



# 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**

**Tirthahalli Taluk, Shimoga District, Karnataka**

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

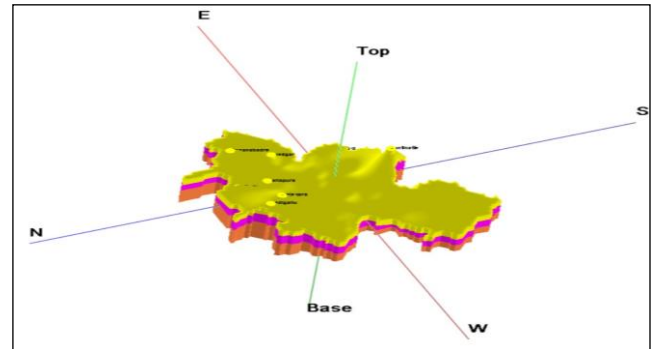
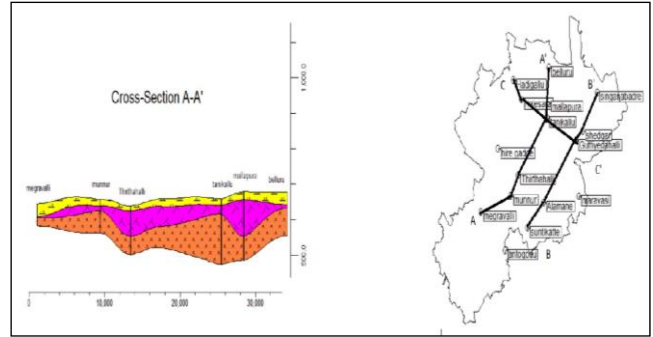
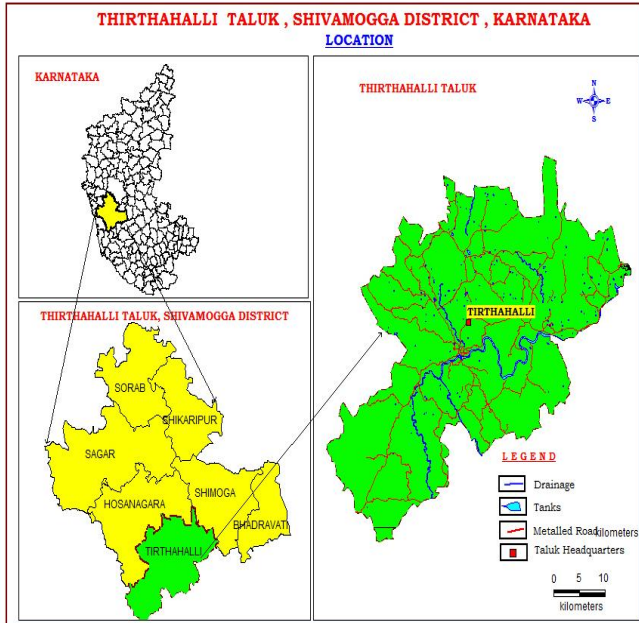
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## Aquifer Maps and Management Plan, Tirthahalli Taluk, Shimoga District, Karnataka State

(AAP: – 2022-2023)



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APRIL 2023

# Aquifer Maps and Management Plan, Tirthahalli Taluk, Shimoga District, Karnataka State

(AAP: 2022-23)

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# **Aquifer Maps and Management Plan, Tirthahalli Taluk, Shimoga District, Karnataka State**

## **1. INTRODUCTION**

In XII five-year plan, National Aquifer Mapping (NAQUIM) has been taken up by CGWB to carry out detailed hydrogeological investigation on topographic sheet scale (1:50,000). Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers.

The vagaries of rainfall, inherent heterogeneity of hard rock aquifers, over exploitation and lack of regulation mechanisms had a detrimental effect on ground water scenario of the country in last decade or so, demanding a paradigm shift from “traditional groundwater development concept” to “modern groundwater management concept”.

Varied and diverse hydrogeological settings demand precise and comprehensive mapping of aquifers down to the optimum possible depth at appropriate scale to arrive at robust and implementable ground water management plans. The proposed management plans will provide the “Road Map” ensuring sustainable development of ground water resources, thereby primarily improving drinking water security and irrigation requirement. Thus, the crux of NAQUIM is not merely mapping, but reaching the goal of community participation in ground water management.

By understanding the goals of NAQUIM, during the Annual Action Plan of 2022-23, Tirthahalli taluka of Shimoga district of Kerala state covering a geographical area of 1253.77F sq.km. has been taken up. The aquifer maps and management plans formulated subsequently by this study will be shared with the Shimoga district administration for its effective implementation.

### **1.1 Objective and Scope**

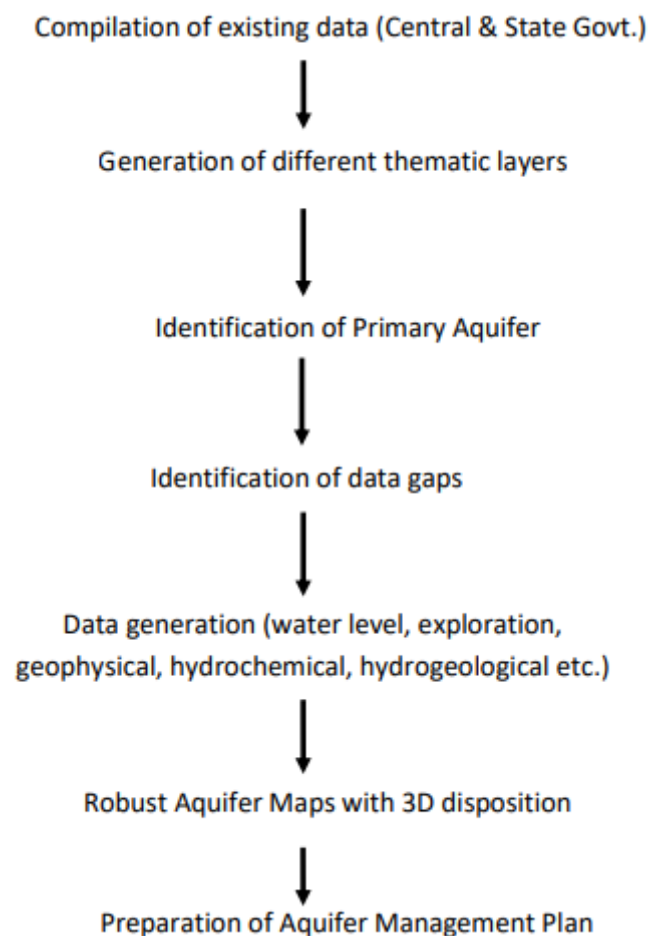
Aquifer mapping itself is an improved form of groundwater management – recharge, conservation, harvesting and protocols of managing groundwater. These protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer map and management plan. The activities under NAQUIM are aimed at:

- Identifying the aquifer geometry,
- Aquifer characteristics and their yield potential
- Quality of water occurring at various depths
- Aquifer-wise assessment of ground water resources
- Preparation of aquifer maps and
- Formulate ground water management plan.

This clear demarcation of aquifers and their potential will help the agencies involved in water sector to ascertain the volume of water available for various uses as well as the need of management measures implemented to achieve a sustainable development goal.

## 1.2. Approach and Methodology

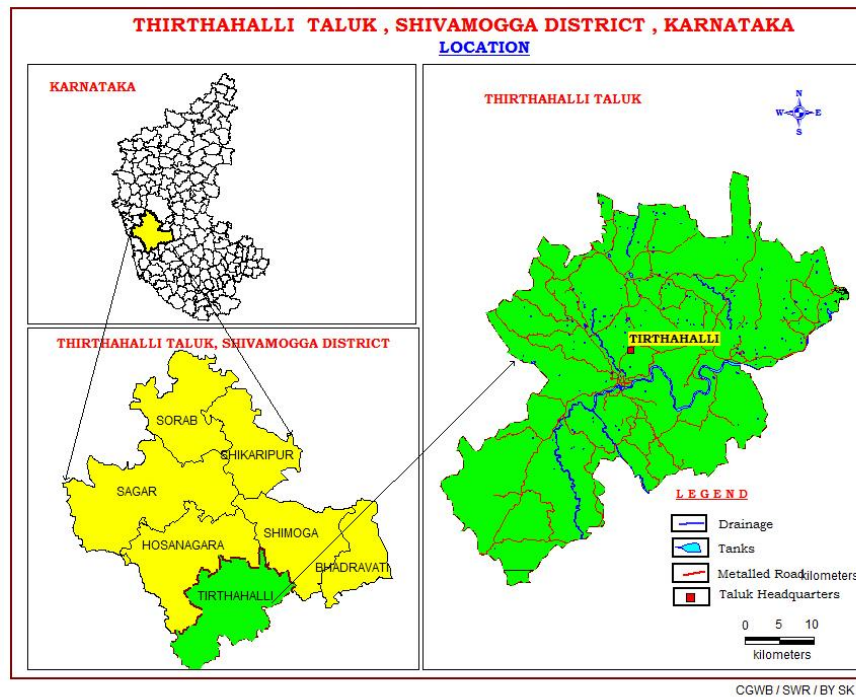
The ongoing activities of NAQUIM include topographic sheet wise micro-level hydrogeological data acquisition, geophysical and hydro-chemical investigations, supplemented by ground water exploration down to the depth of 200/300 meters. The data on various components thus collected were brought on GIS platform by geo-referencing for its utilisation in the preparation of various thematic maps. The approach and methodology followed for Aquifer mapping is as given below:



## 1.3 Study area

Tirthahalli taluka falls in Shimoga subdivision of Shimoga district covering an area of 1254 sq.km covering parts of Survey of India toposheets 48O1, 48O5, 48O6 and 48O3. The taluka is covered with dense tropical forests, plantations, scrublands and agricultural lands with a mappable area of 776.45 sq.km. The district is bounded by North latitudes 13<sup>0</sup>27' and 13<sup>0</sup>55' and East longitudes 75<sup>0</sup>06' and 75<sup>0</sup>22'. It is bounded by Hosanagara taluka in the north west, Shimoga taluka in the north-east, Udupi district in the west and chickmangalur district in the east.

Administratively, the taluka has 01 Town Panchayath and 38 Gram panchayats consisting of 247 villages of which 245 villages are inhabited. The Census data for the year 2011 reveals that the taluka has total population of 1,42,006 persons with 69882 males and 72124 females, with a population density of 113 person per square kilometre. The projected population as on 2021 is 70489 males, 70323 females and a total of 140813 which is 7.5% of total population of the district (*source: District at a glance:2019-20*). The number of rural households in the taluka is 31614, urban households is 3726 and the total households is 35340 as per 2011 census. The taluka falls in south transition zone of agro-climatic zone.



**Figure 1.1 Administrative set-up, Tirthahalli Taluka, Shimoga District**

#### 1.4 Data Adequacy and Data Gap Analysis and Data Generation:

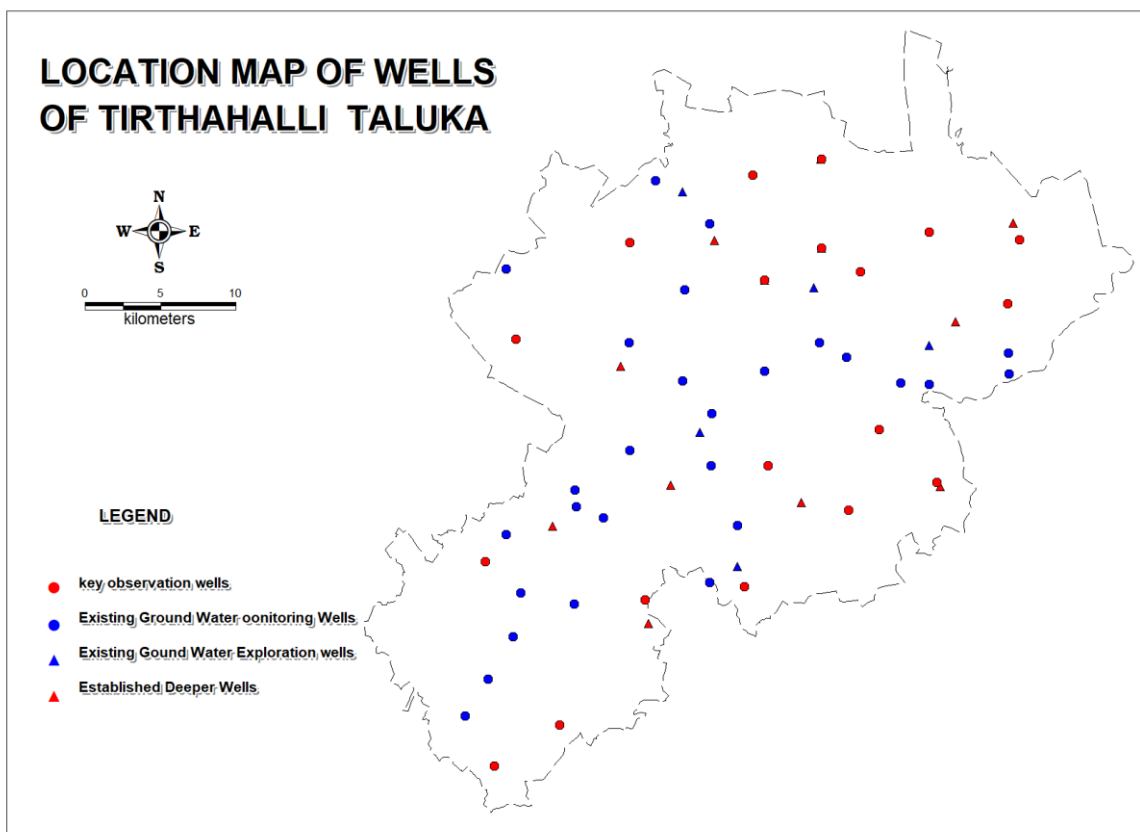
The available data on Exploration activities, Geophysical Surveys, Ground water monitoring and ground water quality of Central Ground Water Board were compiled and analysed for aquifer mapping studies. In addition to these, data on ground water monitoring and ground water quality from State Ground Water Department, Govt. of Karnataka were also utilised. The data adequacy and data gap analysis were carried out for each quadrant of topographic sheet as per the criteria suggested in the manual of Aquifer Mapping in respect of the following primary and essential data requirements and the same is shown in table 1.1 viz.

- Exploratory Wells
- Geophysical Surveys
- Ground Water Monitoring and
- Ground Water Quality

**Table 1.1 Data Gap Analysis**

Sl.No.	Items	Data available with State govt. Agency	Data available with CGWB	Data Requirement/ Data gap identified	Data generated	Total
1	Ground water level data	03 DW+05 PZ	29 DW+0 PZ	18 DW	18 DW	55
2	Ground water quality Data	-	DW 29 + BW 0	18 DW+10 BW	18 DW+10 BW	47 DW+10 BW
3	Borehole Lithology Data	--	5 EW	10 BW	10 BW	15
4	Geophysical Survey	-	-	-	-	-

The location map of existing borewells, dug wells and the locations of established key wells as per data gap is shown in fig 1.2



**Fig 1.2 Location Map of wells of Tirthahalli Taluka**



## 1.5 Rainfall and Climate

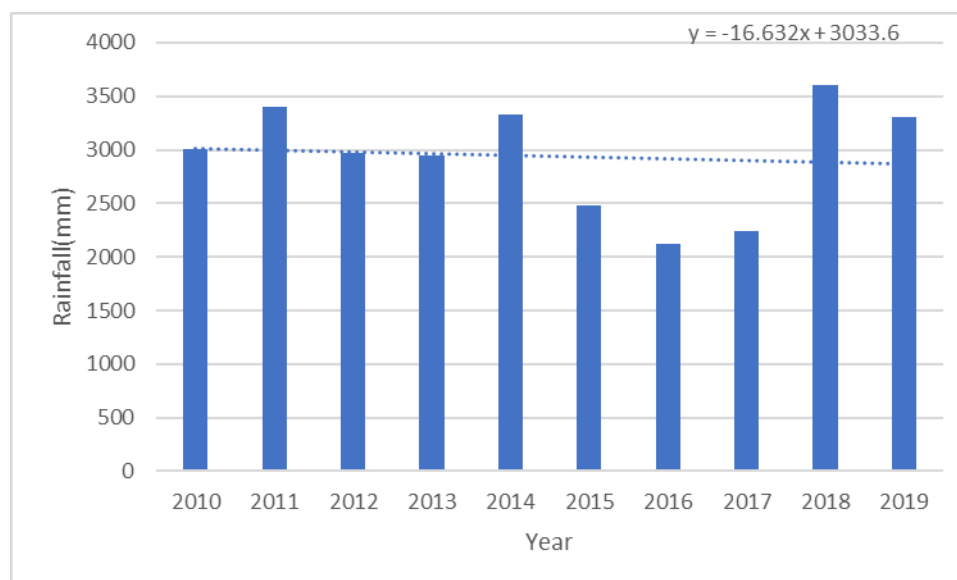
Tirthahalli taluka has tropical climate throughout the year. Generally, the weather is very pleasant in the area. The relative humidity ranges from 27 to 88%, the wind speed recorded is between 4 and 7km/hr. The evapotranspiration is normally high in ghat section. Summer prevails between March to early June, the wet months start from early June to September, October and November months experience scanty rain by N-E monsoon.

The normal annual rainfall (1961 - 2010) of the taluka is 2867 mm and the average annual rainfall of the district is 2942 mm (2010 to 2019 period). The taluka gets heavy rainfall as the taluka is located in the windward side of the Western Ghats. Table 1.2 shows the monthly rainfall in the taluka for the period 2010-2019 and graphical representation of variation of average annual rainfall over the period 2010-19 is given in figure 1.3. The graph shows a slight declining trend in available average annual received in the taluka @ 16 mm/year.

