



## केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

### **Central Ground Water Board**

Department of Water Resources, River  
Development and Ganga Rejuvenation,  
Ministry of Jal Shakti  
Government of India

## **AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES**

**MUDHOL TALUK,**

**BAGALKOT DISTRICT, KARNATAKA**

दक्षिण पश्चिमी क्षेत्र, बैंगलोर

South Western Region, Bengaluru



## **AQUIFER MANAGEMENT PLAN OF MUDHOL TALUK, BAGALKOT DISTRICT, KARNATAKA STATE**

### **CONTENTS**

<b>Sl. No.</b>	<b>Title</b>	<b>Page No.</b>
<b>1</b>	<b>SALIENT INFORMATION</b>	<b>1</b>
<b>2</b>	<b>AQUIFER DISPOSITION</b>	<b>8</b>
<b>3</b>	<b>GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES</b>	<b>9</b>
<b>4</b>	<b>GROUND WATER RESOURCE ENHANCEMENT</b>	<b>10</b>
<b>5</b>	<b>DEMAND SIDE INTERVENTIONS</b>	<b>10</b>
<b>6</b>	<b>SUMMARY</b>	<b>12</b>

# **AQUIFER MANAGEMENT PLAN OF MUDHOL TALUK, BAGALKOT DISTRICT, KARNATAKA STATE**

## **1.0 SALIENT INFORMATION**

Name of the taluk: Mudhol

District: Bagalkot; State: Karnataka

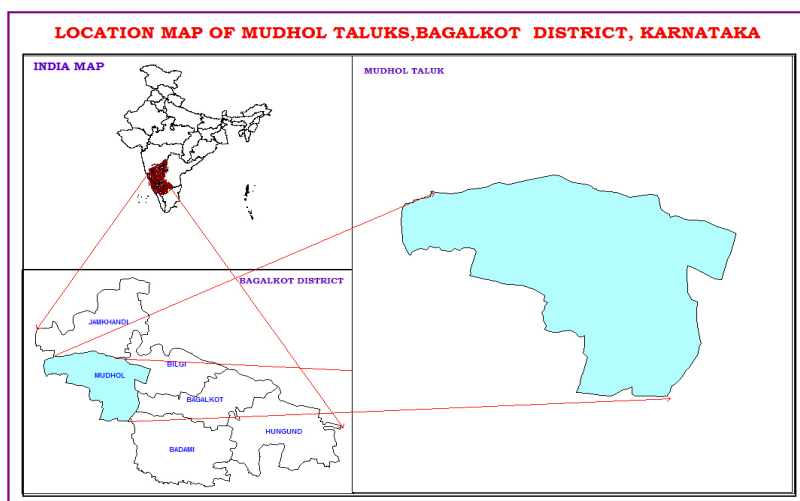
Area: 956 sq.km.

Population: 3,21,970

Annual Normal Rainfall: 511 mm

### **1.1 Aquifer management study area**

Aquifer mapping studies have been carried out in Mudhol taluk, Bagalkot district of Karnataka, covering an area of 956 sq.kms under National Aquifer Mapping Project. Mudhol taluk of Bagalkot district is located between North Latitudes 16°07'22" and 16°26'04" and East Longitudes between 75° 02' 14" to 75°29'11" and is falling in Survey of India Toposheets No forms parts of 47P/3, P/7 & P/8. The study area is bounded on the North by Jamakhandi taluk & Bilgi, Bagalkot, Badami taluks, on the East, Gokak taluk on west and Ramdurg taluk, on the South. Location map of Mudhol taluk of Bagalkot district is presented in **Fig-1**. Mudhol is taluk head quarter and 79 villages in this taluk.



**Fig-1: Location map of Mudhol taluk of Bagalkot district**

### **1.2 Population**

According to 2011 census, the population in Mudhol taluk is 3,21,970. Out of which 1,61,169 are males while 1,60,801 are females. The average sex ratio of Mudhol taluk is 998. The Mudhol taluk has an overall population density of 337 persons per sq.km. The decadal variation in population from 2001-2011 is 17% in Mudhol taluk.

