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

Shimoga Taluk, Shimoga District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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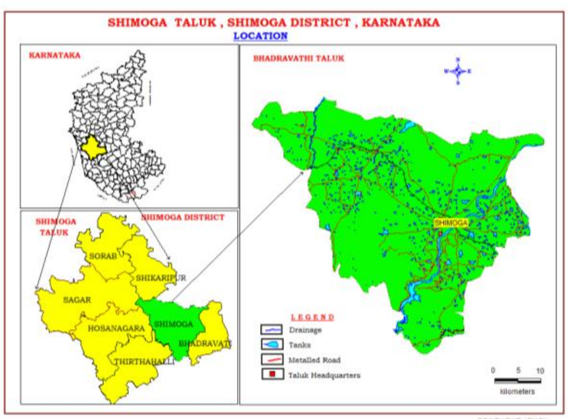
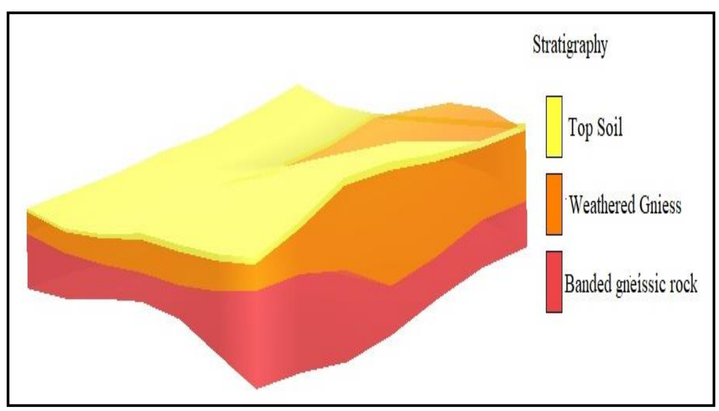
AQUIFER MAPS AND MANAGEMENT PLAN, SHIMOGA TALUK, SHIMOGA DISTRICT, KARNATAKA STATE

(AAP – 2022-2023)





By

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JUNE 2023

AQUIFER MAPS AND MANAGEMENT PLAN, SHIMOGA TALUK, SHIMOGA DISTRICT, KARNATAKA STATE

Contents

REPORT ON NAQUIM STUDIES IN SHIMOGA TALUK, SHIMOGA DISTRICT, KARNATAKA

1. INTRODUCTION:

Aquifer mapping is a multi-disciplinary scientific process where data related to the aquifer system and groundwater regime are integrated to characterize the quantity, quality and movement of groundwater in aquifers. The study area is in the middle of Karnataka state. A better understanding of the hydrogeological processes that control the distribution and availability of groundwater in the weathered and fracture zones of the aquifer system is imperative for sustainable resource management. The sustainable development and management of aquifer system involves development of strategies for balancing the water draft and water availability. Integrated studies on various aspects of the groundwater regime have been carried out to know the disposition and productivity of the aquifer systems.

The hydrogeological environment of the study area has been conceptualized from the study of historical data (available data) on the groundwater regime and from the available technical reports and publications. The data gaps could be identified from the analysis of historical data which facilitated generation of new data in gap areas. The hydrogeological, hydrological, geophysical, hydro chemical and meteorological data were analyzed for data gaps. Groundwater draft from the aquifer systems has been evaluated from well inventory data and integrated use of lithological and geophysical data used to refine the aquifer geometry of the area.

1.1 Objectives

Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. Thus, the main objective of aquifer mapping is to generate an aquifer map of the area in 1:50,000 scale so as to develop a management plan for aquifer sustainability.

1.2 Approach and Methodology

The major activities envisaged under aquifer mapping to achieve the objectives are data gap analysis, data generation, data integration, preparation of thematic maps and development of aquifer models. The data gap analysis primarily involves compilation, analysis and interpretation of the existing data on the groundwater regime. The data inadequacy or data gaps identified from this study forms the base for additional data generation. The existing data and the new data generated under aquifer mapping activities have been integrated and various thematic maps depicting hydrogeology, hydrology, geomorphology, water quality etc.

1.3 About the area and Administration

The study area is situated in middle of Karnataka state and is bounded on the north by Shikaripur taluk of Shimoga district, east by Bhadravathi taluk of Shimoga district, West by Hosanagara taluk of Shimoga district and in the south by Thirthahalli. The area lies between North latitudes 13^0 43' 32" and 14^0 08' 26" and East longitudes 75^0 15' 58" and 75^0 44' 14", covering an area of about 1124. sq.km. and the area is served by a good network of roads and rail connecting important adjoining places in Karnataka and other parts of the india. It is well connected by road to Bangaluru, Mangaore, etc. Shimoga is well connected by road to Bangalore and also other cities of Karnataka state. Shimoga taluk is one of seven taluks of Shimoga district. There are 214 villages and one town in Shimoga taluk.

As per the Census india 2011, Shimoga taluk has 117601 households, Population of 507324 of which 255262 are male and 252062 are females. The Population of children between age 0 to 6 is 52981 Which is 10.44% of the total Population. The sex ratio of Shimoga taluk is around 987 compared to 973 which is average of Karnataka state. The literacy rate of shimoga Taluk is 74.4% out of which 78% males are literate and 70.76% female are literate. The total area of shimoga is 1114 sq.km with Population density of 455 sq.km. Out of total Population, 36.4% of Population lives in urban area and 63.6% lives in Rural area. There are 18.15% Scheduled Caste and 4.14% is Scheduled Tribe. The administrative map of Shimoga taluk is given in **Fig.1.1**.

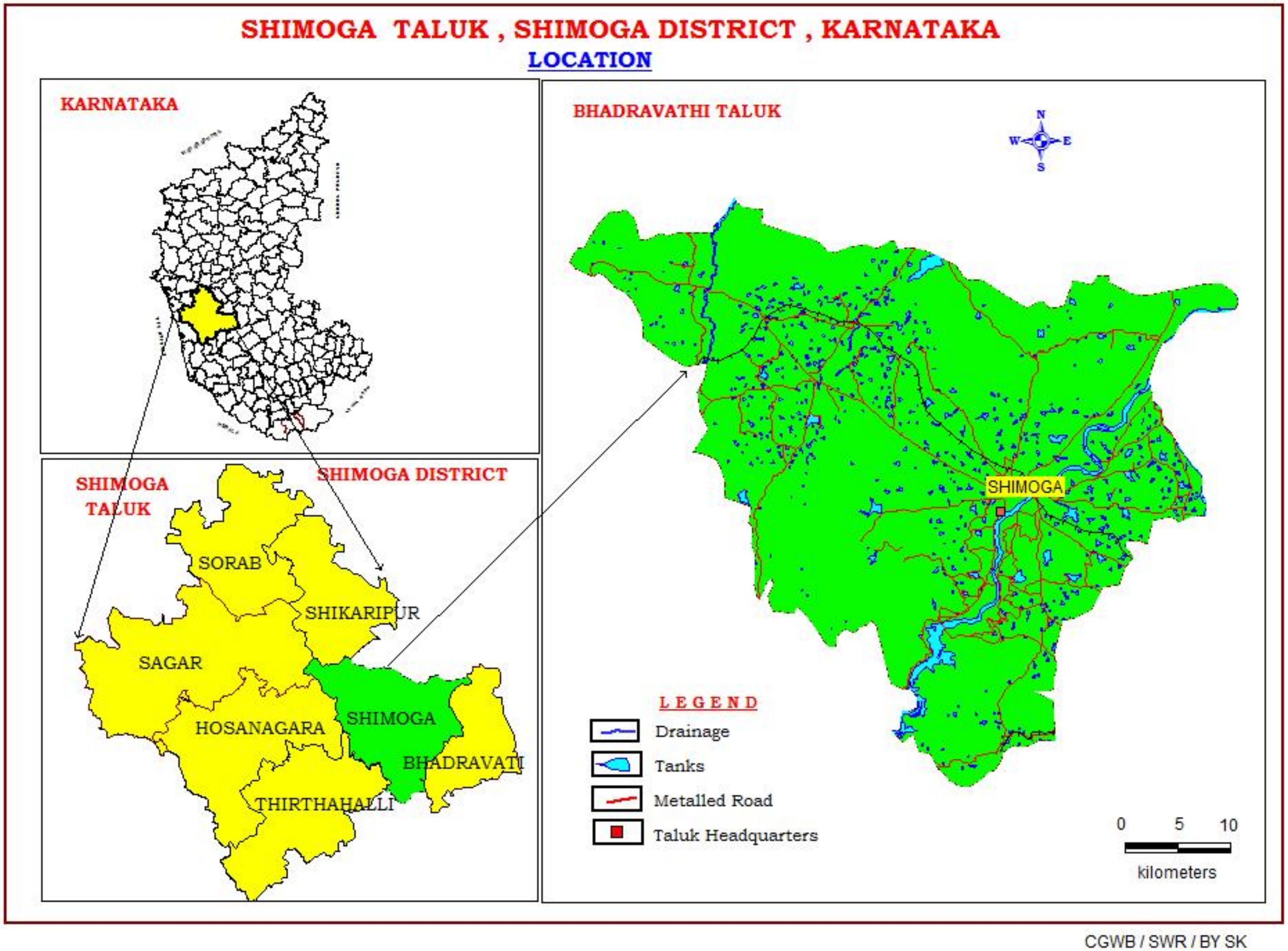


Fig.1.1: Administrative map of Shimoga Taluk

1.4 Data Availability

Existing data of CGWB on groundwater exploration, water level, water quality, geophysical logging and groundwater resource data have been collected and compiled. In addition to this, Borewell data, Water quality, Water level data and Groundwater exploration data have been collected from Ground Water Department, Shimoga, cropping pattern, Minor irrigation data and Soil data has been collected from Agricultural and Soil Conservation Department. Thematic layers such as geology, soils, land use/land cover, geomorphology, etc., from various State Government agencies were collected, compiled, and validated for the study.

1.5 Data Adequacy

In Shimoga taluk, there are 35 Exploratory wells and 2 number of tube wells were constructed during the ground water exploration by the CGWB. Water level monitoring data for 126 Observation wells and Water Quality monitoring data for 40 Observation wells is available. Land use, Cropping and irrigation data has been collected from Agriculture department. After plotting the available historical data on 1:50,000 scale, data gaps were identified and data generation process was taken up in those gap areas to complete the Aquifer map on the desired resolution of 1:50,000 scale.

