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

Shikaripura Taluk, Shimoga District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु

South Western Region, Bengaluru

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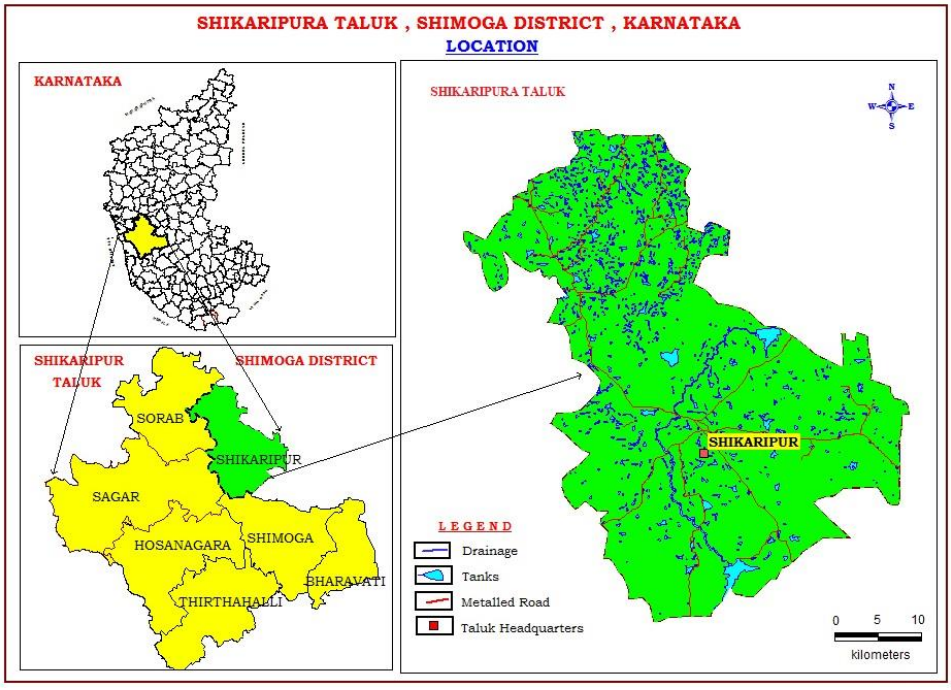
AQUIFER MAPS AND MANAGEMENT PLAN, SHIKARIPURA TALUK, SHIMOGA DISTRICT, KARNATAKA STATE

(AAP – 2022-2023)



By

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MAY 2023

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

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AQUIFER MANAGEMENT PLAN FOR SHIKARIPURA TALUK, SHIMOGA DISTRICT, KARNATAKA STATE

1. INTRODUCTION

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

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

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

1.1 Objectives

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

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

1.2 Scope of the Study

The important aspect of the aquifer mapping programme is the synthesis of the large volume of data already generated during specific studies carried out by **Central Ground Water Board (CGWB)** and various Government organizations with a new data set generated that broadly

describe the aquifer system. The available generated data are assembled, analyzed, examined, synthesized and interpreted from available sources. These sources are predominantly non-computerized data, which is to be converted into computer based GIS data sets.

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

1.3 Ground water Issues in the study area

The main issues pertaining to the Shikaripura taluk is as follows

- About 85% dependency on groundwater for irrigated agriculture
- Lack of surface water resources as alternate water sources
- Source Sustainability for drinking and irrigation, especially in lean periods
- Declining groundwater level trends in wells analyzed tapping phreatic aquifer during pre monsoon period.
- Contamination of Urban areas with municipal waste and sewage

1.4 Approach & Methodology

Integrated multi-disciplinary approach involving geological, geophysical, hydrological, hydrogeological and hydrogeochemical components were taken up in 1:50000 scale to meet the objectives of study. Geological map of the study area has been generated based on the GSI maps, geophysical data have been generated through vertical electrical soundings and geoelectrical layers with different resistivity have been interpreted in corroboration with the litho-stratigraphy of the observation wells and exploratory wells down to depths of 250 mbgl. Hydrological and Hydrometeorological data have been collected from Statistical department, Govt of Karnataka. Drainage, Soil and Geomorphology of the taluk were prepared based on the satellite data interpreted by KSRSAC.

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

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

2. SALIENT INFORMATION

Name of the taluk: **SHIKARIPURA**

District: **SHIMOGA**; State: **KARNATAKA**

Area: 911 sq.km.

Population: 2,38,229 (As 2011 census)

Annual Normal Rainfall: 801 mm

2.1. Study Area

Aquifer mapping studies was carried out in Shikaripura Taluk, Shimoga District of Karnataka, covering an area of 911sq.kms under National Aquifer Mapping Project. Shikaripura Taluk of Shimoga District is located between north latitude 14° 06' 17.95" and 14° 31' 9.66" & east longitude 75° 9' 1.5" and 76° 32' 7.77" and is covered in parts of Survey of India Topo sheet Nos. 48N/3, 7, & 9. Shikaripura Taluk is bounded by Hirekur Taluk on north, Shimoga Taluk on south, Rattehalli, Honnali & Nyamati Taluks on east and Sagara & Soraba Taluks on the western side. Location map of Shikaripura Taluk of Shimoga District is presented in Figure-1. Taluk administration of Shikaripura Taluk is divided into 5 Hoblies. Shikaripura town is the Taluk head quarter. There are 155 inhabited and 21 uninhabited villages in the Taluk.

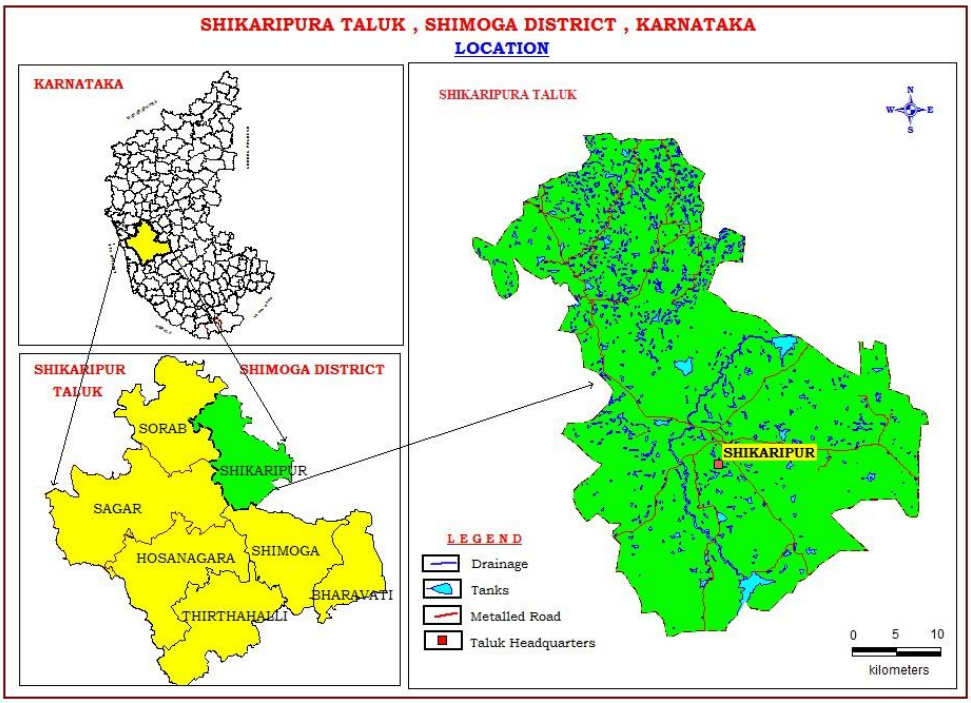

Fig-1: Location map.

2.2. Population

According to 2011 census, the population in the Taluk is 238229, in which 185350 constitute the rural population and 52879 urban population, which works out to 78 % (rural) and 22 % (urban) of the total population of Taluk. The study area has an overall population density of 262 persons per sq.km. The decadal variation in population from 2001 to 2011 is 11.54 % in Shikaripura Taluk.

Table-1: Population details of Shikaripura Taluk

Total	Male	Female	Share of the district population	Rural population	Urban population	Decadal change in population	Decadal change in rural population	Decadal change in urban population
238229	**120487**	**117742**	**13.59**	**78714**	**52879**	**11.54**	**10.61%**	**14.91%**

Source: District at a glance 2018-19, Govt. of Karnataka

2.3. Rainfall

Shikaripura Taluk enjoys semi-arid climate. Dryness and hot weather prevails in major part of the year. The area falls under Southern Dry agro-climatic zone of Karnataka state and is categorized as drought prone. The normal annual rainfall in Shikaripura Taluk for the period 1951 to 2018 is 1056 mm. Seasonal rainfall pattern indicates that, major amount of (641 mm) rainfall was recorded during South-West Monsoon seasons, which contributes about 68% of the annual normal rainfall, followed by North-East Monsoon season (310 mm) constituting 32% (Table-1).

