



केन्द्रीय भूमिजल बोर्ड

जल शक्ति मंत्रालय, जल संसाधन, नदी विकास और गंगा संरक्षण विभाग
भारत सरकार

Central Ground Water Board

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

Report on

AQUIFER MAPPING AND MANAGEMENT PLAN

Dharwad Taluk, Dharwad District, Karnataka

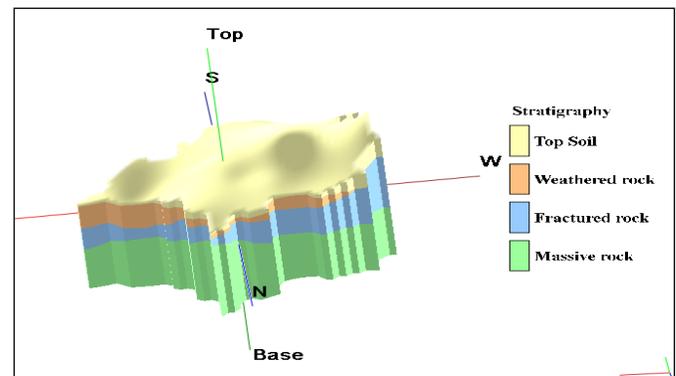
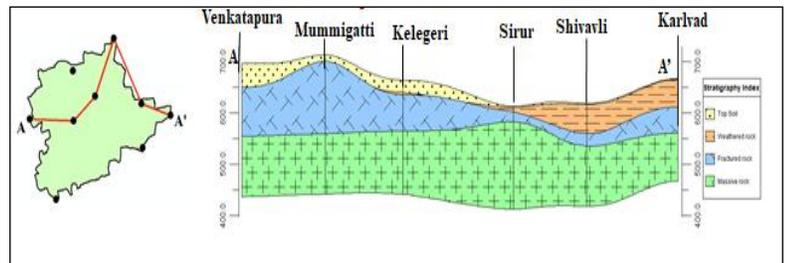
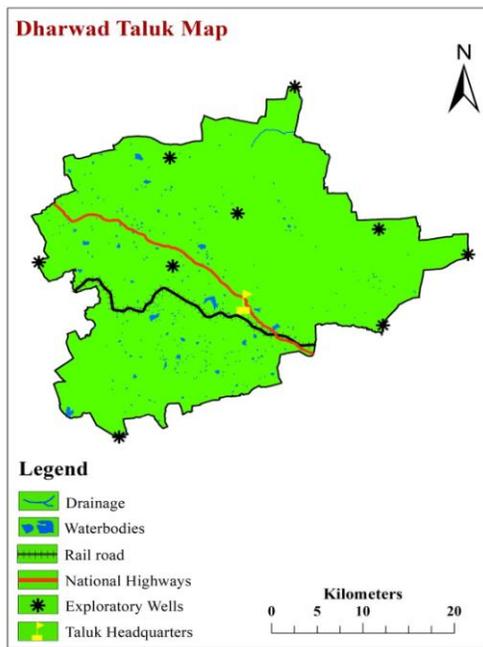
दक्षिण पश्चिमी क्षेत्र, बेंगलुरु
South Western Region, Bengaluru

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Aquifer Maps and Management Plan, Dharwad Taluk, Dharwad District, Karnataka State (AAP: – 2021-2022)



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Aquifer Maps and Management Plan, Dharwad Taluk, Dharwad District, Karnataka State

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1. INTRODUCTION

National Project on Aquifer Mapping (NAQUIM) initiated by Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India with a vision to identify and map the aquifers at the micro level with their characteristics, to quantify the available groundwater resources, to propose plans appropriate to the scale of demand and institutional arrangements for participatory management in order to formulate a viable strategy for the sustainable development and management of the precious resource which is subjected to depletion and contamination due to indiscriminate development in the recent past.

Groundwater is being increasingly recognized as a dependable source of supply to meet the demands of domestic, irrigation and industrial sectors of the country. The development activities over the years have adversely affected the groundwater regime in many parts of the country. Hence, there is a need for scientific planning in development of groundwater under different hydrogeological situations and to evolve effective management practices with the involvement of community for better groundwater governance.

Aquifer Mapping has been taken up in Dharwad taluk, Dharwad district with a view to formulate strategies for sustainable management plan for the aquifer system in accordance with the nature of the aquifer, the stress on the groundwater resource and prevailing groundwater quality which will help in drinking water security and improved irrigation facility. It will also result in better management of vulnerable areas.

1.1 Objectives

The objectives of the aquifer mapping can broadly be stated as:

- To define the aquifer geometry, type of aquifers and their lateral and vertical extent
- To determine the groundwater regime scenario
- To determine the hydrogeochemical characteristics of the aquifer units
- To define 2D and 3-D dispositions of the aquifer units
- To estimate the availability of groundwater resources in the aquifer system
- To develop a sustainable groundwater management plan for the aquifer system

1.2 Scope of the Study

The important aspect of the aquifer mapping programme is the synthesis of the large volume of data already generated during specific studies carried out by **Central Ground Water Board (CGWB)** and various Government organizations with a new data set generated that broadly describe the aquifer system. The available generated data are assembled, analyzed, examined, synthesized and interpreted from available sources. These sources are predominantly non-computerized data, which is to be converted into computer based GIS data sets.

Data gaps have been identified after proper synthesis and analysis of the available data collected from different state organizations like GWD, Watershed Department, etc. In order to bridge the data gap, data generation programme has been formulated in an organized way in the study area. Exploration work has been carried out in different segments of the regions and aquifer parameters have been estimated. Groundwater monitoring regime has been strengthened by establishing/adding State agencies additional monitoring wells. 2D and 3D sections have been prepared to bring out more realistic as the data points are more closure to the field.

1.3 Ground water Issues in the study area

The main issues pertaining to the Dharwad taluk is as follows

- 100% Dependency on groundwater for irrigated agriculture
- Lack of surface water resources as alternate water sources
- Source Sustainability for drinking and irrigation, especially in lean periods
- Declining groundwater Level trends in more than 50% of wells analyzed tapping phreatic aquifer during pre and post monsoon periods.
- Deeper fractures not getting recharge due to thick clay soil
- Ground Water quality: High fluoride concentration
- Ground Water quality: Nitrate contamination
- Contamination of Urban areas with municipal waste and sewage

1.4 Approach & Methodology

Integrated multi-disciplinary approach involving geological, geophysical, hydrological and hydrogeological and hydrogeochemical components were taken up in 1:50000 scale to meet the objectives of study. Geological map of the study area has been generated based on the GSI maps, geophysical data have been generated through vertical electrical soundings and geoelectrical layers with different resistivity have been interpreted in corroboration with the litho-stratigraphy of the

observation wells and exploratory wells down to depths of 302.3 mbgl. Hydrological and Hydrometeorological data have been collected from Statistical department, Govt of Karnataka. Drainage, Soil and Geomorphology of the taluk were prepared based on the satellite data interpreted by KSRSAC.

Based on the data gap analysis, data generation process has been scheduled through establishing key observation wells, integrating Ground Water Directorate (GWD) observation wells, pinpointing exploratory sites for drilling through in-house, collecting geochemical samples in order to study groundwater regime, geometry of the aquifer and aquifer parameters, and quality of the groundwater respectively. Groundwater recharge and draft have been computed based on approved guidelines and method to estimate the ground water resources of the aquifer system.

Based on the above studies Management strategies both on the supply side through augmentation of groundwater through artificial recharge and water conservation and on demand side through change in irrigation pattern have been formulated for sustainable management of the groundwater resource.

2. SALIENT INFORMATION

Name of the taluk: Dharwad

District: Dharwad

State: Karnataka

Area: 1117.9 sq.km (Old Dharwad taluk)

995.81 sq.km New Dharwad after the formation of Alnavara taluk

Population: 249993

Annual Normal Rainfall: 850 mm

2.1 Study area

Aquifer mapping studies have been carried out in Dharwad taluk, Dharwad district of Karnataka, covering an area of 1117.9 sq.km under **NAQUIM** Project. Dharwad taluk is located between North Latitudes 15°41'0.35" – 15°19'20" and East Longitudes between East 74°47'50" – 75°13'40" and falls in parts of Survey of India Toposheets No: 56C/11, 12, 14 , 15, 16 & 56G/2, 3. The study area is bounded on the east by Hubli and Navalgund Taluks of Dharward district, on the North by Bidar district, on the South by Kalghatgi taluk and in the west by Uttara Kannda District. Location map of Dharwad taluk of Dharward district is presented in **Fig.1**. Dharwad is the taluk head quarter (75°00'28.19" E - 15°27'26.63" N. Dharwad well connected by national (NH-4), state highways and the rail. The Dharwad-Hubli, the twin city is a major city, Dharwad is the home to the renown Karnataka University and the University of Agricultural Sciences, Dharward.

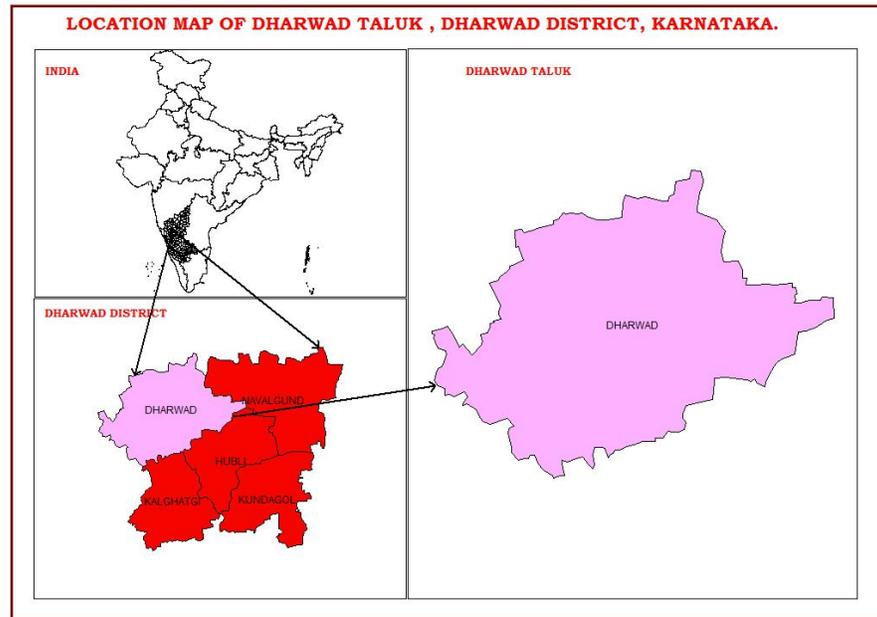


Fig 1: Location Map

2.2 Population & Demography

According to 2011 census, the population in Dharwad taluk is 249993, out of which, 128227 (51.29%) are males and 121766 (48.71%) are females. Rural population comprises 286683 & Urban: 543147. The average sex ratio of Dharwad taluk is 950 .The Dharwad taluk has an overall population density of 170 persons per sq.km. The decadal variation in population from 2001-2011 is 13 % in Dharwad taluk. There are 3 Hoblis, 25 Grama Panchayaths & 118 villages & 50058 households in this taluk.