1. 6 Data collection, generation and integration

The historical or available data on Geology, Geophysics, Hydrogeology and Hydrochemistry generated under various studies by the department (CGWB) such as Systematic Hydrogeologial studies, Reappraisal Hydrogeological studies, Groundwater Management studies, Exploratory drilling, Microlevel hydrogeological studies and special studies have been utilized for data gap analysis in conjunction with the data collected from various State and Central government departments. The thematic layers on drainage, geomorphology, land use and land cover were reproduced from the data obtained from concerned State departments. The existing data on various themes analyzed for finding the data gaps is given in **Table No 1.1.**

Table 1.1. Data gap analysis and data generation

#	Data Requirement	Data Availability with State	Data Availability with CGWB	Total	Additional data Generated
1	Ground water level data	5 DW	11DW	16 DW	17 DW 25 BW
2	Groundwater quality Data	5	11 DW	16 DW	60
3	Borehole Lithology Data			5 BW	22
4	Geophysical Data (VES+ TEM)			12 VES	
5	Pumping Test (EW/DW)			3	
6	Land use and Land Cover	Karnataka State Land Use Board & NRSC			
7	Drainage	Karnataka State Land Use Board			
8	Geology	Geological Survey of India			
9	Soil	National Bureau of Soil Survey (NBSS)			
10	Rainfall / Meteorological data	Indian Meteorological Department / Irrigation Design and Research Board (IDRB)			

1.7 Rainfall & Climate

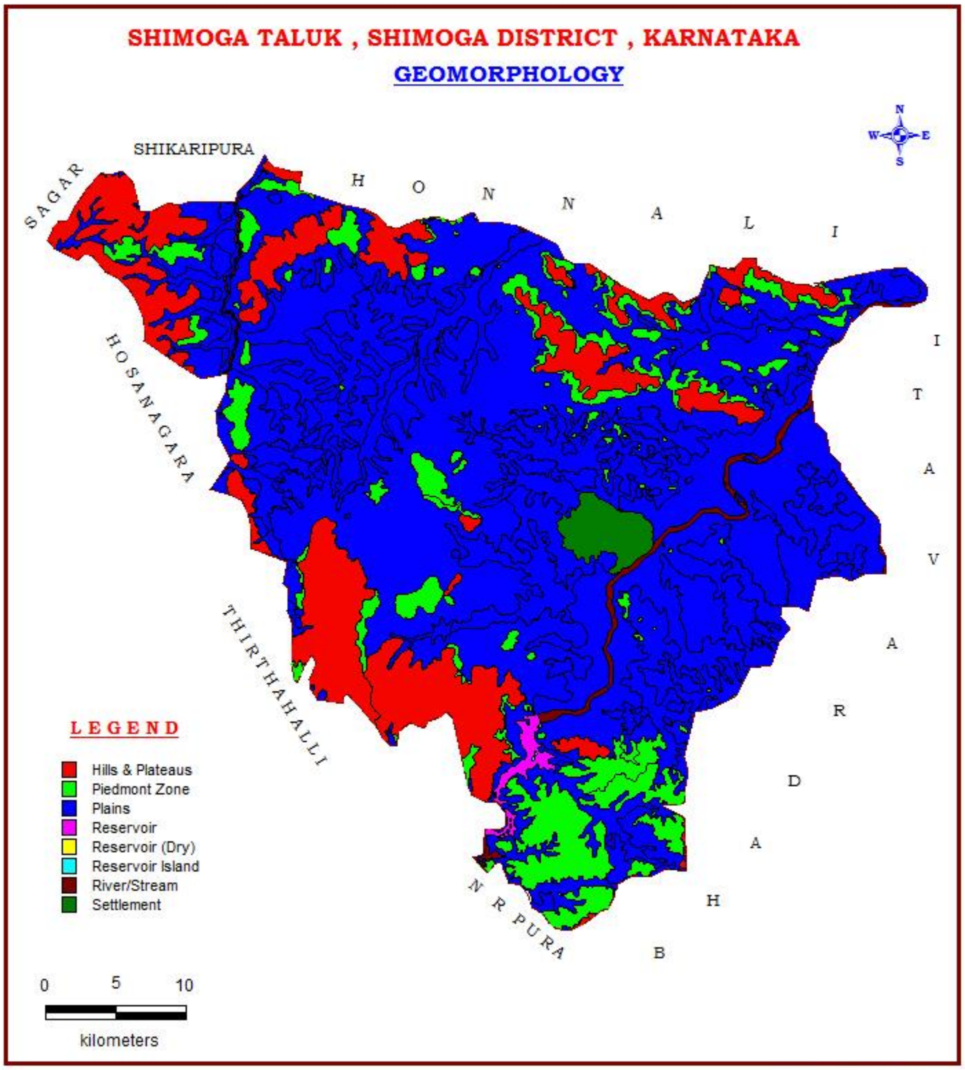
The area enjoys tropical climate throughout the year. Generally, the weather is hot and humid. The relative humidity ranges from 27 to 88%, the wind speed recorded between 4 and 7 Km/hrs. The evapotranspiration is normally high in ghat section as compared to plain in the east. Summer prevails between March to early June, the wet month start from early June to September, October and November months experience scanty rain by N-E monsoon. The winter commences in mid-November and ends in the middle of February. The annual rainfall of the taluk is 1068 mm.

1.8 Geomorphology and Soil types

The taluk forms part of Western Ghats, which can be demarcated in to two zones viz, the densely forested high hilly malnad in the west and sparsely forested table lands in the east.

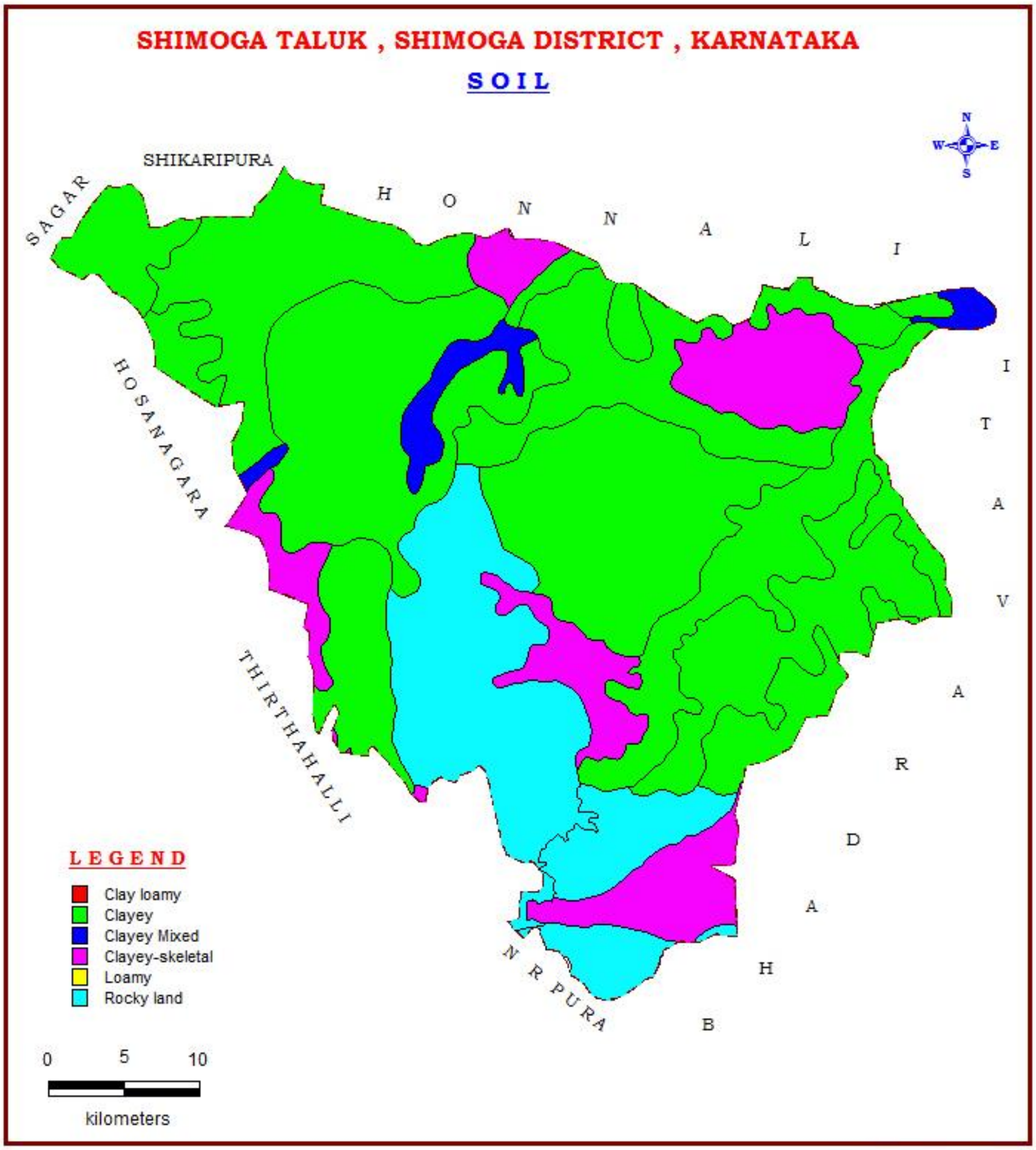
The taluk area mainly comprised of semi-malnad region having vast stretches of plain lands with low and rising hillocks with low vegetation. In the study area drain by two major rivers are, Tunga and Bhadra rivers are structurally controlled. The geomorphology map is given in **Fig. 1.2.**

The soils that occur in the study area is reddish to brownish Clayey loam to Lateritic. The Clayey soil cover major part of the taluk area. Thin strips of yellowish loam soil are seen along the banks of major rivers and nalla courses. In general, these soils are acidic in nature. The thickness varies from few centimeters to 3.50 m. The rate of water infiltration through the soil is recorded as 4.3 to 40.11 Cm/hr. The soil map of the Shimoga taluk is given in **Fig.1.3.**



CGWB / SWR / BY SK

Fig. 1.2. Geomorphology Map



CGWB / SWR / BY SK

Fig.1.3. Soil Map

1.9 Geology

The shimoga taluk is mainly comprised of Banded gneissic complex, Basalt and Schistose rocks, belonging to Archean to lower Proterozoic age. Numerous quartz and Pegmatite veins occur as intrusive in the older schistose rocks (Ambhibolite) and Granitic gneissic rocks. The Laterite occurs over Schists and Granitic-gneisses with an approximate thickness of few centimetres to 15 cm. The alluvium occurs along the river banks. The Geology map is given in **Fig.1.4.**

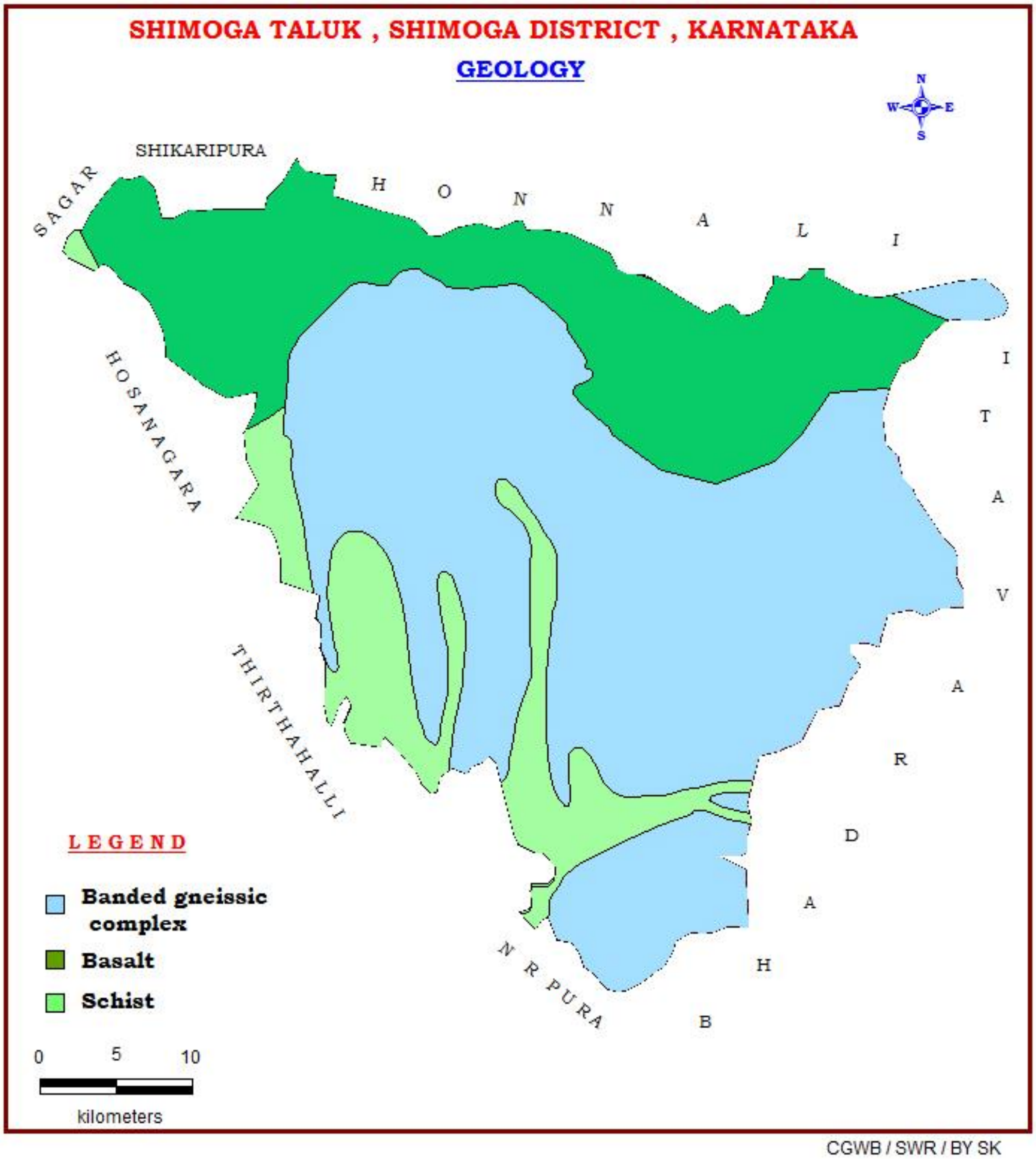


Fig.1.4. Geology Map

1.10 Drainage

The river Tunga is passing through the town shimoga, it originates from Western Ghats on a hill known as Varaha Parvata at a place called Gangamoola. From here, the river flows through Chickmagalur district and passes through Shimoga town. It is 147 km long and merges with the Bhadra River at Koodli, a small town near Shimoga city. The river is given the compound name Tungabhdra flows eastward and merges with the Krishna River.