**Table 1.2. Monthly rainfall (2010-19)**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2010	6	0	7	37	62	521	890	814	339	169	156	0	3001
2011	0	0	0	27	10	902	948	730	566	167	47	0	3397
2012	0	0	0	74	2	382	746	1368	270	48	86	0	2976
2013	0	17	4	28	0	382	746	1368	270	48	86	0	2949
2014	0	28	0	19	135	413	1306	946	385	68	5	28	3333
2015	0	0	5	84	149	782	675	424	144	129	85	0	2477
2016	0	0	1	4	83	515	699	565	195	47	14	3	2126
2017	0	0	17	17	123	551	664	599	191	78	6	0	2246
2018	0	0	49	29	238	1020	1140	1014	84	21	9	6	3610
2019	0	0	0	59	0	215	856	1288	540	348	0	0	3306
<b>Annual Average</b>													<b>2942</b>

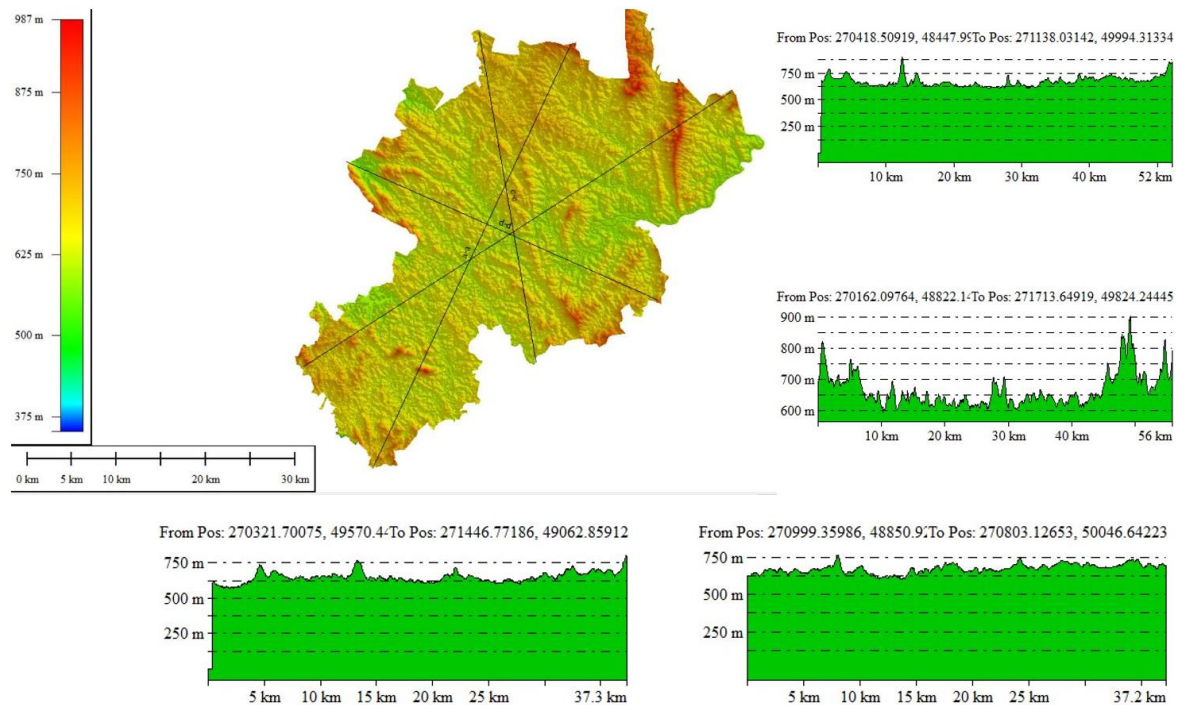
Source: Karnataka District at a glance



**Figure 1.3. Average Annual Rainfall Plot (2010-19)**

## 1.6 Physiography, Geomorphology, Drainage and Slope

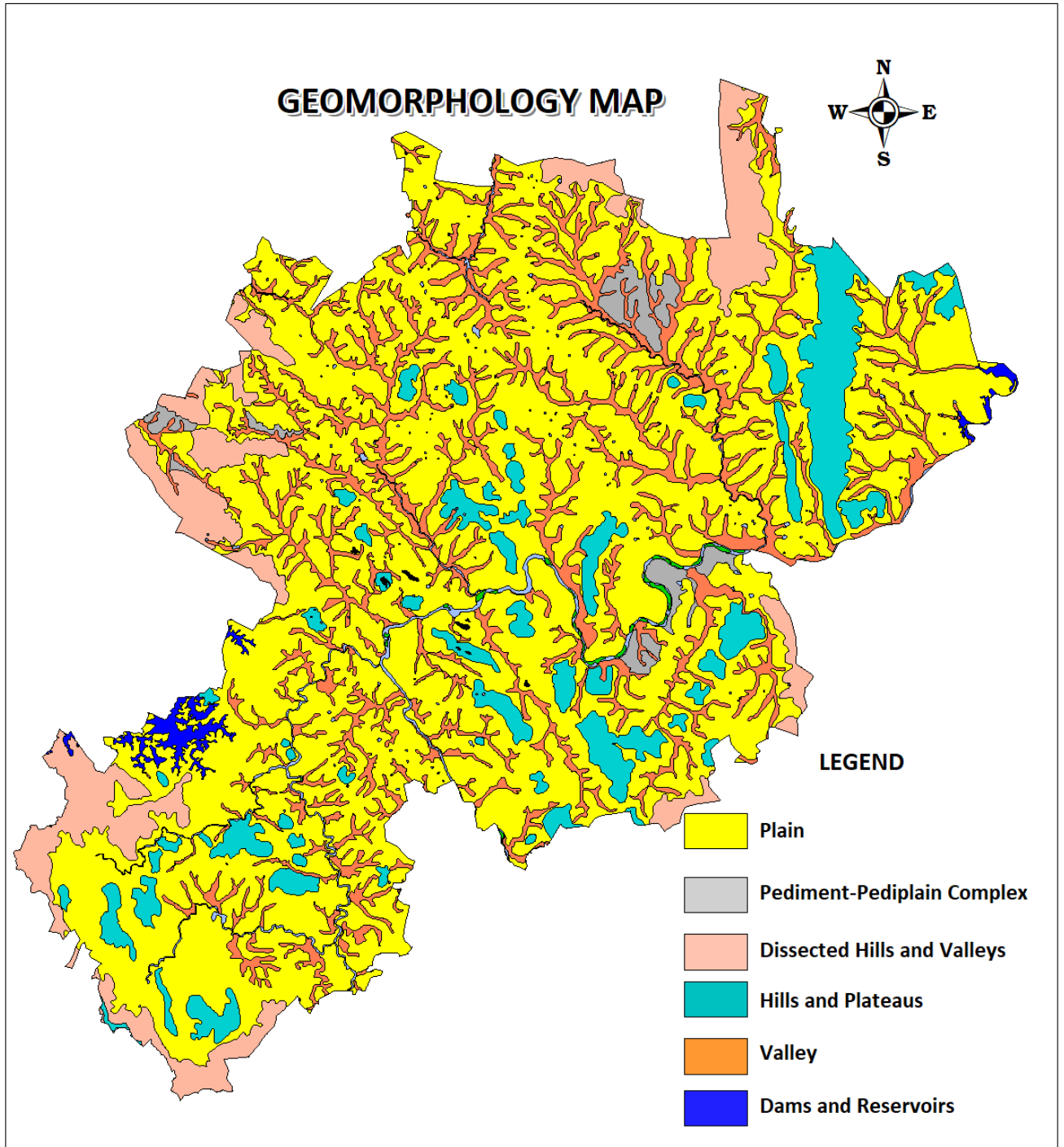
Tirthahalli taluka is classified as Malnad region, characterized by mountains with heavy downpour. The mountains are part of Western Ghats (Sahayadrihill ranges), which can be demarcated into densely forested, high and hilly located in the western part of Shimoga district. Two hills adorn Thirthahalli town. First one is Anandagiri Gudda and the second one is Siddeshwara Gudda. A digital elevation model (SRTM-USGS) depicting the major physiographic features in the district given in figure 1.4.



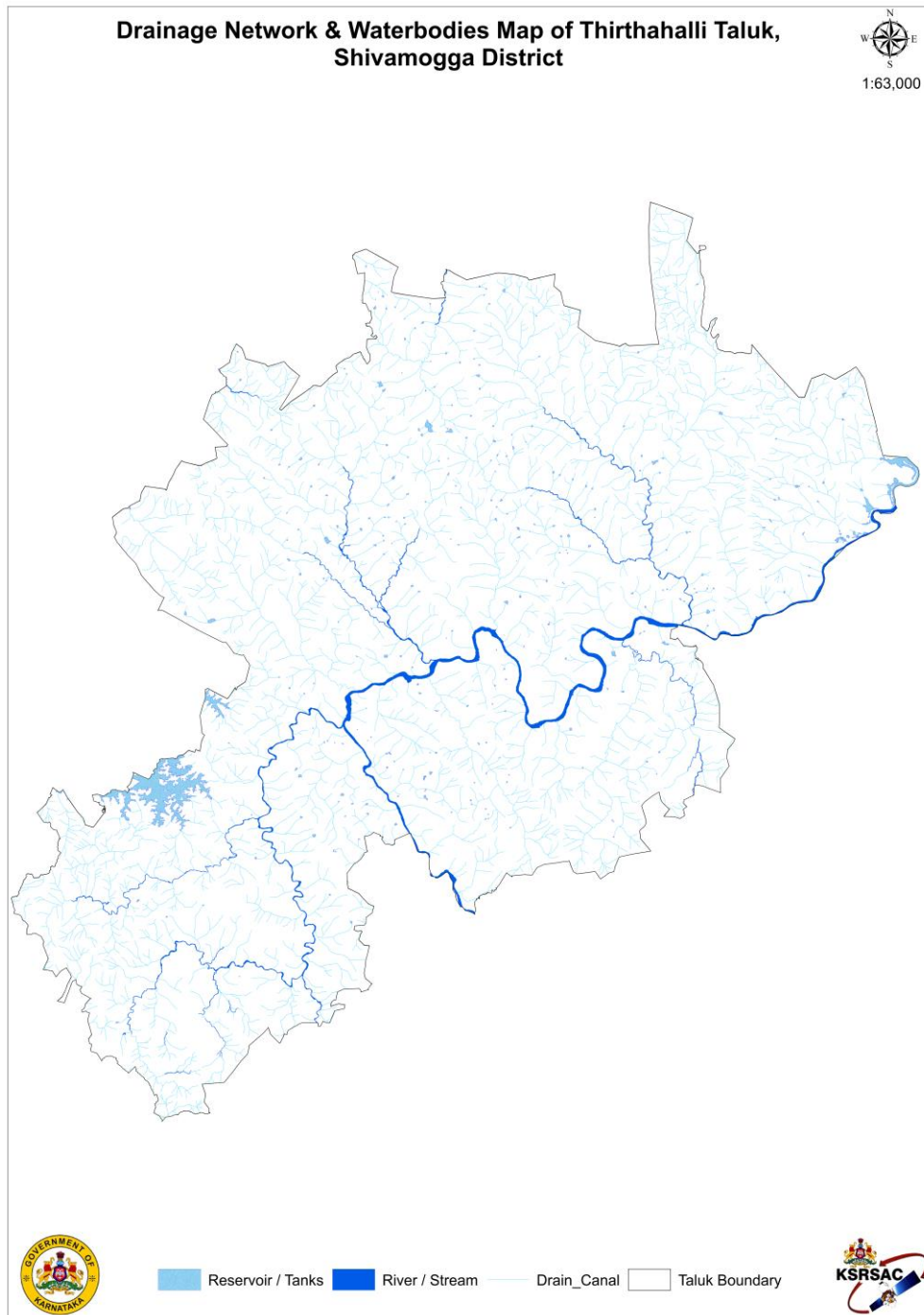
**Figure 1.4. Digital Elevation Model of Tirthahalli Taluka**

Geomorphologically, the area can be divided into dissected hills and valleys along the west and in some parts of the north-west, plains occupy the major part of the taluka covering 785 sq. km area, pediment pediplain complex occur as isolated patches in northern and central part of taluka part of the taluka. Valleys deposits are widely distributed within the taluka. The geomorphological map of the district is given in figure 1.5.

The river Sharavati originates at Ambutheertha near Kavaldurg in Thirthahalli taluk and flows westwards. On its journey, it forms cascades and fall into a gorge, which is popularly called 'Jog falls / Gersoppa falls' in the west flow river basin. The total length of the river is about 132 km and has a drainage area of 2771 sq km The above river systems form a dendritic to sub-dendritic pattern with a drainage density of 0.3 to 4 km/km<sup>2</sup>. The drainage map of the taluka is given in fig 1.6



**Figure 1.5. Geomorphology of Tirthahalli Taluka**



Source: Karnataka State Remote Sensing Application Centre (KSRAC)

**Figure 1.6. Drainage Map of Tirthahalli Taluka**

### 1.7 Land Use, Soil, Slope, Agriculture, Irrigation and Cropping Pattern

An understanding of land use/ land cover is important as it has a direct relation with ground water resource availability and utilisation. As per Annual Season and crop report 2018-19, 39 % of Tirthahalli taluka comes under forest area (477.32 Km<sup>2</sup>). Summarised land use pattern in figure 1.7. The major crops raised in the district are Paddy, arecanut, condiments and spices. The area under different crops is given in table 1.4.

**Table 1.3. Land use pattern**

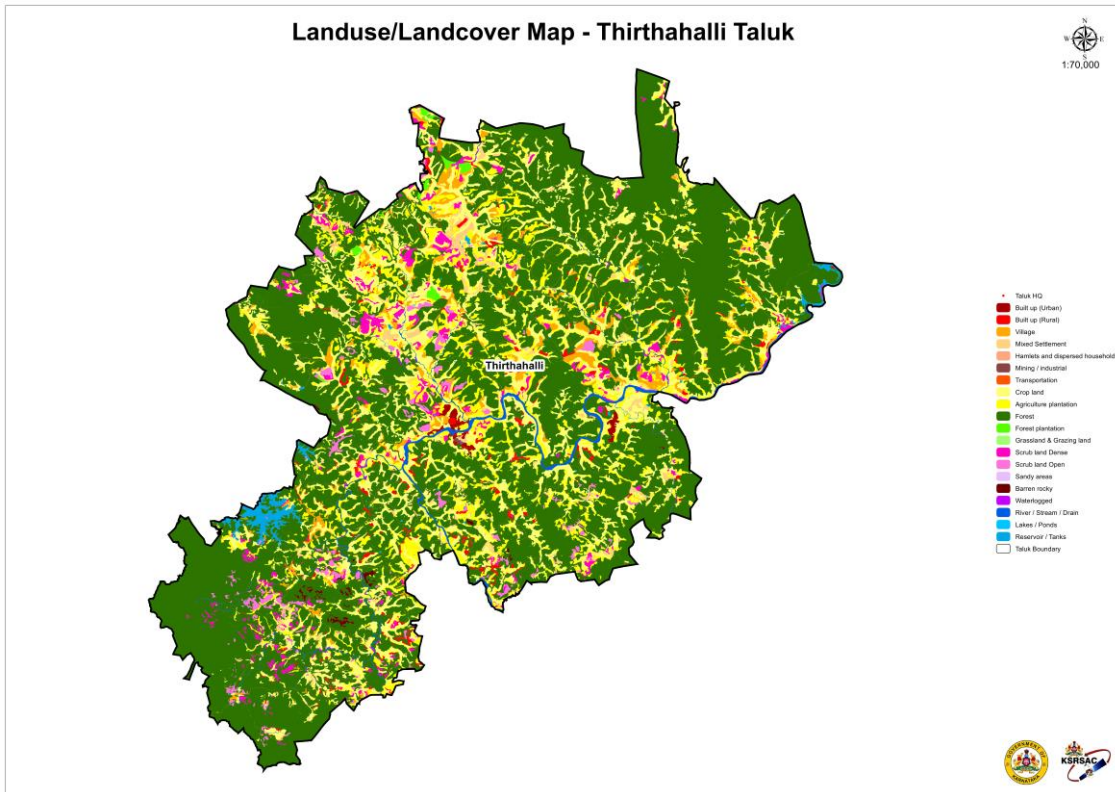
<b>Item</b>	<b>Area (Sq Km)</b>	<b>Percentage to total district area</b>
<b>Forest</b>	477.32	38.07
<b>Land put to non-agricultural use</b>	100.52	8.02
<b>Barren and uncultivable land</b>	16.59	1.32
<b>Land under miscellaneous tree crops</b>	64.4	5.13
<b>Cultivable waste land</b>	17.43	1.39
<b>Fallow other than current fallow</b>	15.10	1.2
<b>Current fallow</b>	21.44	1.71
<b>Net area sown</b>	276.23	22.02
<b>Area sown more than once</b>	27.69	2.21
<b>Total Area Cropped</b>	303.9	24.23

(Source: Karnataka District at a glance 2019-20)

**Table 1.4. Area under different crops**

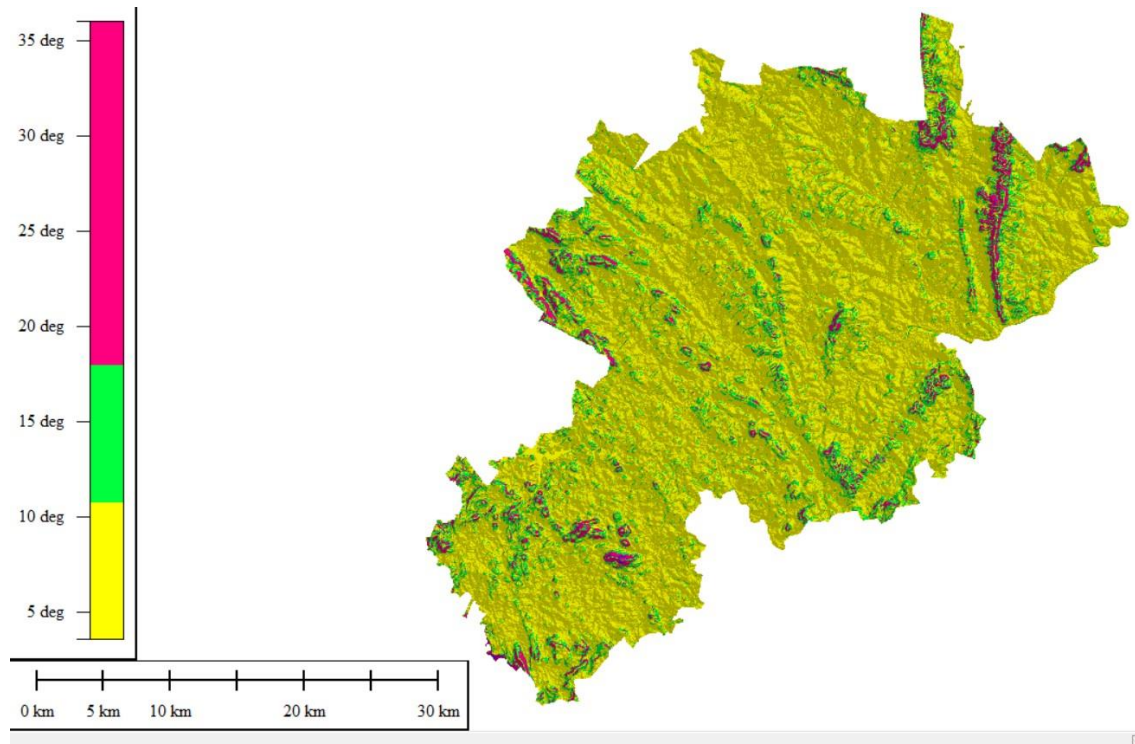
<b>Crop</b>	<b>Area (Ha)</b>	<b>Percentage of total cropped area</b>
<b>Paddy</b>	<b>9833</b>	<b>35.59</b>
<b>Maize</b>	<b>1</b>	<b>0.0036</b>
<b>Pulses</b>	<b>2</b>	<b>0.0073</b>
<b>Oil seeds</b>	<b>31</b>	<b>0.11</b>
<b>Banana</b>	<b>371</b>	<b>1.36</b>
<b>Condiments &amp; Spices</b>	<b>1785</b>	<b>6.53</b>
<b>Coconut</b>	<b>376</b>	<b>1.37</b>
<b>Arecanut</b>	<b>14420</b>	<b>52.7</b>

(Source: Karnataka District at a glance 2019-20)



Source: Karnataka State Remote Sensing Application Centre (KSRAC)

**Figure 1.7. Land use/ Land cover – Tirthahalli Taluka**



**Figure 1.8 Slope Map – Tirthahalli Taluka**

The source wise area irrigated as per Agricultural Statistics 2019-20 is given in table 1.5.

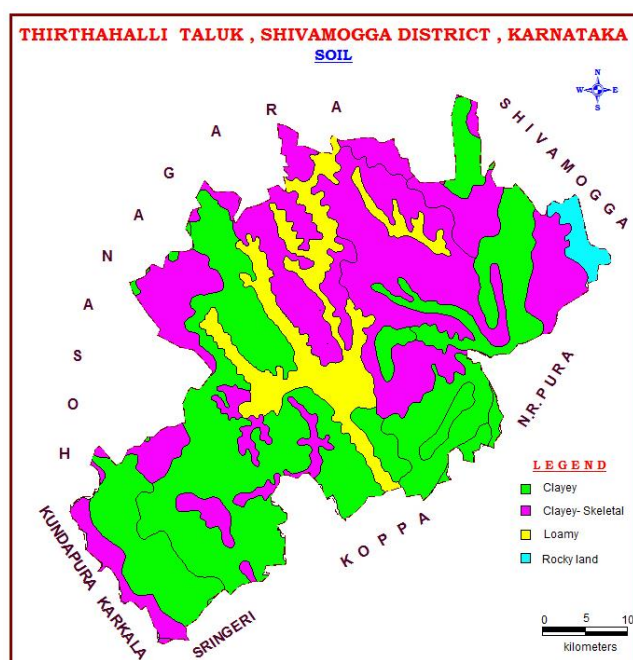
**Table 1.5. Sources of Irrigation**

Source	Area irrigated (Ha)	Percentage of net irrigated area
Small Stream (Thodu/Canal)	-	-
Tanks	11952	43.29
Well	3010	11.03
Bore well	1810	6.63
Lift & Minor Irrigation	2480	9.08
Other sources	-	-
<b>Grand Total</b>	<b>19252</b>	

(Source: Karnataka District at a glance 2019-20)

The soils that occur in the study area is reddish to brownish clayey loam. These cover major parts of the area. In general, these soils are acidic in nature. The thickness varies from few cms to 3.50m. The rate of water infiltration through these soils is recorded as 4.3 to 40.11cm/hr. The Soil map of the taluka is given in figure 1.9

The Slope of the taluka varies from 0 to 50% with 0 to 1% slope in 681 Sq Km area, 1 to 3% slope in 61.8%, 3 to 5% slope in 186 Sq km, 5 to 10% slope in 67.5 Sq Km, 10 to 15% slope in 126.6 sq. km, 15-35% slope in 48.4 Sq Km, 35 to 50% in 82.44 sq. km. This indicates that the major portion covering of the district has slope in the range 0 to 1%. The slope map is given in fig 1.8.



**Figure 1.9. Textural classification of soils -Tirthahalli Taluka**

## 2.0 Data Interpretation, Integration and Aquifer Mapping

Various data pertaining to hydrogeology, geophysics and exploratory drilling were collected and validated. Using this data maps of ground water level scenario, quality aspects, 2-D and 3-D sub-surface aquifers disposition, yield potential etc. were prepared. Finally, aquifer maps were generated and their characteristics are discussed in detail below.