### 1.3 Rainfall

Mudhol taluk enjoys semi-arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Northern Dry agro-climatic zone of Karnataka state and is categorized as drought prone. The climate of the study area is quite agreeable and free from extremes. The year is usually divided into four seasons: summer from March to May; rainy season or south-west monsoon season from June to September; post-monsoon season covering the months of October and November and dry or winter Season from December to February. The data in respect of Mudhol station from the year 1981 to 2010 is analysed and presented in **Table-1**. The data pertaining to these gauges is of long term nature and are well maintained. It is presumed that they are representative of the taluks and the same is used for analysis. Normal annual rainfall in Mudhol taluk for the period 1981 to 2010 is 511 mm. Seasonal rainfall pattern indicates that, major amount of (311 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 61% of the annual normal rainfall, followed by North-East Monsoon season (128 mm) constituting 25% and remaining (72 mm) 14% in Pre-Monsoon season. On Computations were carried out for the 30 year blocks of 1981-2010, the mean monthly rainfall at Navalgund taluk is ranging between 1 mm during February to 117 mm during September. The coefficient of variation percent for pre-monsoon, monsoon and post-monsoon season is 65, 46 & 57 percent respectively. Annual CV at this station works out to be 34 percent.

**Table-1: Statistical Analysis of Rainfall Data of Mudhol taluk, Bagalkot district (1981 to 2010)**

STATION		JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
MUDHOL	NRM	2	1	6	20	43	72	92	47	55	117	311	99	23	6	128	511
	STDEV	7	6	16	31	38	47	65	27	36	74	143	61	30	11	73	175
	CV%	315	461	266	156	88	65	71	57	65	64	46	61	129	204	57	34

### Assessment of Drought

Rainfall data of Mudhol taluk has been analysed for 93 years using IMD method to assess the drought condition in Mudhol taluk. The results of the classification are listed in the Table 2. It is observed that the Mudhol taluk has experienced alternating no drought to severe drought conditions over the years.

% Deviation (Di)		>0	0 to -25	-25 to -50	50 to -75	<-75	Probability of drought occurrences
Category		No drought	Mild (Normal)	Moderate	Severe	Acute	
		Years					
Taluk	Mudhol	16	52	23	2	0	Once in 4 years

The details of the drought assessment are discussed as herein under. Out of 93 years of analysis in Mudhol taluk, “No Drought” condition is experienced in 16 years, “Mild Drought” condition is experienced in 52 years and “Moderate Drought” condition experienced in 23 years. Further it is observed that “Severe Drought” condition is experienced in 2 years i.e., during 1965 and 2003 in Mudhol taluk. Based on occurrence and frequency of past drought events, the probability of occurrence of various intensities of drought at each station has been studied. It has been observed that the frequency of occurrence of drought is **once in 4 years** at Mudhol taluk

#### **1.4 Agriculture & Irrigation**

Agriculture is the main occupation in Mudhol taluk. Major Kharif crops are Maize, Bajra, Jowar, Tur and Vegetables. Main crops of Rabi season are Maize, Bajra and Jowar (**Table-3**). Sugarcane is also one of the major crop in the area grown in 40%, Maize is grown in 23%, Jowar is grown in 12% and wheat in 10% of total crop area of taluk. Oil seeds, Fruits & pulses account 5%, 1% and 8 % of total crop area respectively.

**Table-3: Cropping pattern in Mudhol taluk for 2016-2017 (Ha)**

Year	Wheat	Maize	Paddy	Jowar	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Cotton
Area under cultivation (in ha)										
2016-17	7765	17234	-	8850	5981	734	0	3495	29414	0

It is observed that net sown area accounts 74% and area sown more than once is 9% of total geographical area in Mudhol taluk (**Table-4**). Area not available for cultivation and Fallow land cover 3% & 13% of total geographical area respectively. 16% of net area irrigated is only from canal and 43% from bore wells (**Table-5**).