The drainage pattern of the study area is mainly dendritic and the drainage density is moderate in the plain and it is dense in the hilly region. The drainage map is given in **Fig. 1.5.**

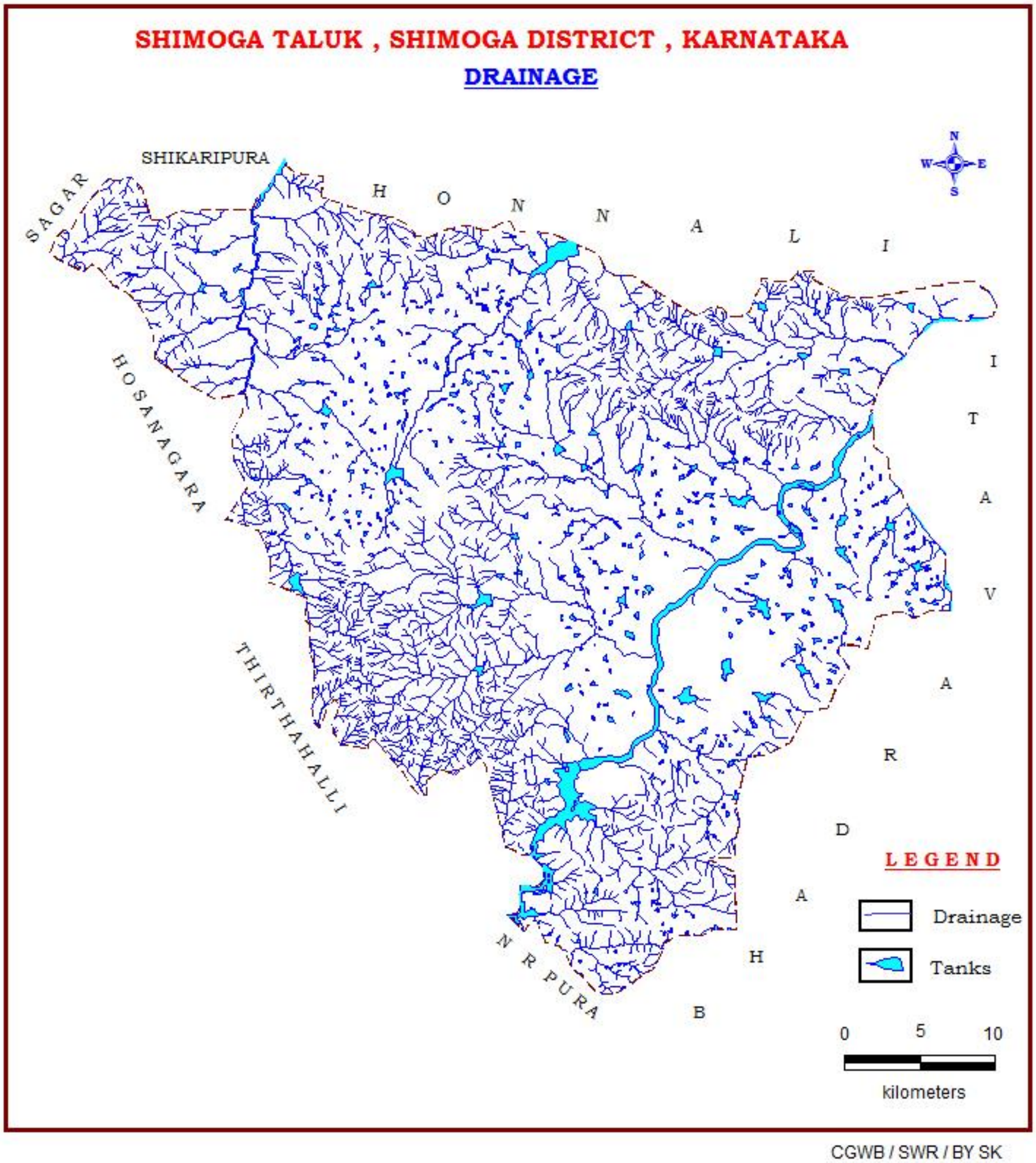


Fig.1.5. Drainage Map

2.0 The aquifer systems

The weathered zone and fracture system in crystalline rocks form the repositories of groundwater in the area. Groundwater exists under phreatic condition in shallow/ weathered zone and under semi confined conditions in fracture systems. The weathered zone and the zone of fractures are interconnected and groundwater draft from the fracture system impacts the groundwater levels in the weathered zone. Hence, the area is considered to have a SINGLE AQUIFER SYSTEM with two distinct horizons of different hydraulic properties such as;

1. Weathered zone with associated shallow fractures
2. Deeper Fracture zone

Weathered zone with associated shallow fractures

The shallow aquifers in the weathered zone form the phreatic aquifer system in the study area. Weathered Banded gneissic rocks and Basalt cover a major part of the area and the weathered thickness varies highly in these formations. The occurrence and movement of groundwater in the weathered zone is mainly influenced by the depth of weathering and topography and generally groundwater follows the topography. Groundwater abstraction structures in this zone include dug wells and shallow bore wells. The depth of dug wells ranges from 5 to 15 m bgl and that of bore well up to the depth of 60 m bgl. The water level ranges from 0 to 7 m bgl during the pre-monsoon period. During post monsoon period the water level ranges from 0 to 6 m bgl. The diameter of the dug well ranges from 1 to 5 m. The yield of dug wells ranges from 3 to 10 m^3/day and sustains 2 to 6 hours of pumping. In canal command area and in deep weathered zones dug wells yield high.

The yielding capacity of phreatic aquifers varies spatially and is related to the aquifer characteristics, rainfall received, surface water availability, and thickness of weathered residuum. The southern and North-western part of the area is having relatively high density of fractures/lineaments, moderate rainfall and surface water recharge to the aquifer systems.

Deeper Fracture zone

The Deeper Fracture zone is very potential as the area is tectonically disturbed and groundwater exists there under semi-confined conditions. Since the area experienced several episodes of tectonic deformations, a large number of interconnected fractures developed which offer very good conduits and storage space for groundwater. The Central Ground Water Board has drilled 5 numbers of exploratory wells in the study area, the depth of the bore wells ranges from 50 m to 200 mbgl. The depth to fracture zones ranges from 40m to 120 m bgl and the discharge ranges from 0.5 to 10 lps. However, most of the potential fracture zones occur within the depth of 120 mbgl. Bore wells located along the lineaments are yielding high compared to the wells located away from the lineaments.

2.1 Thickness of weathered zone

From the exploratory drilling data two aquifer zones were identified viz; the weathered zone (aquifer Zone- 1) and the fracture zone below it. Weathered zone includes the weathered formation and the shallow fractures and its thickness varies in the range of 5-40 m. The weathered thickness in the area vary highly as observed from exploratory drillings and the data have been used to elucidate the lateral and vertical changes in weathered zone. The information from 5 bore wells have been analyzed for understanding the spatial variations in the thickness of weathered zone and the contour map depicting the same is given in **Fig.2.1**. The weathering thickness is relatively shallow in the Southern and Northern part of the area. Similarly, among the geological formations the weathering thickness is shallow in gneisses. Deepest zones of weathering are observed in the North western part of the area. The 3d view and cross sections depicting the spatial variations in the thickness of weathered zone is shown in F**ig 2.1 a & b.**

2.2 Water levels

Measurements of water levels in wells provide the most fundamental indicator of the status of groundwater resource and are critical to meaningful evaluation of the quantity of ground water and its interaction with surface water. It fosters a more comprehensive and systematic approach to the long-term collection of these essential data. Water levels were monitored four times (May, August, November and January) during the field season from 12 existing dug wells (CGWB) and 15 newly established dug wells (Key-wells) for monitoring purpose The water level data given in **Table 2.2.1** shows minimum water levels during the months of August and November and deepest water levels during May. November water level is considered as post-monsoon and that in May is taken as pre-monsoon for detailed analysis.

The water levels in the weathered zone were analyzed for pre and post monsoon water levels and depth to water level maps were prepared (**Fig. 2.2.1 and 2.2.2**). The pre monsoon water level map shows deep water levels in the range of 5 to 7 m in the Central and Northern parts of the area where weathered zone and shallow fractures form the phreatic aquifers. In a major part of the area the water level is less than 5m. The water level fluctuation varies from 0.5 to 2.m. the fluctuation map is given in **Fig.2.2.3**.