2.3 Rainfall

The area experiences tropical climate/semi-arid climate with distinct seasons namely, the summer, rainy season and the winter. The relative humidity is generally high as over 80% in the monsoon season and less in non-monsoon periods. In April month the whirlwinds are common.

The area falls under **Northern Transitional Agro-Climatic zone**. The normal annual rainfall in Dharwad taluk for the period 1981 to 2010 is 850 mm. It has with typical bi-modal rainfall distribution pattern with about 70 rainy days.

Seasonal rainfall pattern indicates that, major amount of 850 mm rainfall was recorded during South-West Monsoon seasons, which contributes about 78% of the annual normal rainfall, followed by North-East Monsoon season (126 mm) constituting 14% and remaining (74 mm) 8% in Pre-Monsoon season.

On Computations were carried out for the 30 year blocks of 1981-2010, the mean monthly rainfall at Dharwad taluk is ranging between 2 mm during February to 223 mm during August. The coefficient of variation percent for pre-monsoon, monsoon and post-monsoon season is 65, 41 & 67 percent respectively. Annual Co-efficient Variation at this station works out to be 33 percent (**Table.1**).

Table.1. Rainfall details of Dharwad taluk

STATION		JAN	FEB	MAR	APR	MAY	PRE	JUN	JUL	AUG	SEP	SW	OCT	NOV	DEC	NE	Annual
DHARWAD	NRM 2016	0	1	5	27	67	100	119	176	111	67	473	34	14	0	48	621
	STDEV	16	5	30	20	31	48	67	115	137	135	300	76	38	10	84	302
	CV%	215	295	233	101	99	65	53	65	61	68	41	73	214	228	67	33

2.4 Assessment of Drought

Rainfall data of Dharwad taluk has been analyzed for 56 years to assess the drought condition in the taluk. The results of the classification are listed in the **Table.2**. It is observed that the 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	Dharwad	11	37	5	3	0	Once in 7 years

The details of the drought assessment are discussed as herein under. Out of 56 years of analysis in Dharwad taluk, “No Drought” condition is experienced in 11 years, “Mild Drought” condition is experienced in 37 years and “Moderate Drought” condition experienced in 5 years. Further it is observed that “Severe Drought” condition is experienced in 3 years. 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 7 years** in Dharwad taluk.

2.5 Agriculture & Irrigation

Agriculture is the main occupation in Dharwad taluk. Jowar, Maize, Green Gram, Bengal Gram, Tur and vegetables, Fruits, Oil seeds are the main crops. Main crops of Rabi season are Maize, Jowar, Bengal gram etc. Irrigation is (100 %) by bore wells (ground water). Water intensive crops like Paddy & Sugarcane are grown in 7 % and Jowar is grown in 20% of the of total cropped area. Details of the cropping pattern is shown in **Table.3**.

Table.3 Cropping pattern in Dharwad taluk 2020-21 (Ha)

Year	Paddy	Wheat	Maize	Bajara	Jowar	T.Pulses	Fruits	Vegetables	T.Oil seeds	Sugarcane	Cotton
	Area under cultivation (in ha)										
	4298	3419	10101	2046	10827	33786	5877	8104	15411	2701	5815
	Total food grains										
	62529										
	Net sown area (in ha)										
	64941										
	Gross sown area (in ha)										
	104684										
2020-2021											

Source: District at a glance 2020-21, DES, Govt. of Karnataka

It is observed that net sown area accounts 66 % of the geographical area and the area sown more than once is 37 % of total geographical area. Area not available for cultivation and Fallow land cover 13% &4% of total geographical area respectively. 100 % of net area irrigated is only from ground water source through bore wells (**Table.4**).

Table-4: Irrigation details in Dharwad taluk (in sq km)

Source of Irrigation	No	Net area irrigated (ha)
Canals	0 k	-
Tanks	25	0
Wells	367	0
Bore wells	1470	17395
Lift Irrigation	0	0
Other Sources	NA	0
Total		17395

Source: District at a glance 2020-21, DES, Govt. of Karnataka

2.6 Geomorphology, Physiography & Drainage

The taluk falls in the western-ghat section (Sahyadri's) of the peninsula within the rugged foothills. An undulating central Pediplain and the eastern maidan is the prominent feature. The surface elevation ranges from 558 to 753 mamsl. This has its bearing on the regional slope which is towards south. 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 Dharwad taluk falls in Krishna and Sub-basin of Malaprabha. West Flow rivers of Gangavali/Bedthi drains Dharwad district. The drainage map is presented in **Fig.3**.

2.7 Geology

Geologically the area is a part of Dharwar Craton, which is one of one most stable land forms on the Earth. The major formations comprise of Schist and Banded Gneissic Complex. Granites, Shale and metagraywackes area also distributed sporadically. Laterites caps are encountered along high lands (**Fig. 4**).

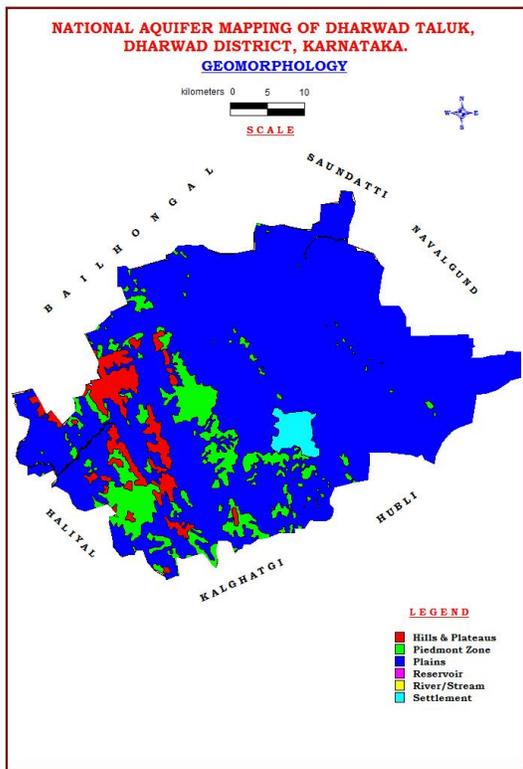


Fig-2: Geomorphology Map

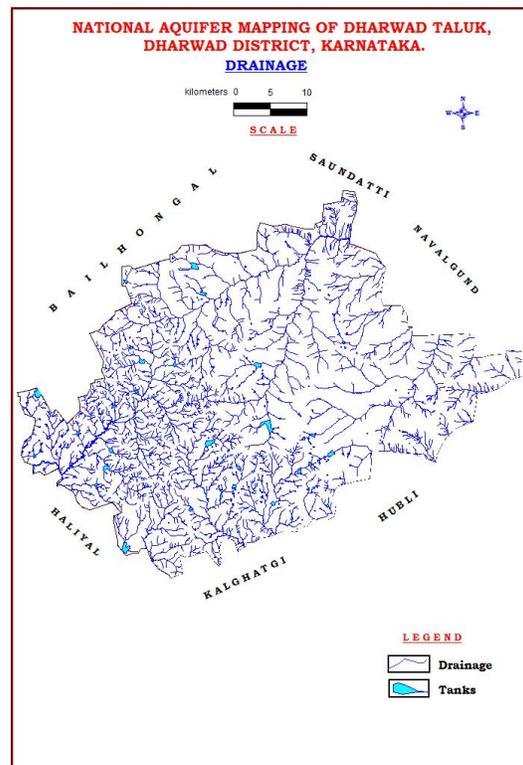


Fig-3: Drainage Map

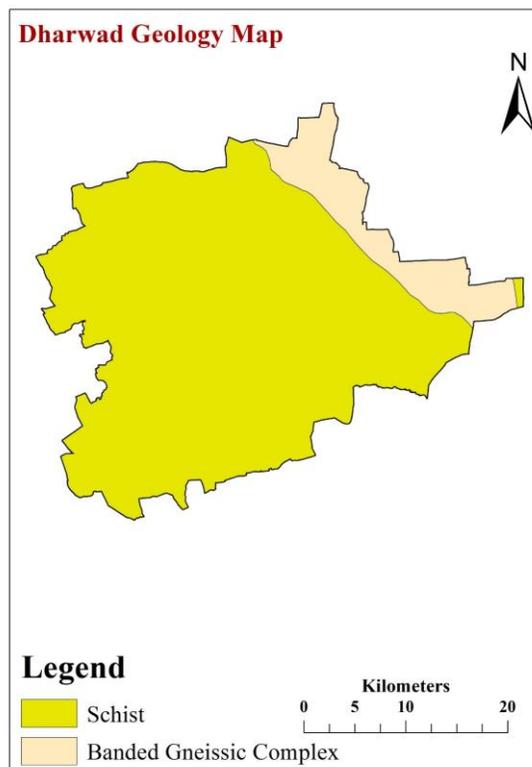


Fig 4. Geology Map

2.8 Soil and Landuse

Red and Black soils are predominant in the taluk. The Loamy to kankary soil are seen along the banks of river/stream courses. The Deep black cotton - clay rich soils cover major part of the taluk. Black cotton soils are mature soils with high humus and are mildly alkaline in nature. They are clayey in nature and often form clay layers in the phreatic zone which hinders the recharge and return seepage. The black cotton soil with 2.0 to 5.0 metres thickness, are high humus and low phosphate content, with normal pH-value and very low infiltration characteristic. Red soils and Lateritic soil form other types of soils. The soil map of the taluk is shown in **Fig.5**. The land use map of the study area is shown in **Fig.6**. Major part of the study area is covered by Agriculture land. Details of the landuse is presented in **Table.5**.

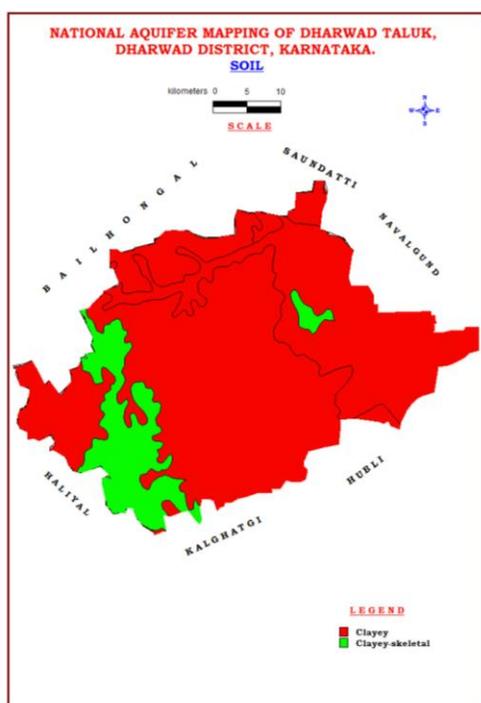


Fig.5: Soil Map

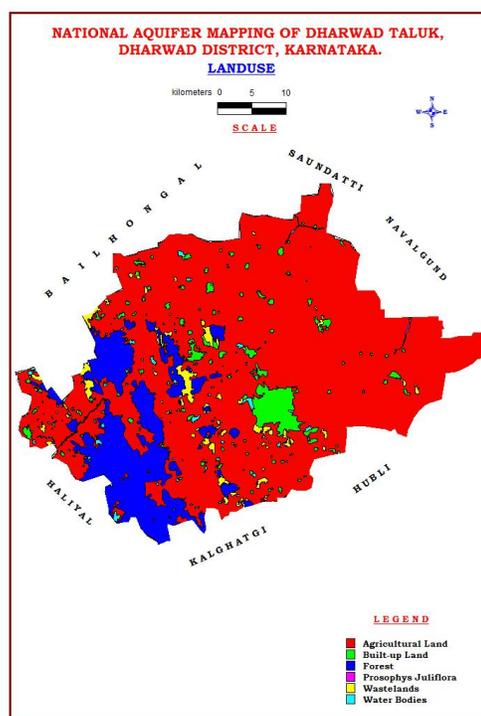


Fig.6: Landuse Map

Table-5: Details of land use in Dharwad taluk (Ha)

Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Cultivable waste	Net sown area	Area sown more than once
173165	4123	12847	70256	4467	112537	12134

Source: DES, District at a glance 2020-21, Govt. of Karnataka

3. AQUIFER CHARACTERISATION

3.1 Types of Aquifers

Two aquifer systems have been mapped namely:

- ❖ Aquifer I: Weathered aquifer down to the depth of 16.65 m bgl
- ❖ Aquifer II: Fractured aquifer down to the depth of 219.1 m bgl

Aquifer system in Dharwad taluk is divided into weathered and fractured aquifers of schists, banded gneissic complexes, granites, shales, phyllites and metagraywackes. Secondary structures like joints, fissures and faults present in them act as a porous media-the Aquifer. The lateritic layer overlying in moderate thickness and alluvium occurs along the riverbanks in less than 3.00 metres thickness acts as an aquifer locally. Ground water in the aquifer generally occurs under unconfined/phreatic and semi-confined conditions.