**Table-4: Details of land use in mudhol taluk 2016-2017 (Ha)**

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
MUDHOL	95,450	5289	6591	12343	70348	8716

Source: District at a glance 2016-17, Govt. of Karnataka

**Table-5: Irrigation details in Mudhol taluk (in ha)**

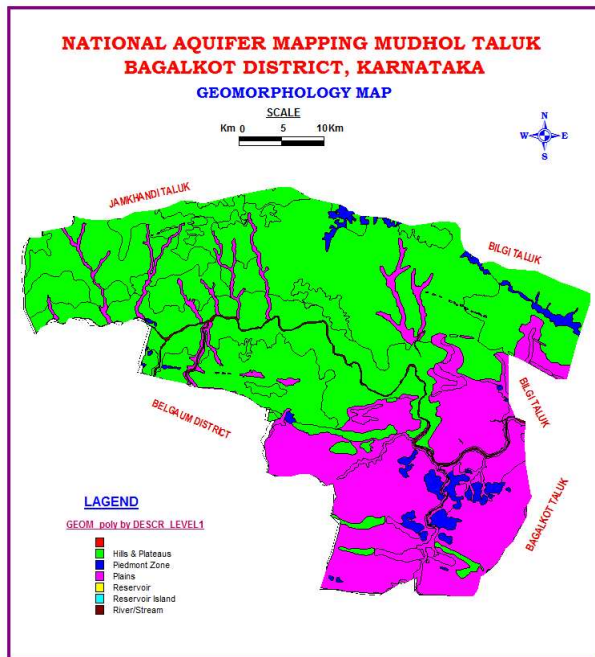
Source of Irrigation	Net area irrigated (Ha.)	% of area
Canals	10015	16
Tanks	-	
Wells	318	0.5
Bore wells	27149	43
Lift Irrigation	-	
Other Sources	25847	40.5
<b>Total</b>	<b>63,329</b>	

Source: District at a glance 2016-17, Govt. of Karnataka

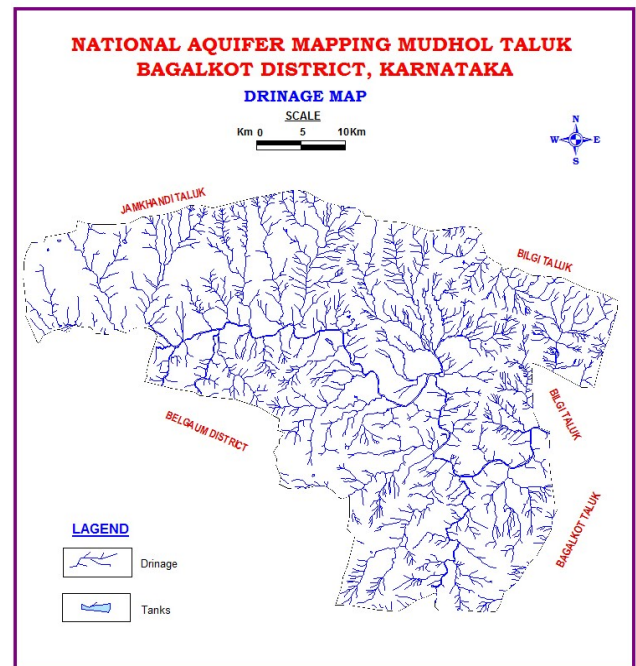
### 1.5 Geomorphology, Physiography & Drainage

Mudhol taluk falls in the eastern maidan region with gentle undulating terrain. Mudhol taluk forms more or less vast plain at an average elevation of 550 m above MSL. The Average elevation of the taluk varies from minimum 543.9 m to maximum 663 m above MSL. A small hill stands out as a ridge near Lokapur town to a height of 663 m above MSL. The entire taluka is either flat or gently sloping towards Ghataprabha river and its tributaries. Except around Lokapur where Kaladgi Limestone are exposed as an small ridge, the rest of the area is soil covered. The differential altitude is significant because, it is likely to cause irregular ground water flow patterns on the micro scale (**Fig.-2**). Topography is dominantly controlled by geological structures.