Table-2: Average Rainfall Data of Shikaripura Taluk, Shimoga District, Karnataka (2001-2022)

Station	JAN	FEB	MAR	APR	MAY	PRE-MON	JUN	JUL	AUG	SEP	MON	OCT	NOV	DEC	POST-MON	ANN.
Shikaripura	1	5	15	59	60	141	135	195	211	100	641	123	37	6	165	947

Table-3: The annual rainfall data ofShikaripura Taluk, Shimoga District, Karnataka (2001-2022)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Annual Rainfall	554	865	705	936	1056	734	1195	1127	1136	1326

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
859	848	827	1411	751	622	727	1043	1271	991	1399	1356

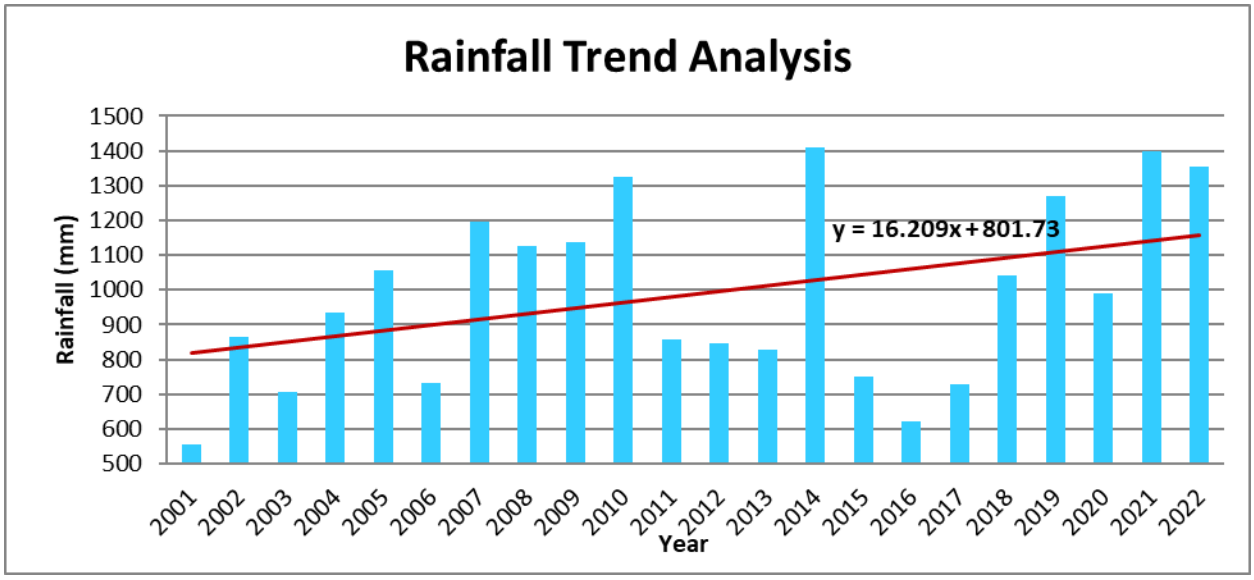

Fig. 2 - Rainfall Trend Analysis

The rainfall pattern in the Shikaripura Talukreveals the irregularity of rainfall behaviour (**Fig-2**) and the rainfall varies from 554 mm to 1411 mm (**Table-3**). As mentioned above, the normal annual rainfall of Shikaripura taluk is 801mm. Shikaripura Taluk received rainfall above normal during the years 2004-2014and 2018 to 2022.

2.4. Agriculture & Irrigation

Agriculture is the main occupation in Shikaripura Taluk. Major Kharif crops are Maize, Paddy, Arecanut, Fruits& Cotton. Main crops of Rabi season are Maize, Paddy,Tur, horse gram, vegetables & Fruits (Table-2). Water intensive crops Paddy is grown in 19% of total crop area. Maize is grown in 62%, Arecanut in 19%, Pulses in 0.7% and Vegetables in 0.3% of total crop area of Taluk shown in Table.4.

Table-4: Cropping pattern in Shikaripura Taluk 2017-18 (Ha)

Year	Paddy	Maize	Arecanut	Cotton	Pulses	Fruits	Vegetables	Oil seeds	Sugarcane	Coconut
2017-18	**10374**	**33469**	**6162**	**1047**	**394**	**1687**	**178**	**328**	**48**	**251**

It is observed that the net sown area accounts 48% and area sown more than once is 7% of total geographical area in Shikaripura Taluk. Area not available for cultivation and Forest covers7% &44% of total geographical area respectively (Table-5). 39% of net area irrigated is only from bore wells and 31% from tank irrigation (Table-6).

Table-5: Details of land use in Shikaripura Taluk 2017-18 (Ha)

Taluk	Total Geographical Area	Area under Forest	Area not available for cultivation	Fallow land	Net sown area	Area sown more than once
Shikaripura	90984	40173	6022	60	43857	6217

Source: District at a glance 2018-19, Govt. of Karnataka

Table-6: Irrigation details in Shikaripura Taluk (in ha)

Source of Irrigation	Net area irrigated (Ha.)	% of area
Canals	6718	29.3
Tanks	7136	31.1
Wells	0	0.0
Bore wells	8939	39.0
Lift Irrigation	126	0.5
Other Sources	0	0.0
Total	22919	

Source: District at a glance 2018-19, Govt. of Karnataka

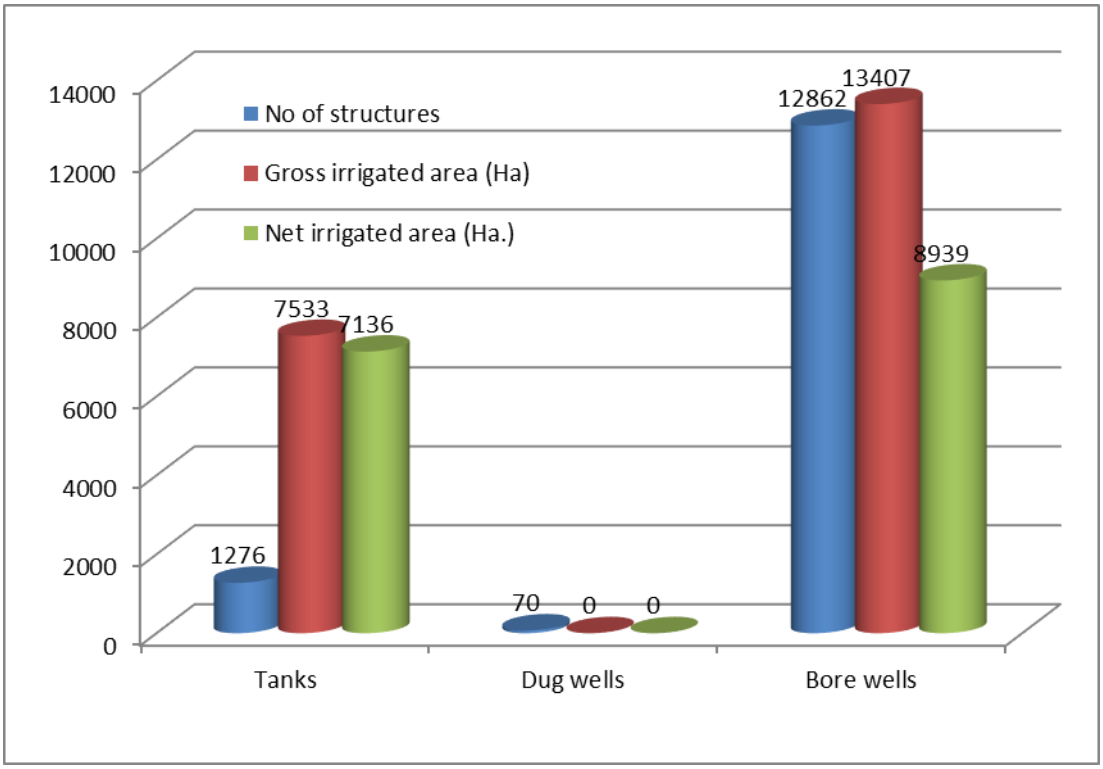

Fig.3. Irrigation source in Shikaripura Taluk, Shimoga District

2.5. Geomorphology, Physiography & Drainage

The general land elevation on the Souther side of the Taluk is about 710 m amsl and. The general slope is mostly towards NE(Fig.-4).

The Taluk is drained by 1st to 4th order streams which flow towards North and east wards. The Kumadvathi River flowing through the center of taluk in SW-NE direction. The tank system is well developed in the Taluk. The general drainage pattern is dendritic to sub-dendritic in nature and mostly joins KumadvathiRiver (Fig.-5)that is the tributary of Tungabhadra River.

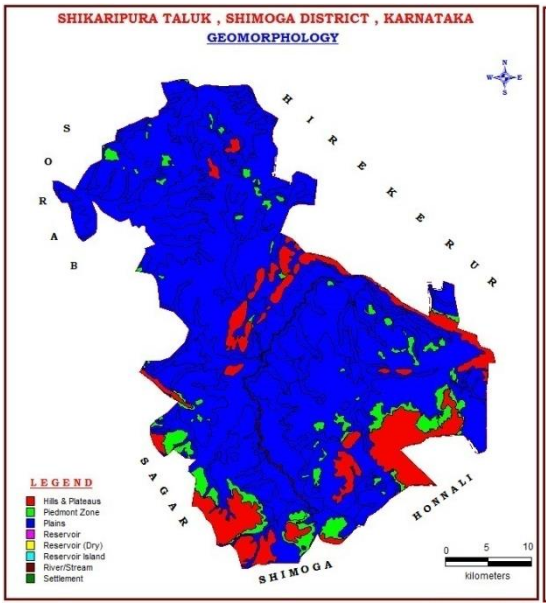

Fig.4. Geomorphology map

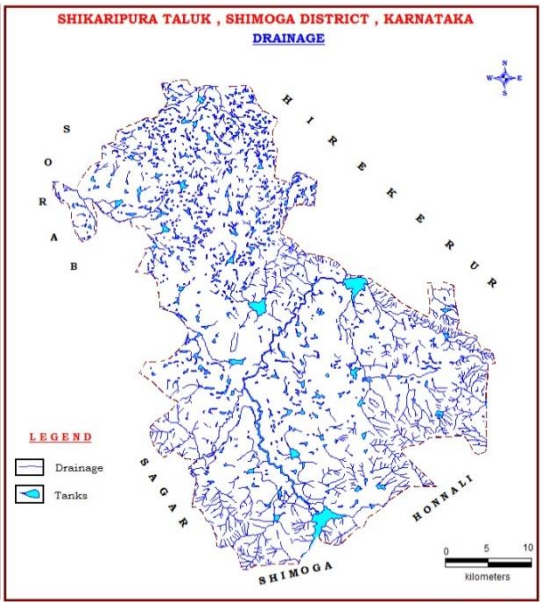

Fig.5. Drainage map

2.6. Soil

In general, the Taluk is covered dominantly by clay skeltal soil and fllowed by clay soils. Patches of clay loamy soil are also found at places. The red soil in general derive from granite gneisses. Black cotton soils are derived from schist and alluvial soil found in limited extent and confined to river/nala courses in Fig.6.

