केन्द्रीय भूमि जल 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

Bangalore North Taluk

Bangalore Urban District, Karnataka

दक्षिण पश्चिमी क्षेत्र, बेंगलुरु
South Western Region, Bengaluru

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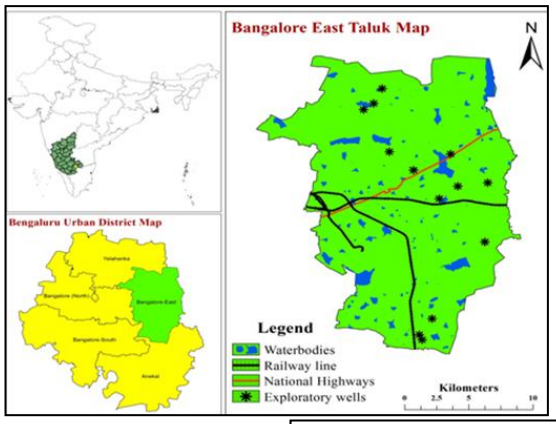
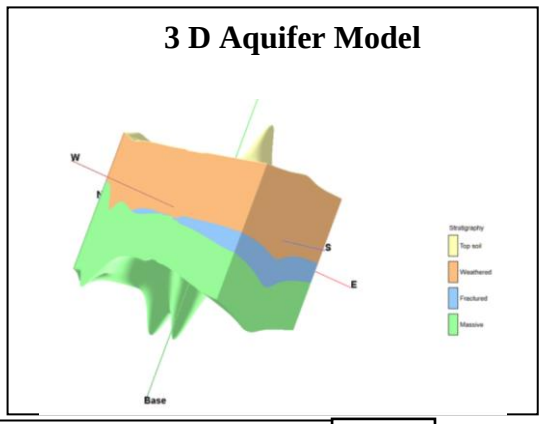
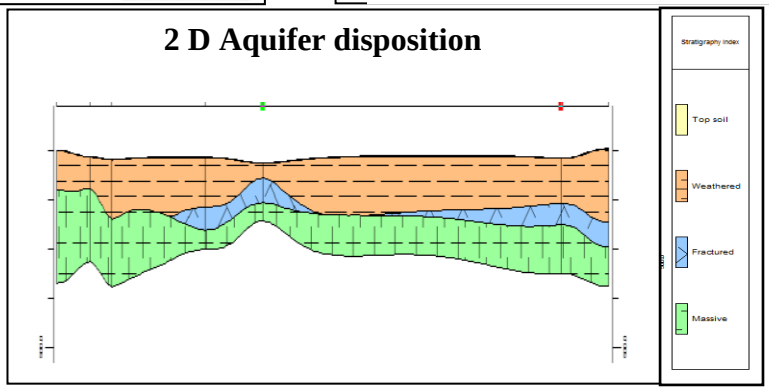
AQUIFER MAPS AND MANAGEMENT PLAN, BANGALORE NORTH TALUK, BANGALORE URBAN DISTRICT, KARNATAKA STATE

(AAP – 2020-2021)







By

Sangita P. Bhattacharjee, Scientist 'B', CGWB, SWR, Bengaluru

JULY 2022

AQUIFER MAPS AND MANAGEMENT PLAN, BANGALORE NORTH TALUK, BANGALORE URBAN DISTRICT, KARNATAKA STATE

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AQUIFER MAPS AND MANAGEMENT PLAN, BANGALORE NORTH TALUK, BANGALORE URBAN DISTRICT, KARNATAKA STATE

1 SALIENT INFORMATION

Name of the Taluk: **BANGALORE NORTH**

District: Bangalore Urban

State: Karnataka

Area: 799 sq. km.

Population: 352420 (as per 2011 census)

Annual Normal Rainfall: 870 mm

1.1 Aquifer Management Study Area

Aquifer mapping studies were carried out in Bangalore North Taluk, Bangalore Urban district o f Karnataka, covering an area of 799 sq.km under National Aquifer Mapping Project during the AAP of 2020-21. The Taluk is located between north latitude E 77°22'24.5" to 77°44'29.5" & east longitude N 12°54'52.5" to 13°13'53.3" and is bounded by Bangalore South Taluk in South, Bangalore East Taluk in East and Bangalore rural district in North and East. The location map is presented in **Fig 1**. Taluk administration of Bangalore North Taluk is divided into 6 Hoblies, 39 Gram Panchayats and 199 villages.

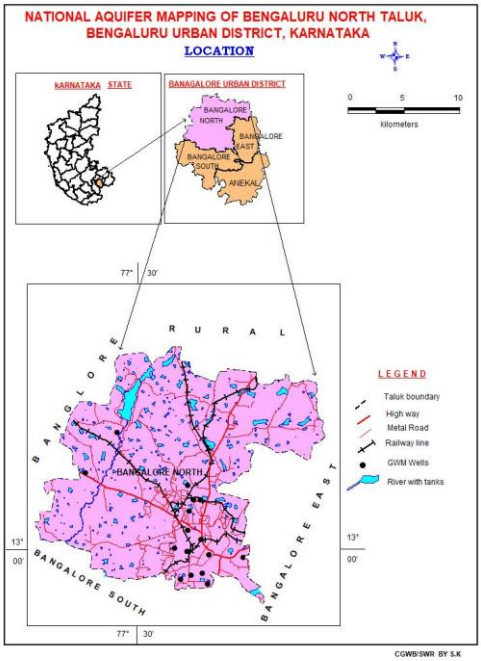


Fig.1: Location Map

1.2 Population

According to 2011 census, the population in Bangalore North Taluk is 352420, of which 77% people live in rural areas and 23% lives in urban areas. In 2011, there were total 166442 females and 185978 males residing in Bangalore North Taluk.

1.3 Rainfall

Bangalore North Taluk enjoys semi-arid climate. Dryness and warm weather prevail in major part of the year. The area falls under Eastern Dry agro-climatic zone of Karnataka state and is categorized as drought prone.

The climate of the study area is quite agreeable and free from extremes. The year is usually divided into four seasons: summer from March to May; rainy season or south-west monsoon season from June to September; post-monsoon season covering the months of October and November and dry or winter Season from December to February.

There are 9 working rain gauge stations. The annual normal rainfall is 870 mm with rainy days of 56 days. And for the year 2019, 937 mm rainfall is recorded. The actual rainfall from the year 2006 to 2019 for the taluk is presented in Table 1.

Table 1: Actual Rainfall in Bangalore North taluk from the year 2006 to 2019

Actual Annual Rainfall from 2006 to 2019 (mm)													
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
681	1246	1287	1058	1039	1179	724	583	1164	1269	1019	1678	1031	937

1.4 Agriculture and Irrigation

Agriculture and Services are the main occupation in Bangalore North Taluk and the rest is covered by built up area. Food grains are the major crop grown in the taluk accounting for almost 56 percent of the total area sown. Cereals (50 %), Pulses (6%) fruits (10%), Vegetables (6.5%) and Oil seeds (0.5%) of the total area sown respectively **(Table 2)**.