The entire Mudhol taluk falls in Ghataprabha river minor basin, which is tributary of Krishna river basin. The river Ghataprabha fed by numerous streamlets joining from both sides. All the water drains into Ghataprabha river flowing in the centre of the taluk. The Drainage pattern is dendritic to sub-dendritic (**Fig.-3**).



**Fig-2: Geomorphology Map**



**Fig-3: Drainage Map**

## 1.6 Soil

Mudhol taluk is covered by black cotton soil (BCS) varying in thickness between 1.0 to 5.0 metres. The soil covers thicker in nala sections and low lying areas and less in elevated places. The soil is medium to deep black in colour. Kankary nodules of different sizes from 0.2 to 5 cm are common, especially where soil profile is low and in nala courses. The black cotton soil contains high humus and low phosphate content, with normal pH- value and very low infiltration characteristic. The loamy to clayey loamy soil are seen along the banks of river/stream courses.

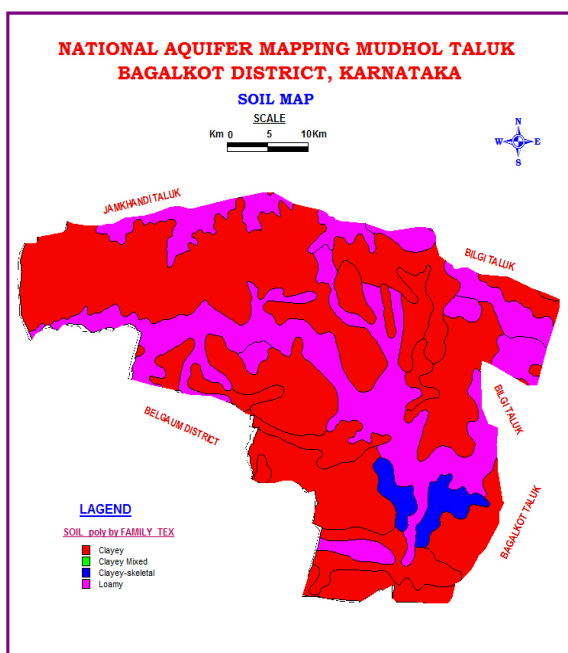


Fig-4 Soil map

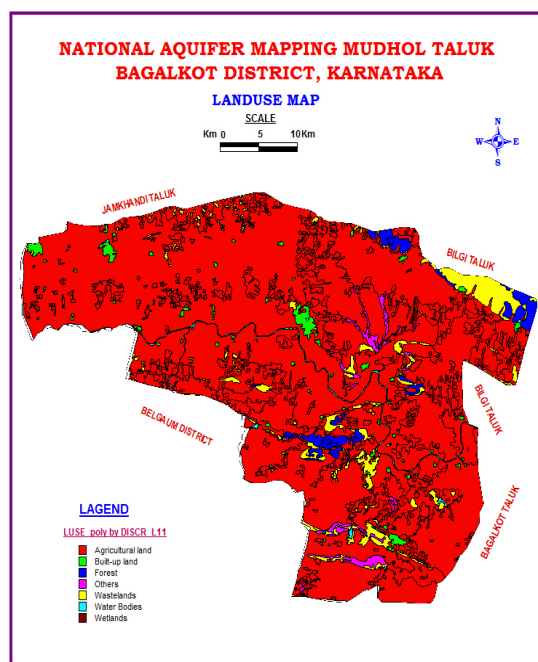


Fig-5 Land Use Map

### 1.7 Ground water resource availability and extraction

Aquifer wise total groundwater resources up to 200 m depth is given in **Table-6** below.