The land use map of the taluk is shown in **Fig.7.** Major part of the taluk is covered by agriculture activity.

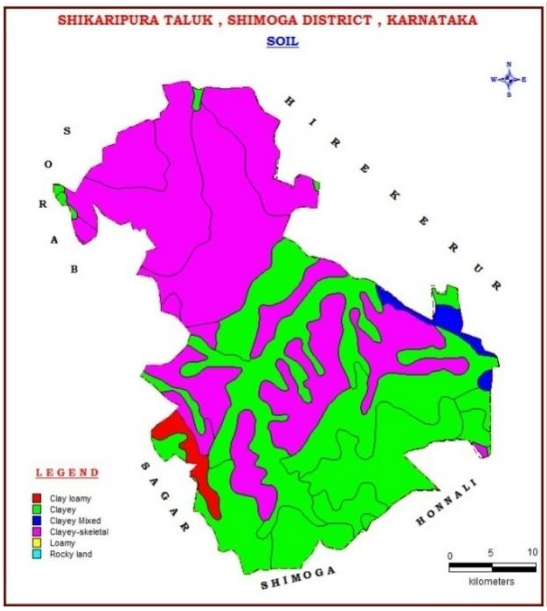

Fig-6: Soil Map

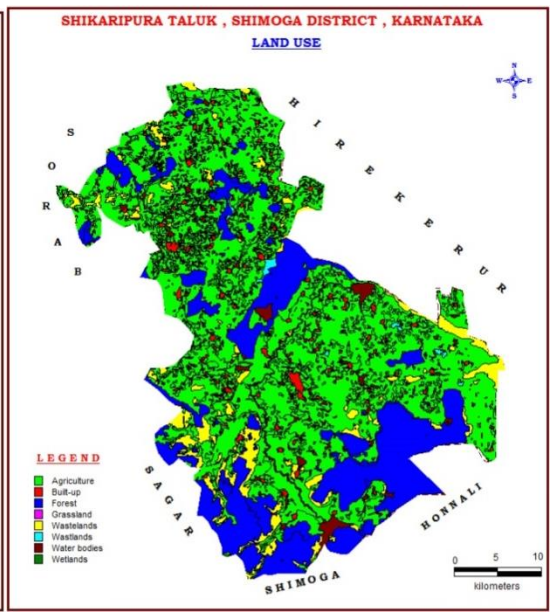

Fig-7: Land use Map

2.7. Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth is given in **Table-7** below.

Table-7: Total Ground Water Resources (2022) (Ham)

Taluk	Annual replenishable GW resources	Fresh In-storage GW resources	Total availability of fresh GW resources
Shikaripura	11270	1822	1822

2.8. Existing and future water demands (as per GEC-2022)

- Net Annual Ground Water Availability for Future Use : 3684.68 ham
- Ground Water Resource for Domestic Utilisation for projected year 2025 : 444.73 ham

2.9. Water level behavior

(a). Depth to water level: The depth to water levels of Aquifer-I in Pre-monsoon are in the range from 0.23 to 5.78 mgbl(Fig.8), in Post-monsoon are from 0.9 to 5.70 mbgl(Fig.9) and of Aquifer-II in Pre-monsoon are in the range from 1.1 to 8.9mbgl(Fig.10), in Post-monsoon are from 1.7 to 5.2mbgl(Fig.11). The depth to water level data is shown in **Table.8**

(b). Seasonal Fluctuation: The seasonal fluctuation in Aquifer-I is from 4.97 to 1.75m (Fig.12) and in Aquifer-II is from 0.6 to 4.1m(Fig.13)

(c). Decadal Avarage water level: The decadal average water level of Pre-monsoon are in the range from 5.53 to 9.51 mbgl and Post-monsoon from 1.51 to 4.42mbgl. Shown in table.9

Table-8: Depth to water level for pre-monsoon and post-monsoon

Sr. No	Village	Longitude	Lattitude	Pre-monsoon Depth to water May-2022 (mbgl)	Post-monsoon Depth to water Nov-2022 (mbgl)	Water level Fluctuation
Aquifer-I						
1	Ambligolla	14.18330	75.28330	5.78	4.88	0.90
2	Arekoppa	14.18330	75.41670	0.23	5.20	-4.97
3	Hosur2	14.25830	75.41670	7.05	5.30	1.75
4	Salur	14.22083	75.21028	5.10	5.70	-0.60
5	Shikaripura1	14.26389	75.35861	1.00	0.90	0.10
6	Shikarpur2	14.25000	75.36670	1.40	2.00	-0.60
Aquifer-II						
7	Hosuru	14.25878	75.47311	1.1	1.7	-0.6
8	Kutrahalli	14.28417	75.31556	6.0	2.2	3.8
9	Shikaripur	14.37917	75.25222	5.0	2.1	2.9

Sr. No	Village	Longitude	Lattitude	Pre-monsoon Depth to water May-2022 (mbgl)	Post-monsoon Depth to water Nov-2022 (mbgl)	Water level Fluctuation
Aquifer-I						
10	Shiralakoppa	14.37917	75.25222	8.0	3.9	4.1
11	taralaghatta	14.21972	75.39444	8.4	5.2	3.2

Table.09. Decadal Avarage depth to water level of Pre & Post-monsoon

Village	Lattitude	Longitude	2012-2021 Mean(Pre)	2012-2021 Mean(Post)
Ambligolla	14.1833	75.2833	9.510	4.42
Shikarpur1	14.2500	75.3667	5.530	1.51

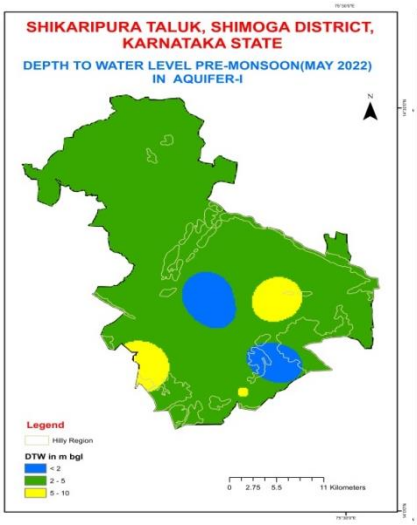

Fig.8. Pre-Monsoon DTW of Aq-I

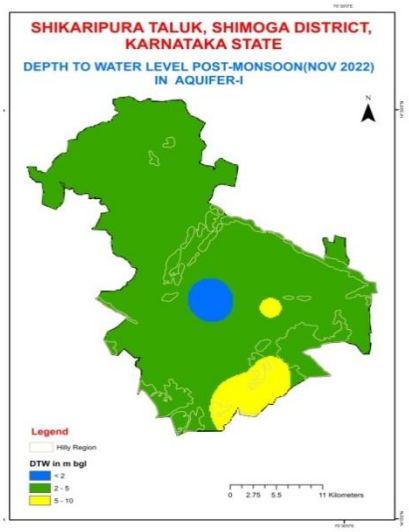

Fig.9. Post-Monsoon DTW of Aq-I

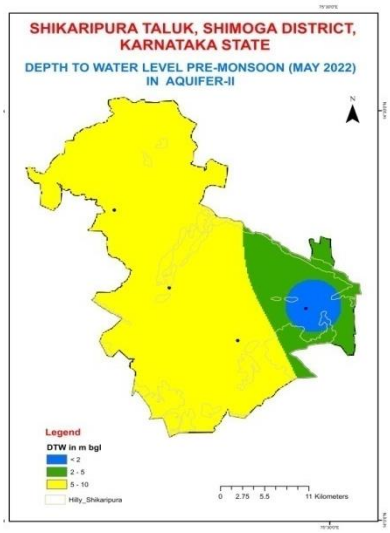

Fig.10. Pre-Monsoon DTW of Aq-II.

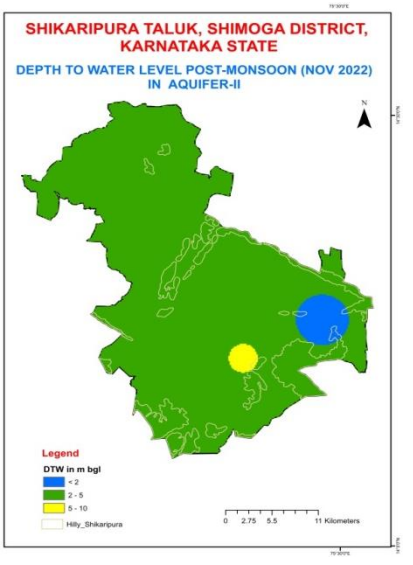

Fig.11. Post-Monsoon DTW of Aq-II.

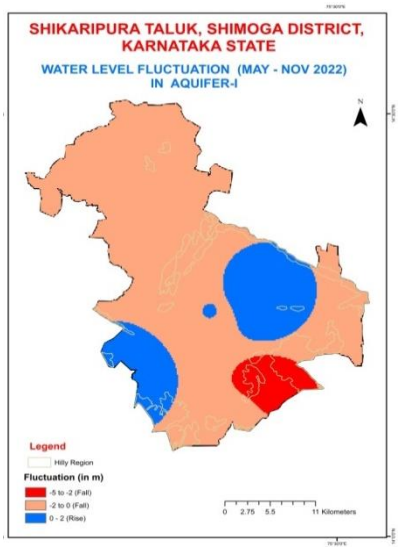

Fig.12. Seasonal fluctuation of Aq-I.