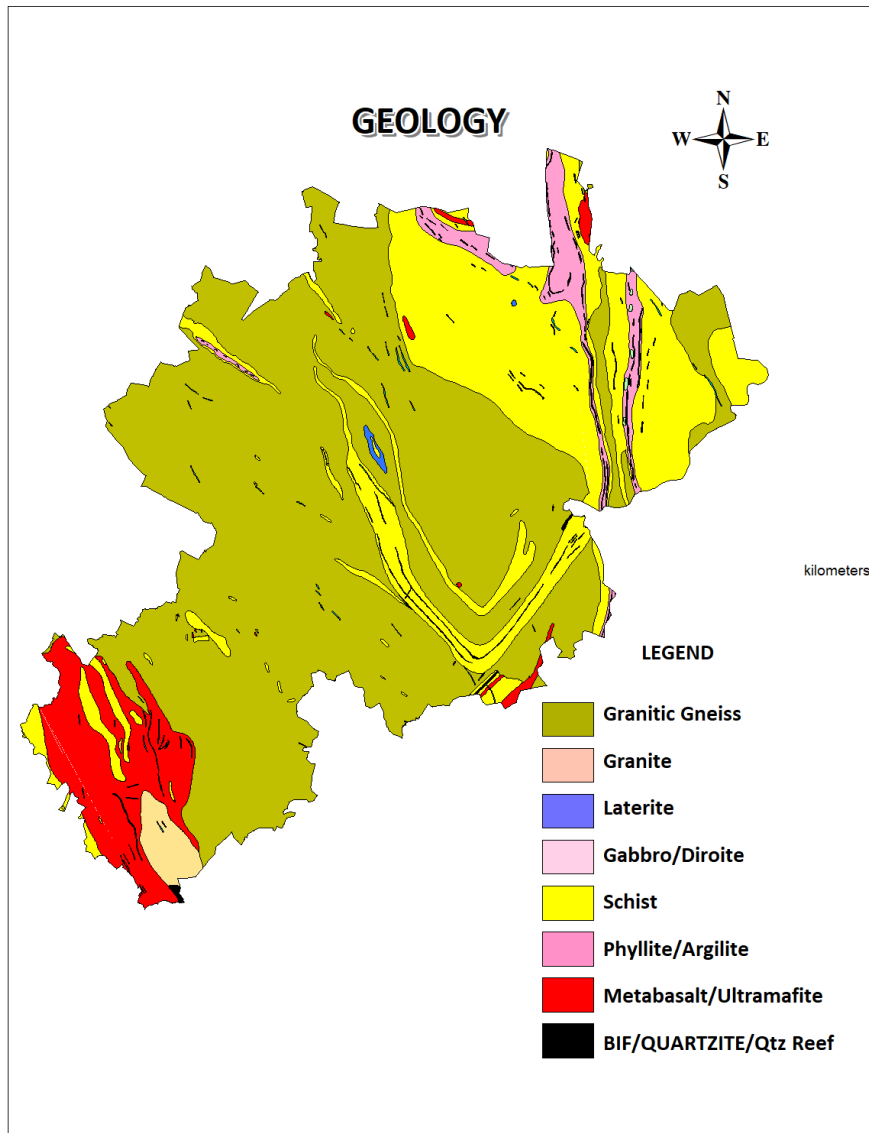
### 2.1 Geology

Geologically, Shimoga district is characterised by various lithounits spanning from Archaean to Present day deposits. The predominant geological formation of Shimoga is as described below:

Quarternary	Alluvium
Dharwar Super group	Ultra mafic complex, Grewacke, Argellite, Quartz Chlorite schist with orthoquartzite
Lower Precambrian	Metabasalt with thin Ironstone.
Archaean formation	Granite Migmatites and Granodioritic to Tonolitic gneisses, Amphibolites and Pelitischists.

The taluka is underlain mostly by Archean formation with the most pre-dominant formation is banded gneissic complex with the occurrence of schist along the north-eastern part of the taluka, ultramafic along the south- western part of the taluka. The geology map of the district is given in figure 2.1.



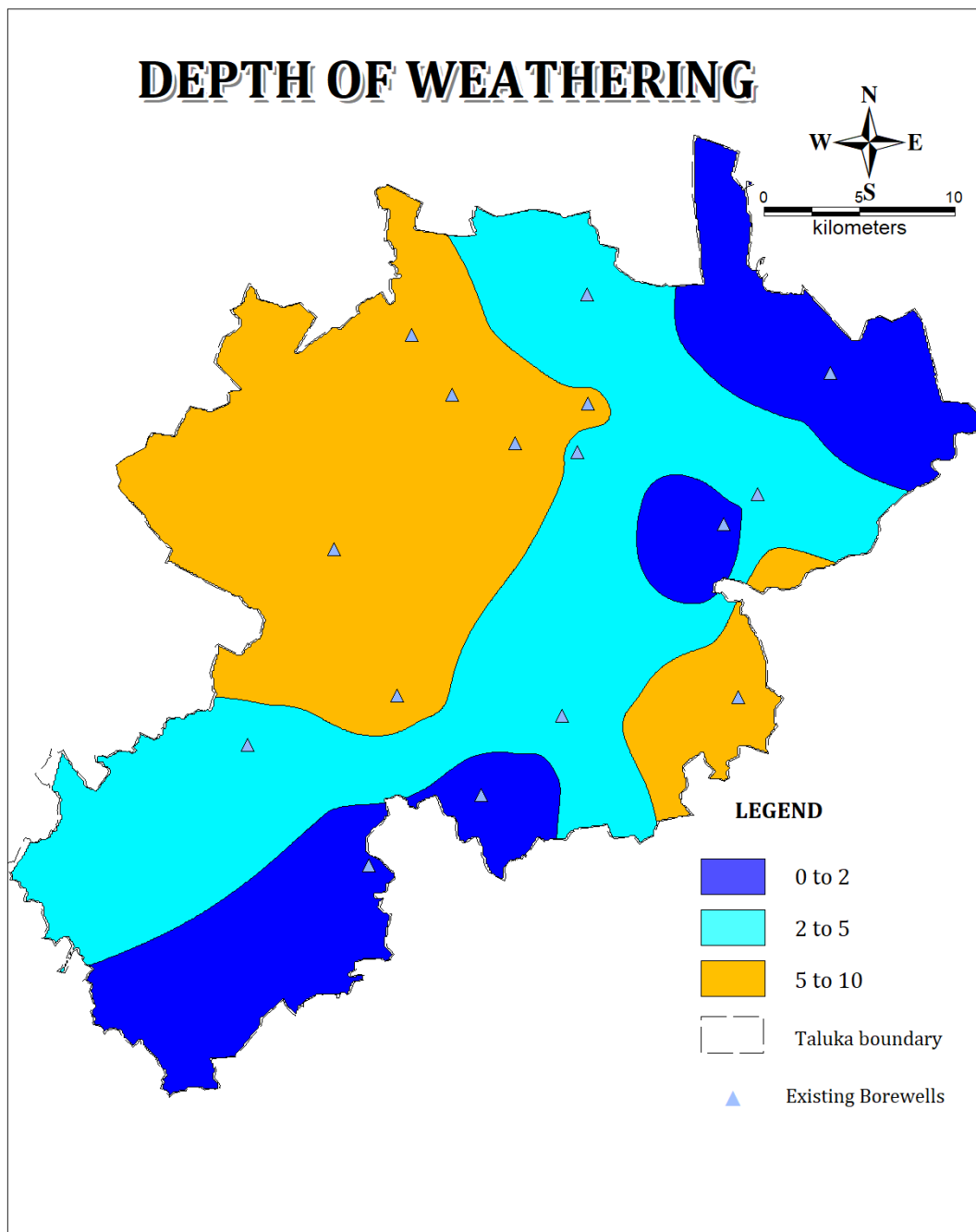


**Figure 2.1. Geology-Tirthahalli Taluka.**

## 2.2 Hydrogeology

Main aquifers in the study area are the weaker weathered and fractured zones of gneissic-granites and schists. The gneissic-granitic complex does not possess the primary porosity. Secondary structures like joints, fissures and faults present in these formations act as a porous media. The ground water occurs under atmospheric influence in the phreatic zone, which generally occurs within the depth range of 12.7 to 36.6 mbgl. The sustained yield of dugwells ranges from negligible to 30 m<sup>3</sup> /day. The fracture zones that occur at various depth zones within the depth of 137.00 mbgl are expected to be saturated with ground water. It is found that the water bearing characteristics of schists are more or less similar to that of gneisses and granites. But the weathered zones of schists may not yield as granites, because of their compact and fine-grained nature. Laterites occur over the schists and granitic-gneisses with an approximate thickness of few centimetres to 10.00 m, which cover isolated patches in central parts of Tirthahalli Taluka. Ground water in these aquifer materials generally occurs

under unconfined to semi-confined conditions. The depth to weathering map of the district is given in figure 2.2.



**Figure 2.2. Depth to weathering map-Tirthahalli Taluka.**

In the deeper aquifers, the occurrence and movement of ground water is controlled by the incidence and inter-connection of fractures or joints. The ground water in deeper aquifer occurs under *semi-confined to confined* conditions. Based on the available data with CGWB, state government agencies and people's participatory approach, it is observed that the depth

of bore wells in the taluka ranges from 30.5– 200 m depth. The yield of bore wells generally ranges from 0.1 to 9.27 lps.

The phreatic aquifers in the district are controlled mostly by local geomorphology rather than geologic structures. Hence, dug wells tapping the weathered crystallines/ laterites located in valley portion and flats are perennial, whereas those along hill slopes dry up during summer, especially where the thickness of overburden is limited

## **2.3 Ground Water Dynamics**

### **2.3.1 Occurrence of Ground Water and Water Level Behaviour in Aquifer-I**

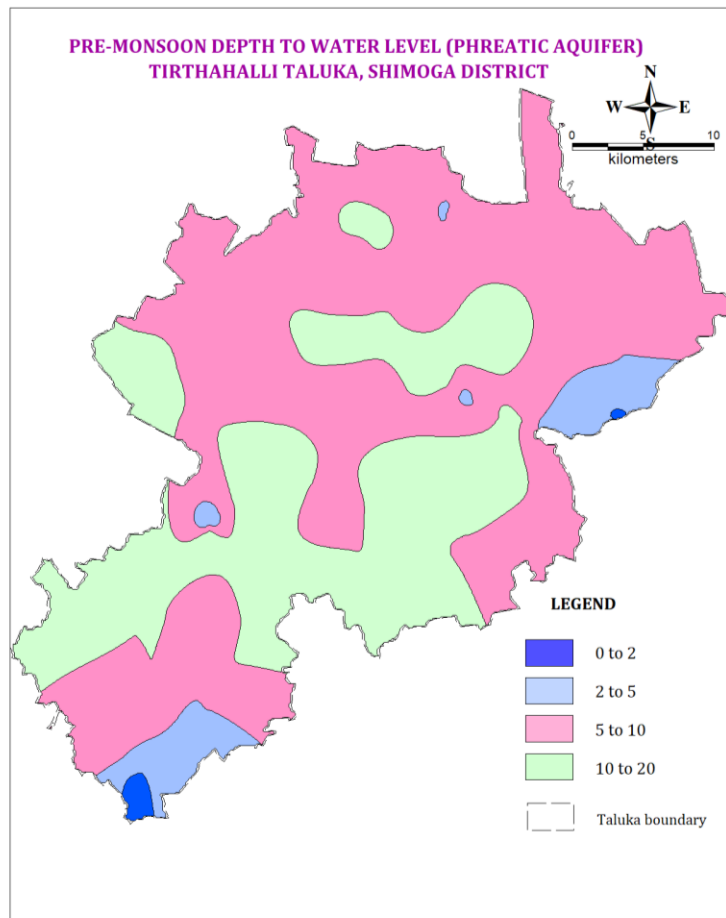
Ground water occurs under atmospheric pressure conditions in aquifer-I. The shallow phreatic aquifers of weathered crystalline are generally developed through dug wells. The depth of dug wells ranges from 5.85 to 22.15 mbgl.

To understand the depth to water level scenario, water level measurement from all the observation wells were carried out in the month of April (pre-monsoon) and November (post-monsoon). The depth to water levels in the taluka during April 2022 ranges between 1.45 (Hosahalli) to 16.5 (Nandikatte). About 66 Sq Km area has depth to water level ranging between 0 to 5 mbgl observed in north-eastern and southern part of the taluka, 730 Sq Km area covering the major parts of the taluka has depth to water level between 5 to 10 and 424 sq km covering southern, parts of central and north-western parts of the taluka have depth to water level >10 mbgl. The Pre-monsoon depth to water level map of the district is given in fig 2.3.

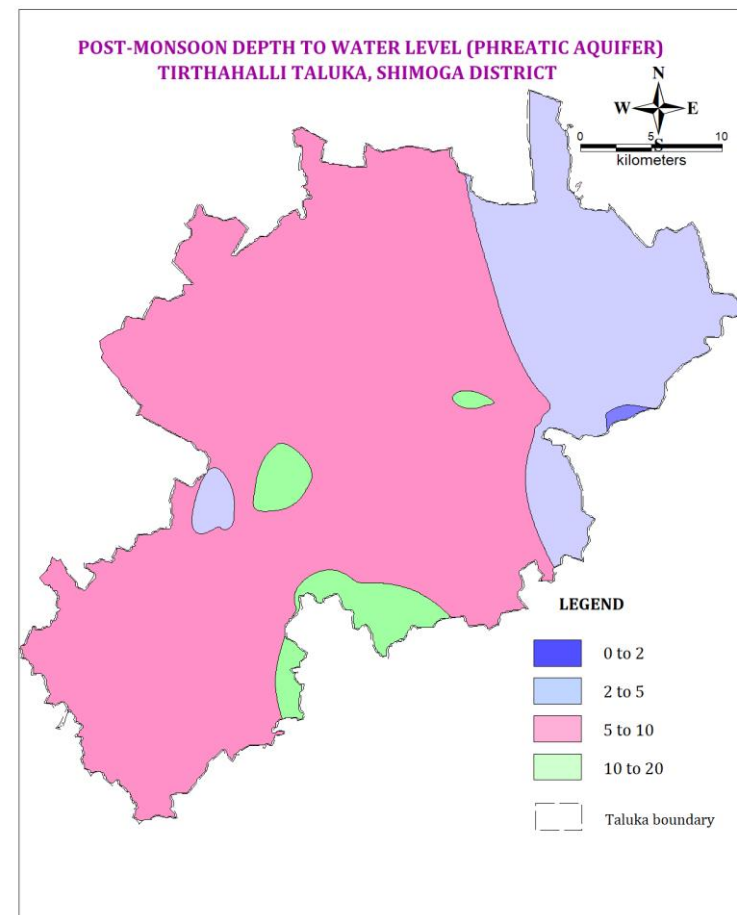
The depth to water levels in the taluka during November 2022 ranges between 1.6 mbgl (Nidagalale) to 14 mbgl (Tirthamattur). Only 257 Sq Km area in the eastern part of the block has depth to water level less than 5 mbgl. The remaining parts of the taluka had water levels in the range 5 to 10 mbgl and 51.6 sq km area in southern parts of the taluka has depth to water level more than 10 mbgl. The Post-monsoon depth to water level map of the district is given in fig 2.4.85

### **2.3.2 Occurrence of Ground Water and Water Level Behaviour Deeper Aquifer-II**

The deeper fractured aquifers are under confined to semi-confined conditions. CGWB has an available data of 5 exploratory wells drilled upto a total depth of 200m of which only 1 is high yielding. The discharge ranges from negligible to 9.27. The yield cum recuperation tests indicate that the specific capacity ranges from 3.4 to 12.5 lpm/m/dd. The data of these wells has deciphered that most potential fractures are encountered up to 90 mbgl. However the fractures extend upto 138 mbgl.. Besides, participatory involvement of local people of the taluka on the details of drilling in their private lands has indicated the presence of occasional fractured aquifers down to the depth of 138 mbgl. However, the productivity of fractures beyond the depth of 90 m is questionable. The depth to water level of the drilled piezometer has depth to water level ranging between 6.7 to 16.2 mbgl.



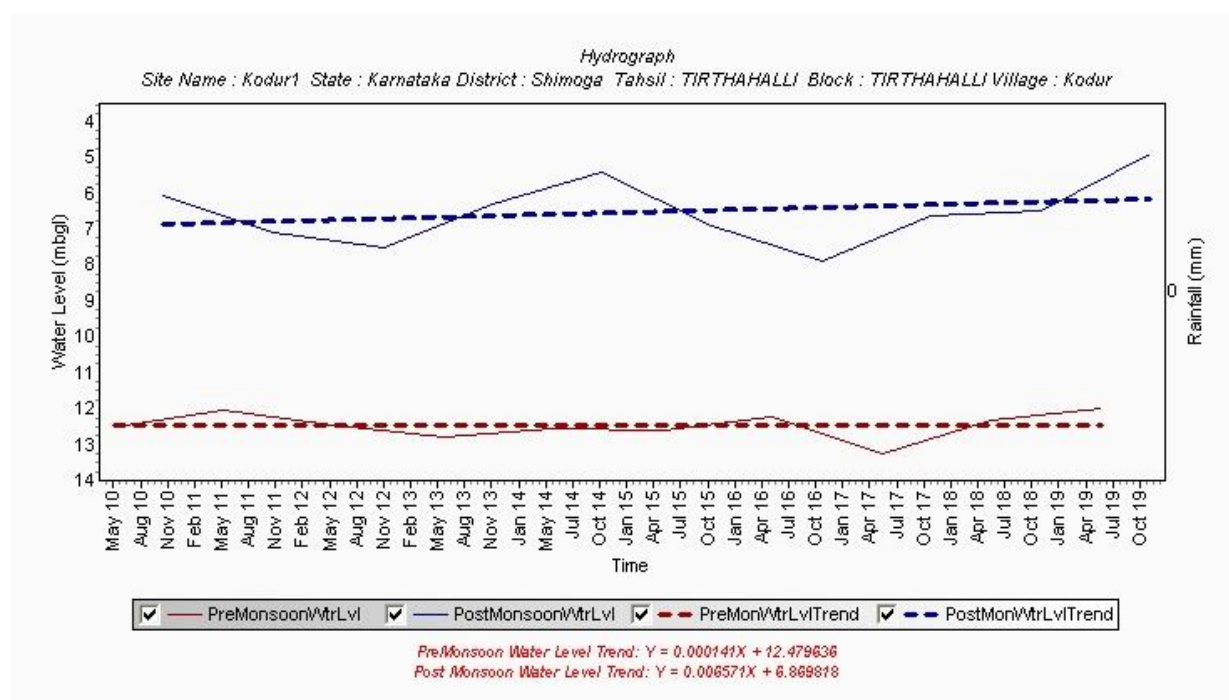
**Figure 2.3. Pre-monsoon depth to water level map, Tirthahalli Taluka**



**Figure 2.4. Post-monsoon depth to water level map, Tirthahalli Taluka**

### 2.3.3 Long Term Water Level Trend (2010-2019)- Hydrograph analysis

The variation in water level with reference to time and space is the net result of groundwater extraction and recharge. The long-term change in water level is apparent from the trend of water levels over a period of time and is best reflected in a hydrograph. The decadal trend (2010-2019) of groundwater levels, for pre-monsoon and post-monsoon periods has been analysed for the present study. The hydrographs of 3 observation wells of CGWB namely Kodur 1, Megaravalli and Guddekoppa has been presented below in fig 2.5 (a), 2.5 b) and 2.5 (c) respectively. Analysis of hydrographs shows that there is a very slight decline of premonsoon water level trend and a slight increase of post monsoon water level trend in Megaravalli @ 0.0144 m/yr and 0.26 m/yr which are negligible whereas in Kodur 1 and Guddekoppa, the premonsoon water level trend is increasing @0.00168 m/yr and 0.075 m/yr respectively; the post monsoon trend is increasing @0.07 m/yr and declining at Guddekoppa @ 0.087 m/year. Hence, all the 3 hydrographs depicts that the decal water level trend during both the seasons are in a pace that is manageable with sustainable use of ground water.