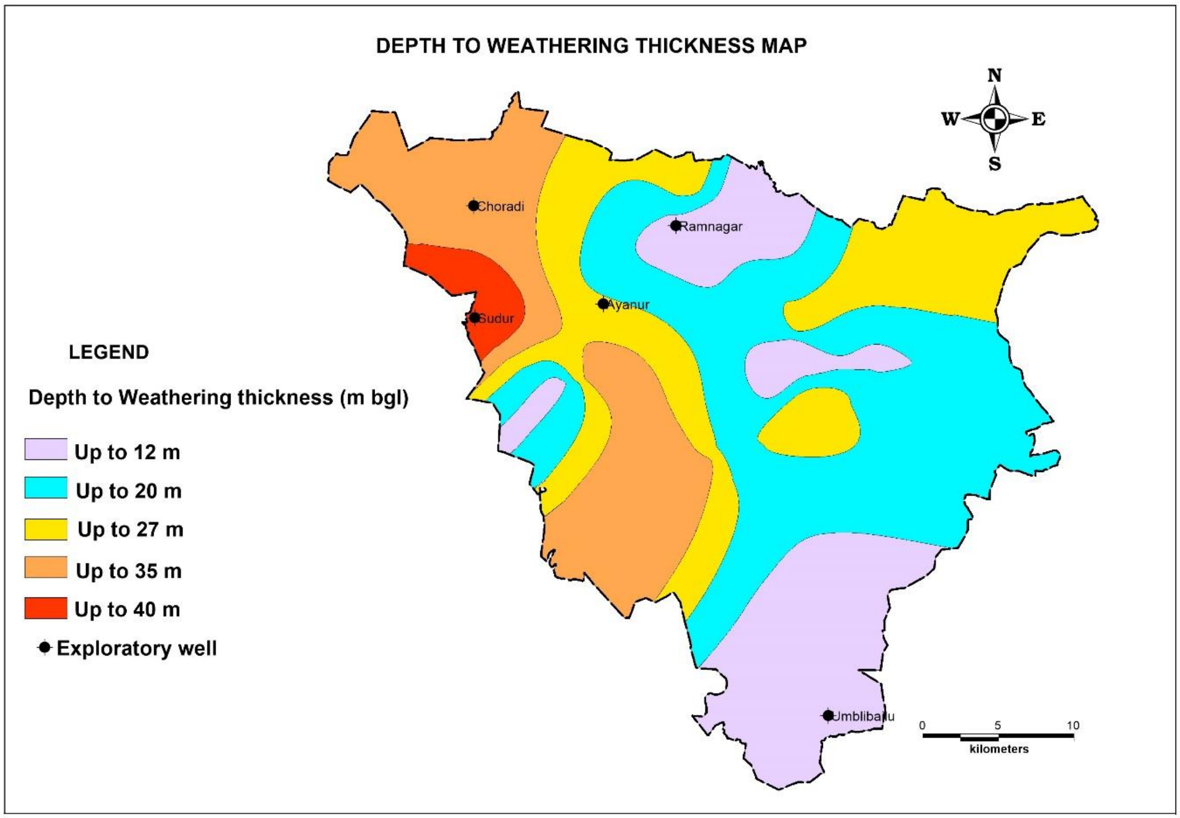


Fig.2.1 Depth to Weathering thickness map

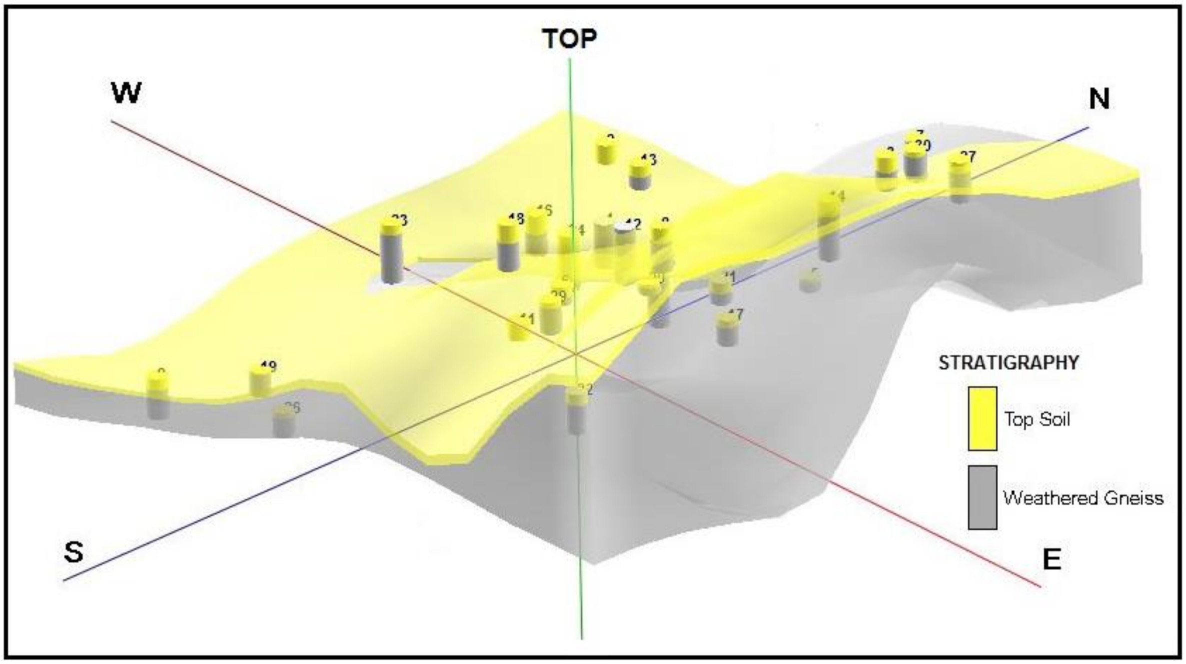


Fig.2.1 a 3D view of the weathered zone

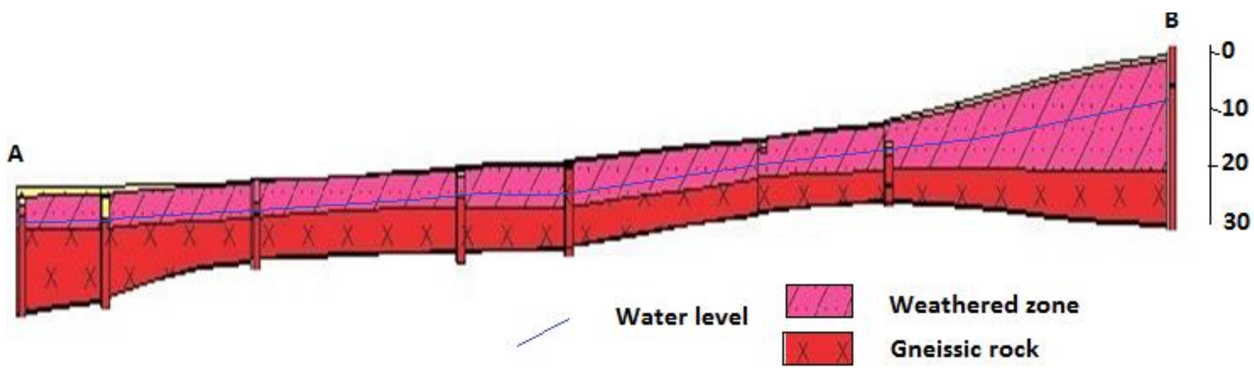


Fig.2.1 b Cross-section of Shimoga Taluk

Table: 2.2.1. Depth to Water level data of Shimoga Taluk:2022

#	Location	Longitude	Latitude	Premon.W.L(m bgl)	Postmon.W.L mbgl	WL_Fluct
1	Ayanur	75.55083	14.00000	0.87	0.65	0.22
2	Gajanur	75.55000	13.85000	0.65	0.55	0.10
3	Jaddihalli	75.05083	14.50750	6.03	4.23	1.80
4	Nidigi	75.61667	13.88333	1.28	1.1	0.18
5	Pillangere	75.63417	13.95833	0.38	0.22	0.16
6	Purale	75.63333	13.91667	1.42	1.15	0.27
7	Shimoga	75.60000	13.83333	1.87	1.3	0.57
8	Shimoga	75.58389	13.92778	5.44	4.1	1.34
9	Sugur	75.65111	14.00833	0.70	0.6	0.10
10	Tevarachatnahalli	75.61667	13.95000	1.21	0.99	0.22
11	Umblibailu	75.56750	13.76667	1.12	0.8	0.32
12	Ambalagere	75.58773	13.99058	2.30	1.5	0.80
13	Kommanalu	75.59720	14.02858	4.67	3.65	1.02
14	Beernakera	75.57529	14.03917	7.02	5.6	1.42
15	Kunchana Halli	75.54814	14.05904	1.30	0.86	0.44
16	Mallapura	75.50476	14.09601	4.43	3.5	0.93
17	Rama Nagara	75.45849	14.04581	1.20	0.9	0.30
18	Harna Halli	75.45849	14.04581	1.27	1.15	0.12
19	Kusmi	75.39843	14.05283	1.62	0.84	0.78
20	Anupinakatte	75.53224	13.92436	6.80	5.1	1.70
21	Govindapura	75.51934	13.91443	2.70	2	0.70
22	Bilguni	75.40358	13.97056	3.45	2.9	0.55
23	Sirigere	75.42157	13.96157	5.00	4.5	0.50
24	Ko-Halli	75.43626	14.00197	1.40	1.1	0.30
25	Kote Ganguru	75.52558	13.97415	6.00	4	2.00
26	Purle	75.60762	13.93237	2.09	1.5	0.59
27	Pillangiri	75.64339	13.95327	1.10	0.98	0.12
28	B.Beerna Halli	75.67455	13.95476	2.30	2	0.30