Table 2: Cropping pattern in Bangalore North Taluk 2016-2017(Ha)

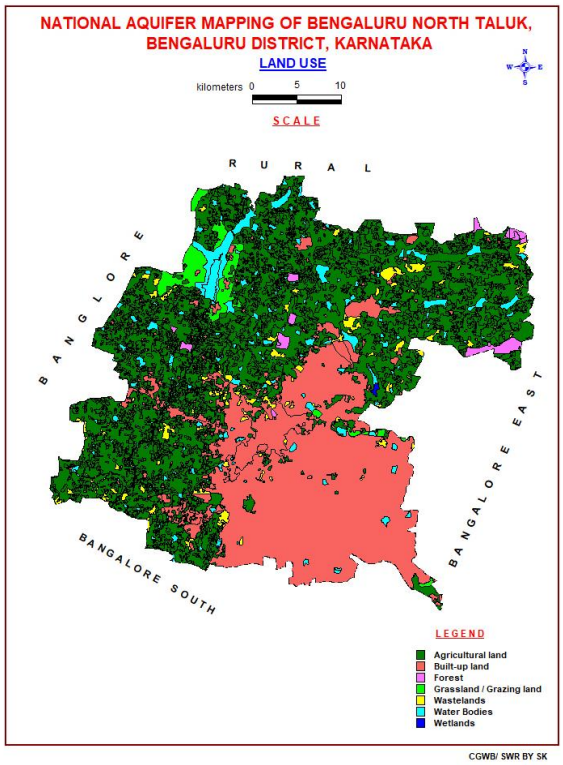
Year	Cereals	Pulses	Food Grains	Fruits	Vegetables	Oilseeds	Commercial crops
2016-17	6895	878	7773	1422	894	72	0

It is observed that net sown area accounts for about 16% of total geographical area, while area sown more than once is 0.88 % of total geographical area in the taluk **(Table 3).** As per the data available, the taluk uses only tube wells for irrigation. Around 5125 tube wells are used for irrigation purpose **(Table 4).** Land use pattern of the Taluk is represented as **Fig.2**.

Table 3: Details of land use in Bangalore North Taluk 2016-2017(Ha)

Area under Forest	Land put to non-agricultural use	Barren and uncultivable land	Other uncultivated land	Fallow land	Net area sown	Area sown more than once	Total area sown
1145	15221	3535	5989	13181	13064	711	13775

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



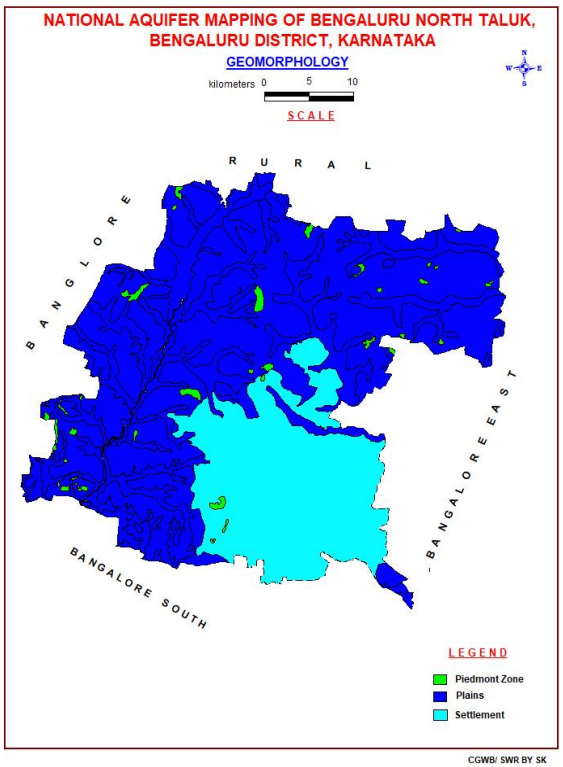


Fig. 2: Land use Map **Fig.3: Geomorphology**

Table 4: Irrigation details in Bangalore North Taluk (Ha)

Source of Irrigation	No.	Net Area irrigated (Ha)
Canals	0	0
Tanks	205	0
Wells	6	0
Tube /Borewells	5125	2251
Lift Irrigation	0	0
Other Sources	0	0
Total	**5336**	**2251**

Source: District at a Glance 2016-17, Government of Karnataka

1.5 Geomorphology, Physiography and Drainage

The entire taluk is categorised as plains of denudational origin interspersed with piedmont zones **(Fig. 3).** In the middle of the taluk a prominent ridge trends in NNE-SSW. Doddabettahalli at 962 m is the highest point. The ground altitude varies from 839 to 962 m above MSL. The taluk falls in Cauvery River basin. The drainage pattern in dendritic to sub-dendritic. **(Fig. 4).**

