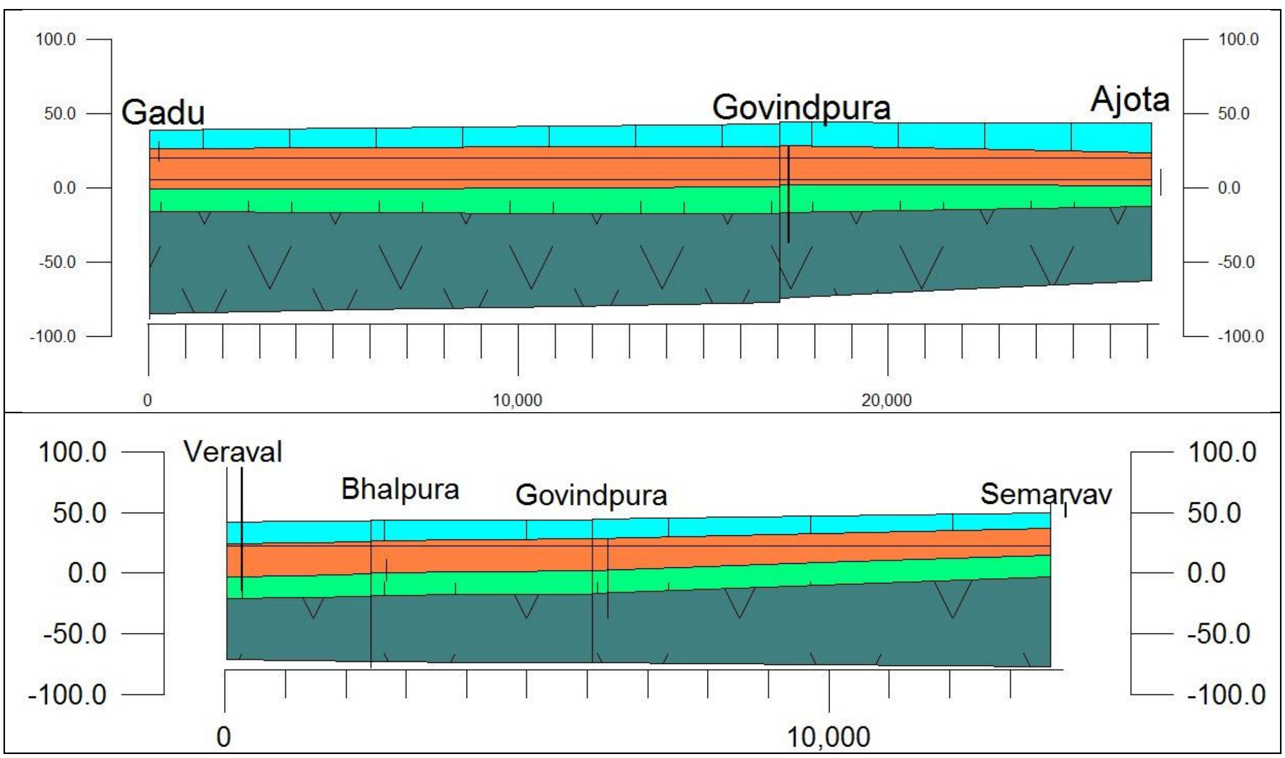



Fig 2: Aquifer disposition of the area



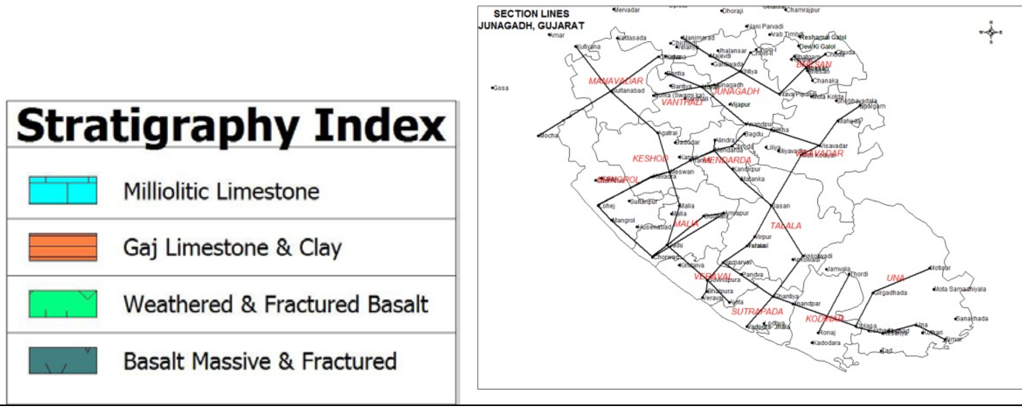



**Fig-3: Stratigraphic Section**

## Depth to water level:

Large part of the taluka is having depth to water level mostly between 20 to 40 m bgl except NE and Eastern fringe area shows water level 