**Fig 2.5(a): Hydrograph of Kodur 1, Tirthahalli Taluka**

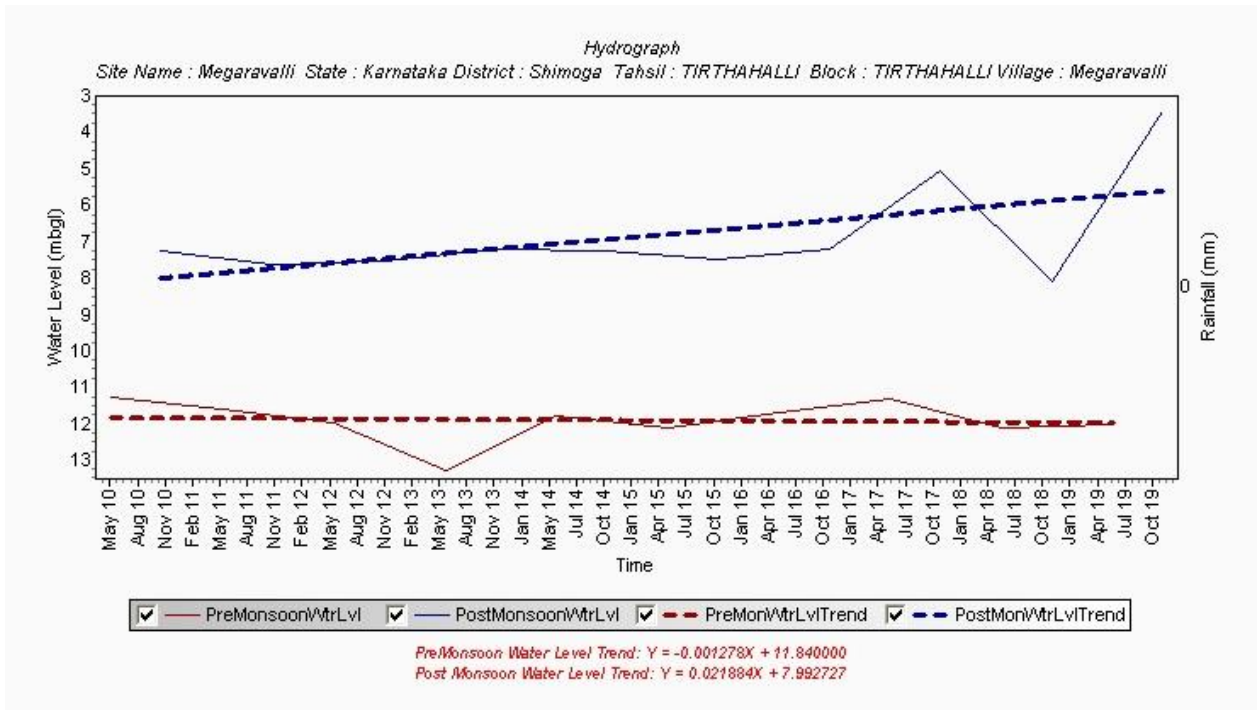


Fig 2.5(b): Hydrograph of Megaravalli, Tirthahalli Taluka

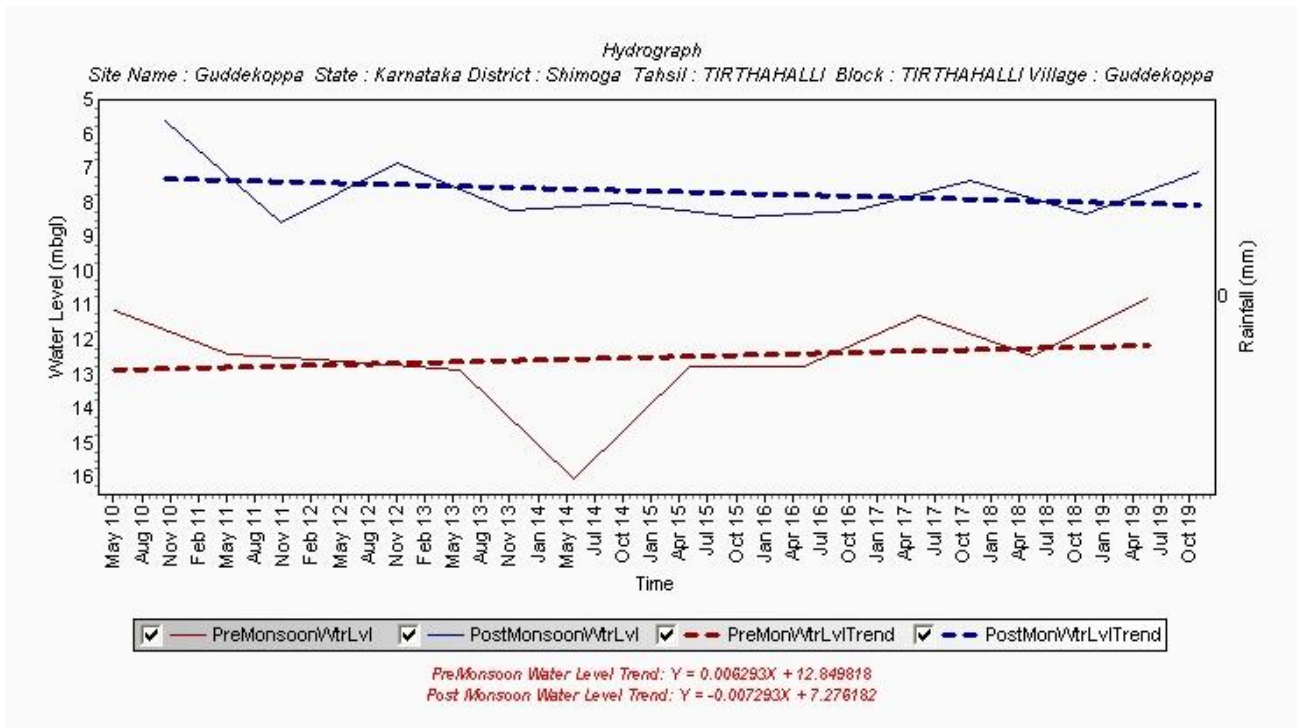
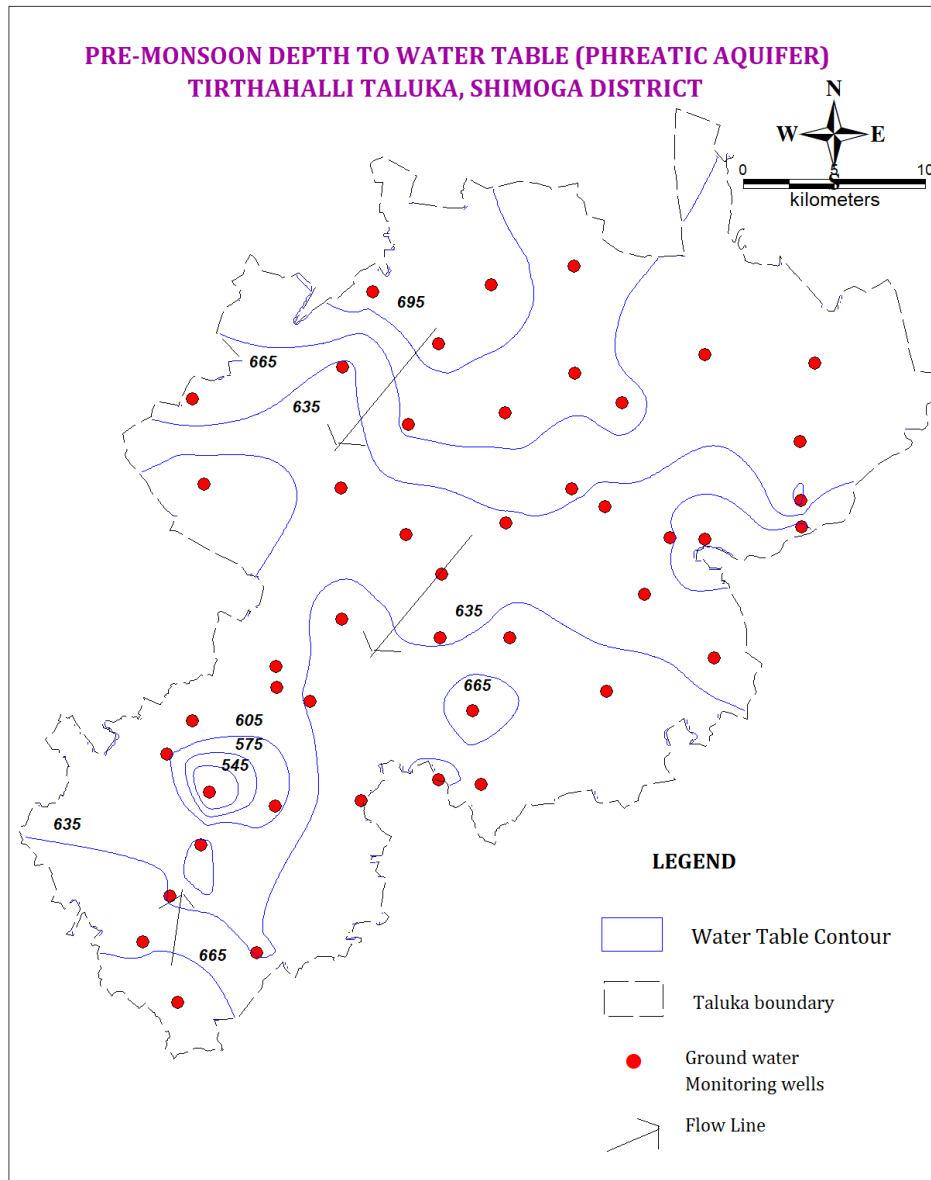


Fig 2.5(c): Hydrograph of Guddekoppa, Tirthahalli Taluka

### 2.3.4 Ground Water Flow

Equipotential lines, the lines joining points of equal head on the potentiometric surface, were drawn for pre-monsoon period, based on the variation of the head in the aquifer. Based on the Water table elevation, ground water flow directions can be identified (Figure 2.6). It has been observed that the topography of the area is the main controlling factor in determining ground water flow direction. Also, the effluent nature of streams (gaining streams) is evident from the contour pattern. The general flow direction is towards west following the terrain slope

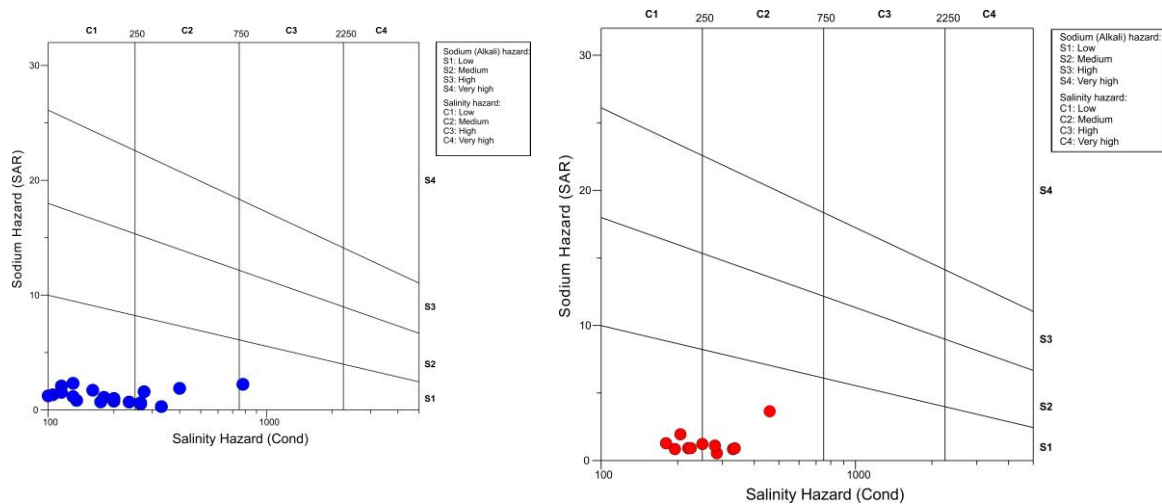


**Figure 2.6. Pre-monsoon DTWT map (mamsl)-Phreatic aquifer system**

## 2.4 Ground Water Quality

The suitability of ground water for drinking/irrigation and industrial purposes is determined by the abundance of various chemical constituents in water. Though many ions are very essential for the growth of plants and human body, when present in excess, have an adverse effect on health. For estimation of the quality of ground water, ground water samples from 20 samples from dug wells dug wells representing phreatic aquifer have been collected during pre-monsoon. Similarly, for Aquifer – II, the ground water samples (11 Nos.) were collected from bore wells. The aquifer wise ranges of different chemical constituents present in ground water are given in Table 3.5. All the major ions are present within permissible limits in the taluka

Generally, the Irrigation suitability is good for Aquifer-I and for aquifer-II (EC <500  $\mu\text{S}/\text{cm}$ ). USSL plot depicting the classification of irrigation water quality with respect to salinity hazard and sodium hazard for both the aquifers are given in figure 2.7.



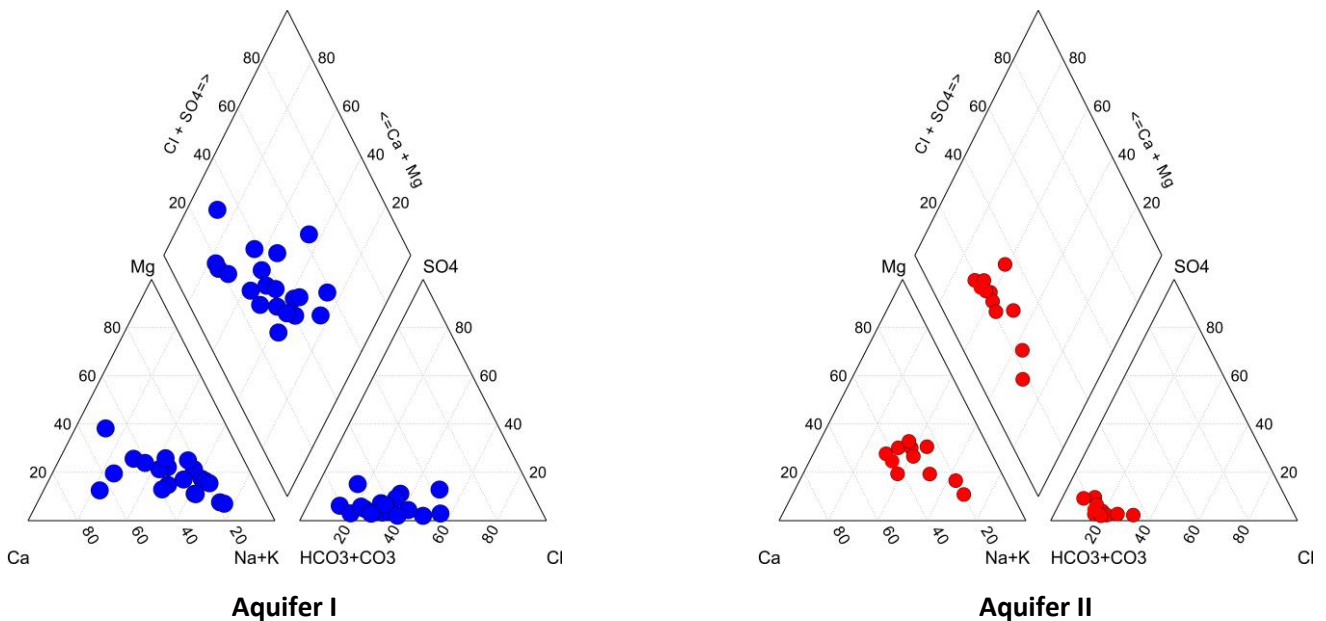
**Figure 2.7. Classification of irrigation based on USSL diagram**

To understand the hydrochemical facies, Hill piper diagrams were prepared separately for both the aquifers. In the current study it has been observed that the water samples from aquifer-I falls in Calcium bicarbonate and mixed Ca-Na-HCO<sub>3</sub> field and aquifer II shows Calcium bicarbonate predominance. Hill piper diagrams for both the aquifers are given in figure 2.8.



**Table 2.1 Aquifer wise ranges of chemical constituents in Tirthahalli Taluka**

Constituents	Aquifer-I		Aquifer-II	
	Min	Max	Min	Max
pH	6.3	7.65	6.55	7.82
EC ( $\mu\text{S}/\text{cm}$ )	80	780	180	460
TH (mg/l)	15	175	35	115
Calcium (mg/l)	4	44	8	28
Magnesium (mg/l)	1	16	4	11
Potassium (mg/l)	0.7	48.6	1.3	15
Sodium (mg/l)	8	68	12	70
Carbonate (mg/l)	0	0	0	
Bi carbonate (mg/l)	18	165	67	226
Chloride (mg/l)	7	121	14	21
Sulphate (mg/l)	1	42	2	20
Nitrate (mg/l)	1	32	1	7
Fluoride (mg/l)	0.15	0.69	0.06	0.96



**Figure 2.8. Hill piper Diagram**

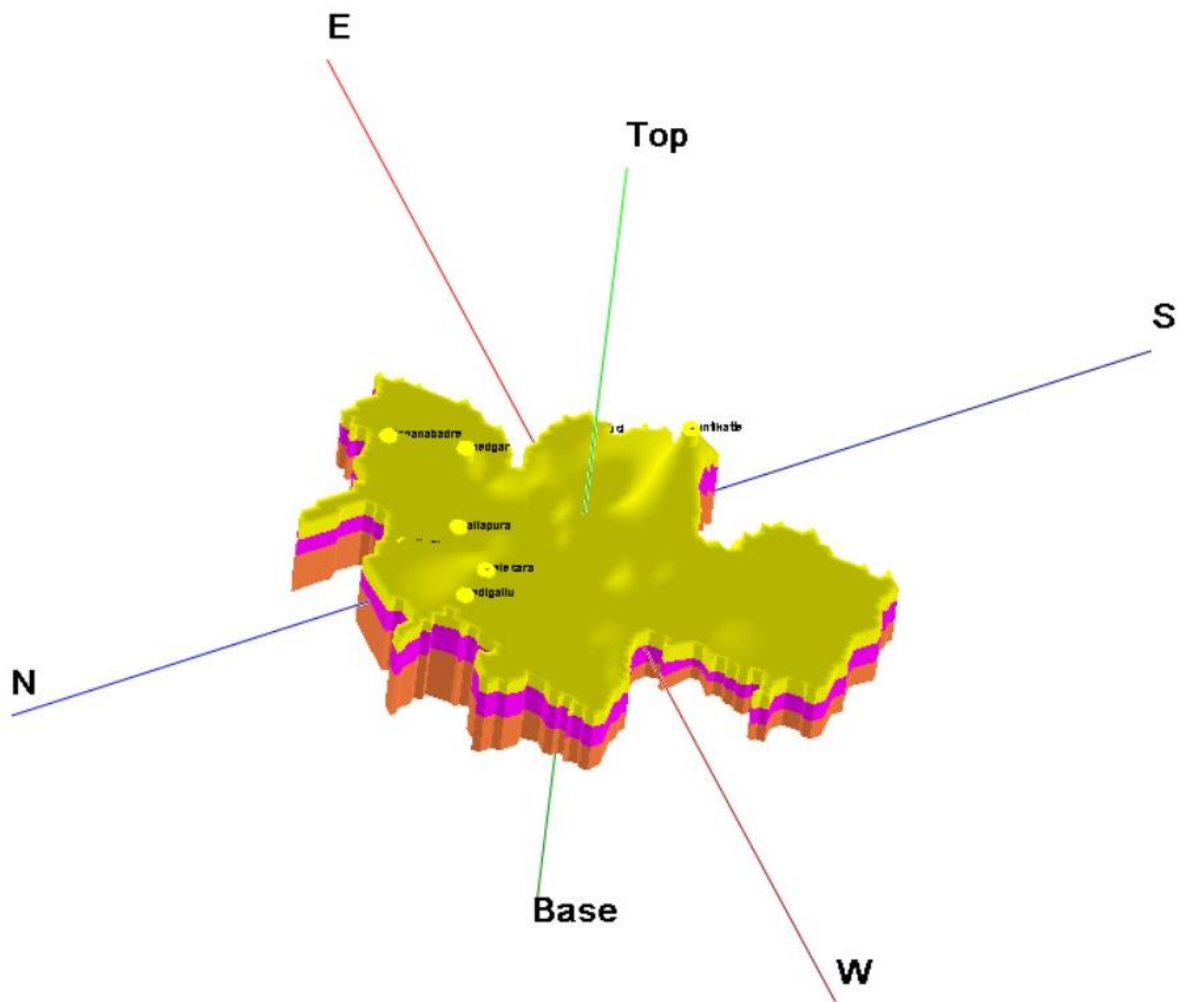
### 2.5 3-D and 2-D Aquifer Disposition

Based on the analysis of existing and generated data through hydrogeological surveys and ground water exploration, following two types of aquifer systems were identified in Tirthahalli taluka. The details of ground water exploration are given in Annexure-I. The litholog data from ground water exploration data has been used to generate the 2D and 3D disposition aquifers. The aquifer disposition models clearly depict the vertical and horizontal extension of various litho-units and the zones tapped, forming aquifers. Based on the ground water exploration and micro-level hydrogeological survey, lithological fence diagrams and