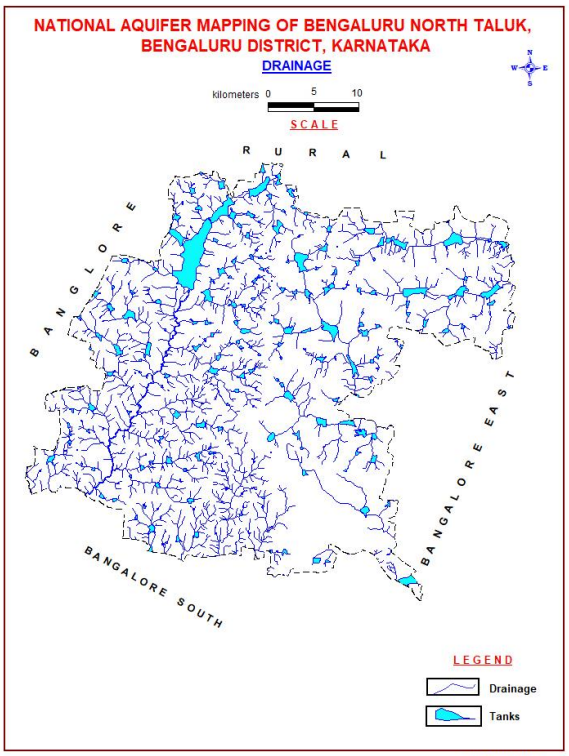


Fig. 4: Drainage

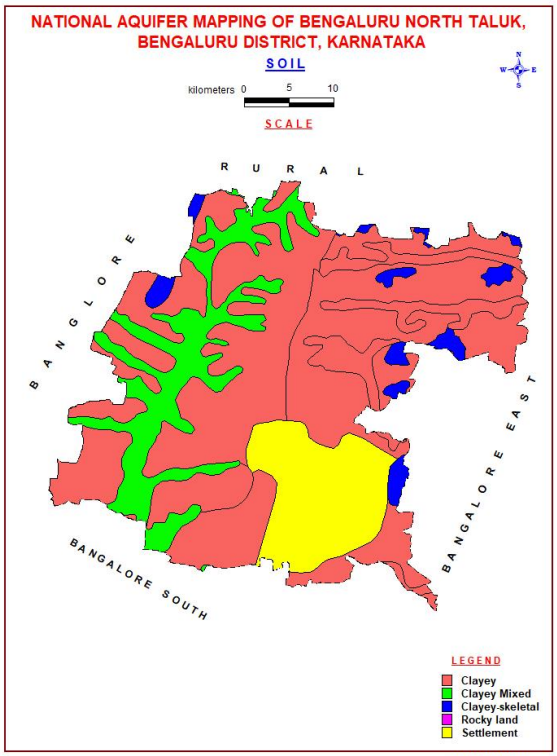


Fig. 5: Soil Map

1.6 Soil

The taluk is occupied by varieties of clayey soils viz. clayey and clayey mixed soils (rocky) generally occur on hilly to undulating land slope on granite and granite gneisses. Formation of various types of soils is a complex function of chemical weathering of bedrocks, vegetative decay and circulation of precipitated water. Soils are mostly insitu in nature **(Fig. 5).**

1.7 Ground water resource availability and extraction

Aquifer wise total ground water resources up to 200 m depth are given in **Table 5** below.

Table 5: Total GW Resources (as on March 2017) (Ham)

Taluk	Annual Replenishable GW resources	Fresh In-storage GW resources		Total availability of fresh GW resources
		Phreatic	Fractured (Down to 200 m)	Dynamic + Phreatic in-storage + fractured
Bangalore North	3239	10199	1297	14735

1.8 Existing and future water demands (as per GEC-2017)

- Irrigation development: Nil due to Over-exploited category.
- Domestic & Industrial Use (for next 25 years): 352 Ham

1.9 Water level behaviour

The depth to water level maps for the year 2019 is given in **Fig 6 and Fig 7** respectively for Aquifer I. During premonsoon season, it varies from 0.87 m bgl to 15.16 m bgl and the water level map shows that in 15% of the area water level ranges in between 2 and 5 mbgl, in 65% of the area water level ranges in between 5 and 10 mbgl and that in 20% of the area water level ranges in between 10 and 20 mbgl. During post monsoon, the water level varies from 0.75 m bgl to 15.63 m bgl and water level map shows that in 10 % of the area water level ranges in between GL and 2 mbgl, in 65 % of the area water level ranges between 2 and 5 mbgl, in 15 % of the area water level ranges in between 5 and 10 mbgl and 10 % of the area water level ranges in between 10 and 20 mbgl.

Aquifer-I

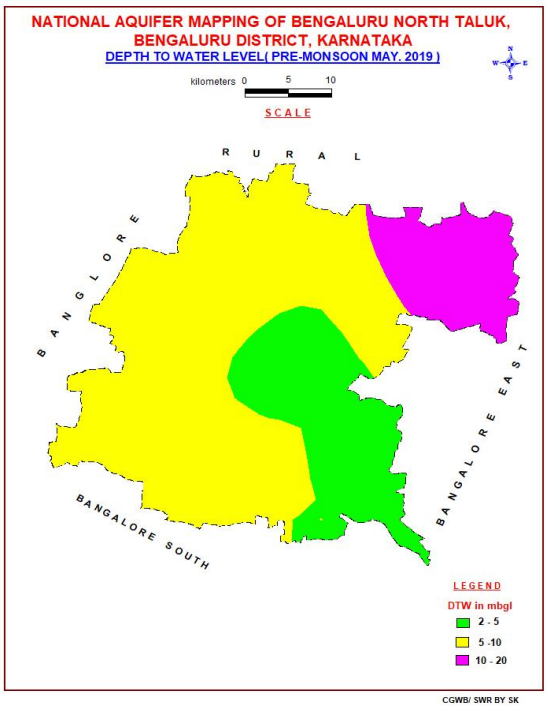
Pre monsoon: 0.87 to 15.16 m bgl (**Fig.6**)

Post-monsoon-0.75 to 15.63 m bgl (**Fig.7)**

Aquifer II

Pre-monsoon: 3.20 to 57.38 m bgl

Post-monsoon:2.50 to 37.50 mbgl



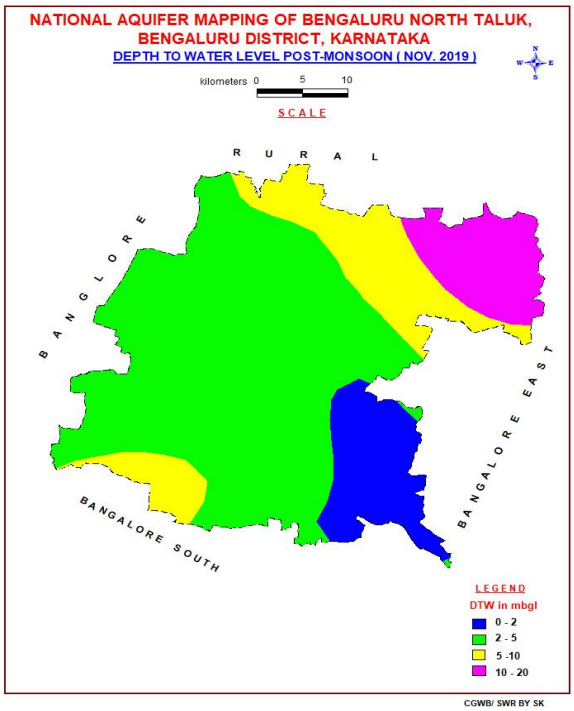


Fig. 6: Pre-Monsoon Depth to Water Leve (May 2019). Fig 7: Depth to water level - Post Monsoon (Nov 2019)

2 AQUIFER DISPOSITION

The Bangalore North Taluk is underlain by banded gneissic complex and granites of Archaean age. **(Fig 8)** Both the rock types are weathered.