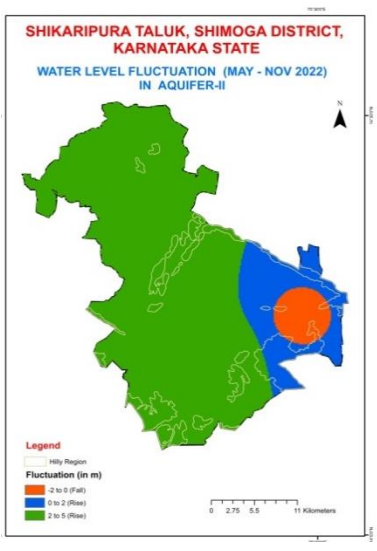

Fig.13. Seasonal fluctuation of Aq-II

3. AQUIFER DISPOSITION

3.1. Number of aquifers:In Shikaripura Taluk, there are mainly two types of aquifer systems;

Aquifer-I (Phreatic aquifer) Weathered Schist & Granite Gneiss
Aquifer-II (Fractured aquifer) FracturedSchist &Granite Gneiss

In Shikaripura Taluk, Schist &granitic-gneisses are the main water bearing formations (Figure-10). Ground water occurs within the weathered and fractured Schist & Granite Gneissunder water table condition and semi-confined condition. In the Taluk, bore wells were drilled from a minimum depth of 70 mbgl to a maximum of 187 mbgl (Table-6). Depth of weathered zone (Aquifer-I) ranges from 10 to 60mbgl (Figure.14). Ground water exploration reveals that aquifer-II fractured formation was encountered between the depths of 23 to 100 mbgl. Yield ranges from 0.8 to 12.1 lps (Figure.15). Transmissivity ranges from 5.28 to 207 m2/day (Table 10a,b & 11).

Depth wise Aquifer System:

The data generated from ground water monitoring wells, micro level hydrogeological inventories, exploratory and observation wells, various thematic layers were utilized to decipher the aquifer disposition of the area. In the Taluk, if we consider the vertical distribution of aquifer, two types of aquifer system are observed i.e., Aquifer – I which is a shallow phreatic aquifer and Aquifer – II which constitutes the deeper fractured aquifer.

a) Aquifer-I (Shallow Phreatic aquifer)

Aquifer – I comprises of weathered schist and weathered Banded Gneissic Complex. The spatial distribution of depth of occurrence and aquifer thickness of Aquifer-I is depicted in **Fig. 14**. It indicates that the depth of occurrence of aquifer – I ranges from 10 to 60 m bgl. However, it mainly occurs in the depth range of 10 to 30 m bgl covering 70% of the area in west part of the Taluk. The depth of occurrence of 30 to 60 m bgl is observed in about 30% of area mainly in Nort-Western parts of the Taluk.

b) Aquifer-II (Deeper Fractured aquifer)

It comprises of fractured Banded Gneissic Complex and Schistose rock. The spatial distribution of depth of occurrence and aquifer thickness of Aquifer-II is depicted in **Fig. 19b**. It indicates that the depth of occurrence of aquifer – II ranges from 23 to 100 m bgl. However, it mainly occurs in the depth range of 60 to 100 m bgl covering 50% of the area mainly in southern parts of the taluk. The depth of occurrence of 28 to 60 m bgl is observed in about 10% of area in southern parts. The depth of occurrence of 100 to 150 m bgl is observed in 30% in north-western & central parts of the taluk. The deeper depth of occurrence of 150-200 & 200-230 m bgl is observed in about 8% & 2% of area respectively in north-western & south-eastern parts of the taluk. The perusal of the map for fractured aquifer thickness indicates that it ranges from 1.5 to 23 m, however aquifer thickness of 1.5 to 10 m is observed in about 70% of the area covering throughout the taluk. The aquifer thickness of 10 to 15 m is observed in 20% of the area covering north-western & south-eastern parts. 15 to 20 m thickness is

observed in 8% of the area in north-western & south-eastern parts of the taluk. The higher fractured aquifer thickness of 20 to 23 m is observed only in 2% area in isolated patches in south-eastern part of the taluk.

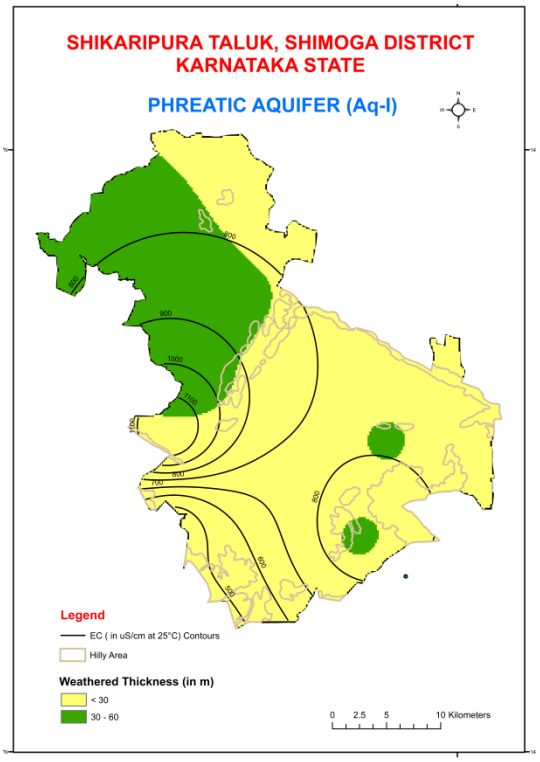

Fig.14A. Phreatic Aquifer map

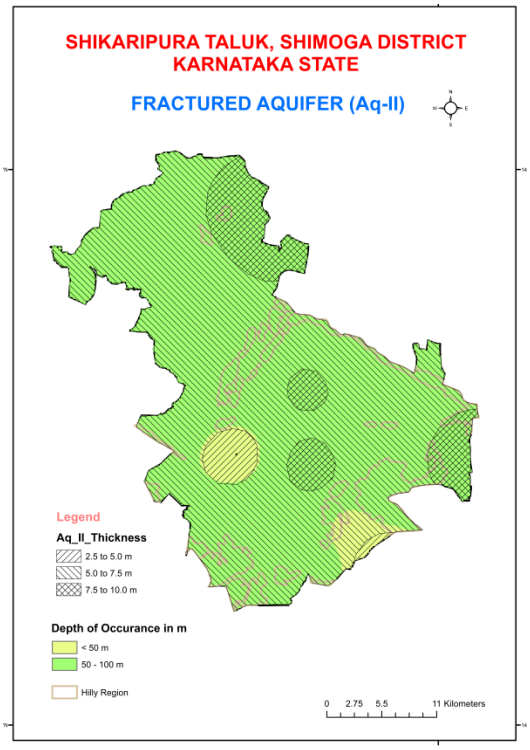

Fig.14B. Fractured Aquifer map

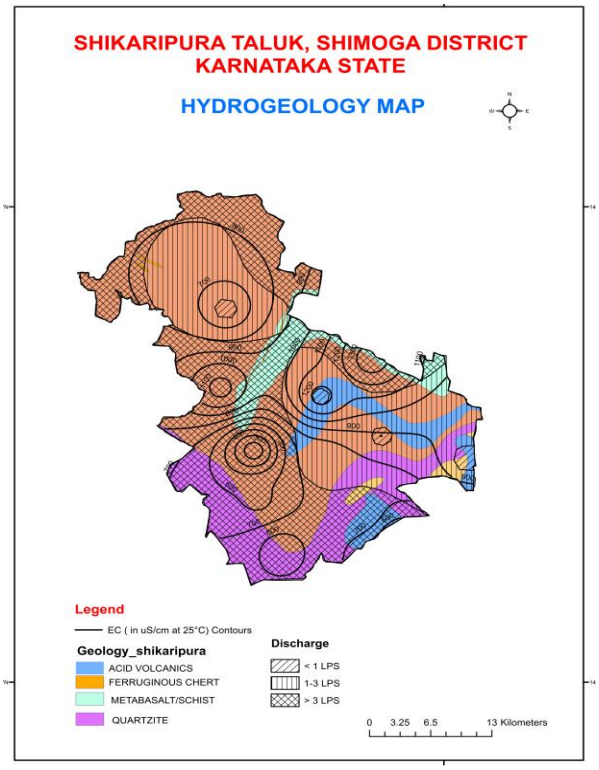

Fig.15. Hydrogeology map

Table-10a: Details of Ground Water Exploration

SI No.	Location	Longitude	Latitude	Depth drilled (mbgl) / Casing (m)	Lithology	Fracture Zones encountered (mbgl)	SWL (mbgl)	Discharge (lps)	Drow down (m)	T (m2/day)
1	**Kolagi**	75.2250	14.4750	187.05 & 33.3	Metabasalt	30,43,83	11.98	2.8	11.47	37.85
2	**Hosur**	75.4555	14.2583	172.8 & 48.47	Granite		15.2	2	2	5.28
3	**Salur**	75.3000	14.2100	137.50 & 27.70	Fractured Greywacke		7.12	6.7	2	207
4	**Salur**	75.3000	14.2100	132.15 & 31.50	Fractured Greywacke		4.27	12.1	3.88	179
5	**Shikaripura EW**	75.4166	14.3333	150.45 & 14.5	Schist		12.56	8.1	24.84	18.41
6	**Shikaripura OW**	75.4166	14.3333	123 & 28.45	Schist		12.15	3.29	3.68	77.77