**Table-6: Total Ground Water Resources (2017) (Ham)**

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (Down to 200m)	
Mudhol	6334	5917	1845	Dynamic + phreatic in-storage + fractured
				14096

### 1.8 Existing and future water demands (as per GEC-2013)

- Net ground water availability for future irrigation development: 6.74 MCM
- Domestic (Industrial sector) demand for next 25 years : 5.72 MCM

### 1.9 Water level behavior

#### (a) Depth to water level

##### Aquifer - I

Pre-monsoon: 5.53– 7.86 mbgl (Fig.-6)

Post-monsoon: 4.80 – 5.72 mbgl (Fig.-7)

#### (b) Water level fluctuation

##### Aquifer-I (Fig.-8)

- Seasonal Fluctuation: Rise ranges 2.50 – 2.97 m;  
Fall ranges 0.00 – 0.19 m



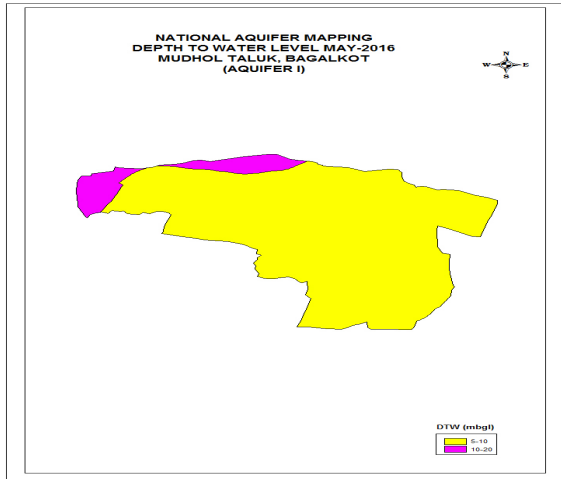


Fig-6: Pre-monsoon Depth to Water Level (Aq-I)

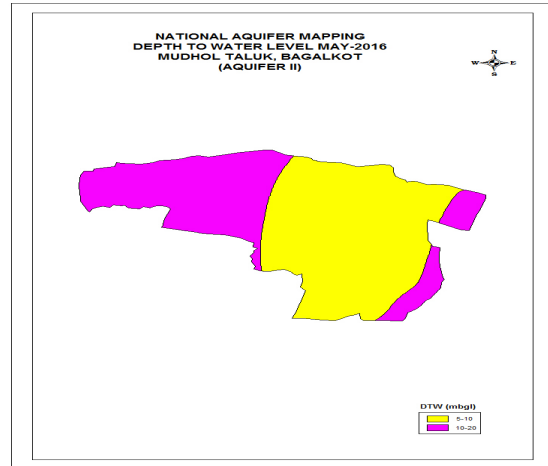


Fig-7: Pre-monsoon Depth to Water Level (Aq-II)

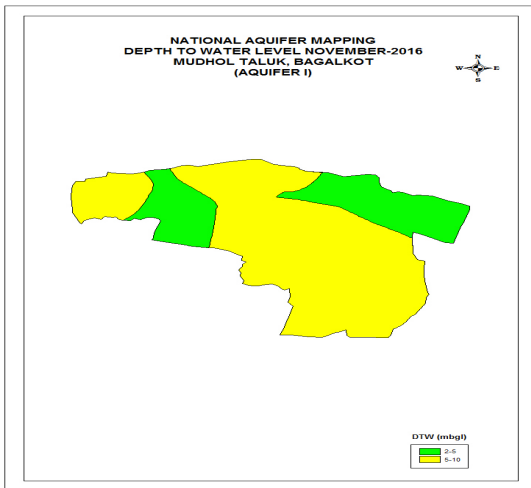


Fig-8 Post-Monsoon Depth to Water Level



Fig-9 Post-Monsoon Depth to Water Level (Aq-II)