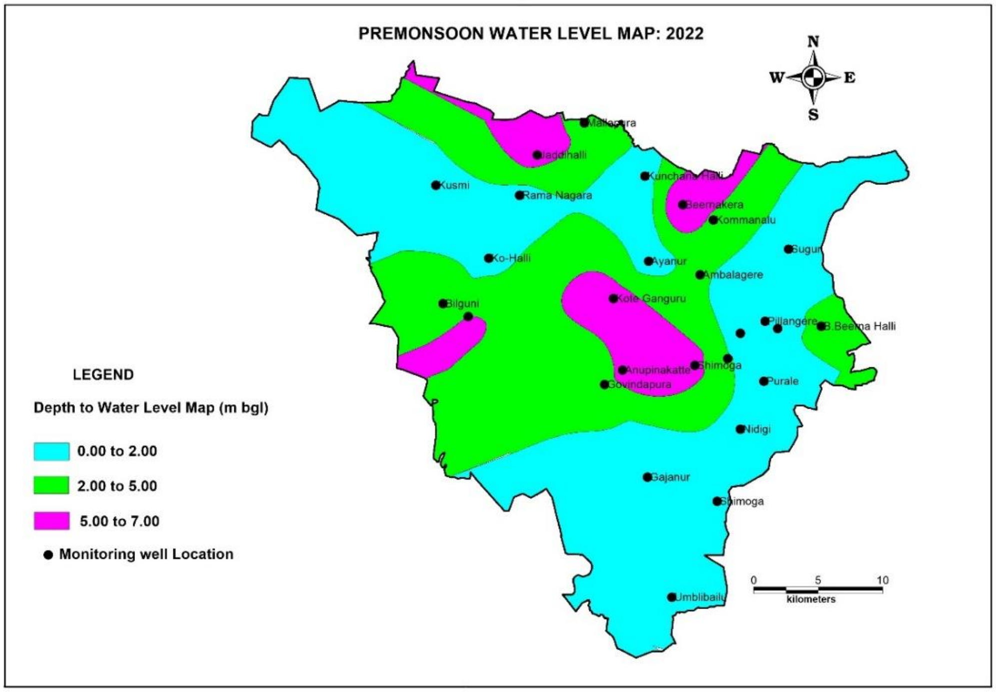


Fig.2.2.1 Premonsoon Water Level Map

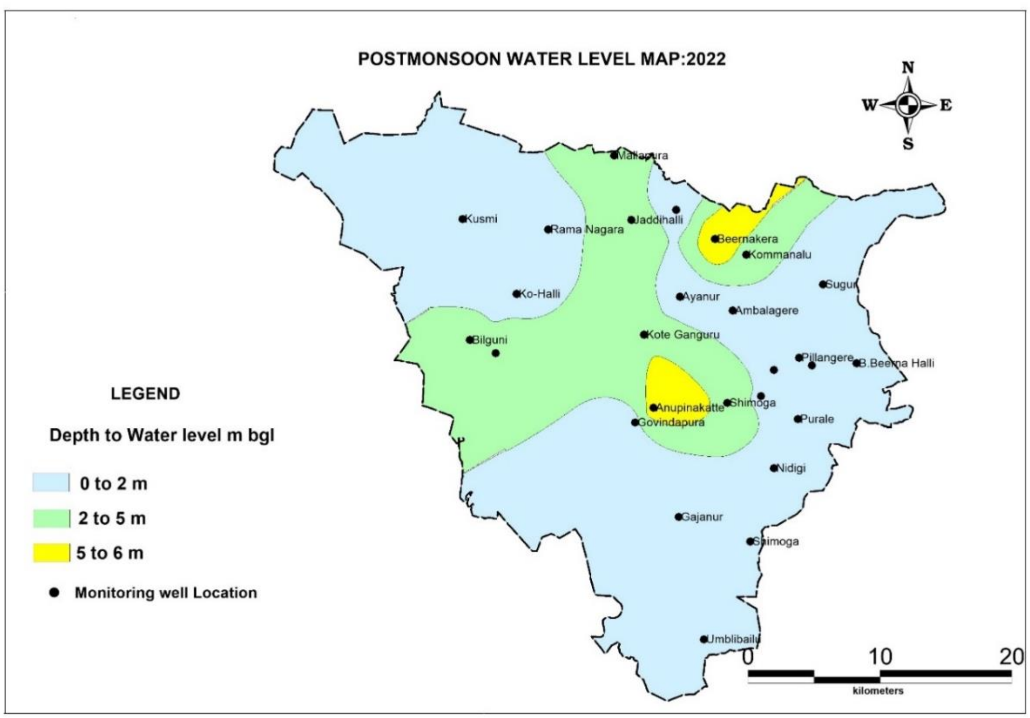


Fig.2.2.2 Postmonsoon Water Level Map

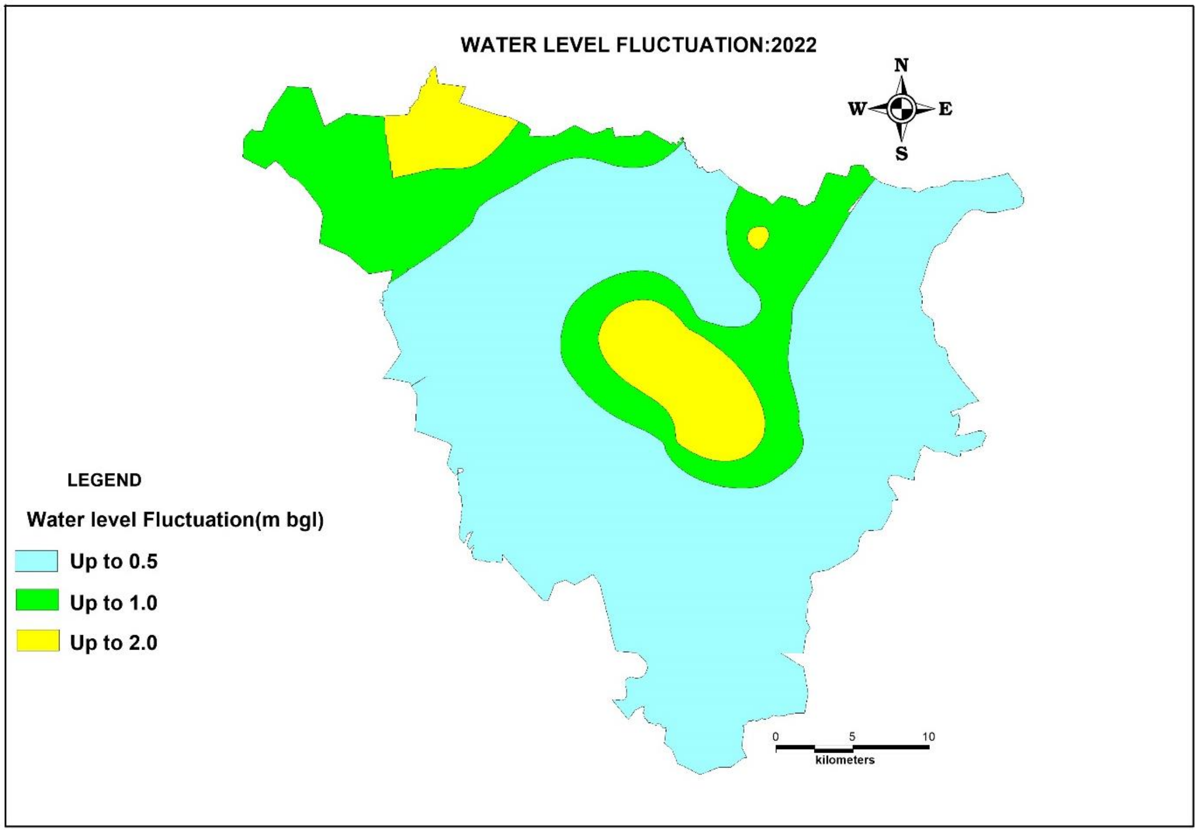


Fig.2.2.3 Water Level Fluctuation Map

2.3 Water level trend

The water level data available for a long term help us in the protection, management, and sustainable development of the aquifer system and make the best possible decisions. More than 50% of the regular monitoring wells of CGWB (NHS) are established within last 5 years and because of that water level data for longer period could be analyzed from 11 NHS only and the analysis result is given in **2.3.1**