3.2. Weathered Aquifer (Aquifer I)

The weathered formations of Granites, Gneissess, schists, Phyllites, metagreywackes forms the phreatic aquifer with thickness in the range of 14 to 40 m with an average thickness of 15 m. The unconfined condition prevails within the depth range of 17 to 40 mbgl. The top porous part in the water table aquifer constitutes approximately 3% of volume of formation. The specific capacity of dug wells in the district ranges from 6.90 to 65.03 m³/m/dd and the aquifer transmissivity estimated in the order of 1.07 to 113.69 m²/day. During the monsoon period the wells tapping this aquifer unit sustains for one to 3 hrs/day of pumping. Yield of this weathered aquifer unit ranges from less than 1 lps to 3 lps, while during the non-monsoon period (May to July), wells sustains only for less than 1 hour/day of pumping

3.3 Fractured Aquifer (Aquifer II)

Fractured Granites, Gneissess, schists, Phyllites, metagreywackes comprise the deeper aquifer II occurs from 16.9 to beyond 200 m bgl. 36 exploratory borewells have been drilled at select places within the depth range of 150 to 200 mbgl reveals the presence of fractured zones; they are occasionally saturated between 20.00 and 150mbgl depths. The schistose formations & Metageywackes have deeper ground water potential zones. Granites, schists, metagreywackes constitute the yielding aquifer in the taluk Based on the analysis of the data from exploratory wells

and vertical electrical soundings data it is inferred that of the productive fractures are encountered from 50 m- 190 m bgl. The yield of this aquifer unit II ranges from <1– 9 lps (2- 5 most frequented range) and desaturated in some parts of the taluk. Transmissivity of the deeper aquifers is estimated in the order of 11 to 40 m²/day (**Table.6**). The yield ranges from 2 to 5 lps. The specific capacity of exploratory bore wells falls in the range of 32 to 65 lpm/m.

Table:6 Summary of Aquifer Characteristics

Granites, Gneissess schists, Phyllites meta greywackes	Particulars	Exploratory wells
	• Depth range (mbgl)	68.35 – 178.15
	• Weathering range (mbgl)	14.7 – 63.36
	• Yield range (lps)	2-5
	• Fractures (mbgl)	23.05 – 122.2 (Most of the fractures are encountered beyond the depth ranges of 50 – 190 m bgl)
	• Transmissivity (m ² /day)	1.11 – 151. Most frequent 11-40

During monsoon period the wells tapping this aquifer unit sustains for 2 to 6 hrs /day of pumping, while during non-monsoon period (May to July) sustains for 1 to 3 hour/day of pumping. In general ground water in fractured aquifer is potable. Fluoride contamination has been reported though from area underlain by Granitic aquifers. Details of the fracture distribution is shown in **Table.7**.

Table 7. Distribution of fractures in Dharwad Taluk

Fractures Encountered (mbgl) in numbers						Yield (m ³ /hr)
Nil	Up to 50	50-100	100-150	150-200	> 200	
6(25%)	5 (21%)	2 (8%)	4 (17%)	6 (25%)	1 (4%)	0.3 to 59.4

3.4 AQUIFER DISPOSITION & GEOMETRY

2D & 3D models showing Aquifer Disposition

Aquifer Disposition (Vertical & Lateral) and aquifer characterization has been brought mainly by analyzing the data collected from 36 Bore well litho-logs and Vertical Electrical Sounding conducted in the taluk.

2D & 3D aquifer disposition models of the aquifer system have been deciphered by using ROCKWORKS software and 2D cross section have been generated along different directions of Dharwad taluk. All such 2D cross sections were verified and the model was calibrated to bring out the 3D aquifer disposition of the aquifer system. The type cross sections generated in different direction of the aquifer system are presented in **Fig.7. Fig.8 and** 3D aquifer disposition fence diagram in **Fig.9.**

The study of the fence diagram and 3-D block diagram indicates the following broad classification of aquifers.

- The top weathered zone, which extends down to the depth of 17 m bgl and forms the shallow or phreatic aquifer, tapped mostly by dug wells, dug-cum-bore wells and shallow bore wells.
- Fractured aquifer, Viz BGC, Granites. Meta gerywackes which lies below the weathered zone, extends to a depth of 200 m bgl. This aquifer is being tapped by deep borewells.