Table 10b: Well Inventory data

Location	Longitude	Latitude	Total depth	Casing depth	Fractures depth
Devarahalli	75.344988	14.139326	70	25	27, 40, 60
Aisenegere	75.322486	14.192817	100	25	60
ChuncinaKoppe	75.318372	14.243486	100	25	40
Nadihalli	75.384377	14.231934	103	20	98
Arekoppa	75.420472	14.178334	130	33	33, 50
Joga	75.457075	14.145629	150	13	28, 40
JokkinaKoppa	75.522743	14.235693	130	10	23, 27, 80, 100
Holinakatte	75.440196	14.258788	130	33	33, 66
Hosanagara	75.382564	14.300686	130	13	50, 66, 83
Havaspura	75.430465	14.339102	130	12	27, 50, 66
Punnadahalli	75.286827	14.309466	150	33	27, 33, 50, 66
MunchinaKoppe	75.292250	14.392540	125	60	27, 66
Sunder Koppe	75.337195	14.437446	120	13	66, 85, 100

Table-11: Basic characteristics of each aquifer

Aquifers	Weathered Zone (Aq.-I)	Fractured Zone (Aq.-II)
Prominent Lithology	Weathered Schist & Granite Gneiss	Fractured Schist & Granite Gneiss
Thickness range (mbgl)	10 to 60	Fractures upto100 mbgl

Depth range of occurrence of fractures (mbgl)	-	23 - 100
Range of yield potential (lps)	Poor yield	0.8 to 12.1
T (m^2/day)	-	5.28 to 207
Quality Suitability for Domestic &Irrigation	Suitable	Suitable

3.2. 3-D aquifer disposition and Cross-Sections

3.2.1. Aquifer disposition – Rockworks output

Sub-surface aquifer disposition are prepared based upon the outcome of ground exploration programme. Mainly. Four zones are categorized namely Top soil, Weathered, Fractured and Massive zones. These zones are represented using rockworks to depict the subsurface sections and models presented in **Fig.-16, Fig.-17 and Fig.18.**

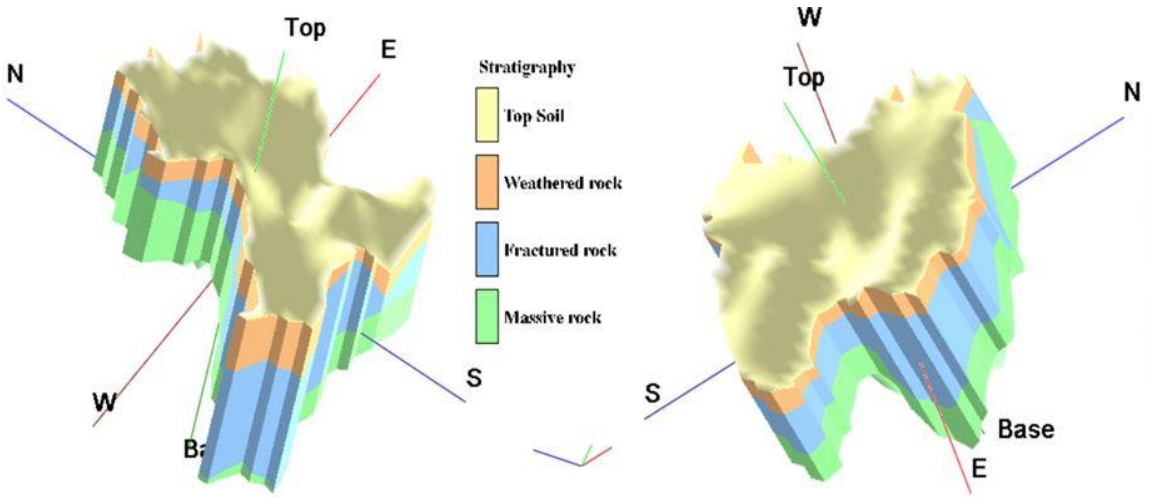

Fig-16: 3D Aquifer Disposition

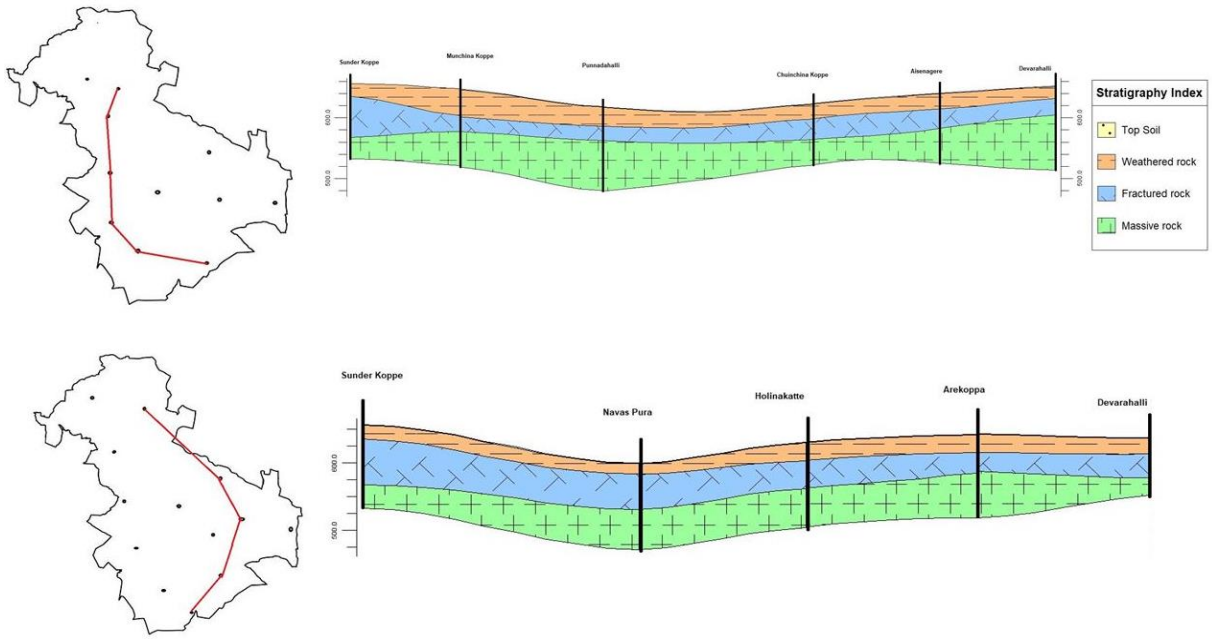

Fig-17: Cross sections in different directions

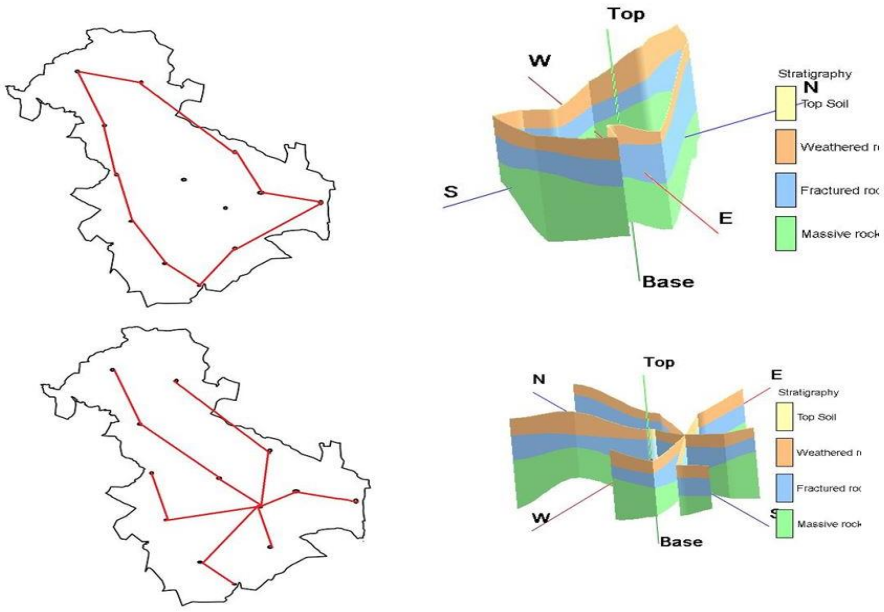

Fig-18: Fence in different directions

4. GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

4.1. Aquifer wise resource availability and extraction

Table.12: Present Dynamic Ground Water Resource of Shikaripura taluk (2022)

Annual extractable ground water resources (ham)	Existing gross ground water draft for irrigation (ham)	Existing gross ground water draft for industrial water supply (ham)	Existing gross ground water draft for domestic water supply (ham)	Existing gross ground water extraction for all uses (ham)	Allocation for domestic and industrial use for projected year 2025 (ham)	Net ground water availability for future irrigation development (ham)	Existing stage of ground water extraction (%)	Category
11270.43	7138.50	2.52	425.74	7566.76	444.73	3684.68	67.14	Safe

Table.13: Comparison of ground water availability and draft scenario in Shikaripura taluk

Taluk	GW availability (in ham)	GW draft (in ham)	Stage of GW development (%)	GW availability (in ham)	GW draft (in ham)	Stage of GW development (%)	GW availability (in ham)	GW draft (in ham)	Stage of GW development (%)
	2017			**2020**			**2022**		
Shikaripura	11348	5553	49	11174	6087	54	11270	7567	67

It is seen that the stage of ground water extraction is not improved in the taluk in comparison with 2017. However, with respect to 2017 estimations, the stage of ground water development is increasedabout5% in 2020 and 18% in 2022. Thetaluk is deteriorated towardssemi-critical catogery from safe.

4.2. Chemical quality of ground water and contamination

Interpretation from Chemical Analysis results in Shikaripura talik is mentioned as under and the data is shown in Table.14.