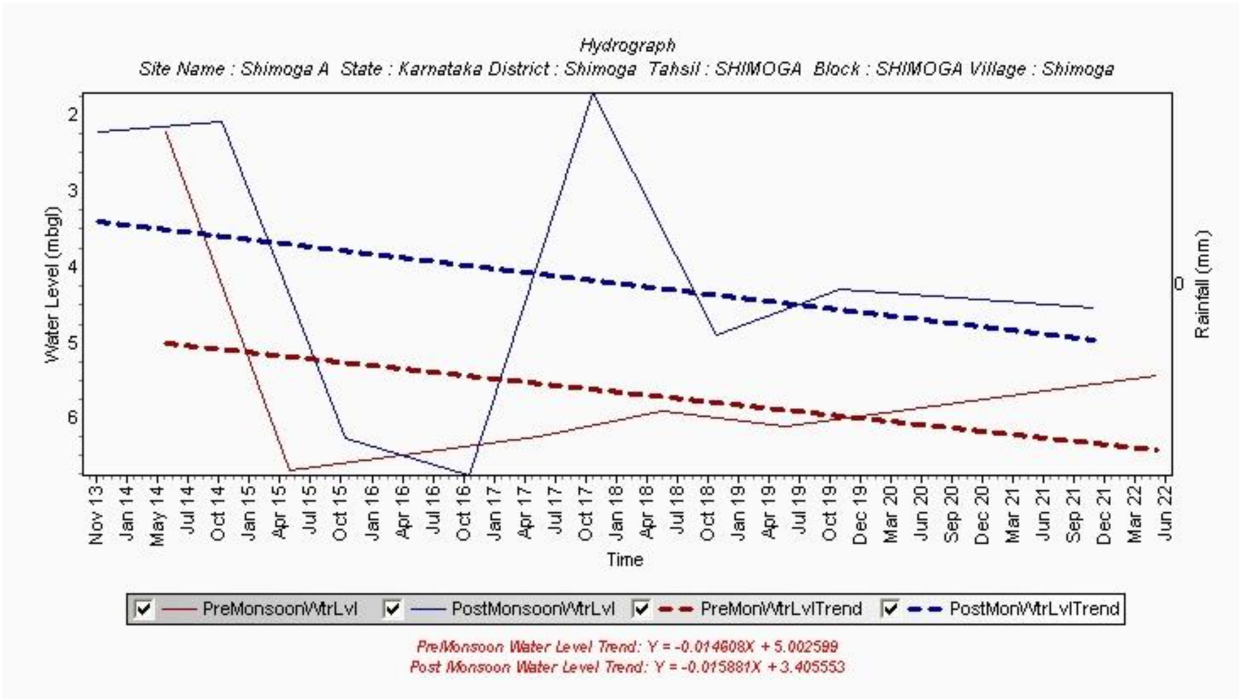


Fig.2.3.1. a. long term water level trend of Shimoga

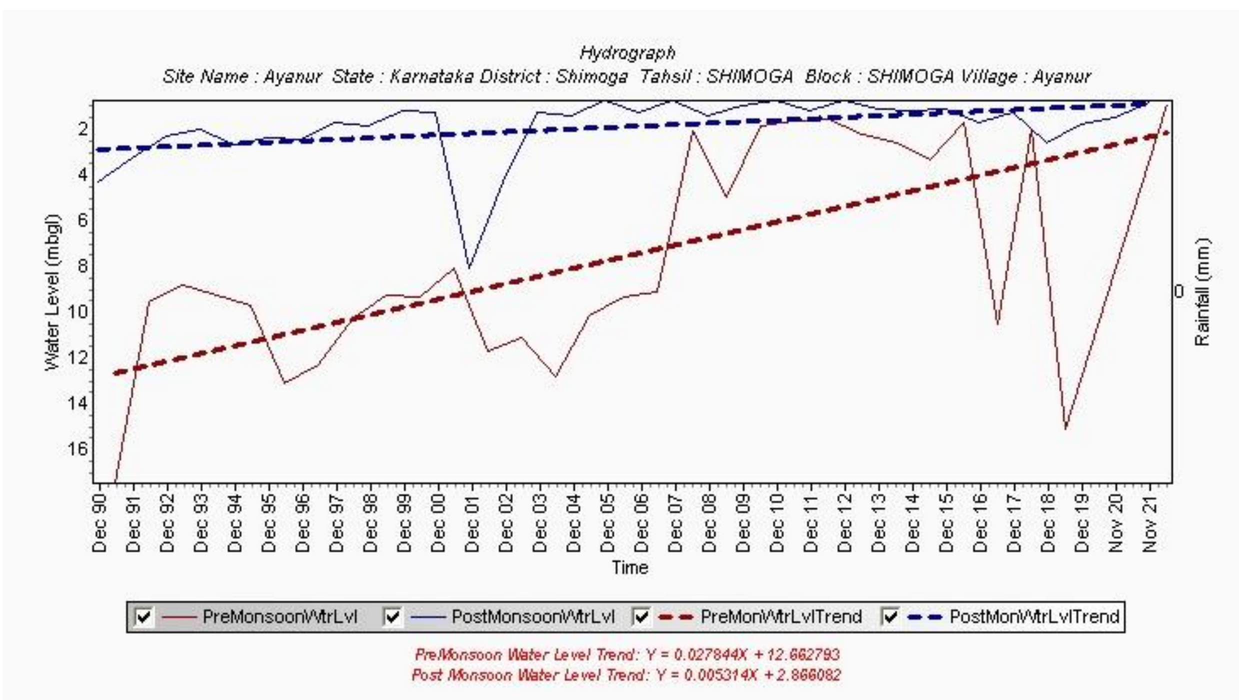


Fig.2.3.1. b. long term water level trend of Ayanur

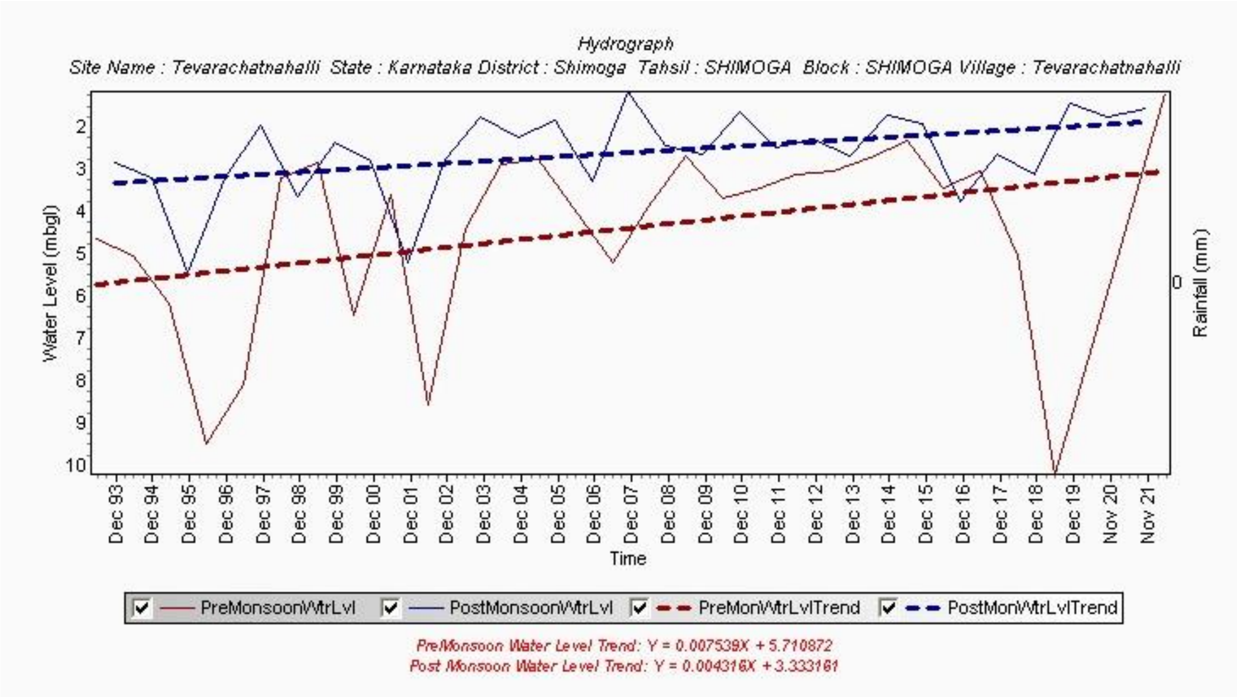


Fig.2.3.1. c. long term water level trend of Devarachatanahalli

2.4 Quality of water in the weathered zone

The existing water quality data from the dug wells have been analyzed for extracting information on regional distribution of water quality and their suitability for various uses. In a groundwater flow regime water chemistry constantly undergoes modification due to various processes such as dissolution of minerals, precipitation of dissolved ions under unstable conditions, cation exchange etc. The hydrochemical evolution along the flow paths are significantly altered under anthropogenic interferences and consequent pollution of aquifer systems (Drever, 1982; Langmuir, 1997;Abu-Jabeer, 2001;Singh et al, 2007). The effects of pollution in the flow system can easily be identified from a comparison of dissolved ions and ion ratio studies in simple terms (Hem, 1985).

The groundwater quality in the area is generally good for all purposes except for certain locations where slight increasing of fluoride and salinity are observed. High salinity is noticed in central and Northern part of the study. The EC value ranges from 350 to 900 and the other chemical elements are within the permissible limits. The chemical elements are plotted in Hill Piper diagram and the same is given in **Fig.2.4.1.**

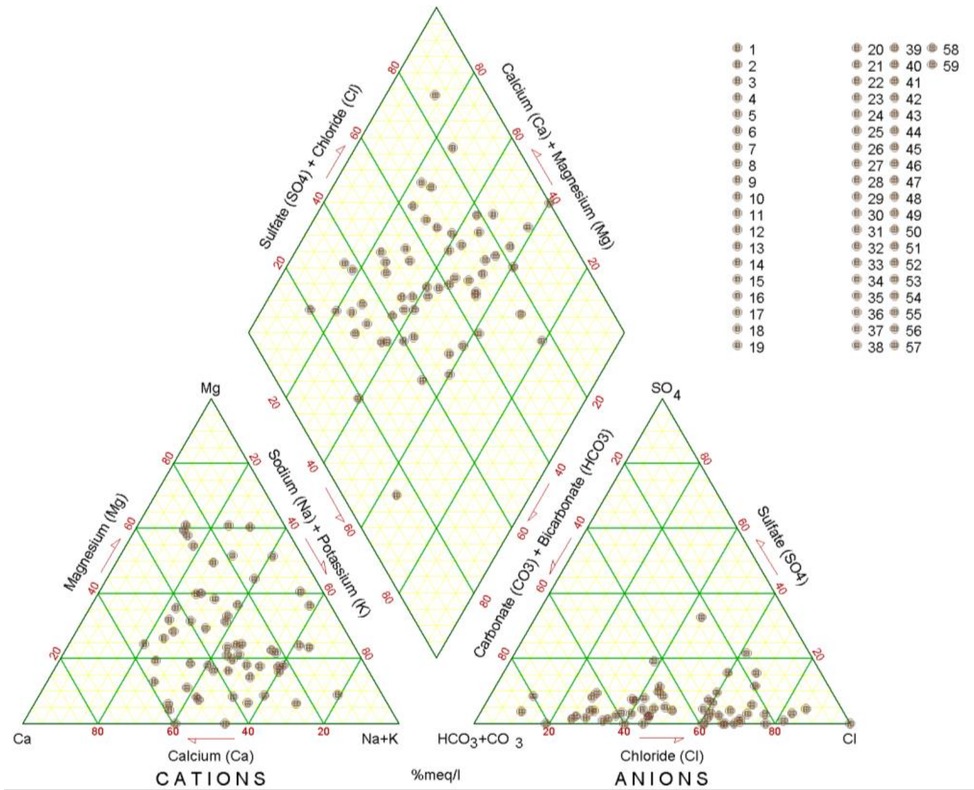


Fig.2.4.1 Hill Piper diagram of Aquifer-I

2.5 Groundwater potential of weathered zone

Based on the weathered thickness, aquifer geometry, water levels, groundwater yield and hydraulic properties the groundwater potential map of the phreatic aquifer system is prepared (**Fig.2.5**). The central part of the study area is having relatively high groundwater potential with yield of wells ranging up to 10 cum/hr. and sustains 2 to 4 hours of pumping.

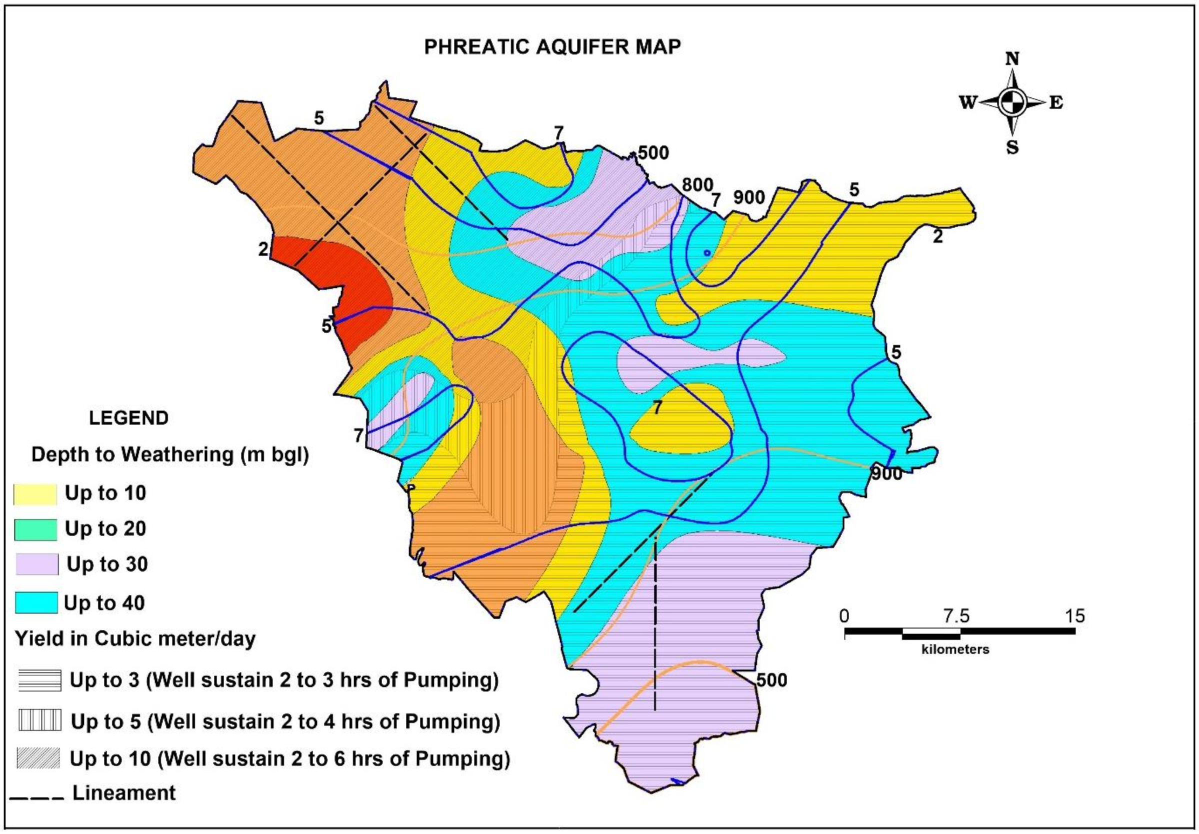


Fig.2.5: Ground water Potential Map (Phreatic Aquifer)

2.5.1 Fracture Aquifer Geometry

The information on weathered thickness and fracture zones from 5 exploratory wells have been used for the preparation of panel diagrams (**Fig.2.5.1** and **2.5.2**). It shows relatively deep weathering in the North-western part of the area. The hard rock below the weathered zone consists of massive formation with fracture zones at varying depths. The fracture zones are encountered in the depth range of 40-120 m in the exploratory wells representing different rock formations with significant changes in yield and aquifer characteristics. They are confined to Semi-confined in nature with a high frequency of occurrence of potential fractures within 120 m depth. Deep fractures are also encountered in the area such as the one encountered.It is a general practice in the area to go for deep drilling even after encountering a potential zone with the expectation of augmented yield or for long survival of wells. This may not give expected results as the study of exploration data reveals. However, the surface manifestations of fractures in the area are best indicators of deep fractures and proper scientific investigations a prior necessity for deep well drilling. Thus, fracture pattern analysis in conjunction with the exploration data has given meaningful information on the fracture aquifer systems in the area.

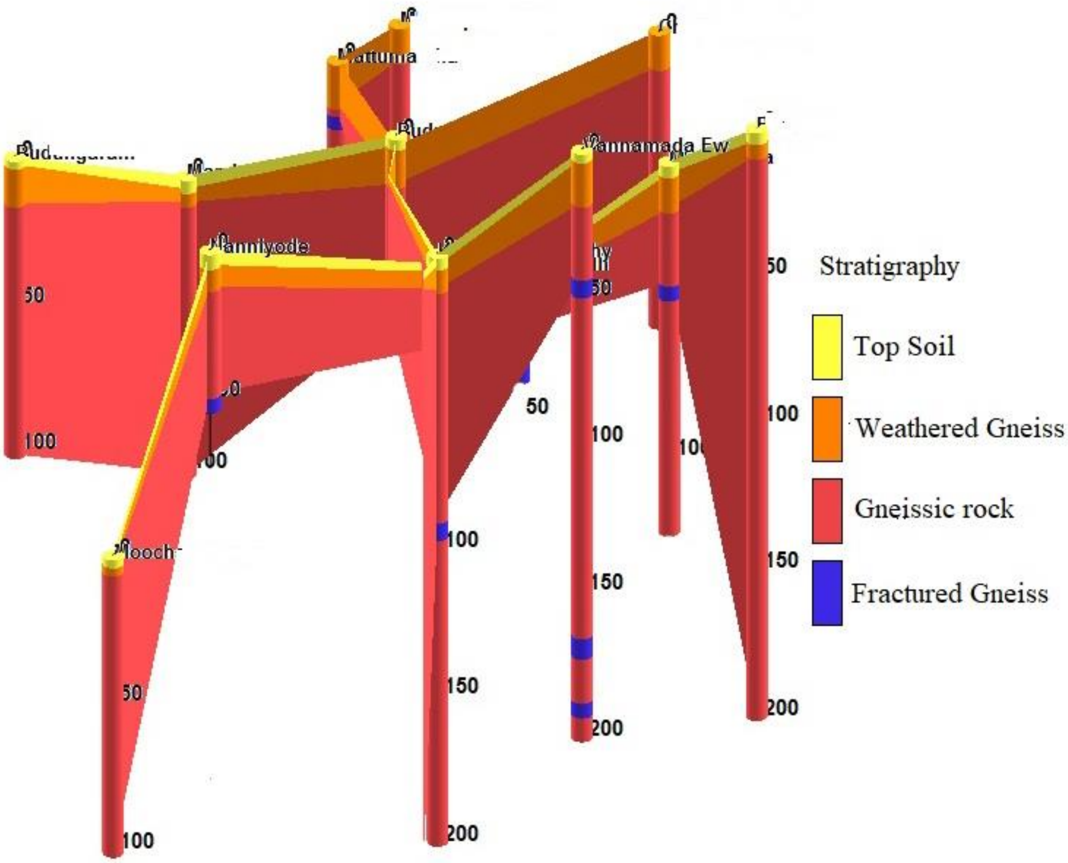


Fig 2.5.1: Panel diagram displaying lateral and vertical variations in weathered thickness and depth of occurrence of fractures