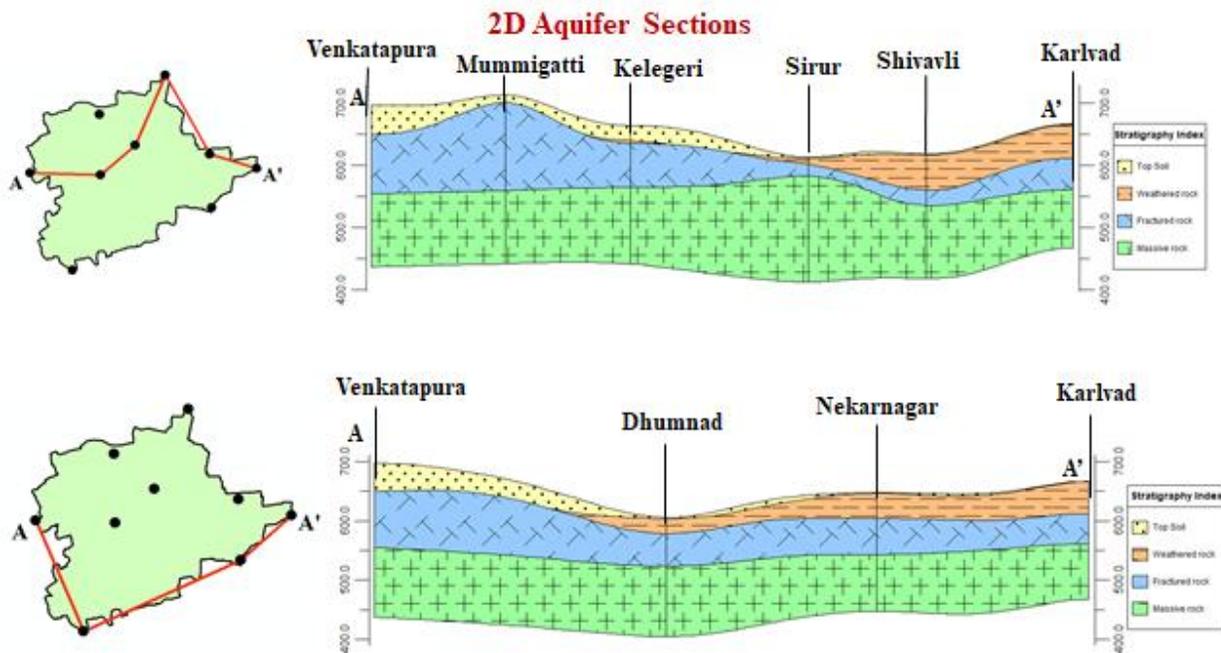


Fig.7: 2D Aquifer Cross Section, Dharwad taluk

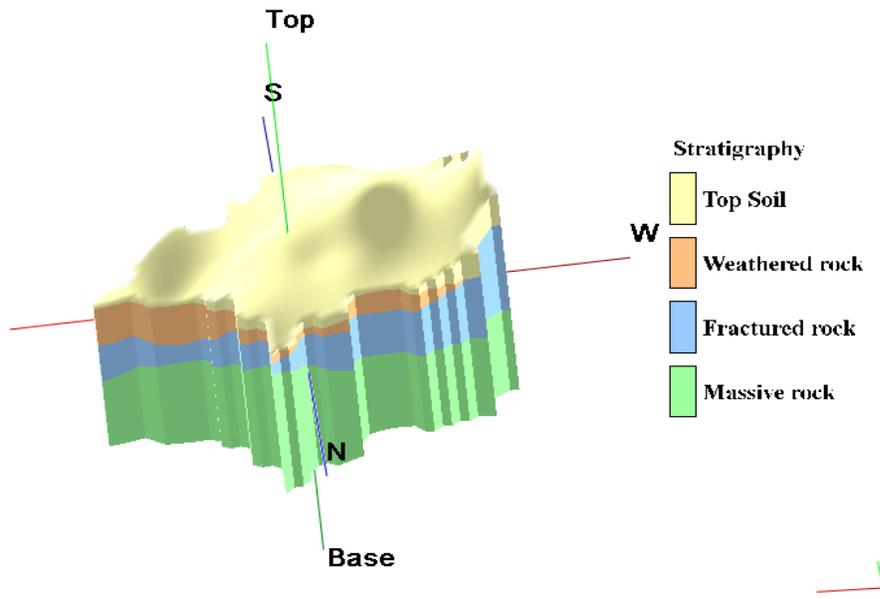


Fig.8: 3D Aquifer Disposition, Dharwad taluk

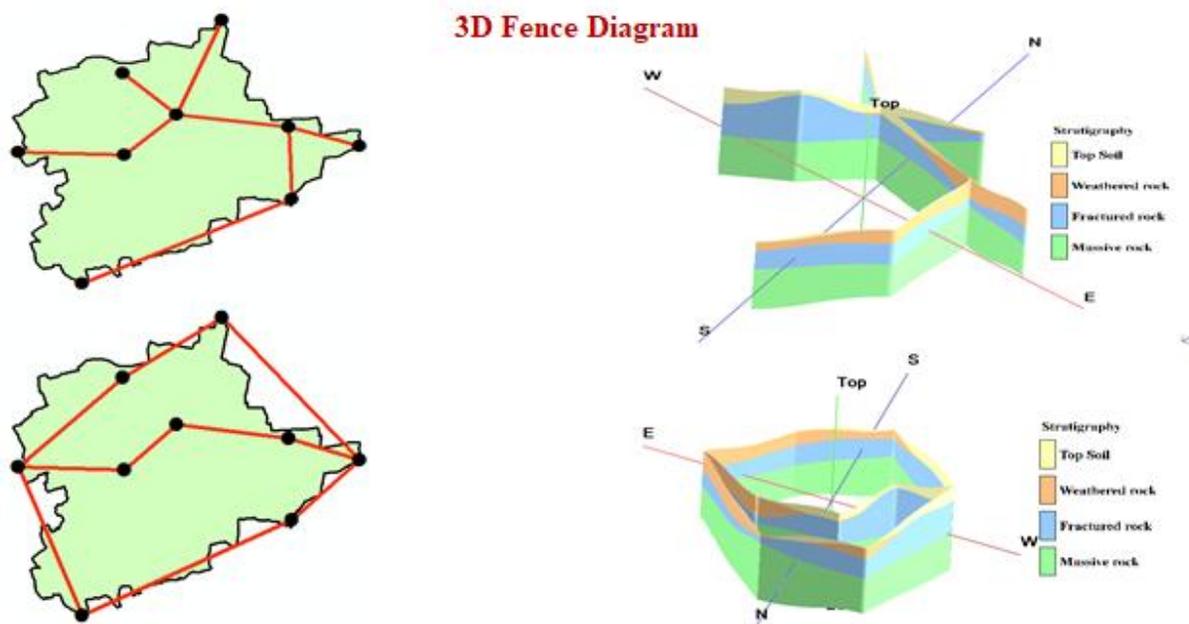


Fig.9: Aquifer Fence diagram, Dharwad taluk

Depth to water level behaviors and aquifer characterization conferred the the deeper aquifer is semi confined in nature and in hydraulic continuity with phreatic aquifer. Sensu stricto confined aquifers are not existing in this area.

3.5 Ground Water Level

During Aquifer Mapping studies in Dharwad taluk, 12 groundwater monitoring wells which were monitoring regularly in phreatic and fractured aquifers in order to know the behavior of the groundwater regime. The water levels were monitored from May 2010 to January 2019 (four times in a year). The summary of the water levels are presented in **Table.8**.

Table: 8 Summary of ground water levels in Phreatic and Fractured aquifer

GW Monitoring	Particulars	Dug wells	Piezometers
	• Water level range (mbgl)	9.27 – 11.30 (May 2019)	7.8 – 46.81 (May 2019)
		1.10 – 1.97 (Nov 2019)	1.15 – 31.99 (Nov 2019)

3.5.1 Depth to Water level for (May 2018)

Water level was observed in the range of **9.27 – 11.30** in phreatic aquifer. Piezometric head during May 2019 is varied from **7.8 – 46.81** m bgl for fractured aquifer.

Major part of the taluk shows water level in the range of 5 to 10 m bgl. Isolated patches were recorded water level in the range of 2 to 4 m bgl. Water levels ranging more than 20 m bgl is observed in in the central & in the south-western part as a small isolated patch. The depth to water level during pre-monsoon (May 2019) representing the fractured aquifer (Aquifer II) is shown in **Fig.10**.

3.5.2 Depth to Water level (November 2018)

Water levels were observed in the range of **1.10 – 1.97 mbgl** in the phreatic aquifer. The piezometric head levels during November 2019 were varied from **1.15 – 31.99** mbgl in the fractured aquifer. Water level in the range of 2 to 10 m bgl occupies the major part of the study area. Water levels ranging less than 2 m bgl is observed as isolated patches in the north western part of the taluk. The depth to water level during post-monsoon is shown in **Fig.11**. The comparison of pre and post monsoon water levels shows that rise in water levels throughout the taluk and the phreatic aquifer is responding to the rainfall and recharging the aquifers.

Water level fluctuation between May 2019 and November 2019 is shown in **Fig.12**.

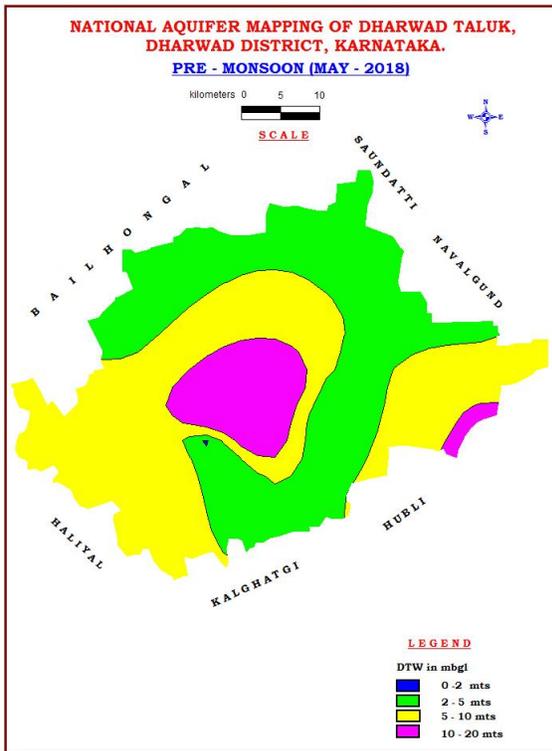


Fig.10: Pre-monsoon Depth to Water Level

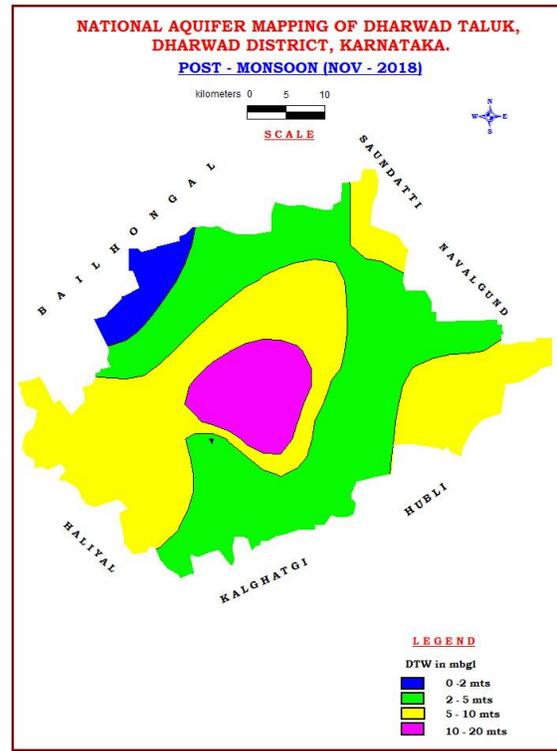


Fig 11: Depth to Water Level – Post-monsoon

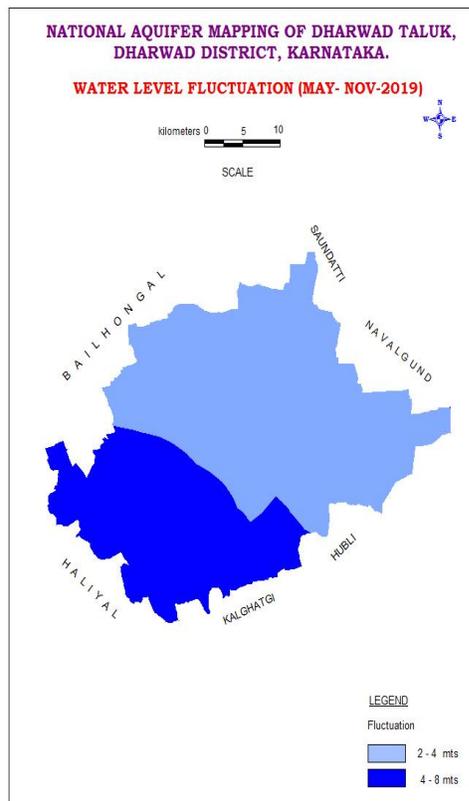


Fig.12. Map showing Water level fluctuation (May-Nov2019)

3.6 Ground water Quality

The water in phreatic aquifer zones are found in potable form whereas it is Alkaline to saline in the deeper zones in part of Dharwad Taluk. Generally, the electrical conductivity (EC) of water is observed to be in the range of 900 to 1200 $\mu\text{m}/\text{cm}$ (Fig. 13). At places, the same were recorded in between 4000 to >7500 at 25°C.

More than permissible limit of Nitrate (NO_3) as >45 mg/litre occur in some isolated localities as indicated in Fig.14. The Nitrate content is less than 45mg/l in about 20 % of the sample analyzed and 80 % of sample shows more than 45 mg/l.

The fluoride presence in some pockets of the central and eastern border areas noticed as around 1.5mg/l, is greater than the permissible limit as depicted in Fig.15, the rest of the area have acceptable limit of 0.2 to 1.0 mg/lit. About 50% of the groundwater samples of phreatic aquifer has recorded the desirable limit of fluoride content, less than 1 mg/l. Remaining 50 % of wells have recorded beyond permissible limit of more than 1.5 mg/l.

The presence of chloride in the deeper aquifer as high as >1000 mg/l in some isolated patches was observed which is said to be due to the extensive use of chemical fertilizers in agricultural lands. However, all the groundwater samples of phreatic aquifer have recorded the chloride concentration less than 250 mg/l which is the desirable limit.

Summarized results of aquifer wise (Phreatic and semi confined) ground water quality of Dharwad taluk as on May-2018 is given in Table.9.

Table.9: Summarized results of aquifer wise ground water quality

GW Quality: Dharwad Taluk	Particulars	Phreatic Aquifer (Aquifer-I)	Fractured Aquifer (Aquifer-II)
	EC ($\mu\text{S}/\text{cm}$ at 25°C) (Most frequent range)	364 – 1491	450 – 850
	F (mg/l) (Most frequent range)	0.19 – 0.63	0.1 – 2.5
	NO_3 (mg/l) (Most frequent range)	4 - 45	5 - 58
	Chloride (mg/l) (Most frequent range)	25-180	15-120

Groundwater Quality Maps

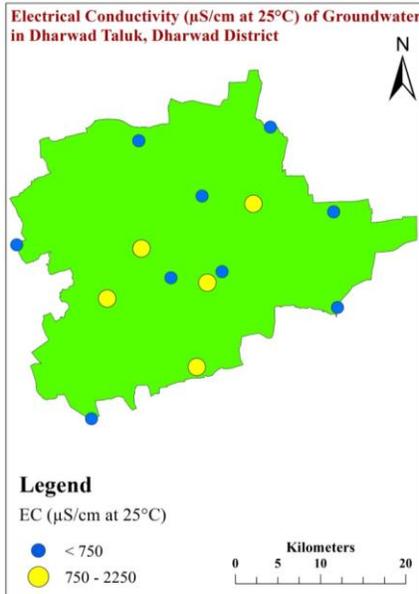


Fig.13: EC distribution

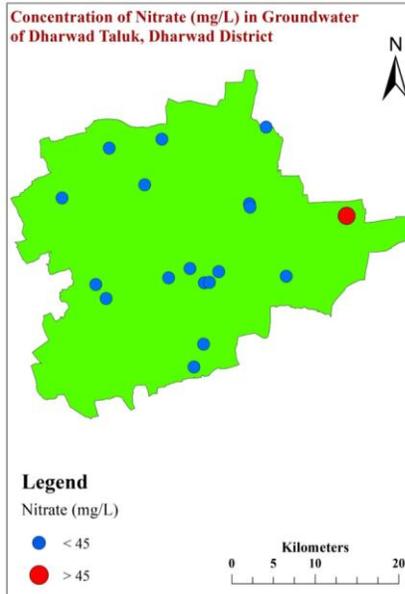


Fig.14: NO_3 Distribution

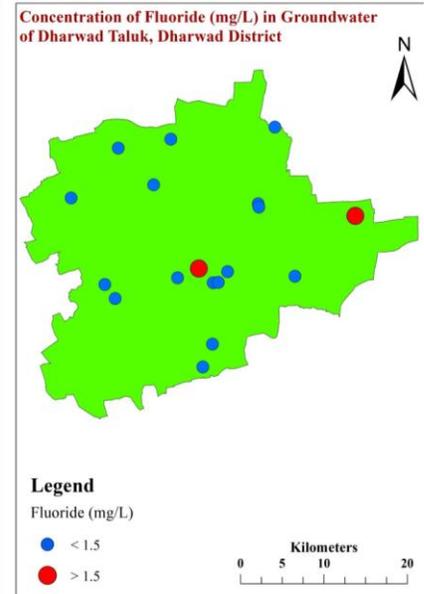


Fig.15: F distribution

4. GROUND WATER RESOURCES

The dynamic groundwater resources have been estimated as on 2020 based on the methodology suggested by Ground Water Estimation Committee (GEC) 2015.