- **ELECTRICAL CONDUCTIVITY:** In general, EC values range from 180 to 1190 µ/mhos/cm in the aquifer-I at 25^{o}C (Fig.19).and range from 250 to 1350 µ/mhos/cm in the aquifer-II (Fig.20).
- **CHLORIDE:** Chloride concentration in ground water ranges between 25 and 135 mg/l in the aquifer-I (Fig.21).and ranges between 25 and 262 mg/l in the aquifer-II (Fig.22).
- **NITRATE:** Nitrate concentration in ground water ranges from 25 and 46 mg/l in the Aquifer–I (Fig.23).and ranges from 2 and 39 mg/l in the Aquifer –II(Fig.24).
- **FLUORIDE:** Fluoride concentration in ground water ranges between 0.1 and 1.1 mg/l in the aquifer-I and ranges between 0.05 and 1.2 mg/l in the aquifer-II (Fig.26).

Table-14: Quality of ground water in Shikaripura taluk of Shimoga district

S. No.	Location	EC (mg/L)	Cl (mg/L)	NO3 (mg/L)	F (mg/L)
Aquifer-I					
1.	Ambligolla	440	92	25	0.2
2.	Arekoppa	850	113	46	1.1
3.	Chennakoppa	350	25	27	0.2
4.	Hosur	180	25	27	0.1
5.	Shikaripura(A)	1190	135	28	1.1
Aquifer-II					
6.	Aisenegere	580	71	36	0.14
7.	Arekoppa	770	82	2	0.51
8.	ChuncinaKoppe	250	25	2	0.11
9.	Devarahalli	850	99	37	0.17
10.	Havaspura	1350	206	30	0.28
11.	Hosanagara	1230	262	38	0.1
12.	Joga	420	53	36	0.08
13.	JokkinaKoppa	950	71	39	1.3
14.	MunchinaKoppe	640	57	17	0.05
15.	Nadihalli	740	82	30	0.15
16.	Punnadahalli	1130	191	36	0.11

In general, ground water quality in Shikaripura taluk is good for drinking purpose except at 1 place where nitrate is found to be greater than the permissible limit as per "Indian Standard Drinking Water Specification 2012". Ground water samples have also been tested and found suitable for agriculture & irrigation purposes in major part of the taluk, where EC is less than 750 µ/mhos/cm.

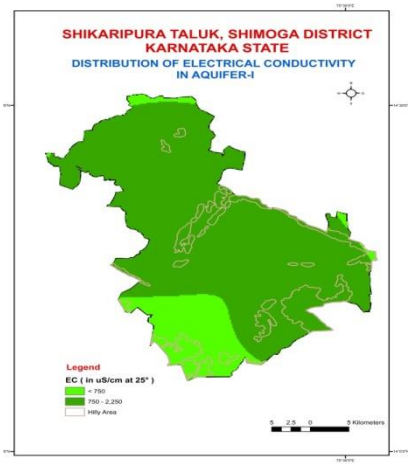

Fig.19. Distribuition of EC in Aq-I

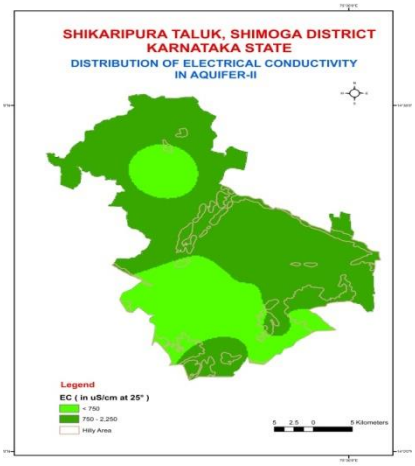

Fig.20. Distribuition of EC in Aq-II

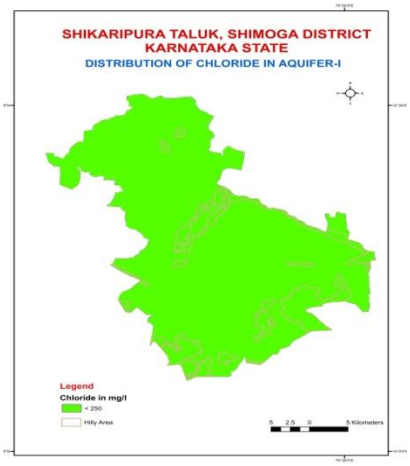

Fig.21. Distribuition of Chloride in Aq-I

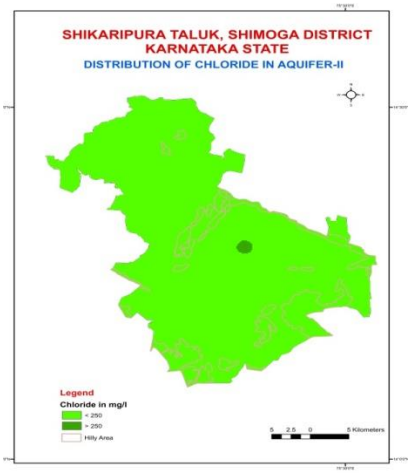

Fig.22. Distribuition of Cl in Aq-II

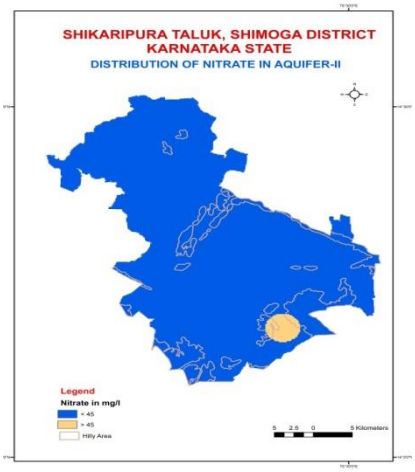

Fig.23. Distribuition of NO_3 in Aq-I

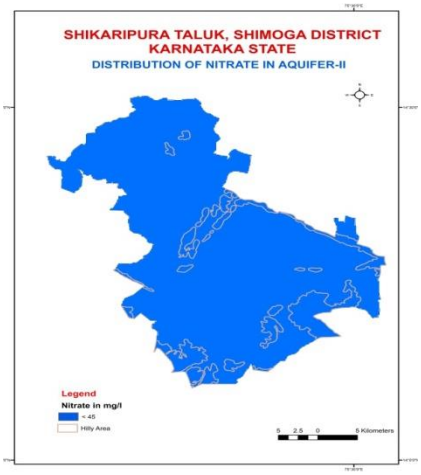

Fig.24. Distribuition of NO_3 in Aq-II.

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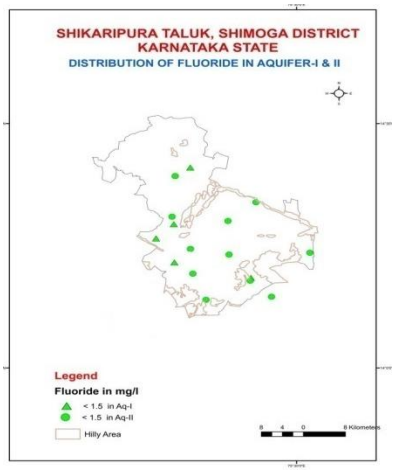

Fig.25. Distribuition of Fluoride in Aq-I & II.

5. GROUND WATER MANAGEMENT PLAN:

5.1. Resource Enhancement by Supply Side Interventions

Recharge to dry **phreatic aquifer zone (Aq-I)** through construction of artificial recharge structures, viz; check dams, percolation tanks & Sub surface dyke (**Table-15**) is recommended. The choice of recharge structures should be site specific and such structures need to be constructed in areas already identified as feasible for artificial recharge.

Out of 909 sq.km of Shikaripura taluk,715 sq.km is feasible for recharge and the surface surplus non-committed runoff availability is 35.369 MCM, which is considered for planning of AR structures. For this, a total of 1 sub-surface dykes, 32 percolation tanks and 181 Check dams are proposed. The volume of water expected to be conserved/recharged @75% efficiency is 26.53 MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 24.61 Cr. The additional area which can be brought under assured ground water irrigation will be about 3200 hectares. However, the figures given are tentative locations (Annexure-1) and pre-field studies / DPR are recommended prior to implementation of these recharge structures (Fig.26).

Table-15: Quantity of non-committed surface runoff & expected recharge through AR structures

Artificial Recharge Structures Proposed	**Shikaripura taluk**
Area feasible for artificial recharge (sq.km)	**715**
Non committed monsoon runoff available (MCM)	**35.369**
Total no. of existing artificial recharge structures	**190**
Number of Check Dams proposed	**181**
Number of Percolation Tanks proposed	**32**
Number of Sub surface dyke proposed	**1**
Tentative total cost of the project (Rs. in Cr)	**24.61**
Excepted recharge (MCM)	**26.53**
Additional irrigation potential (Hectares)	**3200**

Note: The numbers proposed are tentative and detailed feasibility studies are required in field to finalize the actual locations for the construction of AR structures.

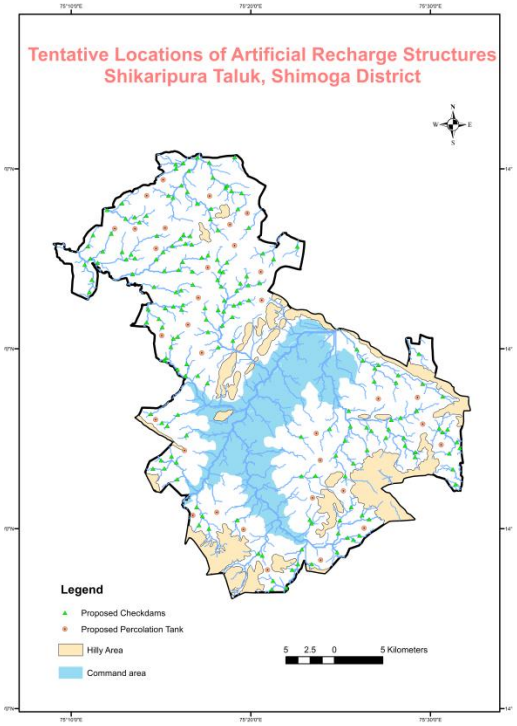

Fig.26. Tentative locations of AR structures.