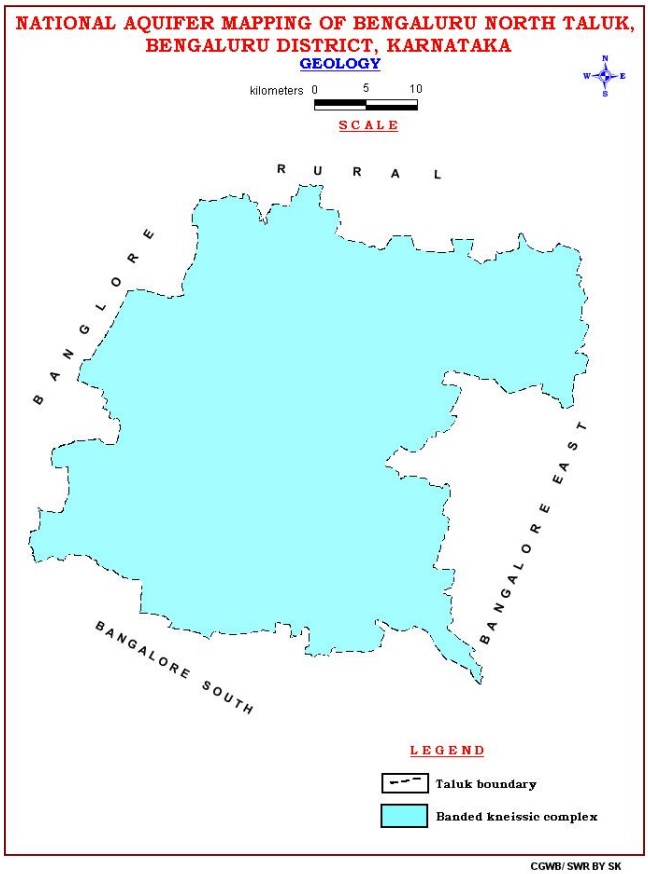


Fig.8: Geology map of Bangalore North

2.1 Number of aquifers

In Bangalore North Taluk, the hard rock aquifers comprising of Granites and Granite gneisses. There are mainly two aquifer systems;

2.1.1 Aquifer -I (Phreatic aquifer)

The phreatic aquifer forms the aquifer I in the weathered portions of the hard rocks. Thickness of weathered zone ranges from 3 mbgl to 32.75 mbgl.

2.1.2 Aquifer II (Fractured aquifer)

In Bangalore North Taluk, fractured granite and gneisses are now the major water bearing formations. Groundwater occurs within fractured Granite under semi-confined to confined conditions. Thickness ranges from 33 to 210 m bgl. In the Taluk bore wells were drilled from a minimum depth of 50.25 to 241.37 m bgl (**Table 6)**. Ground water exploration reveals that aquifer-II fractured formation was encountered between the depths of 33 to 210 m bgl. Yield ranges from <1 to 4.26 lps. Disposition of the Aquifers are depicted in **Fig 9 a** & **b.**

Table 6: Details of Ground water Exploration

Location	EW/OW/PZ	Lat	Long	Depth drilled (mbgl)	Casing (mbgl)	Major Lithology encountered	Zones Encountered	Static Water level (mbgl)	Discharge (lps)	T (m2/day
B'lore-GSI	PZ	12.91027	77.56805	200.2	12	Granite gneiss	11.2-32.12 30.48-32.12		0.51	

Blore CWC	PZ	13.03944	77.53888	52		Granite gneiss				
IISc, Sadashivnagar	EW	13.02775	77.56916	162.5	32.75	Granitic Gneiss with veins	22.84-24.48, 34.12-35.12, 43.76-47.40, 158.36-162.50	54.8	4.26	281.24
Cubbon Park	EW	12.97436	77.59388	116.16	11.5	Granitic gneiss	9.20-11.20, 32.12-34.12	2.12	1	
BWSSB Yelhanka, Jakkur	EW	13.09527	77.60597	139.08	24.05	Fractured and weathered granitic gneiss	59.04 - 61.04, 89.60 - 91.60,137.44 - 139.08	1.6	0.75	4.55
Rachnehalli , Jakkur	EW	13.09750	77.60944	100.88	32	Granitic gneiss , weathered	Nil	24.3	0.08	365.5
IIM, Bannerghatta Road	EW	13.89555	77.60000	108.52	32.5	Granitic gneiss	51.4-55.04	30.8	0.22	1277.75
Hessarghatta	PZ	13.13333	77.50361	310	18	Granite	171.9-173	160.9	negligible	
Vidyanagar	EW	13.14166	77.66666	209.27	39.1	Granitic Gneiss	32, 32.40, 60.49, 62.49, 64, 66.11, 209.27			
Yelahanka	EW	13.11111	77.57083	200	31.5	Granitic Gneiss	31,49,64, 140		1.4	7
Hessarghatta I	EW	13.08888	77.49444	241.37		Granitic Gneiss with quartz	13-21,28-29, 50,80-89		1.75	14
Hassarghatta	OW II	13.08888	77.49444	100		Granitic Gneiss, quartzite	15-19,46-47, 58-60,64-68		1.75	12
Hassarghatta	OW II	13.08888	77.49444	50.25		Granitic Gneiss	15-17, 21-23, 44-46		0.13	
Nimhans	PZ	12.93861	77.59208	100	32.5	Granitic Gneiss with pegmatite veins	47.40-51.40, 68.68-72.32	5.36	1	