The groundwater recharge is calculated both by groundwater fluctuation-specific yield method and by rainfall infiltration method. The annual replenishable groundwater recharge is the summation of four components viz.,

- i) Monsoon recharge due to rainfall
- ii) Monsoon recharge from other sources
- iii) Non-monsoon recharge due to rainfall
- iv) Non-monsoon recharge due to other sources

Taluk wise dynamic groundwater resources have been taken from the approved resources estimation done as on March 2020, jointly by Ground Water Directorate of Karnataka and CGWB, to arrive at the total resources available in Dharwad taluk.

4.1 Ground water resource availability and extraction

The net groundwater availability refers to the available annual recharge after allowing for natural discharge in the monsoon season in terms of base flow and subsurface inflow/outflow. This annual groundwater potential includes the existing groundwater withdrawal, natural discharge due to base flow and subsurface inflow/ outflow in the monsoon season and availability for future development. As the groundwater development progresses the natural discharge gets suitably modified and comes down to negligible quantities due to interception by different groundwater structures. Hence, natural discharges in the monsoon season may not be considered and the total annual groundwater recharge may be taken as net groundwater availability.

As per ground water estimation 2020, the net annual ground water availability in Dharwad taluk is **6551.47** Ham. The existing gross ground water draft for irrigation is **3226.79** Ham and the draft for domestic use is **152.82** Ham. The ground water draft for industrial is Nil. Thus, the total ground water draft for all uses amounts to **3379.61** Ham (**Table.10**).

Allocation for domestic and industrial water supply for next 25 years is **163** Ham. The net ground water availability for future irrigation development is **3161.98** Ham. The existing stage of ground water development is **51.59 %** and the taluk is categorized as '**Safe**'.

Table.10: Total Ground Water Resources (2020, in Ham)

Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (OE/C/SC/Safe/Saline)
6551.47	3226.79	0	152.82	3379.61	163	3161.98	51.59	SAFE

The Dynamic ground water resources for Dharwad taluk as per earlier 2017 estimates is shown in **Table.11**.The aquifer wise total ground water resources up to 200 m depth as on 2017 is given in **Table.12**.

Table.11. Dynamic Ground Water Resources of Dharwad taluk (As on March 2017) in 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 Extraction	Category
Dharwad	4442	2742	155	2897	168	1532	65	SAFE

Table.12. Total Ground Water Resource (As on 2017) in ham

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
4442	16343	2405	23190

The comparison of groundwater availability and draft scenario between 2017 and 2020 is presented in **Table.13**. It is seen that ground water availability is found to be increased during 2020 in comparison with 2017. At the same time, the total ground water extraction is marginally increased during the same period. The stage of ground water extraction is found to be 65% and 52% respectively during 2017 and during 2020.

Table.13. Comparison of ground water availability and draft scenario (in Ham), Dharwad taluk

2017			2020		
GW Availability	GW Extraction	Stage of GW Extraction	GW Availability	GW Extraction	Stage of GW Extraction
4442	2897	65 %	6551	3380	52%

5. GROUNDWATER RESOURCE ENHANCEMENT

5.1 Resource Enhancement by Supply Side Interventions

The Master Plan for Artificial recharge to ground water prepared by CGWB (2020) recommended to replenish the desaturated aquifer system, both phreatic & deeper (**Aquifer I & II**) in the taluk through construction of artificial recharge structures, viz; check dams, percolation tanks & Sub surface dykes (**Table.14**). As of now, recharging dried-up phreatic aquifer in the taluk, through construction of artificial recharge and watershed treatment structures has already been taken up by state Government agencies and is being implemented under MGNREGA. The choice of recharge structures should be site specific and such structures need to be constructed in areas already identified as feasible for artificial recharge. Scientific site selection of AR structures is a prerequisite to improve the efficacy of Managed Aquifer Recharge. In Dharwad taluk, in most of the area the unit area annual recharge is in the range of 0.0025 to 0.25m and SE portion is in the range of 0.15 to 0.25m.

Table-14: Quantity of non-committed surface runoff & expected recharge through AR structures (CGWB, Master Plan 2020)

Artificial Recharge Structures Proposed	Dharwad taluk
Non committed monsoon runoff available (MCM)	84.761
Total no. of existing Artificial Recharge Structures	221
Number of Check Dams proposed	286
Number of Percolation Tanks proposed	76
Number of Sub surface dyke proposed	2
Tentative total cost of the project (Rs. in lakhs)	4425.56 Lakhs
Expected recharge (MCM)	25.14
Likely additional irrigation potential to be created (Lakh.Ha)	0.076

The tentative location of the recharge structures in Dharwad taluk is shown in **Fig.16**. The tentative list of the proposed Percolation tanks and Check dams are listed in **Annexure 1**. In view of the formation of new Alnavara taluk, part of the above figures will shift to this new taluk.

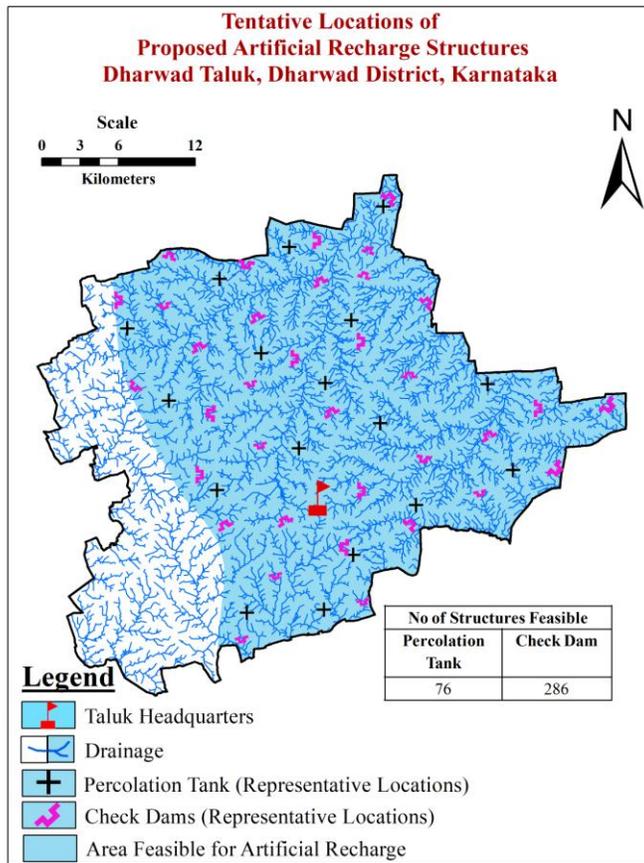


Fig.16 Tentative Locations of AR Structures

5.2 Resource Savings by Demand Side Interventions

The important crops grown are Paddy, Jowar, Wheat, Bajra, Maize, Pulses, Vegetables and Sugarcane etc. Ground water is the major source for irrigation. In view of this, Water Use Efficiency (WUE) practices like Drip needs to be strengthened to save irrigation water by way of precision farming mechanism. This ultimately enhances the area under irrigation potential.

Efficient irrigation practices like Drip irrigation and sprinkler has to be adopted by the farmers in the existing 17395 ha of net irrigated area. It is proposed to adopt micro irrigation (drip) techniques in fruits and vegetables (13981 ha) and in Sugarcane (2701 ha). It is assumed that 50% of this area i.e., 6990 ha and 1350 ha is irrigated by ground water. Implementation of efficient irrigation techniques will contribute in saving ground water by 1549 ham. The details of the resource enhancement through artificial recharge in the taluk and also through Water Efficiency practices in Irrigation are shown in **Table.15**.

Table.15: Improvement in GW availability due to Recharge, Dharwad taluk

Sl. No.	Resource Details	As per 2020 Estimation
1	Net Ground Water Availability in Ham	6551
2	Existing ground water draft for all uses in Ham	3380
3	Existing Stage of Ground Water Development in percentage %	52%
4	Expected Recharge from Artificial Recharge sources in Ham	2514
5	Cumulative Ground water availability in Ham	12871
6	Expected improvement in stage of ground water development %	37%
8	Saving due to adopting Water Use Efficiency in Ham	1549
9	Ground water availability after AR & WUE in Ham	10614
10	Expected improvement in stage of ground water development after implementation of AR & WUE %	32%

5.3 Ground Water Development Plan

In Dharwad taluk, the present stage of ground water extraction (2020) is 52 % with net ground water availability for future use is 3162 ham and total extraction is 3380 ham (2020). The ground water draft for irrigation purpose is 3227 ham, thus indicating that ground water irrigation needs to be encouraged in the area after considering the “Safe” level of extraction of 70%, which can be implemented in scientific manner. The implementation of the plan needs to be based on site specific detailed hydrogeological, geophysical and scientific surveys for pinpointing the sites for construction of dug wells and bore wells.

As per the conservative estimate and after considering the average unit draft figure for the taluk, about 138 dug wells (15-30 m depth; 3 to 5 m diameter) are recommended to be constructed in feasible areas. Further as per the estimate about 331 bore wells (40 to 100 m depth; 150 mm dia) are also recommended to be drilled in feasible areas so as to maintain the safe category of the taluk. The likely additional irrigation potential which can be created considering prevailing crop water requirement for the area is will be 848 ha.