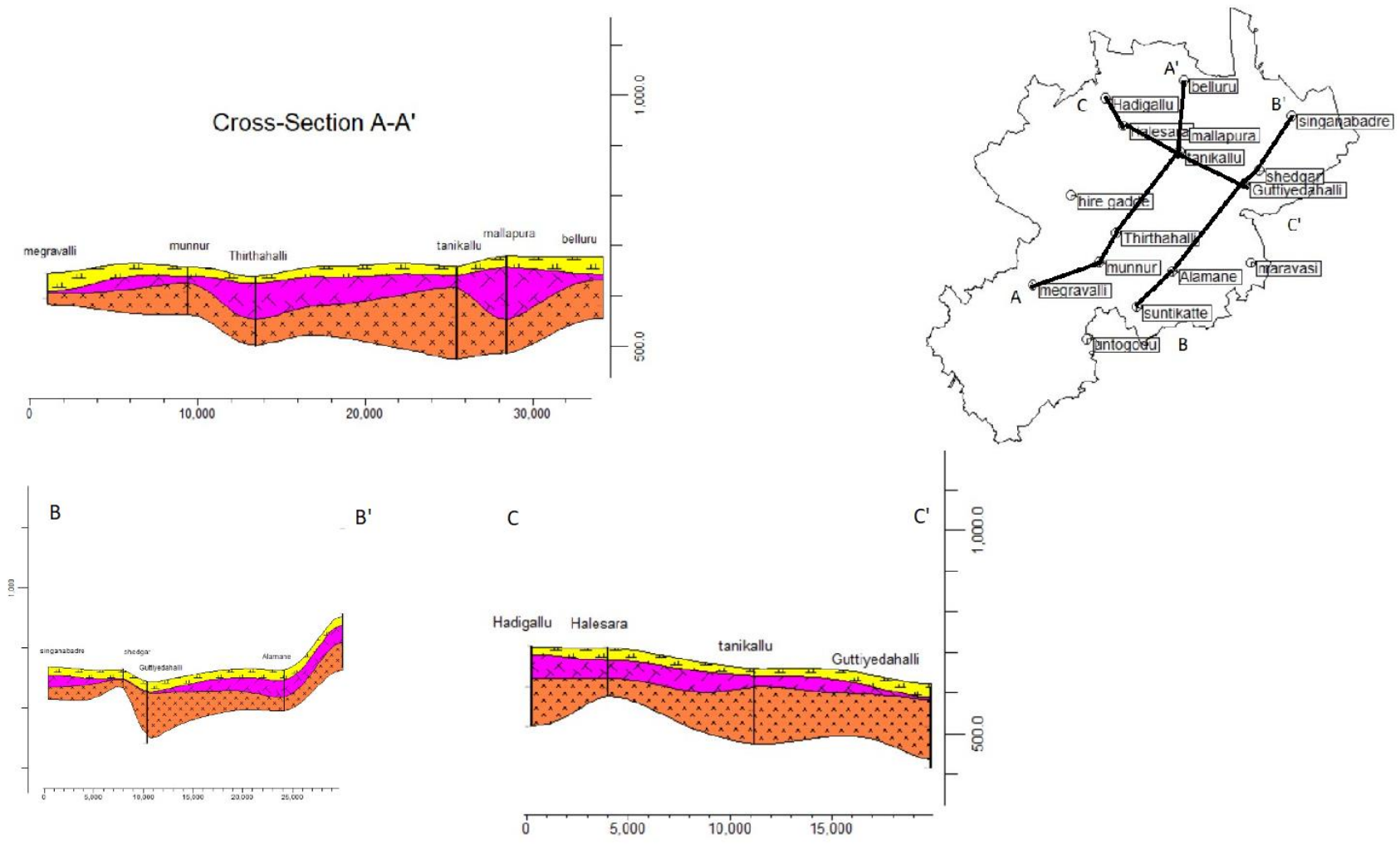
cross sections were prepared and are given in figure 2.10 and 2.11 respectively. The 3D lithological view of Tirthahalli Taluka is shown in figure 2.9.

The aquifer units in each of the formation are listed below:

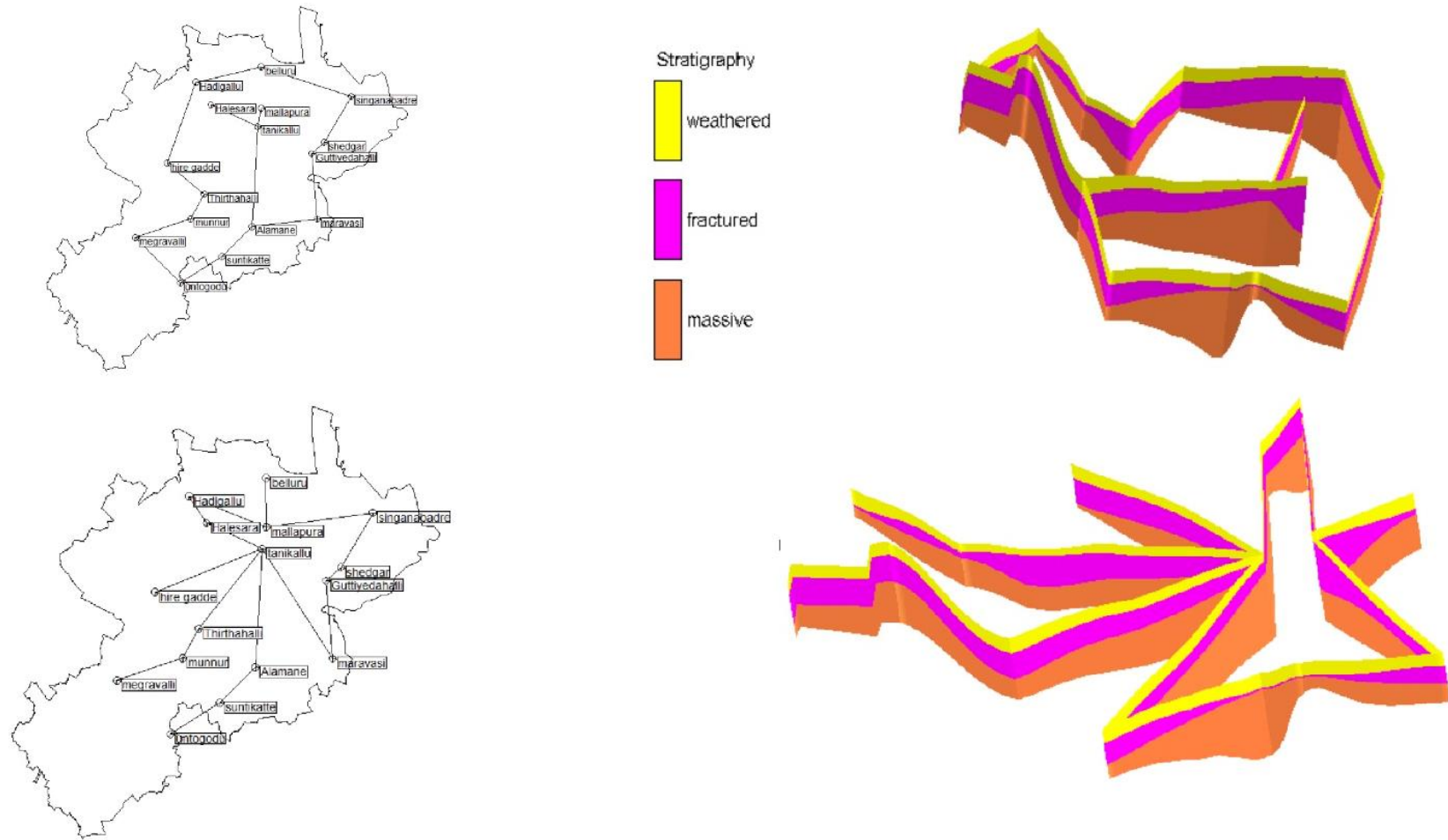
- Aquifer I – Aquifer I consists of weathered crystallines and associated shallow fractures. The thickness of the first aquifer ranges up to 36.6 m and the thickness is highly variable. Along hill slopes it is virtually absent; thickness is maximum along valleys and plateau regions.
- Aquifer-II – Aquifer II consists of massive crystallines and associated fractures. As per drilling data by CGWB, potential fractures are limited down up to 90 mbgl. Besides, participatory involvement of local people of the taluka on the details of drilling in their private lands has indicated the presence of occasional fractured aquifers down to the depth of 138 mbgl. However, the productivity of fractures beyond the depth of 90 m is questionable



**Figure 2.9. 3D Diagram of Tirthahalli Taluka**



**Figure 2.10 2D Sections of Tirthahalli Taluka**



**Figure 2.11 Fence Diagram of Tirthahalli Taluka**

The salient features of the two aquifer systems in the district is summarized in table 2.2 and is given below:

**Table 2.2. Salient features of the aquifer systems in Tirthahalli Taluka**

Type of aquifer	Aquifer-I	Aquifer-II
<b>Formation</b>	Weathered Crystallines/Laterite	Fractured Crystallines.
<b>Depth to bottom (mbgl)</b>	Up to 36.6 m (including in storage part of unconfined aquifer)	upto 200 m.
<b>SWL</b>	Range between 1.45 to 16.5 mbgl	Range between 6.7 to 16.2 mbgl.
<b>Thickness (Weathered zone/fractured)</b>	5.85 to 36.6 m	1 to 7 m
<b>Weathered/Fractured zones encountered</b>	Mostly weathered formations up to 36.6 mbgl	Up to 138 mbgl
<b>Yield</b>	Negligible to 30 m <sup>3</sup> /day	Negligible to 9.27 lps
<b>Aquifer Parameter (Transmissivity-m<sup>2</sup>/day)</b>	-	1.03 to 9.57 m <sup>2</sup> /day
<b>Sy/S</b>	0.02 to 0.09	0.000172
<b>Suitability for drinking &amp; irrigation</b>	Yes	Yes

## 2.6 Aquifer maps

An aquifer map of the area is evolved out finally, based on aquifer geometry, aquifer characteristics, ground water resources, yield characteristics and water quality. The aquifer map of the phreatic (Aquifer-I) and fracture aquifer systems (Aquifer-II) are shown in figures 2.12 and 2.13 respectively. In phreatic aquifer system, along the hilly tracts the yield up to 10 m<sup>3</sup>/ day, in valley portions yield upto 30 m<sup>3</sup>/ day is noticed. In the deeper aquifers discharge is generally found to be within 3 lps. More than 3 lps is noticed in the eastern part of the taluka. The aquifer map of phreatic and deeper aquifers are given in fig 2.12 & 2.13

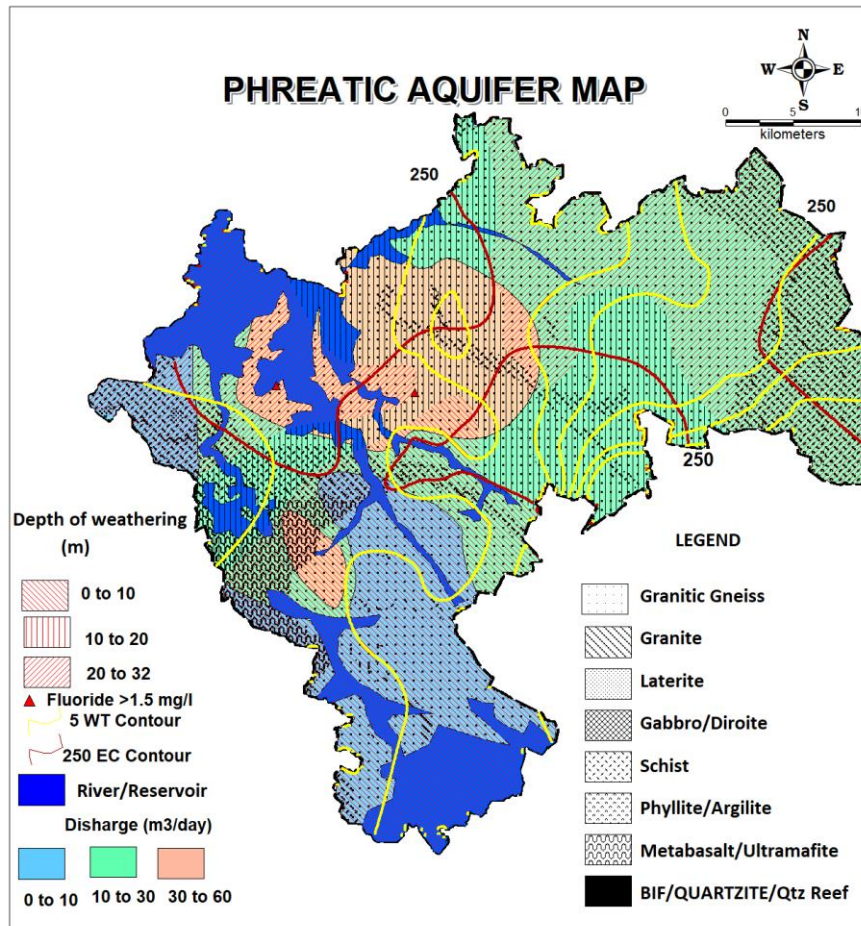


Figure 2.12. Aquifer map-Phreatic aquifer system

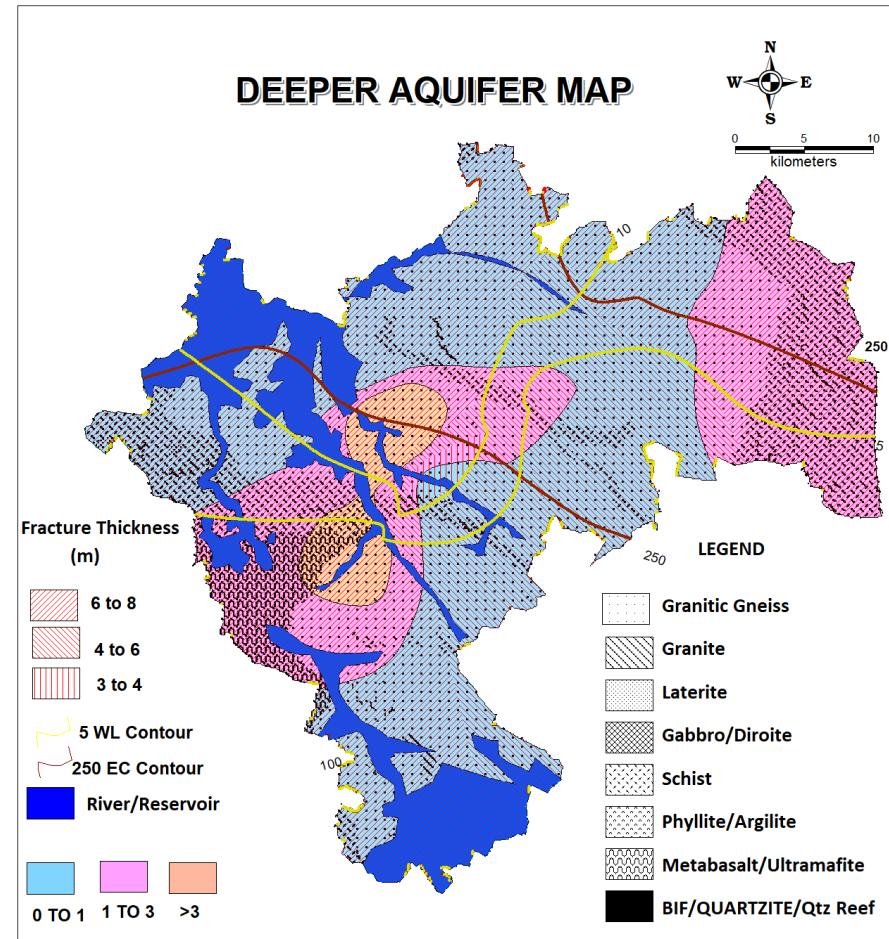


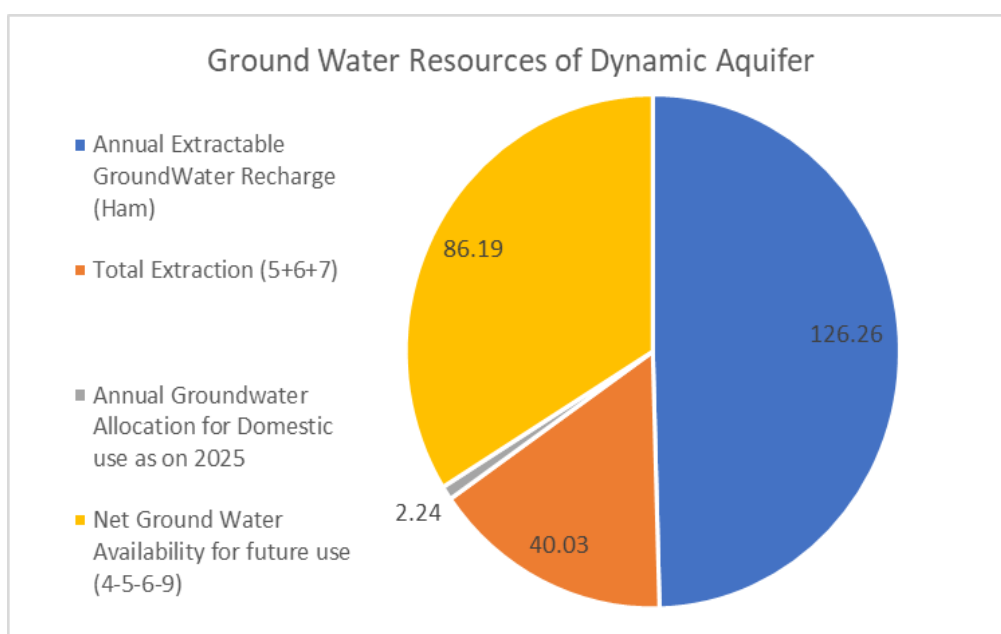
Figure 2.13. Aquifer map-Deeper aquifer system

### 3.0 Ground Water Resources

Aquifer wise and block-wise estimation of ground water resources have been carried out for the 2 aquifers existing in the area i.e., Aquifer-I (the phreatic aquifer) and Aquifer-II (the fractured aquifer system) using GEC-2015 methodology. The details of the assessment are discussed below.

#### 3.1 Ground water resources in the Phreatic aquifer (Aquifer-I)

The annual extractable ground water recharge of aquifer-I was estimated to be 126.26 mcm. As per estimation the annual gross extraction for all uses is 40.03 mcm with extraction for irrigation requirement being the major consumer having a draft of 37.82 mcm. The annual draft for irrigation, domestic and industrial uses together account for about 40.03 mcm. The allocation for domestic use up to 2025 is about 2.24 mcm. The categorisation of Tirthahalli is Safe with Stage of Extraction of 31.7%. The Pie chart depicting the same is shown in fig 3.1.



**Figure 3.1: Ground Water Resources of Aquifer I**

#### 3.2 Ground Water Resources in the fracture aquifer system – Aquifer-II

The total resources of Aquifer-II have been computed to be 10.93 mcm and the is shown in table 3.2.

The total ground water resources of the entire aquifer system (Aquifer-I and II) was estimated to about 137.19 mcm

**Table 3.1. Ground water resources in the phreatic zone of Tirthahalli Taluka (Aquifer-I; Dynamic)**

Sl. No.	Assessment Unit/ Block	Command / Non-Command	Annual Extractable GroundWater Recharge (Ham)	Current Annual Ground Water Extraction (Ham)				Annual Groundwater Allocation for Domestic use as on 2025	Net Ground Water Availability for future use (4-5-6-9)	Stage of Ground Water Extraction (%) (8/4)*100
				Irrigation Use	Industrial Use	Domestic Use	Total Extraction (5+6+7)			
1	Tirthahalli	Non-command	12626	3782.45	0.00	221.46	4003.91	223.91	8619.36	31.7
	<b>TOTAL (ha.m)</b>		<b>12626</b>	<b>3782.45</b>	<b>0.00</b>	<b>221.46</b>	<b>4003.91</b>	<b>223.91</b>	<b>8619.36</b>	<b>31.7</b>
	<b>TOTAL (MCM)</b>		<b>126.26</b>	<b>37.82</b>	<b>0.00</b>	<b>2.21</b>	<b>40.03</b>	<b>2.24</b>	<b>86.19</b>	<b>31.7</b>

**Table 3.2. Ground water resources in the fractured/semiconfined zone of Tirthahalli Taluka (Aquifer-II; Static)**

Sl. No.	Assessment Unit/ Block	Command / Non-Command	Geographical Area (Sq Km)	Storativity	Fractured Thickness	Gw resources
1	Tirthahalli	Non-command	125400	0.000172	50.7	1093.53
	<b>TOTAL (ha.m)</b>		<b>125400</b>	<b>0.000172</b>	<b>50.7</b>	<b>1093.53</b>
	<b>TOTAL (MCM)</b>		<b>1254</b>	<b>0.000172</b>	<b>50.7</b>	<b>10.93</b>



#### **4.0 GROUND WATER RELATED ISSUES**

The extraction of ground water resources in Tirthahalli is increasing over a period of time. It is evident from the comparison of ground water resources carried out as on 2022 by CGWB and GWD, Karnataka. In 2020, the SOE was 19.73 % and in 2022 it come up to 31.7%, In 2022 ‘the annual ground water recharge’ was 126.26 mcm and the existing gross draft for all uses was estimated to be 40.03 mcm, wherein in 2020 the “annual ground water recharge” was 173.53 mcm and the existing gross draft for all uses was estimated to be 34.24 mcm. This shows an a slightly increased dependency in ground water. The major ground water related problems observed in the district are detailed below:

##### **4.1 Deeper water Level during summer**

Many parts of the district experiences deeper ground water levels in dug wells due to limited weathering thickness and lower sustainability. Major part of the taluka has yield range 0 to 30 m<sup>3</sup>/day.