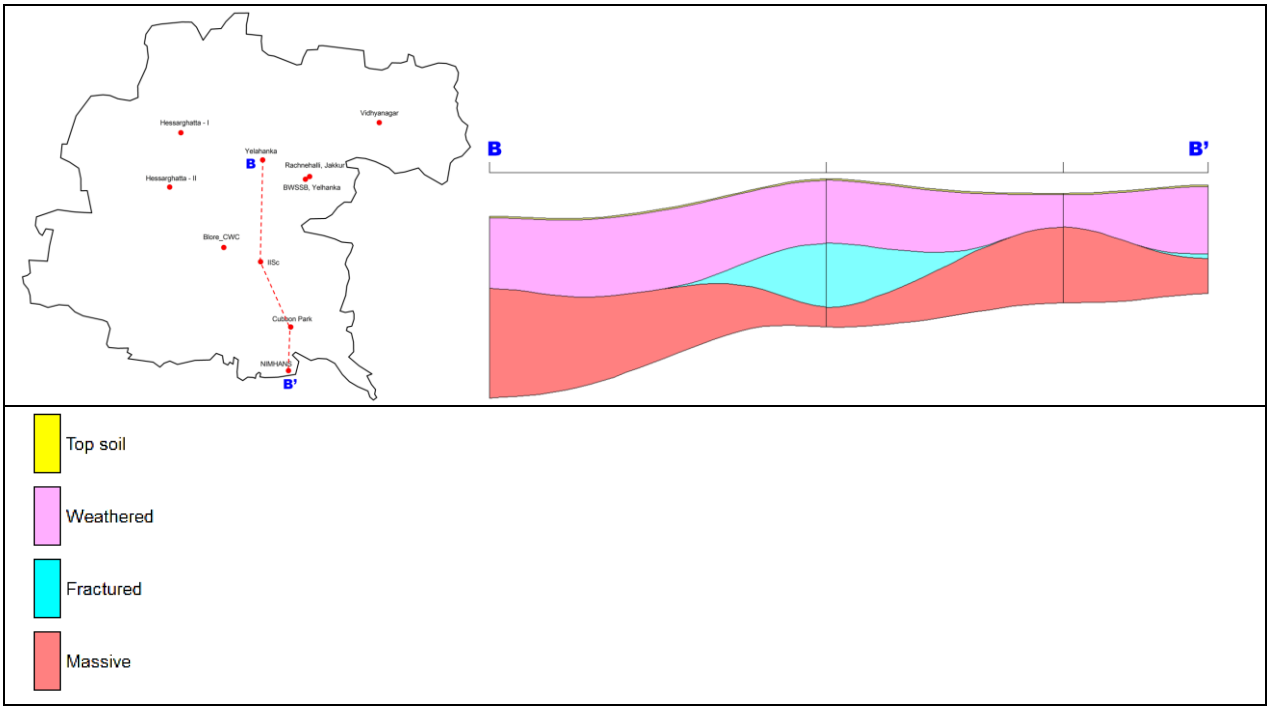


Fig.9a: 2D Cross section in Bangalore North Taluk

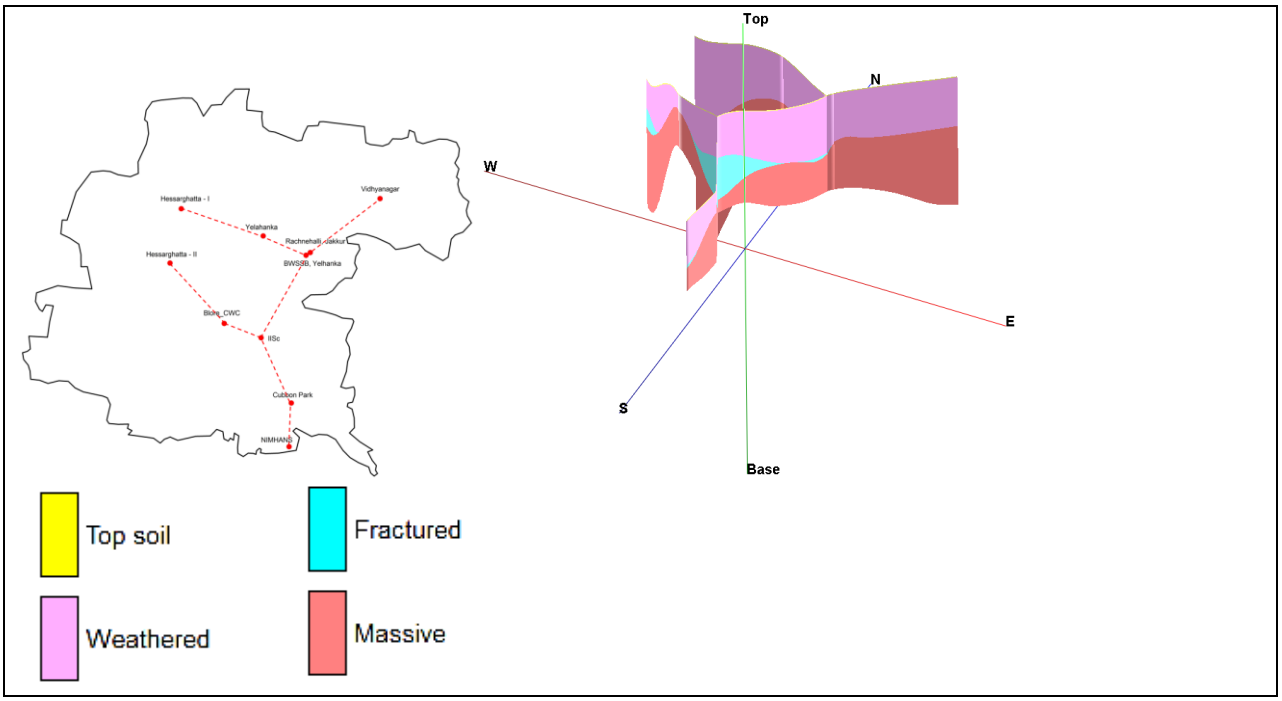


Fig.9b: 3D Cross section in Bangalore North Taluk

3 GROUND WATER RESOURCE, EXTRACTION, CONTAMINATION AND OTHER ISSUES

The main ground water issues are urbanisation, less recharge worthy areas, over exploitation, limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, declining water level trend which are all inter-related or inter dependent and Inferior ground water quality due to nitrate contamination in major part of the area.

3.1 Aquifer wise groundwater resource availability and extraction

Aquifer wise resource availability and extraction as on 2020 is given in Table 7(a). The Dynamic Ground Water Resource as on 2020 have been summarised above and are shown in Table 7(a). It indicates that the net ground water availability is 2023.34 ham and the total ground water draft for all uses is 2932 ham with stage of development at 145% and the taluk falls in Over Exploited category. Thus, the taluk is already under stress from ground water point of view. The domestic (Industrial sector) demand for next 25 years is estimated at 142 Ham

Table 7(a): Present Dynamic Ground Water Resource (2020) in ham

Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground Water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft for All Uses	Allocation For Domestic and Industrial Use for Next 25 Years	Net Ground Water Availability for Future Irrigation Development	Existing Stage of Ground Water Development (%)	Category
2023.34	2808.70	123.27	2931.98	142.03	Nil	144.91	Over Exploited

Table: 7(b) Comparison of Ground Water Availability and Draft Scenario in Bangalore North Taluk

GW availability (ham)	GW draft (ham)	Stage of GW Development (%)	GW availability (ham)	GW draft (ham)	Stage of GW Development (%)	GW availability (ham)	GW draft (ham)	Stage of GW Development (%)	GW availability (ham)	GW draft (ham)	Stage of GW Development (%)
2009			**2011**			**2013**			**2017**		
2975.29	4028.38	135	3269	4174	128	2959	3889	131	3239	4337	134

3.2 Comparison of Ground Water Resource and Extraction

Table 7(b) gives comparison with previous groundwater resource estimations in 2009, 2011, 2013 and 2017. It is observed that the ground water availability has increased over the period mainly due to good rainfall and water conservation activities taken up by State Govt. However, the draft has also increased accordingly for irrigation and domestic use, thereby not much change in stage of extraction and category has been noticed over the period. It is attributable to the intense urbanization.

3.3 Ground Water Quality and Contamination

The water samples from shallow aquifers of GWMS were collected during pre-monsoon and analysed in the Regional Chemical Laboratory for pH, Electrical Conductivity (EC), Chloride, Nitrate and Fluoride by employing standard methods. Based on the hydro chemical data, the potability of these samples has been assessed as per the Standards prescribed by the Bureau of Indian Standards (IS 10500: 2012) and categorized into 'Desirable', 'Permissible' and 'Unsuitable' classes.