Table – 16 a: Feasibility of Additional GW abstraction structures based on GWRA 2020 availability

Annual Extractable GW Resource (Ham)	Net GW Availability for future use (Ham)	Stage of GW Extraction (%)	GWR required to take SOE to 60%	Total Extraction / Draft	Balance GWR available to enhance SOE 60%	No. of DW feasible considering 25% of balance GWR with unit draft of 1 ham	No. of BWs feasible considering 75% of balance GWR with unit draft of 1.25 ham
6551.47	3161.98	51.59	3930.88	3379.61	551.27	138	331

Table – 16 b: Ground Water Resource Development Plan as per GWRA 2020 availability

Items	Proposed Structures		Total
Present GW Availability is 65.51 MCM Present Gross Annual Extraction is 33.79 MCM Present Stage of GW Development is 51.59%	Dug wells – 138 Depth: 15 to 30 m Dia: 3 to 5 m Av. Annual Gross draft - 1.00 ham	Bore well - 331 Depth: 40 to 100 m Dia – 150 mm Av. Annual Gross draft - 1.50 ham	469
Additional irrigation potential created considering crop water requirement of 0.65 m (Ha)	212	636	848

Note- Hydrogeological and scientific intervention is needed for pinpointing the sites for construction of dugwells and Borewells

5.4 Regulation and Control

As per the resource estimation – 2020, Dharwad taluk falls under “**Safe**” category with the stage of ground water extraction of 52%. However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority needs to be strictly implemented in the taluk, so that quality of ground water will improve in due course of time.

5.5 Other interventions proposed

- The ground water worthy areas such as topographic lows, valley portions low fluctuations zones should be developed with an adequate soil conservation measures to prevent the soil erosions.
- Roof top rain water harvesting, Insitu Rainwater harvesting and dilution of contaminated water.
- Periodical maintenance of artificial recharge structures should also be incorporated in the Recharge Plan.
- Wherever, excess fluoride concentration is found in ground water samples require remedial measures viz RO treatment and Dilution with Treated harvested Rainwater/surface water sources.

6. SUMMARY OF MANAGEMENT PLANS

- **Ground Water resource:** As per the resource estimation – 2020, Dharwad taluk falls under Safe category with the stage of ground water extraction of 52%. However, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk during the summer and scarcity of water during the future days.
- **Ground water resource enhancement:** Increase in agricultural activity, excessive ground water withdrawal, depletion of ground water levels, reduction in yield and ground water quality related issues etc., suggests the need for scientific ground water management, enhancement of storage capacity of the aquifers and protection of ground water quality.
- **Quantity of water available through non-committed surface run-off:** The surplus non-committed monsoon run off is estimated to be approximately 85 MCM. This can be used to recharge the aquifer mainly through percolation tanks (about 76) and check dams (about 286) as per CGWB, 2020 figures. In view of the formation of new Alnavara taluk, part of the above figures will shift to this new taluk.
- **Advanced irrigation practices:** Entire irrigated area is fed by ground water. In 3416 Ha area micro irrigation practices are being adopted .The important crops grown are jowar, Maze, Bengal Gram, Soybean, Paddy, Cotton, sugarcane. In view of this, Water Use Efficiency (WUE) practices like Drip needs to be strengthened to save irrigation water by way of precision farming mechanism. This ultimately enhances the area under irrigation potential.
- **De centralized Grey water treatments for upcycling of waste water :**
De- Centralized grey water ponds using NEERI technology / 5 pond technologies can be adopted for treatment of gray water from each village of or municipal waste water treatment for peri-urban agriculture. This treated water can be put in to use through micro irrigation techniques.
- **Ground Water Development Plan:** The stage of extraction is 51.59%, thus indicating that further scope of development exists in the area. The implementation of the plan needs to be based on site specific detailed hydrogeological, geophysical and scientific surveys for pinpointing the sites for construction of dug wells and bore wells. As per the conservative estimate and after considering the average unit draft figure for the taluk, about 138 dug wells (15-30 m depth; 3 to 5 m diameter) are recommended to be constructed in feasible areas. Further as per the estimate about 331 bore wells (40 to 100 m depth; 150 mm dia) are also recommended to be drilled in feasible areas so as to maintain the safe category of the taluk. The likely additional irrigation potential which can be created considering prevailing crop water requirement for the area is will be 848 ha.
- **Drinking water Supply:** In view of ground water contamination with mainly higher concentration Nitrate and fluoride, drinking water supply from surface water needs to be explored/ ensured.

- **Regulation and Control:** Taluk is categorized as "Safe". However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority needs to be strictly implemented in the taluk, so that sustainable development of ground water is achieved.
- **Participatory management:** Awareness programmes and practice of participatory approach needs to be strengthened with the involvement of all the stake holders for sustainable management.
- **Water Linkages with other Activities:** Water sector has strong linkages with other developmental activities. Hence, the proposed management plans cannot be considered as static and needs to be reviewed and improved from time to time.
- **Other Management Options proposed:**
 - Scientific disposal of sewage water by the concerned agency
 - Periodical maintenance of artificial recharge structures is recommended for better recharge and long life of the structure
 - Rooftop Rain Water Harvesting (RTRWH) from each building and in-situ storage and use /mixing with surface water supply or groundwater in urban areas.
 - Priority to promote recycle and reuse of grey water effectively in urban pockets.

A) Tentative Locations of Proposed Percolation Tanks, Dharwad taluk

Sl.No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	74.95015	15.37347	Managundi	Managundi	Dharwad
2	75.00655	15.37557	Kanavihonnapura	Yarikoppa	Dharwad
3	74.99348	15.39985	Yarikoppa	Yarikoppa	Dharwad
4	75.02782	15.41444	Thadasinakoppa	Dharwad	Dharwad
5	74.96555	15.41504	Sannasomapura	Manasura	Dharwad
6	75.05433	15.42676	Navalura	Dharwad	Dharwad
7	74.98603	15.43485	Atthikolla	Dharwad	Dharwad
8	75.02412	15.44034	Lakamanahalli	Dharwad	Dharwad
9	75.05123	15.44586	Navalura	Dharwad	Dharwad
10	74.95494	15.44679	Kalageri	Kyarikoppa	Dharwad
11	75.09984	15.44750	Allapura (Somapura)	Maradagi	Dharwad
12	75.07356	15.44965	Navalura	Dharwad	Dharwad
13	75.13544	15.45487	Shivalli	Shivalli	Dharwad
14	74.92845	15.46018	Dhaddikamalapura	Mandihal	Dharwad
15	74.99712	15.46187	Dharwad	Dharwad	Dharwad
16	74.96133	15.47078	Kalageri	Kyarikoppa	Dharwad
17	75.14439	15.47430	Inamathihebbali	Hebballi	Dharwad
18	75.01829	15.47439	Malapura	Dharwad	Dharwad
19	75.17091	15.47578	Hebballi	Hebballi	Dharwad
20	75.05870	15.47654	Dandikoppa	Maradagi	Dharwad
21	75.13357	15.48416	Hebballi	Hebballi	Dharwad
22	74.92691	15.48554	Kedanhatti	Chikkamalligawada	Dharwad
23	75.08090	15.48561	Dandikoppa	Maradagi	Dharwad
24	75.03835	15.48593	Dharwad	Dharwad	Dharwad
25	74.98822	15.48976	Yatthinagudda	Dharwad	Dharwad
26	74.90152	15.49090	Mummigatti	Mammigatti	Dharwad
27	75.10064	15.49231	Benakanamatti	Kanakura	Dharwad
28	75.01488	15.49559	Kamalapur Thadhabal	Dharwad	Dharwad
29	74.95764	15.49846	Hiremalligawada	Chikkamalligawada	Dharwad
30	75.15428	15.50270	Hebballi	Hebballi	Dharwad
31	75.19005	15.50566	Hebballi	Hebballi	Dharwad
32	75.04742	15.50759	Aminabhavi	Amminabhavi	Dharwad
33	75.09726	15.51136	Kanakura	Kanakura	Dharwad
34	74.93204	15.51632	Mummigatti	Mammigatti	Dharwad
35	75.01466	15.51784	Marewada Aralikatte	Marewada	Dharwad
36	75.07657	15.51869	Chandanamatti	Kanakura	Dharwad
37	75.03856	15.51951	Marewada Aralikatte	Marewada	Dharwad
38	75.12068	15.52006	Thalavayi	Kanakura	Dharwad
39	75.16139	15.52273	Vanahalli	Kanakura	Dharwad
40	74.89324	15.52348	Kotura	Kotur	Dharwad

41	74.97587	15.52573	Devagiri .M. Narendra	Narendra	Dharwad
42	75.05820	15.52667	Aminabhavi	Amminabhavi	Dharwad
43	75.10096	15.53336	Aminabhavi	Amminabhavi	Dharwad
44	75.12578	15.53521	Thalavayi	Kanakura	Dharwad
45	75.00748	15.53602	Lakamapura	Yadawada	Dharwad
46	75.07276	15.53721	Aminabhavi	Amminabhavi	Dharwad
47	74.95225	15.53965	Niralakatti	Belur	Dharwad
48	74.93512	15.54174	Garaga	Garag	Dharwad
49	74.88003	15.54319	Shinganahalli	Kotur	Dharwad
50	75.04789	15.54322	Aminabhavi	Amminabhavi	Dharwad
51	75.03594	15.55328	Karadigudda	Karadigudda	Dharwad
52	75.09596	15.55368	Aminabhavi	Amminabhavi	Dharwad
53	75.00987	15.55694	Yadhavada	Yadawada	Dharwad
54	74.91566	15.55696	Niralakatti	Belur	Dharwad
55	74.96061	15.55708	Kurubagatti	Kurabagatti	Dharwad
56	74.93160	15.57045	Garaga	Garag	Dharwad
57	75.06295	15.57126	Aminabhavi	Amminabhavi	Dharwad
58	74.98988	15.57332	Sibaragatti	Lokur	Dharwad
59	74.86302	15.57445	Mugali	Madhanabhavi	Dharwad
60	75.02638	15.58049	Pudakalakatti	Pudakalakatti	Dharwad
61	74.97456	15.58189	Lokura	Lokur	Dharwad
62	74.94376	15.58251	Garaga	Garag	Dharwad
63	75.05741	15.58784	Harobelawadi	Harobelawadi	Dharwad
64	74.91157	15.59475	Thadakoda (Bhavihala)	Tadakoda	Dharwad
65	74.99849	15.59703	Hanumanakoppa	Uppinabetageri	Dharwad
66	75.02730	15.59789	Uppina Betageri	Uppinabetageri	Dharwad
67	75.06740	15.60777	Harobelawadi	Harobelawadi	Dharwad
68	74.93031	15.60954	Thadakoda	Tadakoda	Dharwad
69	74.88071	15.61087	Madhana Bhavi	Madhanabhavi	Dharwad
70	75.03138	15.61216	Uppina Betageri	Uppinabetageri	Dharwad
71	74.95591	15.61879	Kotabagi	Kotabagi	Dharwad
72	74.90276	15.62126	Thimmapura .M. Thadakoda	Tadakoda	Dharwad
73	75.04960	15.62325	Harobelawadi	Harobelawadi	Dharwad
74	74.98121	15.63219	Kallura	Kotabagi	Dharwad
75	75.00530	15.63260	Hanumanahala	Uppinabetageri	Dharwad
76	75.04966	15.66095	Kabbenura	Harobelawadi	Dharwad

(Source: Master Plan, CGWB, 2020. It is likely that the number of structures proposed may vary depending upon the ground truth verification and feasibility criteria)