5.2. Resource Savings by Demand Side Interventions

5.2.1. Water Use Efficiency by Micro Irrigation Practices

It is observed that bore wells contribute 39% of the source for irrigation in Shikaripura Taluk. The water efficient methodology may be applied for growing paddy which is grown in 10373 ha and is ground water dependent as compared to the other crops which are mainly grown during kharif. Initially, the micro irrigation techniques (drip) are proposed in 25% of paddy cultivated area of 10373 ha i.e., 2593 ha. Considering the crop water requirement of 2.00 m and savings of 25% i.e., 0.50 m by irrigation efficiency, it will contribute in saving ground water by 1296 ham and thus will improve stage of development marginally. However, in long run the practice of Efficient irrigation techniques will add to the ground water resource in large extent. **(Table-16).**

Table 16: Improvement in GW availability (2022) due to savings by adopting water use efficiency

Annual Extractable GW Resource (Ham)	Total GW extraction for all uses	Stage of ground water extraction	Paddy Area proposed for WUE	Unit savings	Total Saving due to adopting WUE measures	Cumulative annual Extractable GW Resource	Expected improvement in stage of ground water extraction after the implementation of the project	Expected improvement in overall stage of ground water extraction
HAM	HAM	%	HA	M	HAM	HAM	%	%
11270.43	7566.76	67.14	2593	0.50	1296	12567	6.93	67.14 to 60.21

5.2.2. Change in cropping pattern

Water intensive crop like paddy are grown in 19% (Less extent) of total cropped area. At present, the stage of ground water extraction is marginally above the safe limit @ 67.14% (2022), thus change in cropping pattern has not been suggested.

5.3. Ground Water Development Plan

In Shikaripura Taluk, the present stage of ground water extraction (2022) is merely 67.14 %, say 67% with net ground water availability for future use of 11270.43ham and total extraction of 7566.76ham. The ground water draft for irrigation purpose is estimated to be 7566.76ham and there is no further scope for developing the resource for irrigation as it is near semi-critical catogery.

5.4. Regulation and Control

Shikaripura Taluk has been categorizedas **"Safe".** However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority(KGWA) needs to be strictly implemented to avoid the taluk from safecategory to semi-critical or higher category in the future.

5.5. Other interventions proposed

- **Periodical maintenance of artificial recharge structures** should also be incorporated in the Recharge Plan.
- Excess nitrate concentration is found in ground water samples require remedial measures viz.
    - Dilution of nitrate rich ground water through artificial recharge & water conservation.
    - Roof top rain water harvesting.
    - Improving quality by proper drainage and limited usage of Nitrogenous fertilizers

- Excess fluoride concentration is found in ground water samples of deeper aquifer require remedial measures viz.
    - Alternate source
    - Removal technology

6. SUMMARY AND RECOMMENDATIONS

The main ground water issues are Low Ground Water Development, Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, Deeper Water Levels particularly in Aquifer-II in some parts, hilly and plateau areas which are all inter-related or inter dependent and Inferior Ground Water Quality due to fluoride contamination especially in deeper aquifer. The summary of ground water management plan of Shikaripura Taluk is given in **Table-17.**

Table 17: Summary of Management plan of ShikaripuraTaluk

Present stage of Ground water Extraction and Category as per GEC-2022(%)	67.14, Safe
Annual Extractable Ground Water Resources (ham)	11270.43
Existing Gross Ground Water Extraction for all uses	7566.76
Ground Water Resource Enhancement by Supply side Interventions	
Area Feasible for Artificial Recharge (ha)	71500
Expected additional recharge from monsoon surplus runoff (ham)	35369
Additional irrigation potential (Hectares)	3200
Ground Water Resource Savings by Demand side Interventions	
Paddy Area proposed for WUE (ha)	2593
Expected Saving due to adopting WUE measures (ham)	1296
Expected improvement in stage of ground water extraction after adopting WUE measures and implementation of the project (%)	67.14 to 60.21
Government to take initiatives to encourage at least 70% farmers to adopt water use efficiency irrigations practices like dip & sprinkler irrigation	-
Ground Water Resource Development Plan	
Balance GWR available to enhance SOE 60% (Ham)	-
No. of DW feasible considering 25% of balance GWR with unit draft of 1 ham	-
No. of BWs feasible considering 75% of balance GWR with unit draft of 1.25 ham	-
Additional irrigation potential created by DW's considering crop water requirement of 0.65 m (Ha)	-
Additional irrigation potential created by BW's considering crop water requirement of 0.65 m (Ha)	-
Total irrigation potential created by DW's and BW's (Ha)	-
Excess Nitrate concentration	In limited places especially in shallow aquifer Dilution of nitrate rich ground water through artificial recharge & water conservation. Roof top rain water harvesting Improving quality by controlling usage of Nitrogenous fertilizers in agriculture field and maintaining the proper domestic drainage network system
Excess Fluoride concentration	In limited places especially in deeper aquifer Alternate source Removal technology

As per the resource estimation – 2022, Shikaripura taluk falls under safe category with the stage of ground water extraction is 67.14 %. However, there is need to formulate management strategy to tackle the water scarcity related issues in the taluk in the coming days to avoid water crisis in the future. It is suggested to adopt a scientific and multi-pronged ground water management strategy covering supply side interventions, demand side interventions, ground water development interventions and ground water quality protection aspects as mentioned in the management plan suggested above

Ground water resource enhancement by supply side interventions: The surface surplus non-committed runoff availability is 35.369 MCM, which is considered for planning of AR structures. For this, a total of 1 sub-surface dykes, 32 percolation tank and 181 Check dams are proposed. The volume of water expected to be conserved/recharged @75% efficiency is 26.52 MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 24.61 Cr. The additional area which can be brought under assured ground water irrigation will be about 3200 hectares. However, the figures given are tentative and pre-field studies / DPR are recommended prior to implementation of these recharge structures.

Ground water resource enhancement by demand side interventions: It is observed that bore wells contribute 39% of the source for irrigation in Shikaripura Taluk. The water efficient methodology may be applied for growing paddy which is grown in 10373 ha and is ground water dependent as compared to the other crops which are mainly grown during kharif. Initially, the micro irrigation techniques (drip) are proposed in 25% of paddy cultivated area of 10373 ha i.e., 2593 ha. Considering the crop water requirement of 2.00 m and savings of 25% i.e., 0.50 m by irrigation efficiency, it will contribute in saving ground water by 1296 ham and thus will improve stage of development marginally. However, in long run the practice of Efficient irrigation techniques will add to the ground water resource in large extent

Change in cropping pattern:Water intensive crop like paddy are grown in 19% (Less extent) of total cropped area. At present, the stage of ground water extraction is marginally above the safe limit @ 67.14% (2022), **thus change in cropping pattern has not been suggested**.

Ground Water Resource Development Plan: In Shikaripura Taluk, the present stage of ground water extraction (2022) is merely 67.14 %, say 67% with net ground water availability for future use of 11270.43ham and total extraction of 7566.76ham. The ground water draft for irrigation purpose is estimated to be 7566.76ham and there is no further scope for developing the resource for irrigation as a part of development with appropriate scientific backing.

Nitrate Contamination: Proper drainage of sewage and scientific disposal of sewage water by the concerned urban/rural agency needs to be adopted along with limited usage of Nitrogenous fertilizers by farmers to avoid nitrate contamination. All the ground water sources for drinking water supply may be checked for ground water quality parameters as per BIS norms.

WUE in Domestic Sector: WUE practices are the prime management option in domestic sector as well in view of having high density clusters of urban households and establishments. In premium apartments and infrastructure projects, use of three-way line for fresh water, bathroom water and toilet water will

enable reuse of grey water for gardening, car washing and flushes etc. The water saver fixtures/ aerators can be used for kitchen & bathroom pipes, bath showers and water free urinals.

Regulation and Control: Taluk is categorised as "Safe". However, the mandatory guidelines like rainwater harvesting and artificial recharge issued by Karnataka Ground Water Authority needs to be strictly implemented to avoid the taluk from deteriorating from semi critical category to critical category in the future.

Water Linkages with other Activities: Water sector has strong linkages with other developmental activities. Hence, the proposed management plans cannot be considered as static and needs to be reviewed and improved from time to time.