The electrical conductivity in water samples is an indication of total dissolved ions. Thus, the higher the EC, the higher the levels of dissolved ions in the sample. The perusal of the data indicates that the distribution of electrical conductivity in the taluk shows wide variations (220-2170 µS/cm at 25˚ C). The BIS has recommended a drinking water standard for total dissolved solids a limit of 500 mg/l (corresponding to about EC of 750 µS/cm at 25˚ C) can be extended to a TDS of 2000 mg/l (corresponding to about 3000 µS/cm at 25˚ C) in case of absence of an alternate source. Water samples having TDS more than 2250 mg/l are not suitable for drinking purpose. In the taluk all the samples were within 2250 mg/l **(Fig 10).**

One of the essential elements for maintaining normal development of healthy teeth and bones is Fluoride. Lower concentrations of fluoride usually below 0.6mg/l may contribute to dental caries. However, continuing consumption of higher concentrations, above 1.2 mg/l however cause dental fluorosis and in extreme cases even skeletal fluorosis. Most of the fluoride found in groundwater is of geogenic origin. Distribution of fluoride in the taluk ranges from 0.02 to1.56 mg/l. Thus, all the samples in the taluk show fluoride concentration below 1.5 mg/l rendering them suitable for drinking purpose (Fig.11).

Nitrate is a problem as a contaminant in drinking water (primarily from groundwater and wells) due to its harmful biological effects. High concentrations can cause methemoglobinemia, and have been cited as a risk factor in developing gastric, an intestinal cancer. The distribution of nitrate in the taluk indicated that the values are in the range of 0.2 to 145 mg/l. Nitrate in drinking water should not exceed 45 mg/l as per BIS (ISO: 10500: 2012) standard **(Fig.12)** and some the samples collected from the taluk indicates that the ground water is contaminated by nitrate.

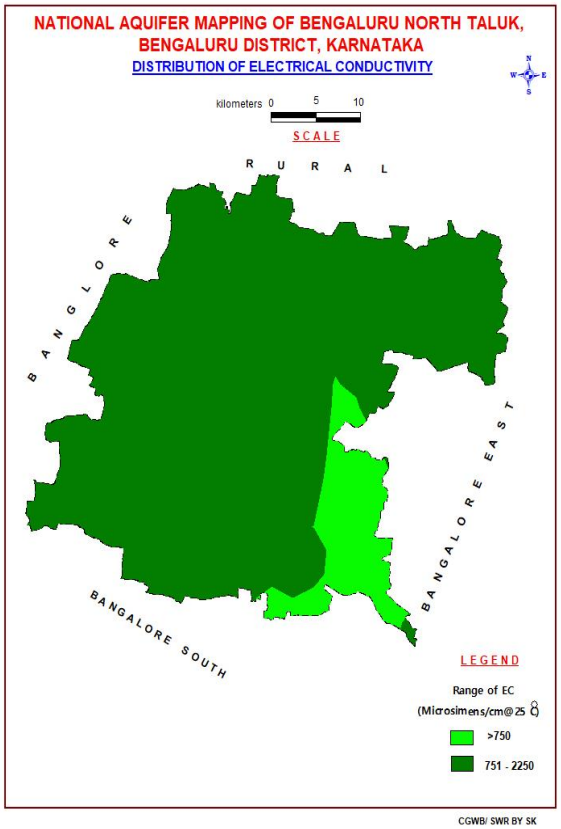


Fig 10: Distribution of EC

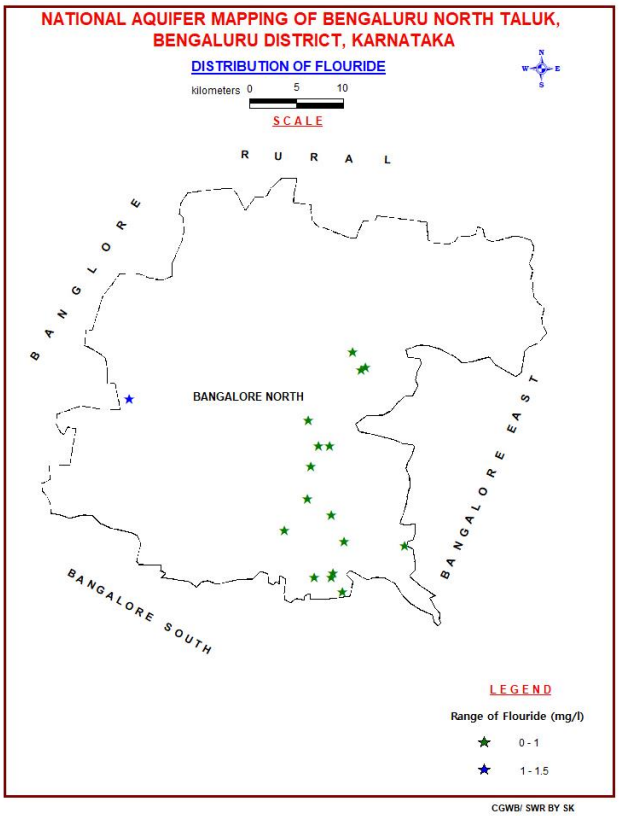


Fig 11: Distribution of Fluoride

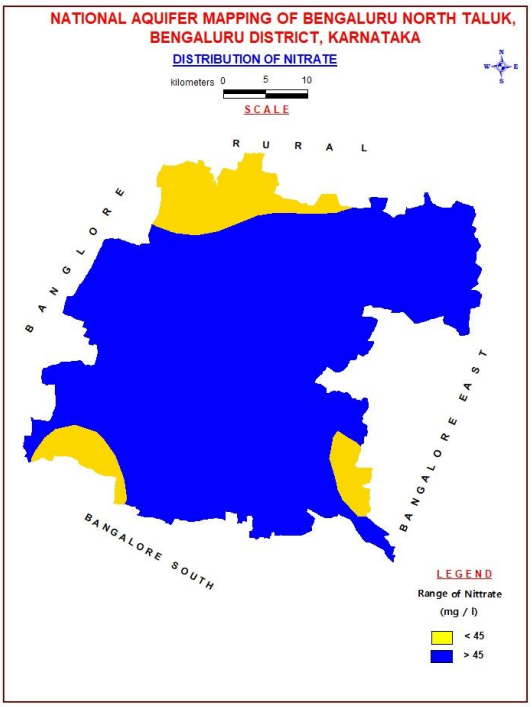


Fig 12: Distribution of Nitrate

A perusal of chemical quality in Fractured Aquifer (Aquifer-II), indicates the following:

- EC: 86 to 2300 (µS/cm at 25°C)
- F: 0.14 to 0.67 mg/l
- NO_3: 2 to 129 mg/l

Thus, it can be inferred that chemical quality of both phreatic and fractured aquifer is good for domestic and irrigation purpose for almost all the parameters, however it is contaminated by localized nitrate pollution which is anthropogenic in origin.