B) Tentative Locations of Proposed Check dams, Dharwad taluk

Sl.NO	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	74.94750	15.35289	Amblikoppa	Halligeri	Dharwad
2	74.93677	15.35645	Amblikoppa	Halligeri	Dharwad
3	74.95710	15.35815	Managundi	Managundi	Dharwad
4	75.00072	15.36260	Naikanaholikatte	Yarikoppa	Dharwad
5	74.96323	15.36671	Managundi	Managundi	Dharwad
6	74.98507	15.36990	Managundi	Managundi	Dharwad
7	75.02948	15.37017	Itigatti	Yarikoppa	Dharwad
8	74.99838	15.37133	Naikanaholikatte	Yarikoppa	Dharwad
9	74.94167	15.37398	Ajjanaikanahatti	Managundi	Dharwad
10	74.95526	15.37611	Managundi	Managundi	Dharwad
11	74.97989	15.37839	Managundi	Managundi	Dharwad
12	74.97093	15.37840	Managundi	Managundi	Dharwad
13	75.03579	15.37993	Itigatti	Yarikoppa	Dharwad
14	74.99727	15.38365	Managundi	Managundi	Dharwad
15	75.02139	15.38472	Itigatti	Yarikoppa	Dharwad
16	74.96250	15.38658	Managundi	Managundi	Dharwad
17	75.00680	15.38816	Yarikoppa	Yarikoppa	Dharwad
18	74.93620	15.38929	Nigadhi	Nigadi	Dharwad
19	74.94698	15.38959	Ajjanaikanahatti	Managundi	Dharwad
20	75.02080	15.39371	Thadasinakoppa	Dharwad	Dharwad
21	74.99614	15.39544	Yarikoppa	Yarikoppa	Dharwad
22	74.97108	15.39792	Manasura	Manasura	Dharwad
23	74.98510	15.39926	Manasura	Manasura	Dharwad
24	75.00423	15.40137	Yarikoppa	Yarikoppa	Dharwad
25	75.03283	15.40290	Satthura	Dharwad	Dharwad
26	74.95392	15.40323	Salakinakoppa	Manasura	Dharwad
27	75.07288	15.40614	Rayapura	Dharwad	Dharwad
28	74.96605	15.40811	Manasura	Manasura	Dharwad
29	75.04309	15.40902	Satthura	Dharwad	Dharwad
30	75.02613	15.40960	Thadasinakoppa	Dharwad	Dharwad
31	74.94404	15.40968	Bada	Nigadi	Dharwad
32	75.06321	15.41093	Rayapura	Dharwad	Dharwad
33	75.00857	15.41266	Nuggikeri	Yarikoppa	Dharwad
34	75.03816	15.41801	Satthura	Dharwad	Dharwad
35	74.93476	15.41810	Bada	Nigadi	Dharwad
36	75.06065	15.41839	Rayapura	Dharwad	Dharwad
37	74.95114	15.41906	Salakinakoppa	Manasura	Dharwad
38	74.98625	15.41925	Atthikolla	Dharwad	Dharwad
39	74.97129	15.42031	Sannasomapura	Manasura	Dharwad
40	75.01962	15.42070	Hosakatti	Dharwad	Dharwad
41	75.07427	15.42183	Rayapura	Dharwad	Dharwad

42	75.00857	15.42452	Atthikolla	Dharwad	Dharwad
43	75.03402	15.42586	Navalura	Dharwad	Dharwad
44	74.94167	15.42652	Salakinakoppa	Manasura	Dharwad
45	75.06421	15.42911	Navalura	Dharwad	Dharwad
46	74.96654	15.43116	Sannasomapura	Manasura	Dharwad
47	75.02337	15.43428	Lakamanahalli	Dharwad	Dharwad
48	75.05553	15.43562	Navalura	Dharwad	Dharwad
49	75.00247	15.43614	Atthikolla	Dharwad	Dharwad
50	74.93436	15.43628	Kyarakoppa	Kyarakoppa	Dharwad
51	75.07092	15.43638	Navalura	Dharwad	Dharwad
52	75.14049	15.43714	Shivalli	Shivalli	Dharwad
53	75.04053	15.43772	Navalura	Dharwad	Dharwad
54	74.95449	15.43800	Kalageri	Kyarakoppa	Dharwad
55	75.10490	15.43879	Navalura Thadadhabeela	Dharwad	Dharwad
56	75.11822	15.43950	Maradagi	Maradagi	Dharwad
57	74.97718	15.43992	Sapthapura	Dharwad	Dharwad
58	75.08961	15.44167	Navalura	Dharwad	Dharwad
59	75.13284	15.44275	Maradagi	Maradagi	Dharwad
60	75.06831	15.44300	Navalura	Dharwad	Dharwad
61	75.01323	15.44399	Lakamanahalli	Dharwad	Dharwad
62	74.94458	15.44577	Kyarakoppa	Kyarakoppa	Dharwad
63	75.03718	15.44653	Lakamanahalli	Dharwad	Dharwad
64	74.99922	15.44915	Sapthapura	Dharwad	Dharwad
65	74.96317	15.45044	Kalageri	Kyarakoppa	Dharwad
66	75.10778	15.45160	Maradagi	Maradagi	Dharwad
67	75.09337	15.45180	Allapura (Somapura)	Maradagi	Dharwad
68	75.14956	15.45289	Shivalli	Shivalli	Dharwad
69	74.98348	15.45360	Sapthapura	Dharwad	Dharwad
70	75.08351	15.45505	Navalura	Dharwad	Dharwad
71	74.90955	15.45508	Dhaddikamalapura	Mandihal	Dharwad
72	75.05687	15.45602	Govanakoppa	Maradagi	Dharwad
73	75.12034	15.45640	Hebballi	Hebballi	Dharwad
74	74.95246	15.45677	Kalageri	Kyarakoppa	Dharwad
75	74.91991	15.45796	Dhaddikamalapura	Mandihal	Dharwad
76	75.02250	15.45815	Hosayellapura	Dharwad	Dharwad
77	75.03513	15.46006	Hosayellapura	Dharwad	Dharwad
78	75.06852	15.46023	Govanakoppa	Maradagi	Dharwad
79	74.93668	15.46059	Kenchanahatti	Kyarakoppa	Dharwad
80	75.00336	15.46121	Dharwad	Dharwad	Dharwad
81	74.99310	15.46126	Narayanapura	Dharwad	Dharwad
82	75.11212	15.46289	Maradagi	Maradagi	Dharwad
83	74.96628	15.46539	Kalageri	Kyarakoppa	Dharwad
84	75.16504	15.46616	Hebballi	Hebballi	Dharwad
85	75.14847	15.46693	Shivalli	Shivalli	Dharwad

86	75.10167	15.46749	Maradagi	Maradagi	Dharwad
87	75.13406	15.47058	Shivalli	Shivalli	Dharwad
88	74.91744	15.47064	Chikkamalligawada	Chikkamalligawada	Dharwad
89	74.93421	15.47112	Chikkamalligawada	Chikkamalligawada	Dharwad
90	75.04480	15.47211	Dharwad	Dharwad	Dharwad
91	75.08648	15.47304	Gongadikoppa	Maradagi	Dharwad
92	75.00948	15.47346	Malapura	Dharwad	Dharwad
93	75.17689	15.47361	Hebballi	Hebballi	Dharwad
94	74.90436	15.47374	Varavanagalavi	Mandihal	Dharwad
95	75.06378	15.47439	Govanakoppa	Maradagi	Dharwad
96	75.16042	15.47646	Hebballi	Hebballi	Dharwad
97	74.95863	15.47687	Kalageri	Kyarikoppa	Dharwad
98	75.11177	15.47710	Maradagi	Maradagi	Dharwad
99	75.03277	15.47843	Dharwad	Dharwad	Dharwad
100	74.93840	15.47973	Kedanahatti	Chikkamalligawada	Dharwad
101	74.99942	15.47996	Gulaganjikoppa	Dharwad	Dharwad
102	75.08040	15.48075	Gongadikoppa	Maradagi	Dharwad
103	75.09460	15.48189	Hebballi	Hebballi	Dharwad
104	75.06316	15.48206	Dandikoppa	Maradagi	Dharwad
105	74.89572	15.48283	Varavanagalavi	Mandihal	Dharwad
106	75.14019	15.48301	Hebballi	Hebballi	Dharwad
107	75.17611	15.48433	Hebballi	Hebballi	Dharwad
108	74.97574	15.48494	Saidapura-Vi	Dharwad	Dharwad
109	75.10763	15.48514	Kurudapura	Hebballi	Dharwad
110	75.04678	15.48666	Dharwad	Dharwad	Dharwad
111	75.03356	15.49068	Dharwad	Dharwad	Dharwad
112	74.96060	15.49074	Hiremalligawada	Chikkamalligawada	Dharwad
113	74.93124	15.49097	Mummigatti	Mammigatti	Dharwad
114	75.12599	15.49106	Hebballi	Hebballi	Dharwad
115	75.00553	15.49145	Kamalapur Thadhabal	Dharwad	Dharwad
116	75.15441	15.49294	Hebballi	Hebballi	Dharwad
117	75.06790	15.49297	Kavalageri	Kanakura	Dharwad
118	75.13664	15.49316	Hebballi	Hebballi	Dharwad
119	75.08908	15.49318	Benakanamatti	Kanakura	Dharwad
120	75.10665	15.49566	Kanakura	Kanakura	Dharwad
121	75.14660	15.49567	Inamathihebbali	Hebballi	Dharwad
122	74.98521	15.49585	Yatthinagudda	Dharwad	Dharwad
123	75.02152	15.49642	Kamalapur Thadhabal	Dharwad	Dharwad
124	75.18927	15.49670	Hebballi	Hebballi	Dharwad
125	75.20115	15.49684	Hebballi	Hebballi	Dharwad
126	74.89325	15.49694	Heggeri	Belur	Dharwad
127	74.94703	15.49720	Mummigatti	Mammigatti	Dharwad
128	75.17036	15.49732	Hebballi	Hebballi	Dharwad
129	74.90682	15.49766	Belura	Belur	Dharwad