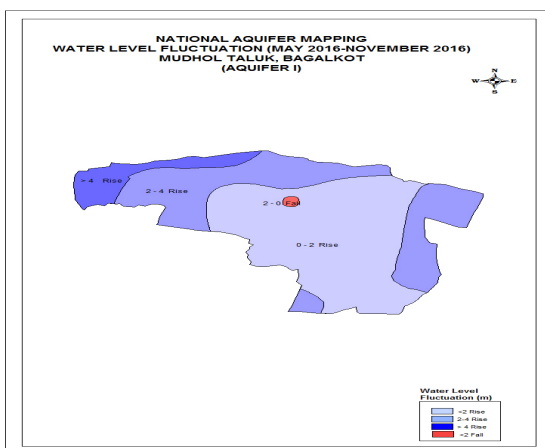


Fig-10: Water Level Fluctuation (Aq-I)

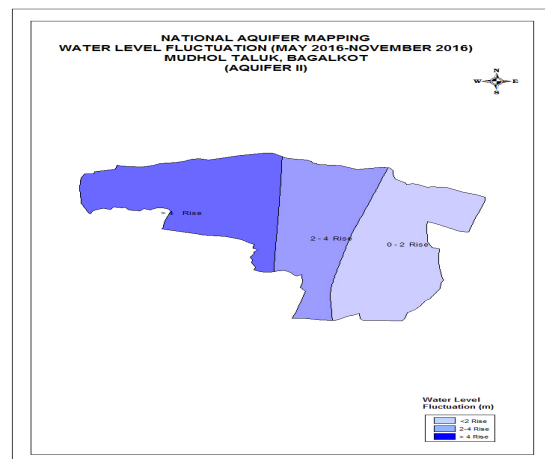


Fig-11: Water Level Fluctuation (Aq-II)

## 2. AQUIFER DISPOSITION

2.1 Number of aquifers: In Mudhol taluk, there are mainly two types of aquifer systems;

- i. Aquifer-I (Phreatic aquifer) Weathered Basalt, Limestone
- ii. Aquifer-II (Fractured aquifer) Fractured & jointed Basalt, caved Limestone.

In Mudhol taluk, Basalt and Lime stones are the main water bearing formations (**Fig-12**). Ground water occurs within the weathered and jointed Basalt, Lime stones under water table condition and semi-confined condition. In Mudhol taluk bore wells were drilled from a minimum depth of 32.76 mbgl to a maximum of 200 mbgl. Depth of weathered zone ranges from 5 mbgl to 13.8 mbgl. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depth of 17 to 78 mbgl. Yield ranges from 1.75 to 7.00 lps. The basic characteristics of each aquifer are summarized in **Table-7**.