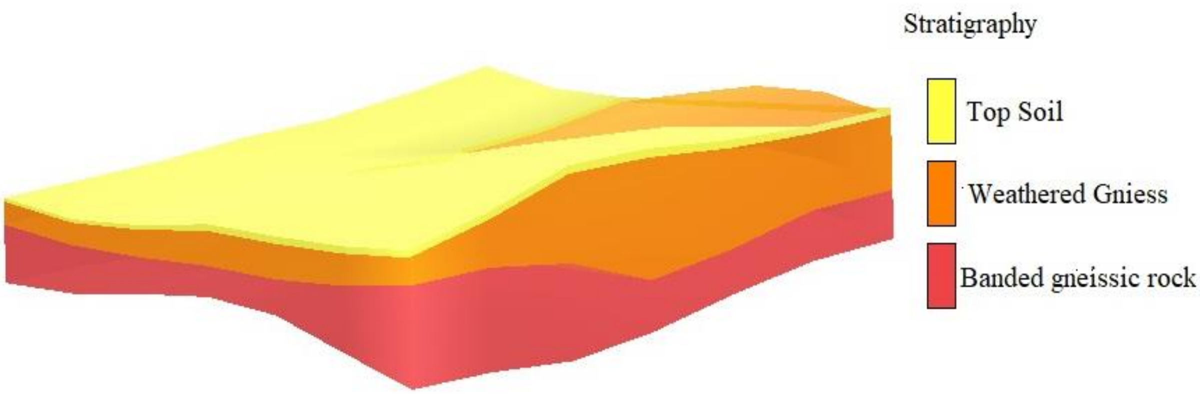


Fig 2.5.2: 3D model shows the contact of Top soil, Weathered zone and Massive rock

2.6. Geophysical Investigations

The interpreted results of the VES indicated that the first layer resistivity varies in the range of 12-800 ohm.m which represents the soil. The thickness of this formation is varying in the range of 0.6-3.5 m. In this range the lower order of resistivities (<55 ohm.m) indicate clayey nature of soil whereas higher order of resistivity indicate red soils.

The second layer resistivity was varying in the range of 12-900 ohm.m with thickness in the range of 2.5-33 m. In this resistivity range the formation with resisitivity up to 160 ohm.m was considered as weathered in nature and was recorded at 30 no. of VES. The resistivity of the second layer at these 30 VES was varying in the range of 12-160 ohm.m with thickness in the range of 3-11m except at one VES where it was 33m. At the remaining 12 no. of VES the resistivity of the second layer is varying in the range of 200-900 ohm.m which is hard formation. The thickness of this formation is varying in the range of 3-18 m.

The third layer resistivity was varying in the range of 35-1300 ohm.m. At about 13 VES the third layer was recorded as massive formation. At about 2 VES the third layer resistivity was varying around 1200 ohm.m and 750 ohm.m respectively which is extending in nature. At the remaining 27 VES the third layer resistivity was varying in the range of 35-1300 ohm.m with thickness in the range of 4-63 m. At 2 VES the third layer resistivity was varying around 35 ohm.m and 45 ohm.m respectively which is weathered in nature.At the remaining 25 VES the resistivity was varying in the range of 100-1300 ohm.m which was considered as hard formation with fractures at some of the sites.

The interpreted results have given rise to fourth layer at about 25 VES only. Of this 25 VES at about 19 VES the fourth layer was recorded as massive formation. At the remaining 6 VES the fourth layer resistivity was varying in the range of 300-2500 ohm.m which is expected to be hard formation with fractures at some of the VES. At about 3, VES this layer was extending with depth with resistivity around 1500-2500 ohm.m. At the remaining 3 VES this layer resistivity was varying in the range of 300-450 ohm.m with thickness in the range of 54-70 m.

In the study area there were 12 number of resistivity survey was carried out and the data is being incorporated in the report

2.7. Groundwater and its relation to Geological Structures

Geological structures like fractures, lineaments, faults, joints, intrusive rocks etc influence the occurrence and movement of groundwater. Such information extracted from field investigations as well as from the study of topo-sheets and imagery were utilized to identify potential lineaments and fractures in the area. The lineaments identified in the basin trend various directions such as N-S, NNE-SSW, ENE-WSW, E-W, ESE-WNW, and NW-SE. The prominent lineaments in the area mainly trend in NW-SE, NE-SW and E-W direction and is shown as a rose diagram (**Fig.2.7.1**) Intersection of lineaments are also observed in many places of the study area. The intrusive rocks and pegmatite veins in the area mainly trend in the NE-SW or NNW-SSE direction.

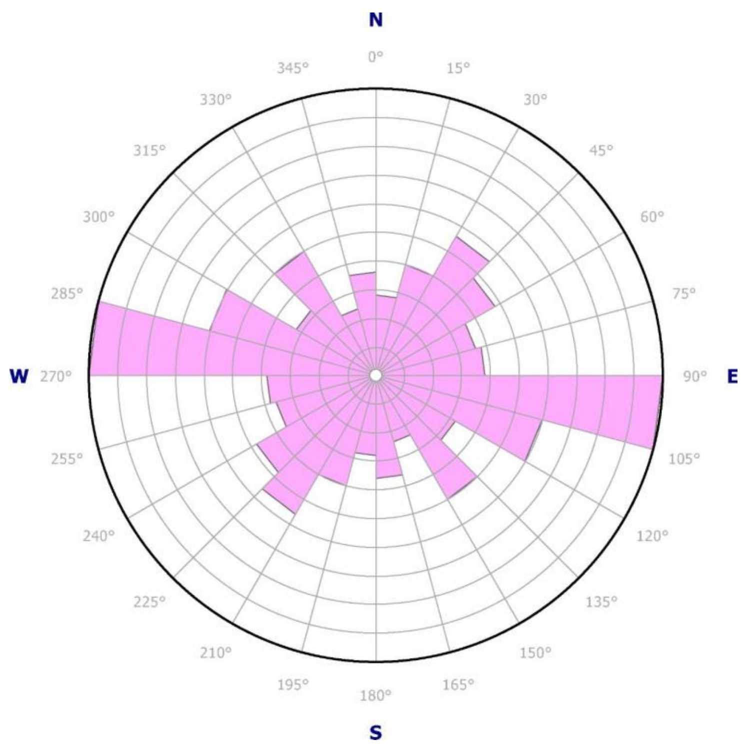


Fig.2.7.1 Rose diagram of the study area

2.8.1. Groundwater potential of fracture aquifer system

The yield from bore wells varies highly in the area irrespective of the geological formations. Within the same geological formation, the spatial variations in yield are very common and it does not show any relation with the spatial variations in weathered thickness. The fracture systems have major influence on the yield. The ground water potential map is given in **Fig.2.8.1.**

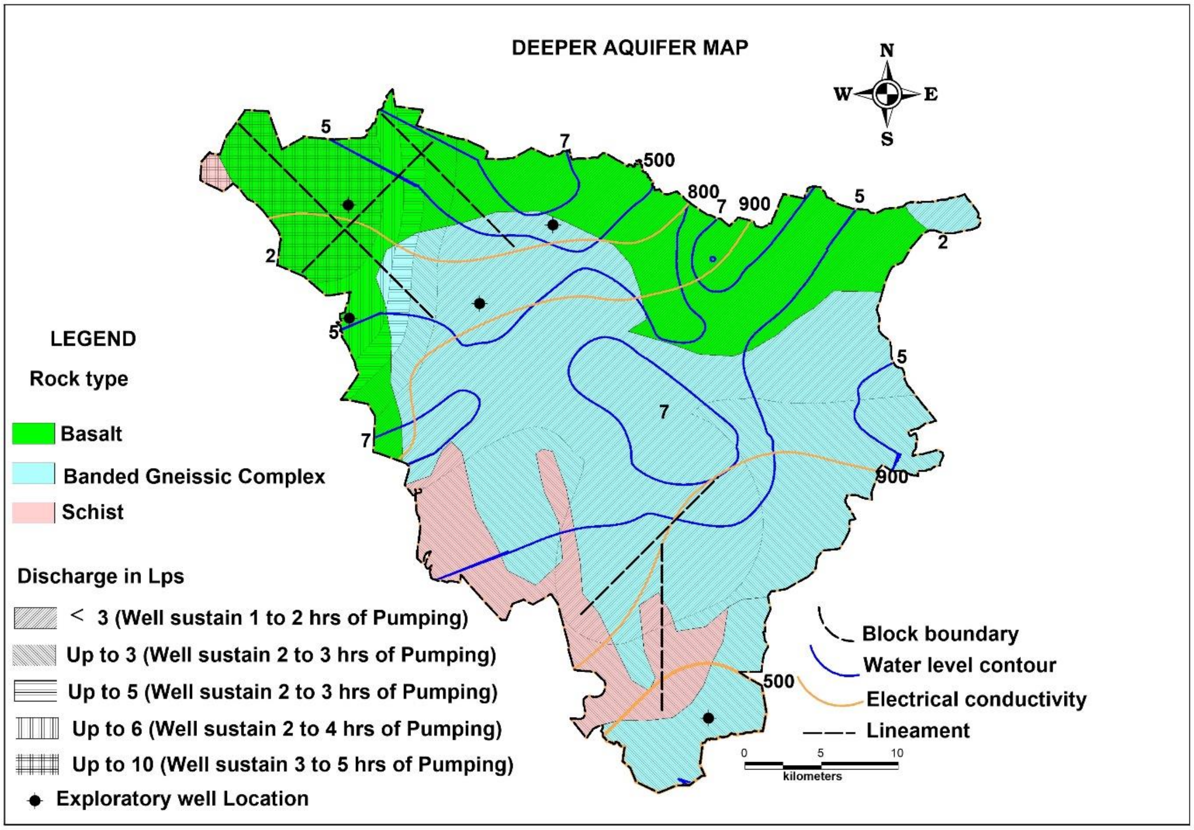


Fig.2.8.1. Ground water Potential map of Deeper Aquifer.

2.8.2. Water quality in fracture aquifer system

Water samples from 30 samples wells were analyzed for EC, pH, major ions and fluoride and the datas are plotted in Hill-Piper diagram and it's given in **Fig.2.8.2.1** The water quality data shows most of the chemical elements are fall within the permissible limit but some places of the study area slightly increase of fluoride up to 0.9 mg/L.

Plotting of the percentage of epm values of major cations and anions in Hill-Piper diagram falls mostly in the calcium-magnesium- bicarbonate field. A comparison of phreatic aquifer characterized by high alkalinity, and no dominant cation-anion type water with fracture aquifer system characterized by low alkalinity, and calcium-magnesium-bicarbonate type water indicates that the water chemistry of fracture aquifer is evolved mainly from the movement of water through the fracture system and associated rock matrix than the vertical leakage from the top phreatic aquifer.