##### **4.2 Low Yielding Deeper Aquifers**

Only one borewell drilled by CGWB has shown a maximum yield of upto 9 lps. All the other 5 borewells drilled in the taluka has yield less than 2 lps. This depicts the low potential of the deeper aquifers. Also, the deeper water levels of dugwells during summer does increase the dependency in borewells for domestic and irrigation purpose.

##### **4.3 Cultivation of Arecanut and Paddy**

The taluka has 144 Sq Km area under Arecanut cultivation, 98.33 Sq Km area under Paddy cultivation. Arecanut requires 175 litres of water/tree/day and paddy requires 1200 mm of water in flood irrigation. Both are water intensive crops and an increased area of cultivation of both the crops using flood irrigation can in long run affect the sustainability of ground water.

##### **4.4 Low Stage of Development**

The majority of agriculture is surface water/rainfed type of agriculture. Increasing the area of cultivation by bringing additional area like cultivable waste land and barren lands into cultivation by use of ground water resources in water efficient method can develop resources in sustainable manner

#### **5.0 MANAGEMENT STRATEGIES & AQUIFER MANGEMENT PLAN**

The groundwater management strategies are inevitable either when there is much demand to the resource than the available quantity or when the quality of resource deteriorates due to contamination in each geographical unit. Hence, it is the need to formulate sustainable management of the groundwater resource in a more rational and scientific way. In the present study, in Tirthahalli Taluka, the sustainable management plan for aquifer is being proposed after a detailed understanding of the aquifer disposition down to a depth of 200 m bgl.

The study area falls under non-command area and out of gross irrigated area of 303.9 Sq Km, 260 Sq Km area is unirrigated or totally rainfed, 119.5 Sq Km is irrigated by tanks/ponds/reservoirs, 48.2 sq km area is irrigated by ground water and 24.8 sq km area is under lift irrigation. Thus in the district, the dependency in ground water and the net area irrigated is comparatively less. Hence, more area can be brought under cultivation by development of ground water resources.

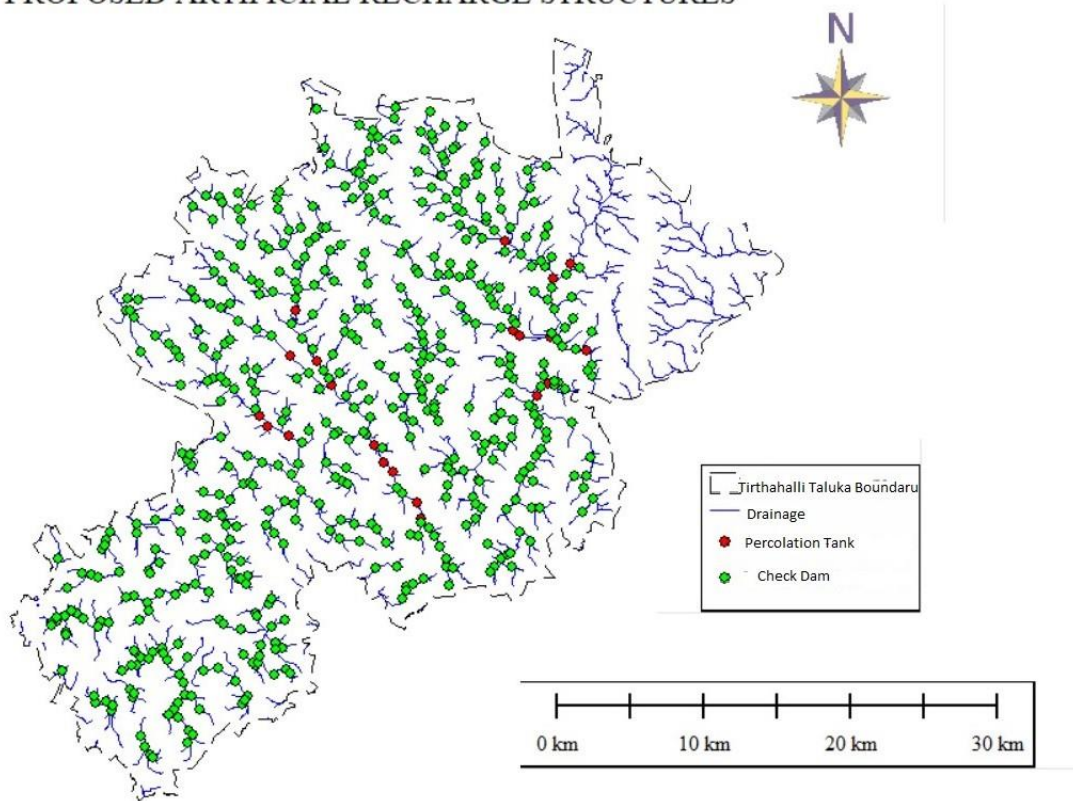
### 5.1. Supply Side Management Plan

Augmentation of groundwater can be achieved through construction of additional recharge structures like check dams, vented cross bars, percolation ponds etc. Normally it can be attained through capturing surface runoff. The details of supply side intervention proposed in the area is discussed below and the tentative location of the structures is depicted in fig 5.1

Geographical Area (Sq Km)	1247
Area unsuitable for artificial recharge ie hilly/rocky area (sq Km)	113
Area Unsuitable for AR DTW < 3 mbgl	103.4
Command area (sq km)	-
Area Suitable for Artificial Recharge (Sq Km)	1030
Mean DTW (mbgl)	6.53
Thickness of usaturated Zone (m)	3.53
Volume of unstruated Zone (MCM)	3636
Total Storage Potential (MCM)	72.73
Surface Water Requirement (MCM)	96.73
Talukwise surplus water Resource Available (MCM)	175.74
Surface water for planning artificial recharge (MCM)	96.73
No. of percolations suitable as per field condition	21
No. of check dam as per field condition	511

The implementation of maintenance and desilting of the existing structures is a necessary check to ensure proper recharge. Periodic de-siltation as well as cleaning of existing Panchayath ponds and irrigation tanks, check dams, individual and community ponds has to be carried out in the study area to increase the storage capacity as well as infiltration rate.

## PROPOSED ARTIFICIAL RECHARGE STRUCTURES



**Figure 5.1: Proposed location of AR Structures**

### **5.2. Creation of irrigation potential through ground water**

Additional irrigation potential can be created in the district considering the relatively low stage of ground water development in the blocks. This will promote the financial stability and economic growth of the farmers in the district. Details are given in table 5.1 and 5.2 respectively.

#### **5.3.1.(a). General suggestions for the creation of irrigation potential through ground water**

Creation of irrigation potential through groundwater depends upon yield potential of underlying aquifers. Hence, any new construction of groundwater well should be based on the data/ knowledge available for the area with the Central/ State Agencies involved in groundwater development and management. Some of the important points to be considered while planning any groundwater development are as below:

- The groundwater management schemes should not be planned in areas classified as over-exploited, critical and semi critical areas. Further eligibility criteria has been laid down in subsequent paras.
- Groundwater development will be carried out preferably through Dug wells and or BWs in hard rock areas whereas shallow/deep tube wells are recommended alluvial

areas. Bore wells are to be taken up in areas where hydro-geological setup and groundwater aquifers justifies their suitability.

- Promotion and adoption of water use efficiency & conservation practices viz. drip/sprinkler, diversification to low water demand crops, promoting on-farm rainwater harvesting etc shall be encouraged by the State Govt/ Project Authorities.
- The State agencies involved in planning and execution of ground water schemes shall formulate the proposals in consultation with State Ground Water Department & CGWB duly considering nature of aquifer system in the area, spatio-temporal behaviour of water level, ground water resource availability, artificial recharge structures suitable for that area, sites for their construction etc.
- To minimize the failure of wells geophysical and hydro-geological investigations may be carried out for proper site selection.

### **5.3.1.(b). Eligibility criteria**

Ground Water irrigation facility through Dug wells, Dug cum Bore wells, Tube wells and Bore wells etc. can be funded for schemes in areas other than Over Exploited (OE), Critical or Semi-Critical meeting the following criteria:

- Less than 60 per cent of the annual replenishable groundwater resources have been developed.
  - Average annual rainfall of 750 mm or more should be received to enable enough water for recharge.
  - Shallow groundwater levels within range of 15m below ground level or less during pre-monsoon period. Ground water development for irrigation can be planned in such a way that after implementation of the project, stage of Ground Water Development (SOD) in an area should not exceed 70% at any time. However, as already mentioned Scheme in unclassified areas shall be considered on case to case basis depending upon various criterions laid down in the guidelines.
1. The beneficiary under this scheme shall be small and marginal farmers only with priority to be given to SC/ST and Women farmers
  2. The scheme is applicable for individual farmer, group of farmers/ cooperatives, Govt. Scheme utilising Govt. Land etc

Considering the above guidelines, creation of additional irrigation potential through ground water is admissible in the taluka. The details of the tentative number of new abstraction structures feasible in these blocks are given in table 6.3.

**Table 5.1. Additional abstraction structures possible in the block**

<b>Annual Extractable GroundWater Recharge (Ham)</b>	12626
<b>Total Extraction (Ham)</b>	4003.91
<b>Net Ground Water Availability for future use (Ham)</b>	8619.36
<b>Stage of Ground Water Extraction (%)</b>	31.7
<b>60% of the Annual extractable GWR (Ham)</b>	7575.6
<b>GW Resource available for Development (Ham)</b>	3571.69
<b>GW Resource to be developed through DW (Ham)</b>	2143.01
<b>GW Resource to be developed through BW (Ham)</b>	1428.67
<b>No. of DW to be feasible</b>	2143
<b>No. of BW to be feasible</b>	952

As the additional number of borewells/dugwells proposed in the study area is large as compared to the available area of the taluka, it is recommended to develop the available cultivable waste land. The additional potential required and additional structures required for development of the waste land is mentioned below. As per the table, 1743 Ha of cultivable waste land can be brought under irrigation by use of 1045 dug wells and 697 borewells

**Table 5.2. Additional abstraction structures recalculated as per the availability of cultivable waste land.**

<b>Area of cultivable waste to develop (Ha)</b>	1743
<b>No. of DW to be feasible( @ 1 ham for 60% of GWR Available)</b>	1045
<b>No. of BW to be feasible ( @ 1.5 ham for 40% of GWR Available)</b>	465

# ANNEXURES

**Annexure-I: Details of ground water exploration**

SI NO	PROJECT	DISTRICT	TALUKA	LOCATION	LONGITUDE	LATITUDE	DEPTH OF WELL	DEPTH OF CASING	BOTTOM OF PHREATIC AQUIFER	lithology	Fracture Zones	DRILLING DISCHARGE) LPS)	SWL	DISCHARGE	DD	T	S
1	GWE	Shimoga	Tirthahalli	Nagara EW	13.82361	75.03056	126.9		22	Gneiss	22.0-23.0 43-44 57-58 118-119 33-35	2.9	3.29	-	5.79	25.35	0.0195
1	GWE	Shimoga	Tirthahalli	Nagara OW	13.82361	75.03056	184.85		17	Gneiss	18-23 33-35 181-182	4.36	3.61	360	17.94	23.54	
2	GWE	Shimoga	Tirthahalli	Karana giri1	13.87778	75.06944	200.1		22	Gneiss	23-24 84.20- 85.20 121-123	0.731	16	-		1.8 (slug test)	
3	GWE	Shimoga	Tirthahalli	Araslu EW	13.99583	75.31667	168.55	32.5	37	Gneiss	32.35- 33.35 36.40- 37.40 46.55- 47.60 86.20- 88.25	2.11	7.36	-	24.7	8.58	3.22E-05
4	GWE	Shimoga	Tirthahalli	Araslu OW	13.99583	75.31667	100.48	24.4	43	Gneiss	26 35-43 57-66	3.34	7.48	328	14.33	8.83	

SI NO	PROJ ECT	DISTRIC T	TALU KA	LOCAT ION	LON GITU DE	LATI TUD E	DEPTH OF WELL	DEPTH OF CASING	BOTTOM OF PHREATIC AQUIFER	litholo gy	Fracture Zones	DRILLI NG DISCH ARGE) LPS)	SWL	DISC HAR GE	DD	T	S
5	GWE	Shimoga	Tirth ahalli	Kodur EW	13.9 3333	75.1 625	200.1	21.2	29	Gneiss	25.20- 26.25 61.80- 62.85 81.15- 82.15 153.5- 154.5 184-185	1.21	3.59	150		1.43 (pyt)	
6	GWE	Shimoga	Tirth ahalli	Tirthah alli EW	13.9 1667	75.0 527 8	336.05	22.6	33	Gneiss	23-25 92-93 126-127 135-136	7.65	15.63	475	29	12	
7	GWE	Shimoga	Tirth ahalli	Tirthah alli oW	13.9 1667	75.0 527 8	129.95	23.95	25	Gneiss	24-25 106-109 120-123 126-130	5.54	14.14	_	20.5 2	12.08	0.0001 96
8	GWE	Shimoga	Tirth ahalli	Marut hipura	13.9 9306	75.1 236 1	90.3	20.4	24	Gneiss	20-21 24-24 81-85	0.136	10.9			0.38 (slug test)	
9	ESTA BLIS HED WELL S	Shimoga	Tirth ahalli	ulukop pa	13.7 167	75.0 499	131.15	8.5	8.5		100.65						
1 0	ESTA BLIS	Shimoga	Tirth ahalli	matad ahalli	13.7 982	75.0 898	137.25	7.63	7.63		61						



SI NO	PROJ ECT	DISTRIC T	TALU KA	LOCAT ION	LON GITU DE	LATI TUD E	DEPTH OF WELL	DEPTH OF CASING	BOTTOM OF PHREATIC AQUIFER	litholo gy	Fracture Zones	DRILLI NG DISCH ARGE) LPS)	SWL	DISC HAR GE	DD	T	S
	HED WELL S																
1 1	ESTA BLIS HED WELL S	Shimoga	Tirth ahalli	maluru	13.9 5064	75.1 917 7	161.65	18.3	18.3		54.9						
1 2	ESTA BLIS HED WELL S	Shimoga	Tirth ahalli	kodrig e	14.0 1819	75.2 240 5	97.6	22.22	22.22		28.3						
1 3	ESTA BLIS HED WELL S	Shimoga	Tirth ahalli	kaduva lli	13.9 627	75.0 621	183	12.2	12.2		178.4						
1 4	ESTA BLIS HED WELL S	Shimoga	Tirth ahalli	SAMPI GARU	13.9 176	74.9 668	152.5	24.4	24.4		115.9						

**Annexure-II: Details of Ground Water Monitoring Wells and Key Wells Established**

TALUK	Type	LOCATION	LON	LAT	DEPTH	MP	Aquifer	May 2022 (mbgl)	Nov 2022 (mbgl)	Altitude	RL
Tirthahalli	GWM	Battemallappa	75.1503	14.0203	14.35	1	Unconfined	9.43	7.1	601.4	591.97
Tirthahalli	GWM	Bilehalli	75.1169	13.9222	14	0.63	Unconfined	6.35	4.64	609.7	603.35
Tirthahalli	GWM	Brahmeeshwara	75.0839	13.9572	11.13	1	Unconfined	6.87	9.57	651.3	644.43
Tirthahalli	GWM	Chennakoppa	75.4011	14.0344	24	0.7	Unconfined	1.7	3.2	661	659.3
Tirthahalli	GWM	Gartikere	75.2333	13.8917	11	0.6	Unconfined	7.8	5.1	690.2	682.4
Tirthahalli	GWM	Heddaripura	75.2669	13.9361	11.5	0.7	Unconfined	3.8	5	666.7	662.9
Tirthahalli	GWM	Tirthahalli1	75.1	13.9	14	0.74	Unconfined	11.51	7.86	596	584.49
Tirthahalli	GWM	Humacha	75.2008	13.8583	10.4	0.76	Unconfined	4.8	4.89	781.7	776.9
Tirthahalli	GWM	Kaijegebulu	75.1008	13.9825	14.55	0.8	Unconfined	8.52	8	610.6	602.08
Tirthahalli	GWM	Kote Kargya	75.2011	13.7989	13.43	0.55	Unconfined	8.85		644.4	635.55
Tirthahalli	GWM	Riponpet	75.2503	13.9917	13	1.16	Unconfined	6.26	6.34	651.3	645.04
Tirthahalli	KOW	mallapura	75.3188	13.7958	9.25	0.85	Unconfined	5.49		680.9	675.41
Tirthahalli	KOW	maskani	75.3322	13.8952	55.458	0.86	Unconfined	2.13		748.4	746.27
Tirthahalli	KOW	talale	75.288	13.9461	9.16	0.85	Unconfined	3.56		671.7	668.14
Tirthahalli	KOW	Mandli	75.276	13.9073	11.9	0.7	Unconfined	7.36		701.5	694.14
Tirthahalli	KOW	Gunavanthe	75.3604	13.5719	13.17	0.75	Unconfined	11.43		775	763.57
Tirthahalli	KOW	Yadur	75.0824	13.6941	13.76	0.8	Unconfined	11.79		611	599.21

Tirthahalli	KOW	Hullikal	75.0087	13.7239	12.68	0.7	Unconfined	9.78		576.7	566.92
Tirthahalli	KOW	Attihalli	75.0356	13.7808	8.12	0.73	Unconfined	5.22		620.5	615.28
Tirthahalli	KOW	Chakranagar colony	75.0038	13.7984	9.19	0.93	Unconfined	5.49		581.5	576.01
Tirthahalli	KOW	Belur	75.0812	13.8069	8.8	0.95	Unconfined	6.99		587.2	580.21
Tirthahalli	KOW	Karagadi	75.0657	13.8701	11.33	0.67	Unconfined	0.6		597.9	597.3
Tirthahalli	KOW	Billodi	75.1389	13.8344	17.89	1.03	Unconfined	12.86		608.6	595.74
Tirthahalli	KOW	Hosanagare	75.0629	13.9138	17.64	0.6	Unconfined	15.27		592.4	577.13
Tirthahalli	KOW	Nagarahalli	75.1917	13.8816	15.28	0.67	Unconfined	14.24		705.1	690.86
Tirthahalli	KOW	Thariga	75.212	13.9641	14.3	0.65	Unconfined	8.77		666	657.23
Tirthahalli	KOW	Harohattilu	75.3387	13.9668	10.59	0.65	Unconfined	6.61		700.5	693.89
Tirthahalli	KOW	Masaruru	75.2969	14.0195	10.08	0.99	Unconfined	4.14		676.4	672.26
Tirthahalli	KOW	Hunasavalli	75.12	14.0534	14.55	0.53	Unconfined	10.26		604.1	593.84
Tirthahalli	KOW	Vijapura	75.0845	14.0175	12.45	0.76	Unconfined	9.14		599.8	590.66
Tirthahalli	KOW	Kaluru	75.0642	13.9336	14.83	0.68	Unconfined	11.96		598.4	586.44
Tirthahalli	KOW	Guddekoppa	75.0311	13.9032	14.44	0.65	Unconfined	10.8		594.9	584.1
Tirthahalli	KOW	Kattinahole	74.9147	13.8739	11.85	0.79	Unconfined	7.95		609.7	601.75
Tirthahalli	KOW	Sampigaru	74.9685	13.9183	15.81	0.91	Unconfined	12.63		590.6	577.97
Tirthahalli	KOW	Edumane	74.8613	13.912	9.16	0.96	Unconfined	4.93		595.8	590.87
Tirthahalli	KOW	Nagara	75.02	13.8313	9.84	0.69	Unconfined	7.05		584.2	577.15

**Annexure-III: Details of Quality monitoring Stations in Tirthahalli Taluka**

Location	District	Longitude	Latitude	Type of well	pH (6.5-8.5)	EC in m S/cm	TH (600)	Ca (200)	Mg (100)	Na	K	CO <sub>3</sub>	HCO <sub>3</sub>	Cl (1000)	SO <sub>4</sub> (400)	NO <sub>3</sub> (45)	SiO <sub>2</sub>	PO <sub>4</sub>	F (1.5)	TDS (2000)
Talale	Shimoga	75.288	13.9461	DW	6.59	230	85	24	6.08	10	3.3	0	85.4	14.18	2	11	18	BDL	0.38	130.94
Mandli	Shimoga	75.2769	13.9072	DW	6.75	170	60	14	6.08	12	0.4	0	54.9	14.18	4	13	9	BDL	0.55	100.21
Yadur	Shimoga	75.08247	13.69408	DW	7.34	90	25	6	2.432	7	1.1	0	24.4	10.635	3	2	6	BDL	0.27	50.437
Hullickal	Shimoga	75.0087	13.7239	DW	7.2	80	20	4	2.432	8	0.4	0	24.4	10.635	1	1	8	BDL	0.23	47.697
Attihali	Shimoga	75.03557	13.78084	DW	6.67	235	65	20	3.648	23	1.3	0	103.7	14.18	6	1	32	BDL	0.32	152.448
Chakranagar colony	Shimoga	75.00385	13.79844	DW	6.75	110	25	6	2.432	12	0.5	0	36.6	10.635	2	2	14	BDL	0.21	67.777
Belur	Shimoga	75.08121	13.80685	DW	6.59	125	25	6	2.432	16	1.1	0	36.6	14.18	2	5	15	BDL	0.27	79.982
Kargadi	Shimoga	75.06568	13.87013	DW	6.5	260	65	14	7.296	27	2.8	0	54.9	38.995	1	27	15	BDL	0.48	160.571
Billodi	Shimoga	75.13895	13.83441	DW	7.02	240	75	22	4.864	19	1.3	0	91.5	17.725	4	13	10	BDL	0.52	137.409
Tirthahalli	Shimoga	75.06293	13.91375	DW	6.57	210	50	12	4.864	23	1.4	0	48.8	28.36	1	19	4	BDL	1.59	119.214
Nagarahalli	Shimoga	75.1917	13.88158	DW	7.33	435	175	54	9.728	14	7.1	0	195.2	21.27	19	5	23	0.44	0.41	249.508
Thariga	Shimoga	75.21202	13.96411	DW	7.13	190	50	10	6.08	18	0.5	0	73.2	14.18	3	4	13	BDL	0.84	105.6
Vijapura	Shimoga	75.08459	14.01756	DW	7.57	335	80	22	6.08	28	6	0	115.9	24.815	10	18	13	BDL	0.35	196.845
Kaluru	Shimoga	75.06423	13.93361	DW	7.32	210	70	22	3.64	13	2.1	0	85.	10.	2	12	11	BDL	0.33	118.