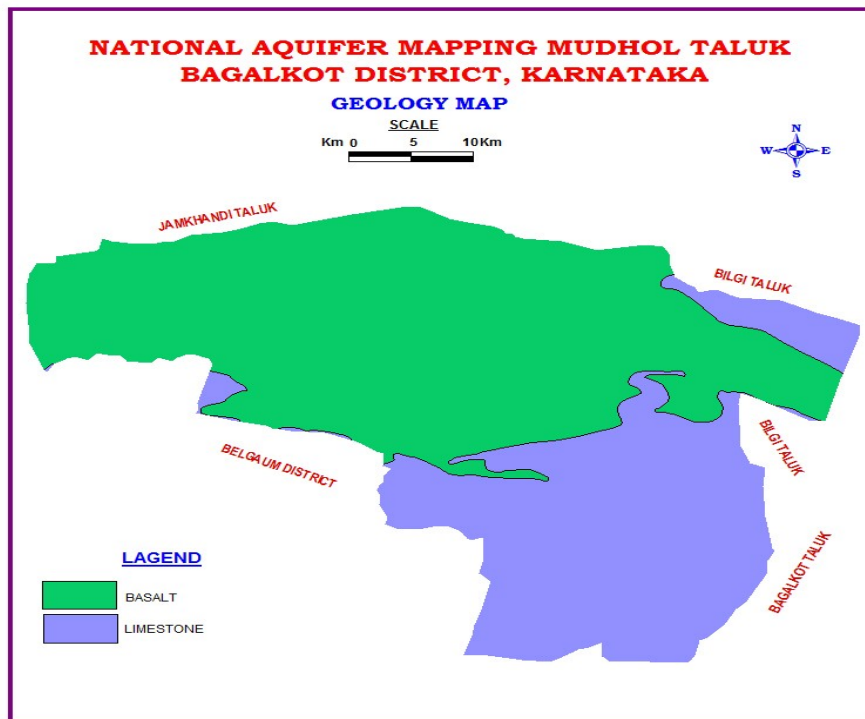


Fig-12: Geology Map

**Table-7: Details of Ground Water Exploration**

Sl. No	Location	Lat & Long	Depth m bgl	Casing (m)	Lithology	SWL (mbgl)	Q (lps)	DD (m)	T (m <sup>2</sup> /day)
1	Bamanabudhni	16 <sup>0</sup> 12 <sup>1</sup> 00" 75 <sup>0</sup> 17 <sup>1</sup> 00"	100.00	5.8	Lime Stone	3.72	1.75	7.20	138
2	Kadarkop	16 <sup>0</sup> 08 <sup>1</sup> 00": 75 <sup>0</sup> 25 <sup>1</sup> 00"	55.00		Lime Stone	9.57	5.50	2.20	55
3	Lokapur	16 <sup>0</sup> 09 <sup>1</sup> 00": 75 <sup>0</sup> 22 <sup>1</sup> 00"	59.00		Lime Stone	6.23	7.00	0.73	666
4	Mahalingapur	16 <sup>0</sup> 23 <sup>1</sup> 30": 75 <sup>0</sup> 06 <sup>1</sup> 30"	70.00		Basalt	6.31	3.00	9.36	53
5	Yadawadi	16 <sup>0</sup> 21 <sup>1</sup> 00" 75 <sup>0</sup> 26 <sup>1</sup> 00"	32.76		Basalt	3.56	0.01	-	-

**Table-8: Basic characteristics of each aquifer**

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered & Jointed Basalt and Limestone	Fractured / Jointed Basalt & Limestone
Thickness range (mbgl)	15	Fractures upto 200 mbgl
Depth range of occurrence of fractures (mbgl)	5-13.5	17-78
Range of yield potential (lps)	Poor yield	1.7- 7.0
Specific Yield	2%	0.2%
T (m <sup>2</sup> /day)	-	1-666
Quality Suitability for Domestic & Irrigation	Suitable	Suitable

### 3.0 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

#### 3.1 Aquifer wise resource availability and extraction

##### (a) Present Dynamic Ground Water Resource (2017)Ham

Taluk	Net annual ground water availability	Existing gross ground water draft for irrigation	Existing gross ground water draft for domestic and industrial water supply	Existing gross ground water draft for all uses	Allocation for domestic and industrial use for next 25 years	Net ground water availability for future irrigation development	Existing stage of ground water development	Category
MUDHOL	6334	5838	380	6218	572	674	98	Critical

(b) Present total Ground Water Resource (in ham)

Taluk	Annual replenishable GW resources (in ham)	Fresh In-storage GW resources (in ham)		Total availability of GW resource (in ham)
		Phreatic	Fractured	Dynamic + phreatic in-storage + fractured in-storage
MUDHOL	6334	5917	1845	14096

### 3.2 Chemical quality of ground water and contamination

Interpretation from Chemical Analysis results in Mudhol taluk is mentioned as under:

**Electrical Conductivity:** In general, EC values range from 980 to 3430  $\mu$ /mhos/cm in the aquifer-I at 25°C.

**Fluoride:** Fluoride concentration in ground water ranges between 0.9 – 1.40 mg/l in the aquifer-I.

**Nitrate:** Nitrate value ranges from 22 and 116 mg/l in the Aquifer –I.

**Table-9: Quality of ground water (Aquifer-I) in Mudhol taluk of Bagalkot district**

Sl.No	Location	PH	EC	TH	Ca	Mg	Na	K	CO <sub>3</sub>	HCO <sub>3</sub>	CL	SO <sub>4</sub>	NO <sub>3</sub>	F
1	Mudhol	7.66	3430	1120	264	160	276	2	0	61	744	499	116	0.9
2	Malapur	7.72	1189	430	76	46	74	2	0	244	199	86	23	1.0
3	Belagalli	8.06	980	290	40	24	92	1	0	305	99	51	66	1.4
4	Lokapur	7.81	1067	330	68	41	81	18	0	366	128	29	22	0.9