10 to 20 m bgl (Fig. 4). Decadal average water level mostly between the period of May 2006 and 2015 ranges from 4.87 to 21.77 m bgl. (Fig5).

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 |
| 0.30 | 0.30 | 8.60 | 25.70 | 2.20 | 9.50 | | 0.30 |

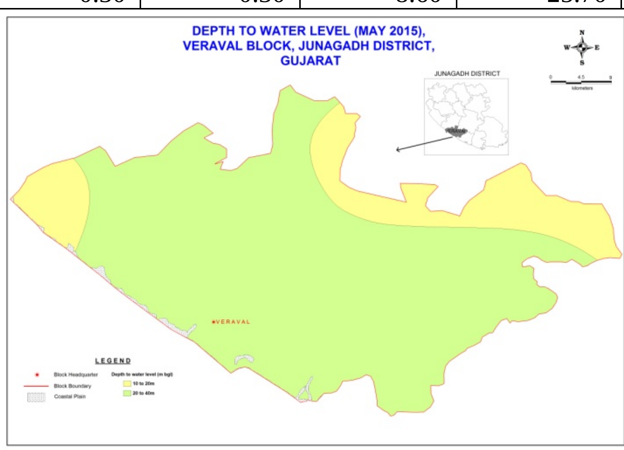



Fig 4: DTW Map (Pre monsoon)