4 GROUND WATER RESOURCE ENHANCEMENT

As per the latest Groundwater resource estimation (GWRA 2020), Bangalore North is categorised as an Over exploited Taluk. Urbanisation and over exploitation are the main issues. Hence, there is an urgent need for proper management of the resource and make it sustainable for future. This is possible by enhancing the existing ground water resource and lessening the extraction of resources so to maintain a balance between the two and make the situation sustainable for future generation. The present trend of declining water levels and drying up of wells has to be controlled to achieve sustainability. Various management techniques such as artificial recharge of groundwater, change in irrigation pattern, change in cropping pattern, restricting free power supply etc can be adopted to bring about the change. Afforestation, revitalization of traditional water bodies schemes had to be implemented too.

4.1 Resource Enhancement by Supply side interventions

Enhancing the groundwater resources is proposed to be brought about by artificial recharge and rainwater harvesting, watershed management measures and various other innovative water conservation techniques. The pre-condition for artificial recharge is presence of uncommitted surface run off and storage space in the aquifers to be recharged. An area of 553 sq.km is found feasible for Artificial Recharge Structures. For this, a total of 1 sub-surface

dykes, 50 percolation tank and 293 Check dams are proposed to be constructed. The volume of water expected to be conserved/recharged @ 10% efficiency considering the urban and hard rock areas is 5.50 MCM through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 39.53 Cr. The details are furnished below in **Table 8.1**. The tentative locations of proposed AR structures and area feasible for recharge is shown in **Fig.-13**, whereas the location details of check dams and percolation tanks are presented in **Annexure-I and II** respectively.

However, the location of recharge structures should be site specific and restricted to areas already identified as feasible for artificial recharge.

Table 8.1: Quantity of non-committed surface runoff and expected recharge through AR structures

Artificial Recharge Structures Proposal	**Bangalore North Taluk**
Area feasible for recharge (sq.km)	553
Non committed monsoon runoff available (MCM)	55.00
Number of Check Dams	293
Number of Percolation Tanks	50
Number of sub surface dyke	1
Tentative total cost of the project (Rs.in Cr)	39.53
Expected Recharge from Artificial Recharge Structures @ 10 % in MCM	5.50

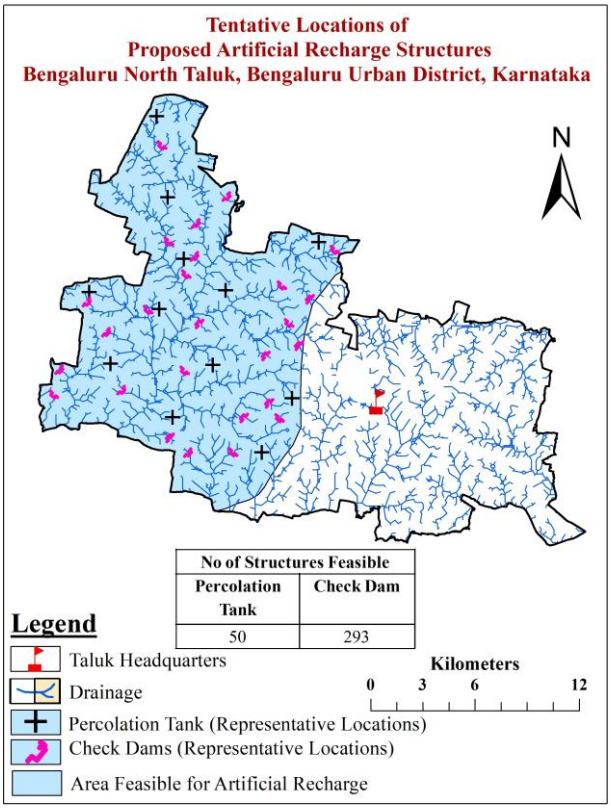


Fig 13: Tentative locations of representative artificial recharge structures.

4.2 Point recharge / Bore-well recharge

A pumping well can be converted into recharge well by providing a filter bed of 3m square and 2m to 3m depth adjoining the pumping well and filled with filter material. This can be connected to the pumping well through a 300 mm diameter pipe at the bottom of the filter bed. This will prevent silt and other matter entering into the pumping well. The first flood should not be tapped if the catchments consist of agricultural land as it may carry residual chemical.

4.3 Rejuvenation of tanks, traditional water bodies and other water bodies

About 205 tanks are present in the taluk may be desilted and embankments strengthened /renovated so as to water which in turn will serve to recharge the groundwater too. The Taluk has a number of traditional water bodies like Kalyanis. These may be revived by desilting and periodic maintenance.

4.4 Roof Top Rain Water Harvesting (RTRWH)

Roof Top Rain Water Harvesting is the technique of collection and storage of rainwater at rooftop at surface or in sub-surface aquifer. Rainwater available from rooftops of buildings/houses can be recharged to aquifer. The Rooftop rain water can be harvested for storage in tanks / sump in roof tops, ground level or can be diverted to recharge aquifer through the dugwell/bore-wells available.

In residential areas, water falling on rooftops can be collected and diverted to the open well / bore well by providing a filter bed around it. Many roof rainwater filters are available in the market, including the rainy filter and the pop-up filter. They can be used while recharging the bore wells. storm water may be diverted to recharge deeper aquifers through Bore wells in public places such as parks or open playgrounds. Clean storm water can be filtered thoroughly through a recharge pit filled with materials such as stone, charcoal and sand and then allowed into bore wells.

4.5 Resource Savings by Demand Side Interventions

4.5.1 Water Use Efficiency by Micro Irrigation Practices

In Bangalore North Taluk, both rainfed irrigation and irrigation from tube or bore wells are practiced. But an area of 2251 ha is the net area irrigated by these groundwater sources. Water use efficiency measures have to be adopted for saving the ground water resources.