130	75.12579	15.50024	Hebballi	Hebballi	Dharwad
131	75.05093	15.50063	Aminabhavi	Amminabhavi	Dharwad
132	75.00494	15.50082	Kamalapur Thadhabal	Dharwad	Dharwad
133	74.92704	15.50269	Mummigatti	Mammigatti	Dharwad
134	74.97342	15.50294	Narendra	Narendra	Dharwad
135	75.09448	15.50493	Chandanamatti	Kanakura	Dharwad
136	75.20319	15.50563	Hebballi	Hebballi	Dharwad
137	75.21257	15.50578	Hebballi	Hebballi	Dharwad
138	75.02428	15.50599	Kamalapur Thadhabal	Dharwad	Dharwad
139	74.94037	15.50628	Mummigatti	Mammigatti	Dharwad
140	75.10605	15.50687	Kanakura	Kanakura	Dharwad
141	74.98481	15.50714	Narendra	Narendra	Dharwad
142	75.07369	15.50729	Kavalageri	Kanakura	Dharwad
143	75.16489	15.50746	Hebballi	Hebballi	Dharwad
144	74.90331	15.50862	Belura	Belur	Dharwad
145	75.14549	15.51070	Hebballi	Hebballi	Dharwad
146	75.12085	15.51105	Thalavayi	Kanakura	Dharwad
147	75.19116	15.51110	Hebballi	Hebballi	Dharwad
148	75.22258	15.51137	Hebballi	Hebballi	Dharwad
149	75.04165	15.51154	Marewada Aralikatte	Marewada	Dharwad
150	75.17708	15.51215	Hebballi	Hebballi	Dharwad
151	74.96676	15.51275	Narendra	Narendra	Dharwad
152	74.92211	15.51393	Belura	Belur	Dharwad
153	75.08245	15.51411	Chandanamatti	Kanakura	Dharwad
154	75.01070	15.51592	Dasankoppa	Narendra	Dharwad
155	75.06181	15.51654	Aminabhavi	Amminabhavi	Dharwad
156	74.88514	15.51664	Kotura	Kotur	Dharwad
157	74.94357	15.51681	Mummigatti	Mammigatti	Dharwad
158	75.21539	15.51759	Hebballi	Hebballi	Dharwad
159	75.16426	15.51766	Vanahalli	Kanakura	Dharwad
160	75.10267	15.51815	Kanakura	Kanakura	Dharwad
161	74.99669	15.51898	Dasankoppa	Narendra	Dharwad
162	75.03336	15.51900	Marewada Aralikatte	Marewada	Dharwad
163	74.98058	15.51921	Devagiri .M. Narendra	Narendra	Dharwad
164	74.95788	15.51944	Sankalapura .M. Narendra	Narendra	Dharwad
165	75.19288	15.52153	Hebballi	Hebballi	Dharwad
166	74.90251	15.52163	Kotura	Kotur	Dharwad
167	75.22274	15.52274	Hebballi	Hebballi	Dharwad
168	75.13335	15.52330	Thalavayi	Kanakura	Dharwad
169	75.15660	15.52373	Vanahalli	Kanakura	Dharwad
170	74.92901	15.52422	Niralakatti	Belur	Dharwad
171	75.09245	15.52472	Kanakura	Kanakura	Dharwad
172	75.08167	15.52518	Chandanamatti	Kanakura	Dharwad
173	75.14313	15.52536	Vanahalli	Kanakura	Dharwad

174	75.04259	15.52579	Marewada Aralikatte	Marewada	Dharwad
175	75.06916	15.52670	Aminabhavi	Amminabhavi	Dharwad
176	75.17333	15.52826	Vanahalli	Kanakura	Dharwad
177	75.11747	15.52869	Thalavayi	Kanakura	Dharwad
178	74.97145	15.52901	Devagiri .M. Narendra	Narendra	Dharwad
179	75.01642	15.53008	Marewada Aralikatte	Marewada	Dharwad
180	75.12672	15.53018	Thalavayi	Kanakura	Dharwad
181	74.94283	15.53021	Niralakatti	Belur	Dharwad
182	74.89580	15.53081	Kotura	Kotur	Dharwad
183	74.98699	15.53093	Lakamapura	Yadawada	Dharwad
184	74.86757	15.53252	Venkatapura	Tegur	Dharwad
185	74.91277	15.53254	Belura	Belur	Dharwad
186	74.95417	15.53356	Niralakatti	Belur	Dharwad
187	75.03759	15.53731	Thimmapura .M. Aminabhavi	Marewada	Dharwad
188	75.16849	15.53736	Vanahalli	Kanakura	Dharwad
189	75.05744	15.53807	Aminabhavi	Amminabhavi	Dharwad
190	75.00063	15.53812	Lakamapura	Yadawada	Dharwad
191	75.15646	15.53828	Vanahalli	Kanakura	Dharwad
192	75.08120	15.53897	Aminabhavi	Amminabhavi	Dharwad
193	74.97557	15.53946	Govanakoppa .M. Narendra	Narendra	Dharwad
194	75.12519	15.54065	Thalavayi	Kanakura	Dharwad
195	75.06885	15.54124	Aminabhavi	Amminabhavi	Dharwad
196	75.01208	15.54195	Lakamapura	Yadawada	Dharwad
197	75.09482	15.54200	Aminabhavi	Amminabhavi	Dharwad
198	75.11013	15.54229	Aminabhavi	Amminabhavi	Dharwad
199	74.94455	15.54269	Garaga	Garag	Dharwad
200	74.96076	15.54290	Mangalagatti	Kurabagatti	Dharwad
201	74.88927	15.54382	Shinganahalli	Kotur	Dharwad
202	74.90289	15.54517	Kotura	Kotur	Dharwad
203	75.04339	15.54717	Thimmapura .M. Aminabhavi	Marewada	Dharwad
204	75.00577	15.54807	Yadhavada	Yadawada	Dharwad
205	74.92776	15.54881	Niralakatti	Belur	Dharwad
206	75.07997	15.55004	Aminabhavi	Amminabhavi	Dharwad
207	74.86420	15.55031	Venkatapura	Tegur	Dharwad
208	74.98642	15.55247	Yadhavada	Yadawada	Dharwad
209	75.10264	15.55276	Aminabhavi	Amminabhavi	Dharwad
210	74.95027	15.55379	Garaga	Garag	Dharwad
211	74.87960	15.55472	Kummanaikanakoppa	Hangaraki	Dharwad
212	75.05808	15.55641	Aminabhavi	Amminabhavi	Dharwad
213	74.96769	15.55756	Mulamutthala	Kurabagatti	Dharwad
214	75.02447	15.55915	Karadigudda	Karadigudda	Dharwad
215	74.90151	15.56047	Agasanahalli	Garag	Dharwad
216	75.00577	15.56146	Yadhavada	Yadawada	Dharwad
217	74.91453	15.56201	Niralakatti	Belur	Dharwad

218	75.03417	15.56506	Karadigudda	Karadigudda	Dharwad
219	75.09561	15.56534	Aminabhavi	Amminabhavi	Dharwad
220	74.86188	15.56570	Bogura	Tegur	Dharwad
221	74.99412	15.56606	Yadhavada	Yadawada	Dharwad
222	75.10624	15.56701	Aminabhavi	Amminabhavi	Dharwad
223	75.05168	15.56748	Aminabhavi	Amminabhavi	Dharwad
224	75.07263	15.56808	Aminabhavi	Amminabhavi	Dharwad
225	74.87964	15.56834	Dubbanamaradi	Hangaraki	Dharwad
226	74.94908	15.56910	Garaga	Garag	Dharwad
227	74.97054	15.57218	Kurubagatti	Kurabagatti	Dharwad
228	75.02072	15.57234	Karadigudda	Karadigudda	Dharwad
229	74.90666	15.57512	Garaga	Garag	Dharwad
230	75.03307	15.57627	Karadigudda	Karadigudda	Dharwad
231	74.92776	15.57656	Garaga	Garag	Dharwad
232	74.97851	15.57870	Sibaragatti	Lokur	Dharwad
233	75.07310	15.57884	Aminabhavi	Amminabhavi	Dharwad
234	75.04683	15.57885	Karadigudda	Karadigudda	Dharwad
235	74.87347	15.58006	Mugali	Madhanabhavi	Dharwad
236	75.05825	15.58218	Aminabhavi	Amminabhavi	Dharwad
237	75.01462	15.58279	Pudakalakatti	Pudakalakatti	Dharwad
238	74.95720	15.58328	Lokura	Lokur	Dharwad
239	75.00025	15.58507	Hanumanakoppa	Uppinabetageri	Dharwad
240	74.93683	15.58536	Garaga	Garag	Dharwad
241	74.92529	15.58726	Hangaraki	Hangaraki	Dharwad
242	74.89074	15.58896	Thadakoda (Mashidhapura)	Tadakoda	Dharwad
243	75.03127	15.59049	Pudakalakatti	Pudakalakatti	Dharwad
244	74.99212	15.59234	Hanumanakoppa	Uppinabetageri	Dharwad
245	75.08256	15.59335	Harobelawadi	Harobelawadi	Dharwad
246	75.01876	15.59352	Pudakalakatti	Pudakalakatti	Dharwad
247	74.85840	15.59368	Madhana Bhavi	Madhanabhavi	Dharwad
248	74.90633	15.59375	Thadakoda (Bhavihala)	Tadakoda	Dharwad
249	75.06341	15.59521	Harobelawadi	Harobelawadi	Dharwad
250	74.96866	15.59598	Lokura	Lokur	Dharwad
251	74.98101	15.59734	Lokura	Lokur	Dharwad
252	74.94340	15.60024	Hangaraki	Hangaraki	Dharwad
253	74.93200	15.60254	Hangaraki	Hangaraki	Dharwad
254	74.87691	15.60350	Madhana Bhavi	Madhanabhavi	Dharwad
255	75.05003	15.60352	Harobelawadi	Harobelawadi	Dharwad
256	75.03612	15.60367	Uppina Betageri	Uppinabetageri	Dharwad
257	74.89468	15.60753	Khanapura . M. Thadakoda	Hangaraki	Dharwad
258	74.86605	15.60828	Madhana Bhavi	Madhanabhavi	Dharwad
259	75.00277	15.60850	Uppina Betageri	Uppinabetageri	Dharwad
260	75.07959	15.61078	Harobelawadi	Harobelawadi	Dharwad
261	75.04315	15.61079	Harobelawadi	Harobelawadi	Dharwad

262	75.06130	15.61094	Harobelawadi	Harobelawadi	Dharwad
263	75.02267	15.61246	Uppina Betageri	Uppinabetageri	Dharwad
264	74.97242	15.61273	Kallura	Kotabagi	Dharwad
265	74.90731	15.61385	Thadakoda	Tadakoda	Dharwad
266	74.93140	15.61588	Thadakoda	Tadakoda	Dharwad
267	74.98682	15.61676	Kallura	Kotabagi	Dharwad
268	74.94828	15.61732	Kotabagi	Kotabagi	Dharwad
269	74.88184	15.61939	Khanapura . M. Thadakoda	Hangaraki	Dharwad
270	75.04182	15.62151	Kabbenura	Harobelawadi	Dharwad
271	75.02079	15.62424	Hanumanahala	Uppinabetageri	Dharwad
272	74.90829	15.62590	Thimmapura .M. Thadakoda	Tadakoda	Dharwad
273	74.89506	15.62705	Thimmapura .M. Thadakoda	Tadakoda	Dharwad
274	74.98995	15.63017	Kallura	Kotabagi	Dharwad
275	75.04004	15.63113	Kabbenura	Harobelawadi	Dharwad
276	75.00293	15.63593	Laddhigatti	Pudakalakatti	Dharwad
277	75.02049	15.64031	Kalle	Pudakalakatti	Dharwad
278	74.98338	15.64154	Laddhigatti	Pudakalakatti	Dharwad
279	74.97243	15.64245	Kallura	Kotabagi	Dharwad
280	74.99517	15.64692	Laddhigatti	Pudakalakatti	Dharwad
281	75.04478	15.65318	Kabbenura	Harobelawadi	Dharwad
282	75.03022	15.65355	Kalle	Pudakalakatti	Dharwad
283	75.05663	15.65773	Kabbenura	Harobelawadi	Dharwad
284	75.03491	15.66443	Kalle	Pudakalakatti	Dharwad
285	75.05602	15.66670	Kabbenura	Harobelawadi	Dharwad
286	75.05837	15.67459	Kabbenura	Harobelawadi	Dharwad

(Source: Master Plan, CGWB, 2020. It is likely that the number of structures proposed may vary depending upon the ground truth verification and feasibility criteria)