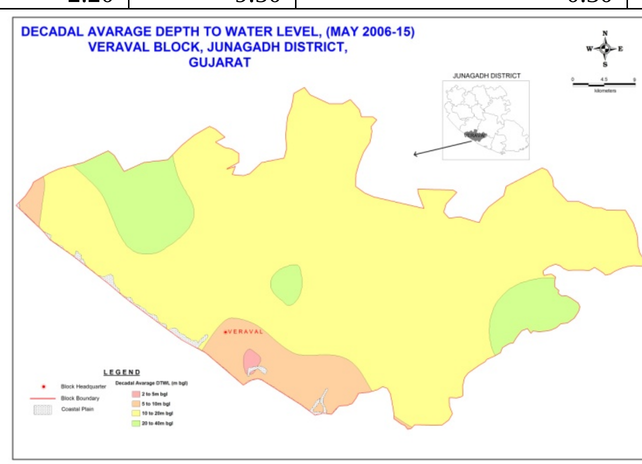



Fig 5: Decadal Average Depth to Water Level

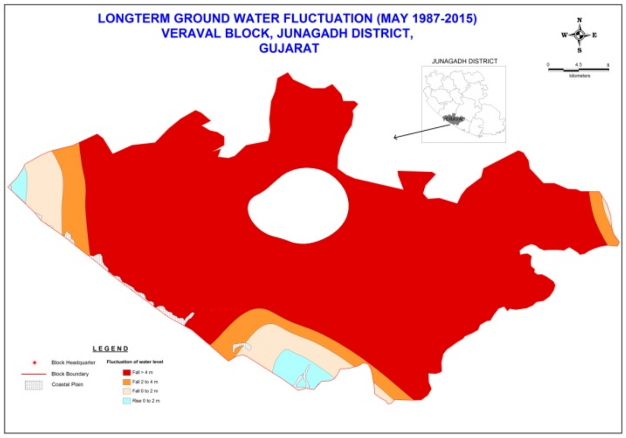



**Fig.6 Absolute fluctuation Pre-monsoon**

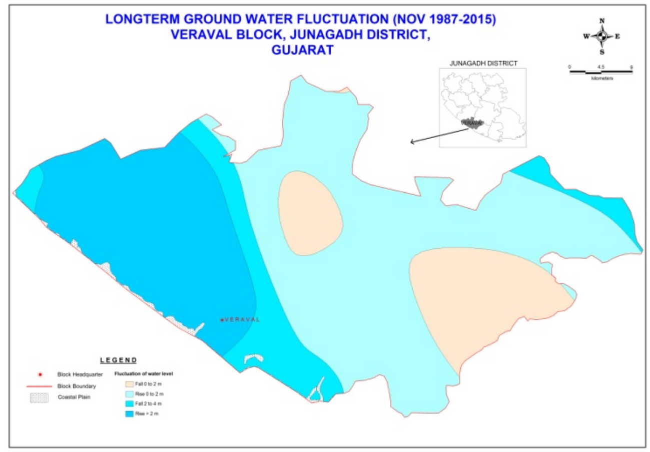



**Fig. 7 Absolute fluctuation Post-monsoon**

Water Table map (Fig 8) shows water table are ranges 7.4 m below msl to 70.0 m above msl and groundwater flow direction is from NE to SW with the gradient of flow steeper in off coastal area portion and flaten in coastal area.