Annexure 1:

A) Tentative Locations of Proposed Check Dams, Shikaripura taluk

S.NO	Longitude	Lattitude	Village
1	75.352778	14.110556	Kalmane
2	75.366389	14.111667	Kumsi
3	75.353889	14.118333	Kalmane
4	75.371667	14.128611	Kalmane
5	75.376944	14.133889	Kalmane
6	75.389722	14.133889	Hirekorlahalli
7	75.343889	14.141789	Kalmane
8	75.340368	14.143593	Kalmane
9	75.413333	14.145000	Hirekorlahalli
10	75.380645	14.147590	Kalmane
11	75.428352	14.156514	Yalaneerukoppa
12	75.423056	14.158333	Yalaneerukoppa
13	75.434167	14.160278	Atthibylu
14	75.414444	14.162500	Hirekorlahalli
15	75.294444	14.166667	Arashinagere
16	75.285278	14.170000	Hariharapura
17	75.389722	14.171667	Matthighatta
18	75.415833	14.174444	Kesaraghatta
19	75.320833	14.174722	Anaginabylu
20	75.388056	14.175000	Matthighatta
21	75.443024	14.175457	Sidaginahal
22	75.288333	14.178333	Saluru
23	75.436519	14.179120	Harogoppa
24	75.283056	14.186667	Hariharapura
25	75.426389	14.186667	Harogoppa
26	75.523333	14.207778	Aralihalli
27	75.265000	14.212500	Annapura
28	75.380278	14.215278	Tarlaghatta
29	75.420833	14.215278	Yarekatte
30	75.393333	14.215556	Tarlaghatta
31	75.520833	14.221667	Aralihalli
32	75.242500	14.222222	Madaba Siddapura
33	75.253056	14.222500	Madaba Siddapura
34	75.428333	14.227222	Ittigehalli
35	75.264285	14.228101	Mallapura
36	75.250000	14.230000	Madaba Siddapura
37	75.485556	14.233056	Nalanikoppa
38	75.259722	14.233611	Mallapura
39	75.412222	14.234540	Ittigehalli
40	75.517500	14.236389	Jakkanakoppa
41	75.485956	14.237500	Nalanikoppa
42	75.441111	14.239444	Hulaginakatte

43	75.527222	14.241389	Jakkanakoppa
44	75.476389	14.243611	Nalanikoppa
45	75.524499	14.246881	Baluru
46	75.420556	14.248333	Muddanahalli
47	75.458611	14.250833	Hosuru
48	75.475278	14.250833	Nalanikoppa
49	75.380000	14.251944	Dhoopadahalli
50	75.273611	14.253333	Hirekalavatthi
51	75.511111	14.256111	Baluru
52	75.445000	14.257222	Hulaginakatte
53	75.515833	14.258692	Baluru
54	75.461111	14.258889	Hosuru
55	75.406389	14.259167	J I Beguru
56	75.508056	14.259722	Baluru
57	75.440757	14.260510	Hulaginakatte
58	75.425556	14.261547	Balekoppa
59	75.255833	14.261944	Chikkalavatthi
60	75.250833	14.264722	Chikkalavatthi
61	75.463611	14.267500	Hosuru
62	75.472222	14.269444	Hosuru
63	75.265556	14.272222	Haragavalli
64	75.240556	14.273056	Kaniya
65	75.424167	14.275833	Kenchagondana Koppa
66	75.487248	14.275884	Gogga
67	75.511389	14.289167	Kaginalle
68	75.492778	14.300833	Chowdanayakanakoppa
69	75.293056	14.301389	Jakkanahalli
70	75.468056	14.301944	Maravalli
71	75.447778	14.303056	Maravalli
72	75.272778	14.308333	Punidahalli
73	75.284167	14.308333	Punidahalli
74	75.470000	14.308889	Maravalli
75	75.265278	14.314167	Bhadrapura
76	75.448333	14.315278	Maravalli
77	75.451667	14.318333	Maravalli
78	75.273889	14.319167	Punidahalli
79	75.437222	14.322500	Dindadhahalli
80	75.253056	14.322778	Udagani
81	75.254722	14.324722	Udagani
82	75.489167	14.328611	Guledahalli
83	75.431667	14.332778	Kavasapura
84	75.303056	14.334722	Nagihalli
85	75.259167	14.335000	Udagani
86	75.316667	14.340833	Bhogi
87	75.261389	14.342778	Udagani
88	75.265556	14.344444	Udagani

89	75.293611	14.348889	Kuskuru
90	75.251111	14.353333	Thadagani
91	75.306944	14.355000	Hirejamburu
92	75.236667	14.357778	Kyadhigikoppa
93	75.291944	14.360556	Hirejamburu
94	75.248056	14.361111	Thadagani
95	75.316111	14.362778	Kodikoppa
96	75.308205	14.367988	Hirejamburu
97	75.303056	14.369444	Hirejamburu
98	75.269013	14.369604	Neralage
99	75.238189	14.369867	Jamburu Hosakoppa
100	75.253983	14.370888	Neralage
101	75.290833	14.371111	Virupapura
102	75.261389	14.372500	Neralage
103	75.317591	14.373480	Chikkajamburu
104	75.270278	14.373889	Neralage
105	75.323056	14.375556	Chikkajamburu
106	75.308611	14.378056	Bhogasamudra
107	75.331389	14.378333	Bhakthanakoppa
108	75.183611	14.385833	Guddadhahosahalli
109	75.263988	14.385893	Belavanthanakoppa
110	75.320278	14.387222	Bhakthanakoppa
111	75.268611	14.387500	Hakkali
112	75.243541	14.390690	Belagavi
113	75.305721	14.391040	Uttaranihalli
114	75.330833	14.392222	Adaganti
115	75.279444	14.392778	Hakkali
116	75.323611	14.393889	Bhakthanakoppa
117	75.341618	14.394167	Adaganti
118	75.185833	14.397222	Guddadhahosahalli
119	75.302500	14.397222	Muttiage
120	75.329444	14.400556	Bidarakoppa
121	75.223611	14.402500	Belagavi
122	75.307500	14.404444	Muttiage
123	75.278889	14.405000	Mugalikoppa
124	75.253056	14.405556	Thalagundha
125	75.304444	14.405556	Muttiage
126	75.266389	14.406389	Thalagundha
127	75.179310	14.411204	Guddadhahosahalli
128	75.191111	14.413056	Maluru
129	75.311136	14.413358	Hulaginakoppa
130	75.270000	14.413889	Thalagundha
131	75.302222	14.415833	Hulaginakoppa
132	75.217778	14.416111	Devikoppa
133	75.245556	14.416111	Thalagundha
134	75.354444	14.416389	Kadenandihalli

135	75.184444	14.416944	Haragi
136	75.225833	14.417222	Devikoppa
137	75.287778	14.417778	Basavanandhihalli
138	75.293602	14.419932	Basavanandhihalli
139	75.222222	14.420833	Devikoppa
140	75.344512	14.421689	Thadasanahalli
141	75.213889	14.423056	Yindikana Hosakoppa
142	75.251944	14.423056	Thalagundha
143	75.195833	14.423611	Kodihalli
144	75.376389	14.428056	Kadenandihalli
145	75.182222	14.428333	Haragi
146	75.260460	14.428582	Thalagundha
147	75.278475	14.429971	Bisalahalli
148	75.272638	14.430590	Bisalahalli
149	75.268056	14.435278	Kanahalli
150	75.276944	14.437778	Bisalahalli
151	75.246217	14.438056	Kadatthanahalli
152	75.186944	14.438611	Haragi
153	75.270833	14.438889	Kanahalli
154	75.203889	14.440000	Kodihalli
155	75.302778	14.443333	Koratikere
156	75.331389	14.445556	Sunnadakoppa
157	75.230000	14.450556	Kali
158	75.295833	14.453333	Koratikere
159	75.217131	14.453870	Thorgasi
160	75.225556	14.455278	Shiddihalli
161	75.236389	14.456667	Kali
162	75.200000	14.461944	Thorgasi
163	75.321389	14.462778	Karnalli
164	75.296389	14.463056	Mulakoppa
165	75.283611	14.467778	Shirahalli
166	75.213889	14.468056	Thandagundha
167	75.261111	14.473333	Shankrikoppa
168	75.256944	14.475278	Shankrikoppa
169	75.324722	14.477500	Malavalli
170	75.274444	14.478611	Narasapura
171	75.315278	14.479444	Malavalli
172	75.310000	14.482778	Malavalli
173	75.311389	14.484444	Malavalli
174	75.268889	14.484722	Bandalike
175	75.298056	14.491944	J.I.Mutthahalli
176	75.275833	14.498333	Bandalike
177	75.263889	14.500278	Chikkamagadi
178	75.263611	14.504167	Chikkamagadi
179	75.270556	14.505278	Chikkamagadi
180	75.294722	14.505833	Mallenahalli

181	75.283889	14.510556	Inam Agrahara Muchhadi
182	75.318333	14.510833	Mallenahalli

B) Tentative Locations of Proposed Percolation Tanks, Shikaripura taluk

S.No	Longitude	Lattitude	Village
1	75.348834	14.128538	Kalmane
2	75.398059	14.137610	Hirekorlahalli
3	75.326527	14.165866	Madravalli
4	75.438361	14.167204	Harogoppa
5	75.279576	14.178998	Hariharapura
6	75.301738	14.181863	Arashinagere
7	75.390623	14.195163	Doddajogihalli
8	75.419177	14.201706	Yarekatte
9	75.397762	14.230111	Nandhihalli
10	75.271799	14.239057	Mallapura
11	75.509894	14.244388	Baluru
12	75.394044	14.254947	Kengatte
13	75.492791	14.263572	Baluru
14	75.244959	14.267736	Kaniya
15	75.451597	14.286921	Gogga
16	75.487884	14.288259	Chowdanayakanakoppa
17	75.287789	14.329483	Kuskuru
18	75.250669	14.345545	Udagani
19	75.274940	14.355539	Neralage
20	75.343421	14.378262	Bhakthanakoppa
21	75.284600	14.380547	Manjikoppa
22	75.342588	14.404555	Sadhapura
23	75.293357	14.408529	Basavanandhihalli
24	75.245316	14.426209	Shivapura
25	75.318198	14.428945	Hulaginakoppa
26	75.225804	14.444376	Kali
27	75.207083	14.444583	Thorgasi
28	75.253882	14.445125	Kadatthanahalli
29	75.313844	14.448421	Mayathammana Muchhadi
30	75.330024	14.458890	Mayathammana Muchhadi
31	75.295046	14.474833	J.I.Mutthahalli
32	75.236750	14.475106	Kanasogi
33	75.251978	14.489823	Yalagere

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