Location	District	Longitude	Latitude	Type of well	pH (6.5-8.5)	EC in m S/cm	TH (600)	Ca (200)	Mg (100)	Na	K	CO <sub>3</sub>	HCO <sub>3</sub>	Cl (1000)	SO <sub>4</sub> (400)	NO <sub>3</sub> (45)	SiO <sub>2</sub>	PO <sub>4</sub>	F (1.5)	TDS (2000)	
									8				4	635							713
Guddekoppa (Nandikoppa)	Shimoga	75.03108	13.90323	DW	7.41	155	30	6	3.648	20	0.9	0	48.8	14.18	1	11	6	BDL	0.42		87.148
Kattanihole	Shimoga	74.91467	13.87385	DW	7.16	150	45	16	1.216	12	1.2	0	61	10.635	1	7	17	BDL	0.52		96.571
Sampigaru	Shimoga	74.96857	13.91834	DW	7.47	500	175	54	9.728	30	2.3	0	256.2	14.18	4	2	58	BDL	2.27		302.478
Edumane	Shimoga	74.86125	13.91201	DW	6.55	95	30	6	3.648	7	0.4	0	36.6	7.09	2	1	8	BDL	0.53		53.668
Nagara	Shimoga	75.02007	13.83136	DW	7.11	225	90	28	4.864	8	2	0	97.6	10.635	2	3	18	BDL	0.47		124.969
Harohittalu	Shimoga	75.33874	13.96684	DW	7.86	350	105	34	4.864	27	4.9	0	164.7	10.635	11	2	45	BDL	0.63		221.029
Marasaruru	Shimoga	75.2969	14.01951	DW	6.51	140	45	10	4.864	12	0.4	0	42.7	17.725	4	2	8	BDL	0.46		80.449
Hunasavalli	Shimoga	75.12005	14.05346	DW	6.52	80	20	4	2.432	8	0.8	0	24.4	10.635	1	1	5	BDL	0.43		45.297

**Annexure-IV: Proposed location of AR Structures in Tirthahalli Taluka**

SI No	LATITUDE	LONGITUDE	Type
1	13° 39.98496' N	75° 15.96509' E	Percolation Tank
2	13° 38.51829' N	75° 17.16842' E	Percolation Tank
3	13° 37.91829' N	75° 17.31509' E	Percolation Tank
4	13° 42.80496' N	75° 14.03842' E	Percolation Tank
5	13° 45.58496' N	75° 12.69176' E	Percolation Tank
6	13° 41.70496' N	75° 11.39176' E	Percolation Tank
7	13° 41.31829' N	75° 11.68176' E	Percolation Tank
8	13° 43.88496' N	75° 12.50176' E	Percolation Tank
9	13° 43.69829' N	75° 13.50842' E	Percolation Tank
10	13° 39.65162' N	75° 16.28176' E	Percolation Tank
11	13° 40.60223' N	75° 15.58115' E	Percolation Tank
12	13° 40.93162' N	75° 12.48509' E	Percolation Tank
13	13° 44.61162' N	75° 20.96176' E	Percolation Tank
14	13° 48.13496' N	75° 20.39842' E	Percolation Tank
15	13° 42.41496' N	75° 21.58509' E	Percolation Tank
16	13° 44.58496' N	75° 22.06509' E	Percolation Tank
17	13° 44.83496' N	75° 20.68176' E	Percolation Tank
18	13° 46.75829' N	75° 22.15176' E	Percolation Tank
19	13° 47.29496' N	75° 22.81509' E	Percolation Tank
20	13° 44.06829' N	75° 23.38176' E	Percolation Tank
21	13° 42.86496' N	75° 21.98509' E	Percolation Tank
22	13° 29.52162' N	75° 7.17842' E	Check Dam
23	13° 29.90162' N	75° 6.99842' E	Check Dam
24	13° 31.15496' N	75° 5.37176' E	Check Dam
25	13° 31.20162' N	75° 5.76509' E	Check Dam
26	13° 30.85162' N	75° 5.94842' E	Check Dam
27	13° 34.13829' N	75° 3.90509' E	Check Dam
28	13° 34.31496' N	75° 4.22176' E	Check Dam
29	13° 34.24496' N	75° 4.88509' E	Check Dam
30	13° 31.62496' N	75° 6.61842' E	Check Dam
31	13° 37.10829' N	75° 5.75842' E	Check Dam
32	13° 32.79162' N	75° 7.03842' E	Check Dam
33	13° 32.51829' N	75° 6.88176' E	Check Dam
34	13° 33.00162' N	75° 6.83176' E	Check Dam
35	13° 33.12829' N	75° 7.82176' E	Check Dam
36	13° 32.70496' N	75° 7.99509' E	Check Dam
37	13° 32.18496' N	75° 8.43176' E	Check Dam
38	13° 31.41829' N	75° 8.64842' E	Check Dam
39	13° 30.88496' N	75° 8.23509' E	Check Dam
40	13° 31.93496' N	75° 10.48176' E	Check Dam
41	13° 32.30162' N	75° 9.33176' E	Check Dam
42	13° 32.41829' N	75° 9.86509' E	Check Dam
43	13° 31.40162' N	75° 10.94842' E	Check Dam

SI No	LATITUDE	LONGITUDE	Type
44	13° 35.08496' N	75° 6.74842' E	Check Dam
45	13° 34.80162' N	75° 7.26509' E	Check Dam
46	13° 35.13496' N	75° 8.29842' E	Check Dam
47	13° 35.52829' N	75° 9.04176' E	Check Dam
48	13° 36.38496' N	75° 8.98176' E	Check Dam
49	13° 36.01829' N	75° 10.34842' E	Check Dam
50	13° 36.50162' N	75° 10.18176' E	Check Dam
51	13° 37.85162' N	75° 7.54842' E	Check Dam
52	13° 37.94496' N	75° 9.46842' E	Check Dam
53	13° 38.10162' N	75° 9.94842' E	Check Dam
54	13° 37.64162' N	75° 10.16842' E	Check Dam
55	13° 38.00162' N	75° 10.03176' E	Check Dam
56	13° 34.16829' N	75° 9.93176' E	Check Dam
57	13° 34.41829' N	75° 11.21509' E	Check Dam
58	13° 34.79162' N	75° 11.71842' E	Check Dam
59	13° 33.95162' N	75° 11.81509' E	Check Dam
60	13° 32.34829' N	75° 12.37176' E	Check Dam
61	13° 32.49496' N	75° 11.21842' E	Check Dam
62	13° 31.14162' N	75° 8.40509' E	Check Dam
63	13° 31.87162' N	75° 8.57509' E	Check Dam
64	13° 33.75162' N	75° 4.26509' E	Check Dam
65	13° 33.81496' N	75° 10.67176' E	Check Dam
66	13° 33.35496' N	75° 11.97842' E	Check Dam
67	13° 33.24829' N	75° 11.41842' E	Check Dam
68	13° 35.71829' N	75° 10.59842' E	Check Dam
69	13° 37.65496' N	75° 11.65176' E	Check Dam
70	13° 38.22162' N	75° 11.73509' E	Check Dam
71	13° 38.53829' N	75° 12.29509' E	Check Dam
72	13° 38.43496' N	75° 12.66509' E	Check Dam
73	13° 38.95162' N	75° 12.92176' E	Check Dam
74	13° 39.53162' N	75° 12.55509' E	Check Dam
75	13° 39.98496' N	75° 11.49842' E	Check Dam
76	13° 39.86829' N	75° 12.08176' E	Check Dam
77	13° 37.48496' N	75° 13.98176' E	Check Dam
78	13° 37.86829' N	75° 14.39842' E	Check Dam
79	13° 38.46829' N	75° 13.59842' E	Check Dam
80	13° 37.15162' N	75° 14.33176' E	Check Dam
81	13° 37.05162' N	75° 16.05176' E	Check Dam
82	13° 37.70162' N	75° 15.50509' E	Check Dam
83	13° 36.15162' N	75° 18.26509' E	Check Dam
84	13° 30.08829' N	75° 8.79842' E	Check Dam
85	13° 30.59829' N	75° 8.41176' E	Check Dam
86	13° 37.24829' N	75° 17.22842' E	Check Dam
87	13° 36.86829' N	75° 17.99509' E	Check Dam
88	13° 46.00162' N	75° 9.04842' E	Check Dam

<b>SI No</b>	<b>LATITUDE</b>	<b>LONGITUDE</b>	<b>Type</b>
89	13° 46.98829' N	75° 9.70842' E	Check Dam
90	13° 46.63496' N	75° 10.01176' E	Check Dam
91	13° 45.80829' N	75° 10.29176' E	Check Dam
92	13° 45.66829' N	75° 9.96509' E	Check Dam
93	13° 45.18162' N	75° 10.59842' E	Check Dam
94	13° 44.88496' N	75° 11.26509' E	Check Dam
95	13° 44.61829' N	75° 11.83176' E	Check Dam
96	13° 47.22162' N	75° 12.73509' E	Check Dam
97	13° 48.62829' N	75° 13.67842' E	Check Dam
98	13° 48.04162' N	75° 13.21176' E	Check Dam
99	13° 47.53829' N	75° 13.02842' E	Check Dam
100	13° 48.01829' N	75° 12.24509' E	Check Dam
101	13° 48.51829' N	75° 12.45509' E	Check Dam
102	13° 46.27496' N	75° 8.85842' E	Check Dam
103	13° 47.95829' N	75° 11.54509' E	Check Dam
104	13° 48.27162' N	75° 13.42176' E	Check Dam
105	13° 46.57496' N	75° 12.71842' E	Check Dam
106	13° 46.48496' N	75° 13.39842' E	Check Dam
107	13° 47.03496' N	75° 13.78176' E	Check Dam
108	13° 47.78496' N	75° 13.98176' E	Check Dam
109	13° 47.17829' N	75° 15.16842' E	Check Dam
110	13° 45.62829' N	75° 14.99509' E	Check Dam
111	13° 45.25829' N	75° 14.54176' E	Check Dam
112	13° 44.77829' N	75° 14.51842' E	Check Dam
113	13° 45.06829' N	75° 12.58176' E	Check Dam
114	13° 44.52162' N	75° 12.95176' E	Check Dam
115	13° 44.13496' N	75° 13.36509' E	Check Dam
116	13° 43.33496' N	75° 13.73842' E	Check Dam
117	13° 43.06829' N	75° 13.94842' E	Check Dam
118	13° 42.40829' N	75° 14.55176' E	Check Dam
119	13° 46.66829' N	75° 11.08176' E	Check Dam
120	13° 43.91829' N	75° 9.83176' E	Check Dam
121	13° 44.19162' N	75° 9.29842' E	Check Dam
122	13° 43.06829' N	75° 9.66509' E	Check Dam
123	13° 42.89496' N	75° 11.10842' E	Check Dam
124	13° 41.47162' N	75° 12.23176' E	Check Dam
125	13° 41.94829' N	75° 11.24509' E	Check Dam
126	13° 42.90162' N	75° 10.16509' E	Check Dam
127	13° 42.66829' N	75° 10.44842' E	Check Dam
128	13° 44.06829' N	75° 8.29842' E	Check Dam
129	13° 44.63496' N	75° 7.56509' E	Check Dam
130	13° 43.39829' N	75° 11.30509' E	Check Dam
131	13° 43.38496' N	75° 10.86509' E	Check Dam
132	13° 43.26496' N	75° 14.31842' E	Check Dam
133	13° 42.95162' N	75° 9.48176' E	Check Dam



<b>SI No</b>	<b>LATITUDE</b>	<b>LONGITUDE</b>	<b>Type</b>
134	13° 40.30829' N	75° 8.53509' E	Check Dam
135	13° 39.20496' N	75° 10.78842' E	Check Dam
136	13° 39.23496' N	75° 11.04842' E	Check Dam
137	13° 39.11829' N	75° 11.13176' E	Check Dam
138	13° 42.58496' N	75° 11.24842' E	Check Dam
139	13° 39.26829' N	75° 14.43176' E	Check Dam
140	13° 39.20496' N	75° 14.59842' E	Check Dam
141	13° 39.45162' N	75° 14.20176' E	Check Dam
142	13° 44.32162' N	75° 8.02509' E	Check Dam
143	13° 43.11829' N	75° 9.94842' E	Check Dam
144	13° 43.85162' N	75° 8.43176' E	Check Dam
145	13° 36.15162' N	75° 20.03509' E	Check Dam
146	13° 36.13162' N	75° 20.65842' E	Check Dam
147	13° 36.41496' N	75° 20.23842' E	Check Dam
148	13° 36.58496' N	75° 20.51509' E	Check Dam
149	13° 37.43496' N	75° 20.93176' E	Check Dam
150	13° 37.06829' N	75° 21.33176' E	Check Dam
151	13° 38.29829' N	75° 21.38176' E	Check Dam
152	13° 38.58496' N	75° 20.81509' E	Check Dam
153	13° 39.63829' N	75° 21.10842' E	Check Dam
154	13° 38.70162' N	75° 19.21509' E	Check Dam
155	13° 39.96829' N	75° 18.34842' E	Check Dam
156	13° 39.61829' N	75° 18.44842' E	Check Dam
157	13° 41.77496' N	75° 20.23842' E	Check Dam
158	13° 39.28664' N	75° 21.45506' E	Check Dam
159	13° 38.28829' N	75° 21.67509' E	Check Dam
160	13° 39.33496' N	75° 19.41509' E	Check Dam
161	13° 40.08829' N	75° 19.99176' E	Check Dam
162	13° 40.95162' N	75° 19.33176' E	Check Dam
163	13° 40.55162' N	75° 20.33176' E	Check Dam
164	13° 40.23496' N	75° 21.51509' E	Check Dam
165	13° 41.86829' N	75° 17.58509' E	Check Dam
166	13° 41.81829' N	75° 17.81509' E	Check Dam
167	13° 43.64162' N	75° 20.19842' E	Check Dam
168	13° 46.28496' N	75° 18.21509' E	Check Dam
169	13° 39.80496' N	75° 21.33842' E	Check Dam
170	13° 47.67162' N	75° 16.59842' E	Check Dam
171	13° 47.94829' N	75° 16.78509' E	Check Dam
172	13° 47.50162' N	75° 17.81509' E	Check Dam
173	13° 46.90162' N	75° 17.94842' E	Check Dam
174	13° 46.86829' N	75° 18.33176' E	Check Dam
175	13° 47.24496' N	75° 19.16842' E	Check Dam
176	13° 46.86496' N	75° 19.14509' E	Check Dam
177	13° 46.51829' N	75° 19.54842' E	Check Dam
178	13° 46.36496' N	75° 19.80176' E	Check Dam

SI No	LATITUDE	LONGITUDE	Type
179	13° 45.75162' N	75° 20.03176' E	Check Dam
180	13° 45.62670' N	75° 20.53140' E	Check Dam
181	13° 45.22829' N	75° 20.70176' E	Check Dam
182	13° 45.69829' N	75° 18.80842' E	Check Dam
183	13° 45.29162' N	75° 19.00176' E	Check Dam
184	13° 45.78829' N	75° 16.82509' E	Check Dam
185	13° 45.53496' N	75° 17.16509' E	Check Dam
186	13° 45.15162' N	75° 17.31842' E	Check Dam
187	13° 47.98496' N	75° 10.69842' E	Check Dam
188	13° 42.80162' N	75° 17.25176' E	Check Dam
189	13° 42.65496' N	75° 18.03842' E	Check Dam
190	13° 42.15162' N	75° 17.78509' E	Check Dam
191	13° 41.59162' N	75° 20.01509' E	Check Dam
192	13° 42.00162' N	75° 19.08176' E	Check Dam
193	13° 44.48496' N	75° 14.96509' E	Check Dam
194	13° 49.78496' N	75° 9.41509' E	Check Dam
195	13° 49.72496' N	75° 9.90176' E	Check Dam
196	13° 49.13496' N	75° 15.58176' E	Check Dam
197	13° 49.51829' N	75° 15.39842' E	Check Dam
198	13° 49.68496' N	75° 15.39842' E	Check Dam
199	13° 50.13162' N	75° 15.18509' E	Check Dam
200	13° 50.65162' N	75° 14.89842' E	Check Dam
201	13° 50.90162' N	75° 15.14842' E	Check Dam
202	13° 40.79314' N	75° 20.03179' E	Check Dam
203	13° 44.67162' N	75° 18.05176' E	Check Dam
204	13° 44.37829' N	75° 17.42176' E	Check Dam
205	13° 41.65162' N	75° 16.69842' E	Check Dam
206	13° 42.38496' N	75° 16.69842' E	Check Dam
207	13° 43.09829' N	75° 16.33842' E	Check Dam
208	13° 43.16829' N	75° 21.81509' E	Check Dam
209	13° 42.90496' N	75° 22.35509' E	Check Dam
210	13° 42.82162' N	75° 22.22509' E	Check Dam
211	13° 41.60829' N	75° 21.62176' E	Check Dam
212	13° 41.97162' N	75° 21.41842' E	Check Dam
213	13° 40.90162' N	75° 20.66176' E	Check Dam
214	13° 43.53496' N	75° 15.78176' E	Check Dam
215	13° 43.92162' N	75° 17.42176' E	Check Dam
216	13° 49.28829' N	75° 12.05509' E	Check Dam
217	13° 49.38496' N	75° 8.93176' E	Check Dam
218	13° 49.30666' N	75° 10.58106' E	Check Dam
219	13° 49.39829' N	75° 13.33176' E	Check Dam
220	13° 48.68829' N	75° 18.76509' E	Check Dam
221	13° 48.20162' N	75° 19.59842' E	Check Dam
222	13° 49.53496' N	75° 17.38176' E	Check Dam
223	13° 50.53496' N	75° 18.03176' E	Check Dam