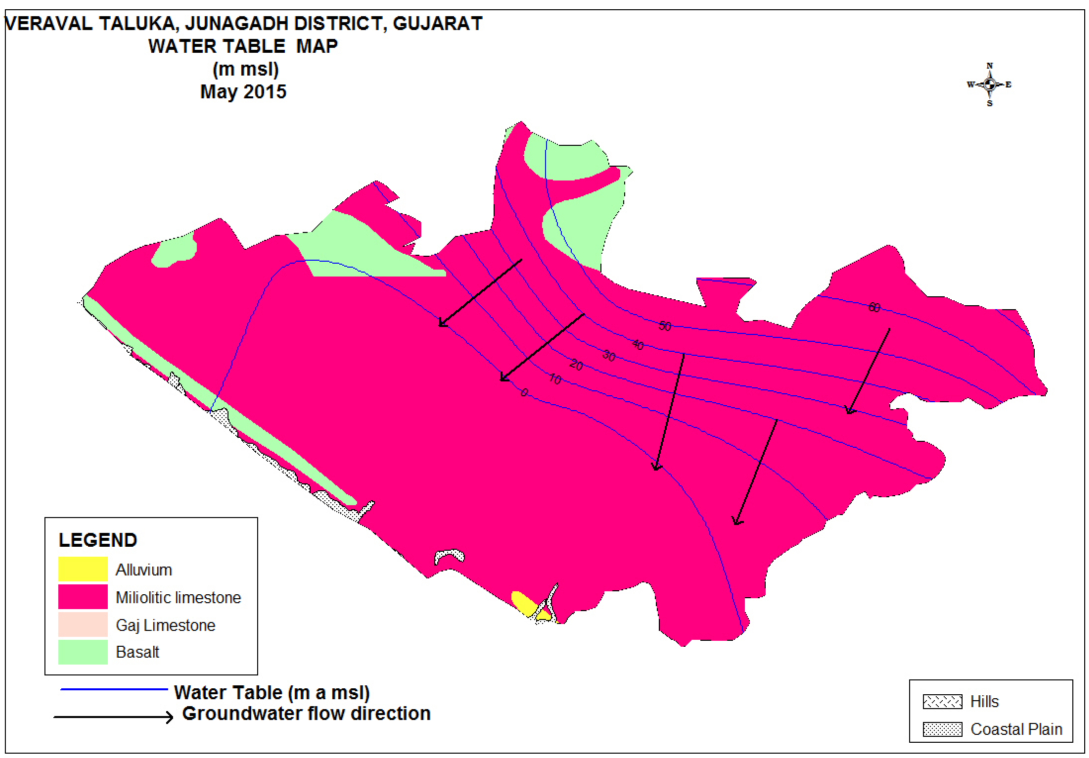



Fig 8: Water Table map with flow direction

## 3. Groundwater resource extraction, contamination.

### Dynamic GW Resources in MCM

Total groundwater availability of the area is estimated in year 2013 in fresh area is 61.85 MCM and total groundwater withdrawal for all purposes is 41.98 MCM. The stage of groundwater development is 67.87% and the taluka is categorized "Safe" (Table 2).

Table: 2 Groundwater resources 2013

| S No. | Item | Fresh | Saline |
|---|---|---|---|
| 1 | Area | 291.90 | 138.70 |
| 2 | Total GW Recharge (MCM) | 65.11 | 34.87 |
| 3 | Net GW Availability (MCM) | 61.85 | 33.13 |
| 4 | Gross Draft (MCM) | 41.98 | 14.33 |
| 5 | Net Availability for Future Irrigation (MCM) | 17.34 | 18.80 |
| 6 | Stage of GW Development % | 67.87 (safe) | 43.24 (safe) |

### In Storage GW Resources

| Typr 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| Alluvium | 0.98 | 0 | 0.96 | 9.95 | 9.83 | 0.12 | | 0.1 | 0.00 | 0.01 |
| Basalt Weathered | 26.11 | 21.34 | 4.75 | 18.43 | 13.59 | 4.84 | | 0.02 | 2.07 | 0.46 |
| Basalt-Massive-Fractured zone | | 21.34 | 4.75 | | | | 11.49 | 0.01 | 2.45 | 0.55 |
| Milliolitic Limestone | 331.63 | 273.87 | 57.3 | 21.79 | 14.96 | 6.83 | | 0.1 | 187.05 | 39.14 |
| | 358.72 | 295.21 | 63 | | | | | | 191.57 | 40.15 |

## 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 <2000 mg/litre whereas some pockets in coastal area shows TDS ranges 2000 to 4000 mg/l. Min. &Max. ranges of some of the constituents is given in the following Table.

| Taluka | Total dissolved solids | | Cl | | F | | HCO3 | |
|---|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max | Min | Max |
| Veraval | 103 | 2770 | 14 | 1440 | 0.13 | 1.7 | 61 | 329 |