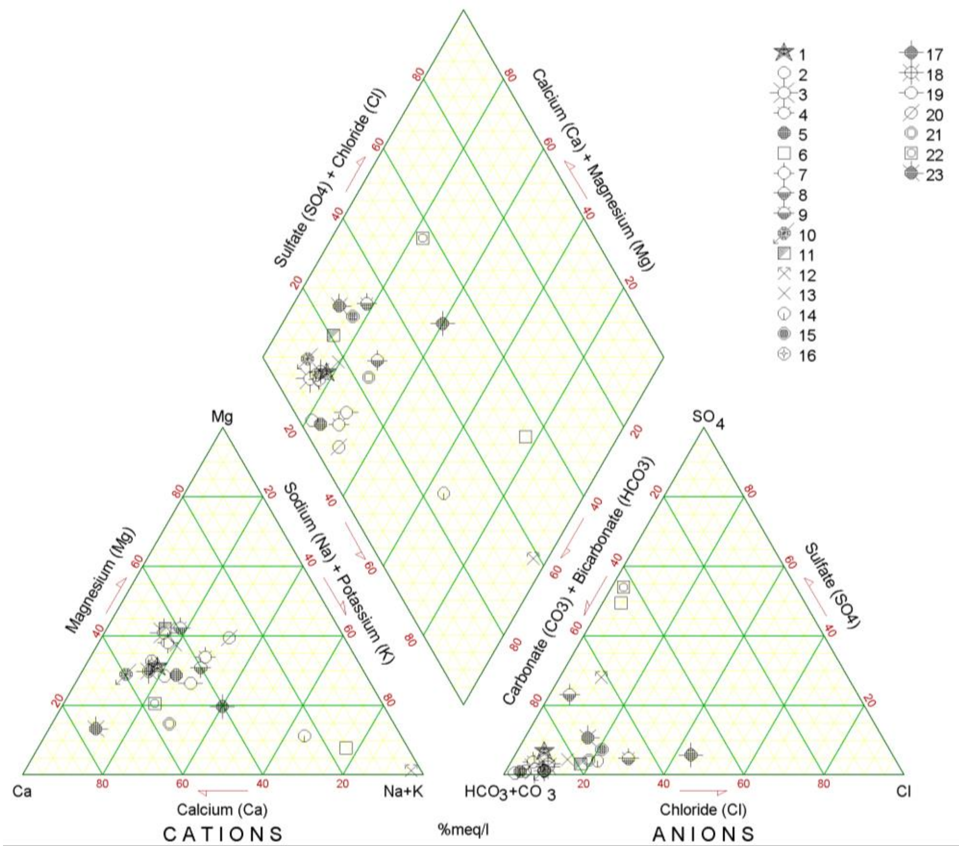


Fig.2.8.2.1 Hill-Piper diagram of Deeper Aquifer

3.0 GROUNDWATER RESOURCES:

3.1 Dynamic groundwater Resources:

Phreatic aquifers are major sources for irrigation and drinking water in the area. Groundwater draft for irrigated agriculture in the area has been high and depletion in the resource is observed over the years. Any decision about future utilizations depends on having a clear understanding of the status of the resource, the amount that has already been extracted, the amount remaining, and the impact of further depletion. The dynamic groundwater resources in the area are estimated based on the methodology proposed by Groundwater Estimation Committee (GEC 1997 methodology).

In this study the area under command and non-command could not be separated mainly due to non-availability of data pertaining to canal command areas of the State. Further, the irrigation projects of Karnataka are mostly planned for irrigating paddy along the topographic lows and as such the irrigation canals are all centre controlled. Hence in each unit there are large areas along the upstream side of the canal, which do not get benefits of surface water irrigation. Due to the highly undulating topography of the mid land area where most of the canals exist, it is quite difficult to accurately demarcate the areas under command and non-command. In view of the factors mentioned above, the computations have been made by taking all assessment units as non-canal command area. The recharge from canal segments and return seepage from irrigation due to surface water in the command area have, however, been incorporated into the computations.

The block wise groundwater resources in the area are estimated as per ground water estimation methodology 1997. The stages of ground water development is 42.88 % and is categorised as Safe. Most of the rural water supply schemes use ground water as the source, whereas the urban schemes depend on Surface water or both, rest of the population is depending on ground water. The block wise ground water resources estimated in 2022 and is given in **Table 3.1**.

Table 3.1. Stage of Ground Water development

Taluk	Net Annual GW Availability(Ham)	Existing Gross GW draft for Irrigation(Ham)	Existing Gross GW draft for Domestic & Industrial (Ham)	Existing Gross GW draft for all uses(Ham)	Allocation for Domestic & Industrial use for next 25 year(Ham)	Net GW availability for future irrigation & development(Ham)	Stages of GW development(%)	Category
Shimoga	17790	2877	332	3209	556	14357	18	SAFE

4.0 AQUIFER MANAGEMENT PLAN

The households in the study area have own drinking water wells, both dug and bore wells. The dependence on bore wells has gained momentum during the last few decades and they are mainly been used for irrigation. As the area receives sufficient rainfall and well drained by the tributaries of Tunga and Bhadra rivers there is sufficient scope for aquifer management through effective utilization of both rainwater and surface water. The stage of groundwater development in the area is only 18% and categorized as safe which points to the need for optimal utilization of the available resources and augmentation of groundwater resources through appropriate artificial recharge methods.

Since the taluk is comes under Safe Category, further ground water development is possible. 300 number of dug wells and 150 number of bore wells can be constructed adjacent to the lineament and fracture plane and it can be irrigated about 975 Ha of area. The proposed bore well and dug well locations are given in **Fig.4.1.**

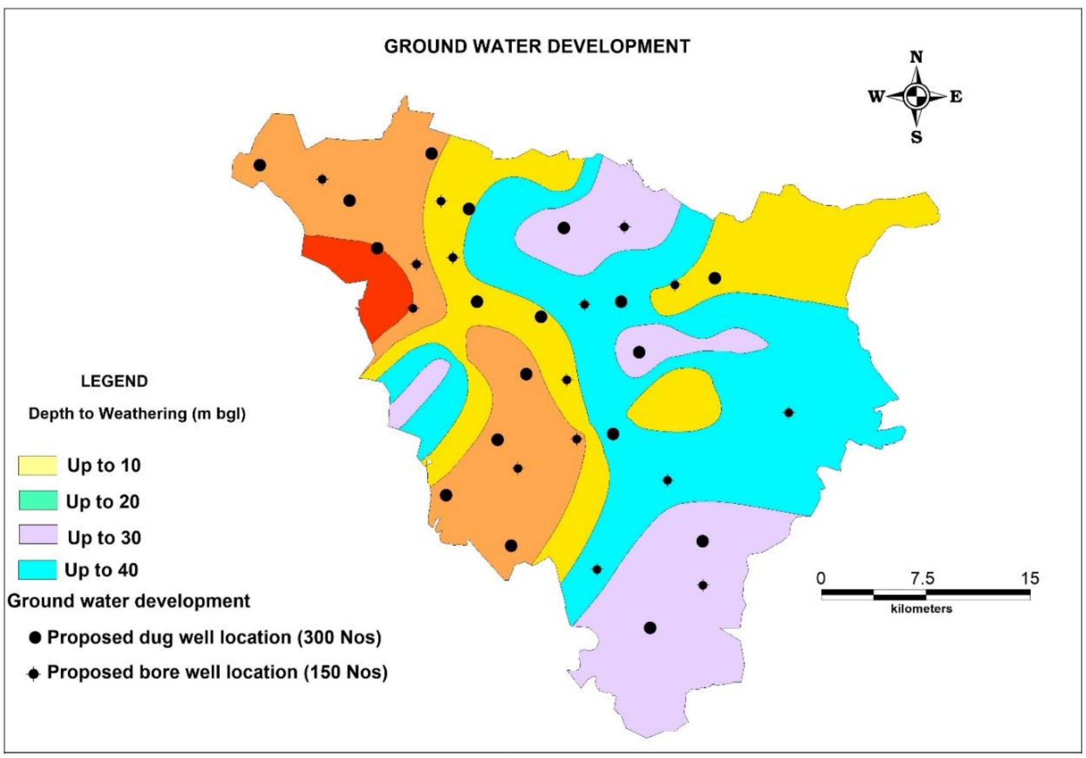


Fig 4.1: Ground water Development

4.1. Supply side Management plan:

- Regular desilting of existing check dams and ponds are suggested for augmenting recharge to the phreatic aquifers. Moreover, the canal system in the area needs to be improvised and ensure water distribution to the tail ends. This way irrigation draft from deeper fracture system can be reduced and at the same time groundwater recharge will be augmented.
- More stress should be given for watershed development with an integrated approach to conserve soil and augment recharge of rain water. It is observed that many surface water structures like ponds, tanks, irrigation canal and even cultivable land are being encroached for settlement purposes which reduce natural recharge. The existing water resources and dug wells, ponds, streams, need to be cleaned, protected and conserved so as to augment the groundwater resources in the area.
- In addition to the above suggestion some suitable recharge structure should be constructed in the study area for managing the ground water level, structures like Check dam, Percolation Pond and Contour bunding are to be constructed in suitable location (**Fig.4.1.1**). Details of Tentative locations of ARS given in Annexure 1.

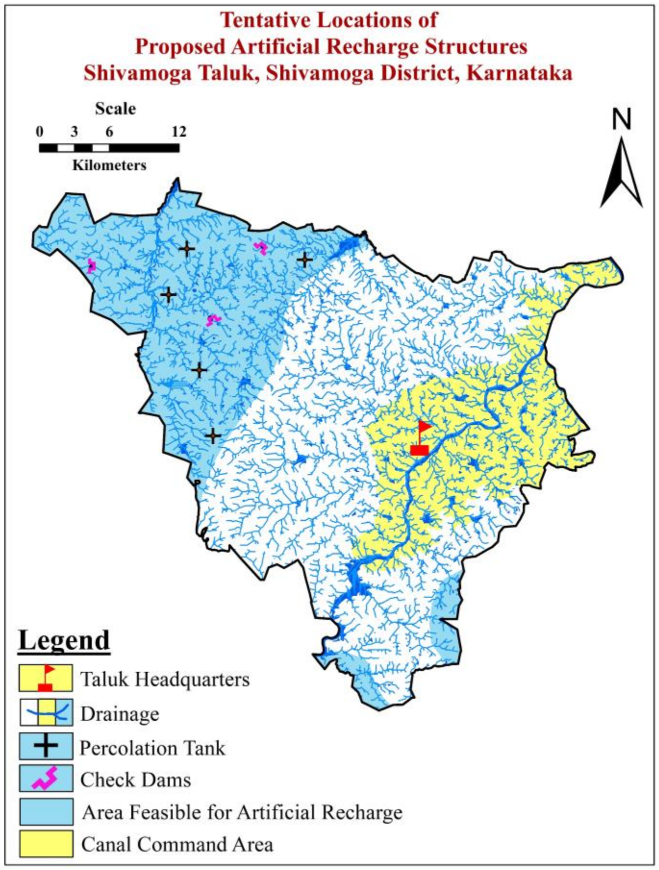


Fig.4.1.1 Proposed Artificial recharge structures map

4.2. 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.

4.3.(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.

4.3.(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.

Annexure 1:

A) Tentative Locations of Proposed Check Dams:

Sl.No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	75.408214	14.030025	Chikkadhanavandhi	Mandagatta	Shimoga
2	75.313788	14.070340	Horabylu	Tuppuru	Shimoga
3	75.450412	14.086061	Keshavanakatte	Ramanagara	Shimoga

B) Tentative Locations of Proposed Percolation Tanks:

Sl.No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	75.410024	13.938616	Mallishankara Forest	Sirigere	Shimoga
2	75.399268	13.989852	Adagadi	Mandagatta	Shimoga
3	75.374793	14.048543	Kumsi	Kumsi	Shimoga
4	75.483521	14.075537	Byranakoppa	Ramanagara	Shimoga
5	75.389479	14.084213	Kumsi	Kumsi	Shimoga