<b>SI No</b>	<b>LATITUDE</b>	<b>LONGITUDE</b>	<b>Type</b>
224	13° 51.06829' N	75° 18.18176' E	Check Dam
225	13° 50.40829' N	75° 18.96176' E	Check Dam
226	13° 49.93496' N	75° 18.63176' E	Check Dam
227	13° 48.84162' N	75° 19.70176' E	Check Dam
228	13° 51.81829' N	75° 17.74509' E	Check Dam
229	13° 51.58496' N	75° 18.58176' E	Check Dam
230	13° 50.66829' N	75° 17.19842' E	Check Dam
231	13° 51.91829' N	75° 15.49842' E	Check Dam
232	13° 51.92162' N	75° 15.76509' E	Check Dam
233	13° 52.20829' N	75° 15.54509' E	Check Dam
234	13° 49.68162' N	75° 18.25176' E	Check Dam
235	13° 49.18829' N	75° 18.83842' E	Check Dam
236	13° 43.07496' N	75° 12.76842' E	Check Dam
237	13° 42.68496' N	75° 13.57842' E	Check Dam
238	13° 41.84829' N	75° 12.35176' E	Check Dam
239	13° 49.55162' N	75° 10.03176' E	Check Dam
240	13° 41.98162' N	75° 14.84842' E	Check Dam
241	13° 41.48496' N	75° 17.97842' E	Check Dam
242	13° 45.60162' N	75° 15.34842' E	Check Dam
243	13° 46.41829' N	75° 16.59842' E	Check Dam
244	13° 45.58496' N	75° 6.48176' E	Check Dam
245	13° 45.98496' N	75° 6.53176' E	Check Dam
246	13° 37.91496' N	75° 19.31509' E	Check Dam
247	13° 40.45162' N	75° 21.73509' E	Check Dam
248	13° 35.70496' N	75° 17.41509' E	Check Dam
249	13° 36.13496' N	75° 16.44842' E	Check Dam
250	13° 35.40162' N	75° 16.78176' E	Check Dam
251	13° 38.70162' N	75° 18.23176' E	Check Dam
252	13° 39.70095' N	75° 17.44775' E	Check Dam
253	13° 39.76829' N	75° 18.28176' E	Check Dam
254	13° 38.28496' N	75° 19.53176' E	Check Dam
255	13° 37.65496' N	75° 18.99176' E	Check Dam
256	13° 39.16018' N	75° 18.28889' E	Check Dam
257	13° 40.13496' N	75° 18.53176' E	Check Dam
258	13° 39.30162' N	75° 19.48176' E	Check Dam
259	13° 38.26829' N	75° 20.44842' E	Check Dam
260	13° 36.10162' N	75° 18.49842' E	Check Dam
261	13° 36.44496' N	75° 18.26842' E	Check Dam
262	13° 38.83496' N	75° 16.63176' E	Check Dam
263	13° 37.70162' N	75° 14.88176' E	Check Dam
264	13° 36.98496' N	75° 12.26509' E	Check Dam
265	13° 40.49496' N	75° 15.88509' E	Check Dam
266	13° 40.98496' N	75° 15.29842' E	Check Dam
267	13° 41.10162' N	75° 14.29842' E	Check Dam
268	13° 39.98496' N	75° 13.83176' E	Check Dam

<b>SI No</b>	<b>LATITUDE</b>	<b>LONGITUDE</b>	<b>Type</b>
269	13° 36.65162' N	75° 20.59842' E	Check Dam
270	13° 39.36829' N	75° 20.96509' E	Check Dam
271	13° 36.43496' N	75° 3.96509' E	Check Dam
272	13° 35.88496' N	75° 4.88176' E	Check Dam
273	13° 35.86829' N	75° 5.19842' E	Check Dam
274	13° 35.76829' N	75° 5.43176' E	Check Dam
275	13° 35.95162' N	75° 6.21509' E	Check Dam
276	13° 36.76829' N	75° 5.59842' E	Check Dam
277	13° 37.40162' N	75° 5.86509' E	Check Dam
278	13° 36.00162' N	75° 7.33176' E	Check Dam
279	13° 36.26829' N	75° 7.71509' E	Check Dam
280	13° 36.80162' N	75° 7.53176' E	Check Dam
281	13° 37.70162' N	75° 6.86509' E	Check Dam
282	13° 37.41829' N	75° 8.46509' E	Check Dam
283	13° 35.80162' N	75° 10.96509' E	Check Dam
284	13° 36.32496' N	75° 10.67509' E	Check Dam
285	13° 29.68496' N	75° 8.74842' E	Check Dam
286	13° 31.10162' N	75° 10.74842' E	Check Dam
287	13° 32.23496' N	75° 12.53176' E	Check Dam
288	13° 33.15162' N	75° 12.19842' E	Check Dam
289	13° 35.28496' N	75° 16.76509' E	Check Dam
290	13° 32.80162' N	75° 8.74842' E	Check Dam
291	13° 33.27829' N	75° 8.38842' E	Check Dam
292	13° 29.23143' N	75° 7.35195' E	Check Dam
293	13° 39.86829' N	75° 8.88176' E	Check Dam
294	13° 40.06829' N	75° 8.73176' E	Check Dam
295	13° 39.91829' N	75° 12.78176' E	Check Dam
296	13° 37.51829' N	75° 15.70176' E	Check Dam
297	13° 37.76829' N	75° 17.31509' E	Check Dam
298	13° 35.94162' N	75° 19.86176' E	Check Dam
299	13° 37.36496' N	75° 11.94176' E	Check Dam
300	13° 33.63496' N	75° 4.26509' E	Check Dam
301	13° 34.06496' N	75° 3.71509' E	Check Dam
302	13° 31.38496' N	75° 8.89842' E	Check Dam
303	13° 32.33496' N	75° 6.34842' E	Check Dam
304	13° 32.16829' N	75° 11.91509' E	Check Dam
305	13° 34.41829' N	75° 4.68176' E	Check Dam
306	13° 34.50162' N	75° 7.33176' E	Check Dam
307	13° 31.31829' N	75° 6.69842' E	Check Dam
308	13° 33.01829' N	75° 7.46509' E	Check Dam
309	13° 34.53496' N	75° 4.44842' E	Check Dam
310	13° 31.21829' N	75° 10.86509' E	Check Dam
311	13° 37.13496' N	75° 10.29842' E	Check Dam
312	13° 34.04470' N	75° 10.05535' E	Check Dam
313	13° 35.21829' N	75° 9.51509' E	Check Dam

SI No	LATITUDE	LONGITUDE	Type
314	13° 34.11829' N	75° 5.56509' E	Check Dam
315	13° 34.95162' N	75° 11.83176' E	Check Dam
316	13° 29.11829' N	75° 7.46509' E	Check Dam
317	13° 31.03496' N	75° 5.96509' E	Check Dam
318	13° 31.38496' N	75° 5.31509' E	Check Dam
319	13° 30.70162' N	75° 8.04842' E	Check Dam
320	13° 29.95162' N	75° 8.91509' E	Check Dam
321	13° 30.88496' N	75° 9.19842' E	Check Dam
322	13° 31.50162' N	75° 6.74842' E	Check Dam
323	13° 32.33162' N	75° 4.12509' E	Check Dam
324	13° 34.28829' N	75° 3.94176' E	Check Dam
325	13° 33.95162' N	75° 5.43176' E	Check Dam
326	13° 33.06829' N	75° 6.76509' E	Check Dam
327	13° 32.61829' N	75° 11.14842' E	Check Dam
328	13° 33.11829' N	75° 11.96509' E	Check Dam
329	13° 32.63496' N	75° 11.31509' E	Check Dam
330	13° 32.86829' N	75° 11.38176' E	Check Dam
331	13° 34.33496' N	75° 11.29842' E	Check Dam
332	13° 32.95162' N	75° 7.84842' E	Check Dam
333	13° 32.75162' N	75° 7.29842' E	Check Dam
334	13° 32.51829' N	75° 6.66509' E	Check Dam
335	13° 33.98496' N	75° 3.73176' E	Check Dam
336	13° 35.01829' N	75° 6.46509' E	Check Dam
337	13° 34.20496' N	75° 6.94509' E	Check Dam
338	13° 35.38162' N	75° 8.63509' E	Check Dam
339	13° 36.93496' N	75° 5.71509' E	Check Dam
340	13° 35.88496' N	75° 7.34842' E	Check Dam
341	13° 35.71829' N	75° 10.68176' E	Check Dam
342	13° 35.52829' N	75° 10.88509' E	Check Dam
343	13° 37.71829' N	75° 6.84842' E	Check Dam
344	13° 37.37932' N	75° 6.86509' E	Check Dam
345	13° 38.22829' N	75° 8.45176' E	Check Dam
346	13° 40.26829' N	75° 8.84842' E	Check Dam
347	13° 38.60162' N	75° 10.28176' E	Check Dam
348	13° 38.03496' N	75° 9.31509' E	Check Dam
349	13° 36.83496' N	75° 9.98176' E	Check Dam
350	13° 34.96496' N	75° 16.64509' E	Check Dam
351	13° 39.05162' N	75° 16.44842' E	Check Dam
352	13° 38.45162' N	75° 19.33176' E	Check Dam
353	13° 36.09829' N	75° 15.63176' E	Check Dam
354	13° 39.66829' N	75° 18.88176' E	Check Dam
355	13° 41.96829' N	75° 17.83176' E	Check Dam
356	13° 43.96829' N	75° 14.06509' E	Check Dam
357	13° 43.65162' N	75° 17.33176' E	Check Dam
358	13° 40.38496' N	75° 19.58176' E	Check Dam

<b>SI No</b>	<b>LATITUDE</b>	<b>LONGITUDE</b>	<b>Type</b>
359	13° 40.67162' N	75° 19.66842' E	Check Dam
360	13° 40.86829' N	75° 21.94842' E	Check Dam
361	13° 41.08496' N	75° 21.91509' E	Check Dam
362	13° 41.38496' N	75° 21.63176' E	Check Dam
363	13° 42.10162' N	75° 21.31509' E	Check Dam
364	13° 41.01829' N	75° 14.11509' E	Check Dam
365	13° 40.71829' N	75° 12.96509' E	Check Dam
366	13° 41.10162' N	75° 15.19842' E	Check Dam
367	13° 43.20162' N	75° 17.16509' E	Check Dam
368	13° 43.06829' N	75° 20.71509' E	Check Dam
369	13° 43.18496' N	75° 20.54842' E	Check Dam
370	13° 43.55162' N	75° 20.58176' E	Check Dam
371	13° 43.83496' N	75° 20.58176' E	Check Dam
372	13° 42.75162' N	75° 21.73176' E	Check Dam
373	13° 41.71829' N	75° 21.50176' E	Check Dam
374	13° 43.61829' N	75° 21.84842' E	Check Dam
375	13° 44.69829' N	75° 14.78176' E	Check Dam
376	13° 46.56829' N	75° 15.36509' E	Check Dam
377	13° 45.06496' N	75° 20.78176' E	Check Dam
378	13° 50.23496' N	75° 18.94842' E	Check Dam
379	13° 49.70162' N	75° 19.53176' E	Check Dam
380	13° 49.91829' N	75° 20.19842' E	Check Dam
381	13° 48.61829' N	75° 20.61509' E	Check Dam
382	13° 52.02496' N	75° 17.73509' E	Check Dam
383	13° 51.51829' N	75° 18.49842' E	Check Dam
384	13° 50.96829' N	75° 13.96509' E	Check Dam
385	13° 52.97829' N	75° 13.49509' E	Check Dam
386	13° 52.36829' N	75° 15.06509' E	Check Dam
387	13° 51.47162' N	75° 17.46842' E	Check Dam
388	13° 51.26496' N	75° 18.09509' E	Check Dam
389	13° 50.53496' N	75° 18.11509' E	Check Dam
390	13° 52.35162' N	75° 18.84842' E	Check Dam
391	13° 52.88496' N	75° 17.66509' E	Check Dam
392	13° 50.99496' N	75° 19.34176' E	Check Dam
393	13° 39.04162' N	75° 23.28509' E	Check Dam
394	13° 40.18496' N	75° 23.54842' E	Check Dam
395	13° 38.66829' N	75° 23.63176' E	Check Dam
396	13° 43.85162' N	75° 17.64842' E	Check Dam
397	13° 44.18496' N	75° 18.03176' E	Check Dam
398	13° 44.19496' N	75° 16.86509' E	Check Dam
399	13° 40.91496' N	75° 16.92176' E	Check Dam
400	13° 41.48162' N	75° 17.03176' E	Check Dam
401	13° 39.78829' N	75° 14.57509' E	Check Dam
402	13° 39.50162' N	75° 22.96509' E	Check Dam
403	13° 42.51829' N	75° 20.54842' E	Check Dam

<b>SI No</b>	<b>LATITUDE</b>	<b>LONGITUDE</b>	<b>Type</b>
404	13° 38.14496' N	75° 23.25842' E	Check Dam
405	13° 39.46829' N	75° 23.38176' E	Check Dam
406	13° 41.98162' N	75° 16.27509' E	Check Dam
407	13° 41.15162' N	75° 13.18509' E	Check Dam
408	13° 36.97162' N	75° 19.77509' E	Check Dam
409	13° 37.55162' N	75° 17.61509' E	Check Dam
410	13° 37.28496' N	75° 17.79842' E	Check Dam
411	13° 37.31829' N	75° 16.93125' E	Check Dam
412	13° 42.31829' N	75° 17.34842' E	Check Dam
413	13° 42.79496' N	75° 15.16176' E	Check Dam
414	13° 42.26496' N	75° 15.42176' E	Check Dam
415	13° 44.83496' N	75° 9.13176' E	Check Dam
416	13° 44.33405' N	75° 10.11509' E	Check Dam
417	13° 44.48496' N	75° 10.28176' E	Check Dam
418	13° 45.05162' N	75° 19.31509' E	Check Dam
419	13° 44.25162' N	75° 22.53176' E	Check Dam
420	13° 44.76829' N	75° 23.59842' E	Check Dam
421	13° 47.20162' N	75° 21.89842' E	Check Dam
422	13° 47.63496' N	75° 20.99842' E	Check Dam
423	13° 49.45162' N	75° 21.08176' E	Check Dam
424	13° 49.53496' N	75° 21.46509' E	Check Dam
425	13° 49.28496' N	75° 20.28176' E	Check Dam
426	13° 51.41496' N	75° 15.41509' E	Check Dam
427	13° 50.70162' N	75° 21.26509' E	Check Dam
428	13° 48.30496' N	75° 21.87509' E	Check Dam
429	13° 47.40162' N	75° 21.73176' E	Check Dam
430	13° 48.50829' N	75° 19.21509' E	Check Dam
431	13° 45.95162' N	75° 21.98176' E	Check Dam
432	13° 46.25162' N	75° 21.50842' E	Check Dam
433	13° 47.20496' N	75° 21.41176' E	Check Dam
434	13° 48.65162' N	75° 21.99842' E	Check Dam
435	13° 46.05162' N	75° 22.88176' E	Check Dam
436	13° 45.60162' N	75° 22.21509' E	Check Dam
437	13° 44.11829' N	75° 23.03176' E	Check Dam
438	13° 43.53496' N	75° 23.58176' E	Check Dam
439	13° 43.15162' N	75° 23.60176' E	Check Dam
440	13° 43.33496' N	75° 23.43176' E	Check Dam
441	13° 42.98496' N	75° 22.21509' E	Check Dam
442	13° 44.90162' N	75° 22.61176' E	Check Dam
443	13° 44.48496' N	75° 22.31509' E	Check Dam
444	13° 44.71829' N	75° 22.13176' E	Check Dam
445	13° 44.90162' N	75° 20.24842' E	Check Dam
446	13° 46.78162' N	75° 18.71842' E	Check Dam
447	13° 50.60048' N	75° 15.04842' E	Check Dam
448	13° 49.85162' N	75° 15.96509' E	Check Dam

<b>SI No</b>	<b>LATITUDE</b>	<b>LONGITUDE</b>	<b>Type</b>
449	13° 49.33496' N	75° 18.66509' E	Check Dam
450	13° 50.57829' N	75° 19.37842' E	Check Dam
451	13° 48.50352' N	75° 20.02986' E	Check Dam
452	13° 46.39107' N	75° 22.12120' E	Check Dam
453	13° 46.88496' N	75° 22.68176' E	Check Dam
454	13° 47.70496' N	75° 20.43176' E	Check Dam
455	13° 50.08162' N	75° 21.33842' E	Check Dam
456	13° 50.83162' N	75° 20.06509' E	Check Dam
457	13° 49.67162' N	75° 14.82509' E	Check Dam
458	13° 48.58496' N	75° 13.83176' E	Check Dam
459	13° 47.59754' N	75° 9.90210' E	Check Dam
460	13° 46.25162' N	75° 11.88176' E	Check Dam
461	13° 49.69829' N	75° 12.02509' E	Check Dam
462	13° 44.03496' N	75° 7.03509' E	Check Dam
463	13° 42.24162' N	75° 9.95176' E	Check Dam
464	13° 45.95496' N	75° 6.92509' E	Check Dam
465	13° 46.12829' N	75° 11.39509' E	Check Dam
466	13° 45.39162' N	75° 13.35176' E	Check Dam
467	13° 41.65496' N	75° 15.45176' E	Check Dam
468	13° 45.08162' N	75° 15.70842' E	Check Dam
469	13° 37.88162' N	75° 12.70509' E	Check Dam
470	13° 39.83496' N	75° 10.23176' E	Check Dam
471	13° 40.19162' N	75° 10.95509' E	Check Dam
472	13° 38.78496' N	75° 9.91509' E	Check Dam
473	13° 37.08829' N	75° 15.06509' E	Check Dam
474	13° 40.80162' N	75° 14.64842' E	Check Dam
475	13° 47.14496' N	75° 10.43176' E	Check Dam
476	13° 46.97496' N	75° 12.12176' E	Check Dam
477	13° 45.83162' N	75° 9.54509' E	Check Dam
478	13° 46.52162' N	75° 11.38509' E	Check Dam
479	13° 46.00162' N	75° 12.69842' E	Check Dam
480	13° 48.88496' N	75° 9.65842' E	Check Dam
481	13° 46.66496' N	75° 14.13176' E	Check Dam
482	13° 43.65829' N	75° 18.38509' E	Check Dam
483	13° 47.09781' N	75° 17.13557' E	Check Dam
484	13° 48.28496' N	75° 21.17176' E	Check Dam
485	13° 48.15032' N	75° 18.99117' E	Check Dam
486	13° 50.09829' N	75° 17.69176' E	Check Dam
487	13° 48.87829' N	75° 16.05509' E	Check Dam
488	13° 51.55162' N	75° 13.79842' E	Check Dam
489	13° 48.59670' N	75° 12.88612' E	Check Dam
490	13° 52.63496' N	75° 16.33509' E	Check Dam
491	13° 53.02162' N	75° 16.38509' E	Check Dam
492	13° 50.14496' N	75° 14.51176' E	Check Dam
493	13° 52.12496' N	75° 17.33176' E	Check Dam



<b>SI No</b>	<b>LATITUDE</b>	<b>LONGITUDE</b>	<b>Type</b>
494	13° 51.86162' N	75° 16.32176' E	Check Dam
495	13° 51.50314' N	75° 15.91221' E	Check Dam
496	13° 49.93496' N	75° 12.13176' E	Check Dam
497	13° 49.88496' N	75° 10.58176' E	Check Dam
498	13° 49.45162' N	75° 11.06509' E	Check Dam
499	13° 46.93496' N	75° 17.23176' E	Check Dam
500	13° 46.01829' N	75° 19.84842' E	Check Dam
501	13° 49.01829' N	75° 19.73176' E	Check Dam
502	13° 47.94829' N	75° 14.38509' E	Check Dam
503	13° 46.36829' N	75° 12.79842' E	Check Dam
504	13° 41.52667' N	75° 20.69005' E	Check Dam
505	13° 41.43496' N	75° 22.88176' E	Check Dam
506	13° 42.66829' N	75° 22.60129' E	Check Dam
507	13° 52.32162' N	75° 18.22509' E	Check Dam
508	13° 50.85162' N	75° 19.41509' E	Check Dam
509	13° 51.74829' N	75° 19.67509' E	Check Dam
510	13° 42.83496' N	75° 8.48176' E	Check Dam
511	13° 40.92496' N	75° 9.96842' E	Check Dam
512	13° 45.31829' N	75° 6.74842' E	Check Dam
513	13° 45.55162' N	75° 6.61509' E	Check Dam
514	13° 41.46496' N	75° 13.84842' E	Check Dam
515	13° 32.89829' N	75° 10.80842' E	Check Dam
516	13° 34.10162' N	75° 5.81509' E	Check Dam
517	13° 35.15162' N	75° 7.69842' E	Check Dam
518	13° 38.88829' N	75° 9.33509' E	Check Dam
519	13° 44.69984' N	75° 17.34842' E	Check Dam
520	13° 43.06496' N	75° 17.59176' E	Check Dam
521	13° 47.64829' N	75° 15.27176' E	Check Dam
522	13° 48.87829' N	75° 10.68509' E	Check Dam
523	13° 50.37611' N	75° 15.57624' E	Check Dam
524	13° 48.97829' N	75° 18.07176' E	Check Dam
525	13° 47.53496' N	75° 22.11509' E	Check Dam
526	13° 50.84162' N	75° 21.91509' E	Check Dam
527	13° 47.83496' N	75° 11.71509' E	Check Dam
528	13° 43.25162' N	75° 13.18176' E	Check Dam
529	13° 42.63496' N	75° 17.38176' E	Check Dam
530	13° 47.27496' N	75° 18.41842' E	Check Dam
531	13° 46.38211' N	75° 20.20778' E	Check Dam
532	13° 45.26829' N	75° 22.89842' E	Check Dam