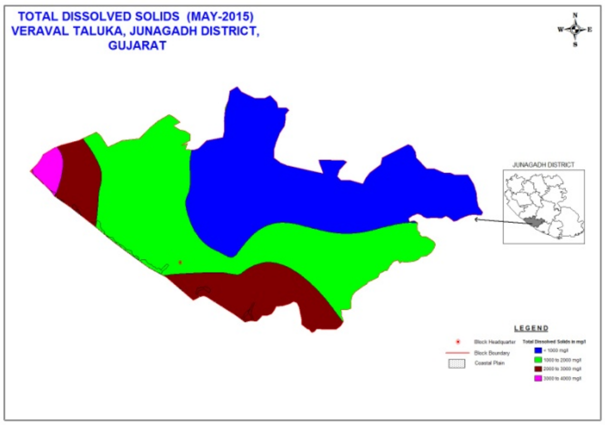



Fig.9 Iso-TDS May 2015

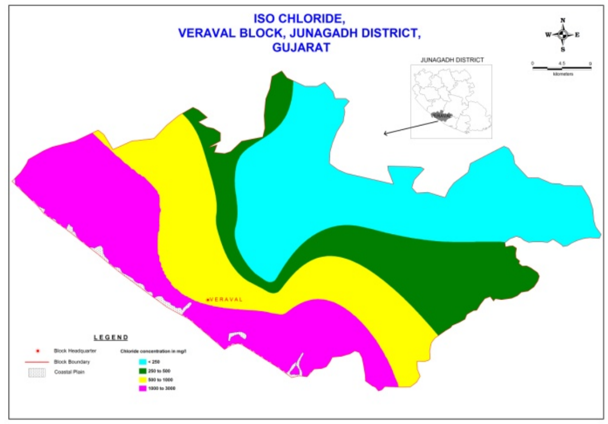



Fig. 10 Iso-Chloride May 2015

## Ground Water Issues

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

| Aquifer | Volume of unsaturated zone avilable for artificial recharge | Specific yiled factor | Volume of water required for recharge MCM | Volume of rain water planned for Artificial recharge (MCM) |
|---|---|---|---|---|
| Basalt | 74.03 | 0.02 | 1.48 | 0.08 |
| Milliolitic Limestone | 479.68 | 0.1 | 47.97 | 0.62 |
| Total | 553.71 | | 49.45 | 0.70 |

**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** | 17.91 | 0.51 | 0.43 | 0.08 | 8 | 1 |
| **Milliolitic Limestone** | 128.44 | 3.67 | 3.04 | 0.62 | 60 | 12 |
| **Total** | 146.36 | 4.18 | 3.48 | 0.70 | 68 | 13 |

**Financial Outlay of the Plan**

The total estimated cost of the Plan is 831.39 lakh, which includes Rs 104 lakh for ground water recharge activities, Rs 680 lakh (Farm ponds), 7.8 lakh for ground water monitoring (Piezometer construction) and Rs 39.59 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 | | 13 | 0.65 | 8 | 104 | 0.59 |
| Sub total | | | | | 104 | 0.59 |
| **Water Conservation Activities** | | | | | | |
| Farm Pond (3 fillings) | ( 30 m x 30m x 1.5 m) 900 sq.m or 0.1 ha | 68 | 3.4 | 10 | 680 | 2.38 |
| **Impact assessment & Monitoring** | | | | | | |
| Piezometer | Up to 80 m bgl | 13 | | 0.6 | 7.8 | |
| *Impact assessment will be carried out by implemneting agency* | | | | | | |
| O & M - 5% of total cost of the scheme | | | | | 39.59 | |
| **TOTAL** | | | | | **831.39** | |

*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 STRUCTREUS CAN BE TAKEN UP**

| Sr. No. | Village Name | Sr. No. | Village Name |
|---|---|---|---|
| 1 | Adri | 8 | Lumbha |
| 2 | Ajotha | 9 | Mathasuriya |
| 3 | Chamoda | 10 | Nakhada |
| 4 | Hasnavadar | 11 | Tantivela |
| 5 | Khandheri | 12 | Ukadiya |
| 6 | Kodidara | 13 | Vavdi Adri |
| 7 | Kukras | | |