## 4.0 GROUND WATER RESOURCE ENHANCEMENT

### 4.1 Aquifer wise space available for recharge and proposed interventions

Recharge dry **phreatic aquifer (Aq-I)** in the taluk, through construction of artificial recharge structures, has not been recommended as the average post monsoon water level is less than 5m bgl. But in non command area where stage of ground water development is 111 %, groundwater level is around 10 to 12 mbgl is considered for artificial recharge structures, viz; check dams, percolation tanks & point recharge structures. The choice of recharge structures should be site specific and such structure need to be constructed in areas already identified as feasible for artificial recharge.

## 5.0 DEMAND SIDE INTERVENTIONS

### 5.1 Advanced irrigation practices

It is observed that ground water through wells & borewells contribute 43% of the source for irrigation in Mudhol taluk. Balance 57% irrigation is from surface water from canals. Also,

water intensive crops sugarcane is grown in 37% of total crop area from surface water source. Present stage of ground water development in **non command** area is 111 % (GEC 2017). Thus, Water use efficiency measures are suggested in the taluk especially in non command area. Adopting these measures will contribute in ground water resource enhancement in the long run. Efficient irrigation practices like Drip irrigation and sprinkler need to be adopted by the farmers in the existing 49650 ha of gross irrigated area.

**Table-12: Improvement in irrigation due to saving by adopting water use efficiency Management Plan – Other options**

Volume of Water proposed / saved and Increase in area of Irrigation					
Interventions	Volume of Water proposed by inter basin transfer / savings by WUE		Area of crop can be irrigated using 75% of Irrigation Efficiency (Ha)		
	(Ham)	(TMC)	Maize	Jowar	Bajra
<b>GW Recharge Schemes Proposed (Inter-basin Transfer)</b>	<b>7363.2</b>	<b>2.60</b>	11045	18408	22090
<b>Savings from Water Use Efficiency</b>	<b>1751.4</b>	<b>0.62</b>	-	-	-
<b>Volume of GW to be withdrawn from Water Logged area</b>	<b>300</b>	<b>0.106</b>	<b>450</b>	<b>750</b>	<b>900</b>
<b>Total</b>	<b>9414.6</b>	<b>3.32</b>	11495	19158	<b>22990</b>

## 5.2 Other interventions proposed

- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Excess nitrate & fluoride concentration is found in ground water samples require remedial measures viz.
  - Dilution of nitrate rich ground water through artificial recharge & water conservation.
  - Roof top rainwater harvesting.

## 6.0 Summary

The summary of Management plan of Mudhol taluk is given in **Table-13**.

**Table-13: Summary of Management plan of Mudhol taluk**

Mudhol taluk is Critical & present stage of GW Development (2017)	98%
Net Annual Ground Water Availability (MCM)	63.34
Existing Gross Ground Water Draft for all uses	62.18
Total GW Resources (Dynamic & Static up to the depth of 200 mbgl (MCM)	140.96
Expected additional recharge from monsoon surplus runoff (MCM)	16.758
Change in Stage of GW development, %	98 to 77.62
Expected Saving due to Inter-basin transfer, groundwater withdrawn from water logged area and adopting WUE measures (MCM)	94.15
Change in Stage of GW development, %	77.62 to 35.68
Excess nitrate & fluoride concentration	<ul style="list-style-type: none"><li>• Dilution of nitrate rich ground water through artificial recharge &amp; water conservation.</li><li>• Roof top rainwater harvesting.</li></ul>