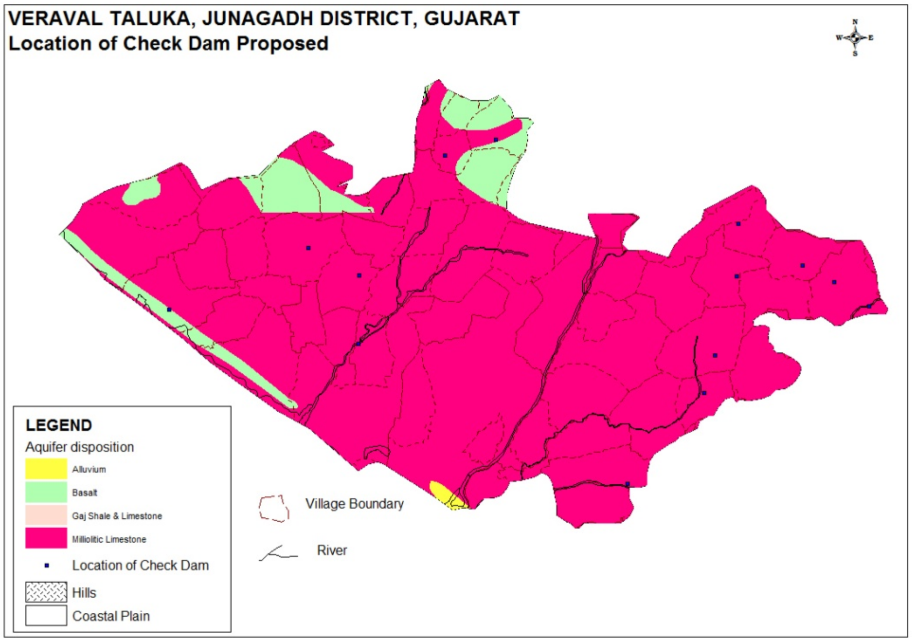



**Fig. 11 tentative location of Check Dams**

## 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. |
|---|---|---|---|---|---|
| ANOLA | 26 | COTTON | 311.98 | PAPAYA | 0.6 |
| Banana | 161.85 | CUSTARD APPLE | 5.34 | POTATO | 0.4 |
| BITTER GUARD | 30.48 | GARLIC | 1 | RIDGEGOURD | 12.08 |
| BOTTLE GUARD | 143.4 | GRAM | 31.01 | Sapota | 1 |
| BRINJAL | 7.27 | GREEN GRAM | 14.68 | SPONGE GOURD | 0.82 |
| CAPSICUM | 1.18 | GROUNDNUT | 3040.2 | SUGARCANE | 41.77 |
| CASTOR | 46.16 | KANTOLA | 2.4 | WATERMELON | 6.01 |
| CHILLI | 2.9 | LEMON | 1 | WHEAT | 95.49 |
| COCONUT | 153.55 | Mango | 70.15 | Grand Total | 4208.72 |

**Water use efficiency by Drip Irrigation in Rabi crop season:**

An area of 4209 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 1.62 MCM.It is estimated saving of groundwater through Drip irrigation for Groundnut are 10.30 MCM. and Cotton crop is not grown in the area (Table 8).

Table :8 Groundwater saving by Drip irrigation in MCM

| Taluka | Rabi_Crops | Cotton crop | | Grounnut crop | | Total |
|---|---|---|---|---|---|---|
| | | Summer | Kharif | Summer | Kharif | |
| Veraval | 1.62 | 0.00 | 0.00 | 7.98 | 2.31 | 11.91 |

## Expected Benefits or outcome of the Plan

Ground water recharge and water conservation Plan of Mendarda Taluka, Junagadh district envisages gainful utilization of 0.70 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 3.48 MCM annually through construction of farm ponds. By adopting the micro-irrigation area in the remaining area conserve the 11.91 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 43% from the existing 68%. 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. Develepement (in %) |
|---|---|---|---|---|---|---|---|---|---|
| Veraval | 61.85 | 0.70 | 62.55 | 41.978 | 3.48 | 11.91 | 26.59 | 68 | 43 |

**Projected irrigation potential:**

It is estimated 1762 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 avilable on 70% development MCM | Existing G.W Draft for all purpose (mcm) | Balanced GW avilable on 70% development and Existing Draft | Saving of Ground water through conservation (mcm) | **Net GW avilable for withdrawl after interventions (mcm)** | Average crop water requirement by Drip Irrigationm | Additional area to be Irrigate in sq. km | Area can be Irrigate in Ha |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Veraval | 70 | 61.85 | 0.70 | 62.55 | 43.79 | 41.98 | 1.81 | 3.48 | 5.29 | 0.30 | 17.62 | 1762.43 |

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 13 check dam and 68 Farm ponds in the Taluka to recharge 0.7 MCM and conserve 3.48 MCM of rainfall runoff.
3. During the electrification of well/ bore wells, the micro-irrigation through drip/sprinkler irrigation should be made mendatory, so as to minimize use of groundwater.
4. 94 Hectares area may brought under micro-irrigation to adopt Drip method to save about 1.62 MCM of water during the Rabi crop season.
5. 9576 Hectare Groundnut crop area during pre-Kharif season and last phase of Kharif season may brought under Drip irrigation to save 10.30 MCM of water.
6. 17.62 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.