Efficient irrigation practices like drip irrigation and sprinkler have to be adopted by the farmers in the existing 2251 ha of gross irrigated area. It is proposed to adopt micro irrigation (drip) techniques in fruits and vegetable grown area of 2316 ha. It is assumed that 50% of this area i.e., 1158 ha is irrigated by ground water. Implementation of efficient irrigation techniques will contribute in saving ground water by 145 ham and thus enhancing the cumulative net availability of ground water from 2573 ham to 2718 ham. Being an urban area, sewage water to the tune of 3951 ham, which can be subjected to tertiary/secondary treatment and the treated water can be reused. However, almost entire treated water is being transferred to Kolar and Chikballapur talukas for ground water recharge, thus this quantum cannot be used for reuse in the taluk. **(Table 9).**

Table 12: Details of Resource Enhancement after proposed supply side and demand side interventions

Sl. No.	Resource Details	As per 2020 Estimation
1	Net Ground Water Availability in Ham	2023
2	Existing ground water draft for all uses in Ham	2932
3	Existing Stage of Ground Water Development in percentage %	145
4	Expected Recharge from Artificial Recharge sources Ham	550
5	Cumulative Ground water availability after adopting AR in Ham	2573
6	Expected improvement in stage of ground water development %	31
7	50% of Fruits and vegetable grown area (Ha)	1158
8	Expected Savings (m) (Surface irrigation – 0.50 m, Drip irrigation – 0.375)	0.125
9	Saving due to adopting water Use Efficiency measures in Ham	145
10	Saving due to adopting grey water in Ham	Nil as treated water is transferred to other taluks for AR
11	Cumulative Ground water availability after adopting WUE and AR in Ham	2718
12	Expected improved stage of ground water development after implementation of WUE and AR %	108% from 145%

4.5.2 Change in crops

Bangalore North being over exploited taluk water intensive crops may not to be promoted for cultivation. Water intensive crops like paddy, banana and sugarcane should be avoided as far as possible in ground water stressed areas. Paddy requires about 4 times more water as compared to other crops like ragi, wheat, jowar, bajra, pulses and ground nuts etc. The farmers may be advised to shift over to less water intensive crops. Already in Bangalore North Taluk, the farmers have started practising cultivation of less water intensive crops. Here, food grains are the major crops and among these the major cereal crops are Maize and Ragi which are mostly rainfed. The AR and WUE measures will be adequate to address the issue of over exploitation, hence change in cropping pattern is not recommended.

4.6 Regulation and Control

The entire Taluk is in non-command area with the stage of development 144.91% and is falling under over exploited category (GWRA 2020). The Karnataka Ground Water Authority (KGWA) is tasked with regulation of groundwater and NOC has to be obtained for industrial/commercial purpose. Strict regulation has to be enforced by KGWA like protecting/notifying the deeper aquifers below 100 m depth for drinking and domestic use for controlling the over exploitation of ground water in the Taluk. Groundwater recharge component needs to be made mandatory in the Taluk to save the situation from deteriorating further.

Spacing of drinking water bore wells: Bore wells are drilled close to each other, sometimes less than 100 mts, resulting in mutual interference and dwindling of yield and eventually drying up of these bore wells. The spacing of bore wells may be regulated and indiscriminate drilling of irrigation bore wells close to the drinking water wells. Artificial recharge structures may be constructed to sustain the sources of drinking water supply.

Restricting of Power Supply: It is observed that there is continuous pumping of the irrigation bore-wells continuously during morning and again in the evening during power supply time. This should be regulated to need based pumping.

4.7 Other measures proposed:

- **Maintenance of artificial recharge structures:** Maintenance of artificial recharge structures is essential as the process of recharge is a continuous one and the benefits would be felt over a period of time and mostly of indirect in nature. Further, the measures adopted are mainly oriented towards protecting and improving the natural ground water environment.
- **Capacity building and training:** The involvement of the public and their participation in implementing artificial recharge scheme is another important criterion for proper water conservation and management. This needs proper awareness and understanding of such schemes. Hence, awareness and training programmes are essential. The water harvesting and recharging of ground water would require group action by communities, societies, and farmers with financial assistance from govt. and financial institutions.
- **Key well monitoring and Rain fall monitoring:** Sufficient number of Key wells may be established for monitoring the water level in the aquifers and also to have a historical data bank on the groundwater conditions. Rain gauge station is to be established to have data on rainfall pattern.
- **Groundwater quality monitoring:** The quality of groundwater may be monitored from the key wells and data and other technical reports so generated may be disseminated with concerned state government departments.

5 SUMMARY AND RECOMMENDATIONS

The main ground water issues are urbanisation, reduction in recharge worthy areas, over exploitation, Limited Ground Water Potential / Limited Aquifer Thickness / Sustainability, Deeper Water Levels particularly in Aquifer-II in some parts which are all inter-related or inter dependent and Inferior Ground Water Quality due to nitrate contamination in major part of the area. The summary of ground water management plan of Bangalore North taluk is given in Table-13.

Table 13: Summary of Management plan of Bangalore North Taluk

Stage of GW Extraction and Category (2020)	144.91 %, Over Exploited
Annual Extractable GW Resource (Ham)	2023.34
Total Extraction (Ham)	2931.98
Ground Water Draft for Irrigation (Ham)	2808.70
Ground Water Resource Enhancement by Supply side Interventions	
No of Proposed AR structures SSD PT CD Filter Beds	 1 50 293 0
Expected Additional Recharge to GW due to AR (Ham)	550

Total Estimated Expenditure (Rs. in Cr)		39.53
Rejuvenation of tanks, traditional water bodies and other water bodies		205 water bodies
Ground Water Resource Savings by Demand side Interventions		
50% of Fruits and vegetable grown area (Ha)		1158
Expected Savings (m) (Surface irrigation – 0.50 m, Drip irrigation – 0.375)		0.125
Expected Saving due to adopting WUE (Ham)		145
Expected Saving due to adopting grey water use (Ham)		2718
Change in Stage of GW development (%)		108% from 145%
Change in Cropping Pattern		Not Suggested
Ground Water Quality – Nitrate contamination	Improving quality by proper drainage of sewage and Limited usage of Nitrogenous fertilizers	
Ground Water Regulation	Strict regulation has to be enforced by KGWA like protecting/notifying the deeper aquifers below 100 m depth for drinking and domestic use.	

As per the resource estimation – 2020, Bangalore North taluk falls under Over-exploited category with the stage of ground water extraction is 144.91 %. Thus, there is need to formulate management strategy to tackle the over exploitation related issues in the taluk. It is suggested to adopt a scientific and multi-pronged ground water management strategy covering supply side interventions, demand side interventions, regulation and ground water quality protection aspects as mentioned in the management plan suggested above

Ground water resource enhancement by supply side interventions: Quantity of surface water available through non-committed surface run-off is estimated to be 5500 ham. This can be used to recharge the aquifer mainly through percolation tanks (50) and check dams (293). The volume of water expected to be conserved/recharged @ 10% efficiency is 550 ham through these AR structures. The approximate cost estimate for construction of these AR structures is Rs. 39.53 Cr. However, the figures given are tentative and pre-field studies / DPR are recommended prior to implementation of these recharge structures. Along with this, rejuvenation of 205 tanks, traditional water bodies and other water bodies needs to be taken up. Cumulative Ground water availability after adopting AR in the identified area will be 2573 Ham.

Ground water resource enhancement by demand side interventions: At present maximum irrigation is by bore wells (ground water). The micro irrigation practices like drip and sprinkler irrigation are practiced to less extent in comparison with traditional mode of irrigation. Implementation of efficient irrigation techniques in fruits and vegetable grown area will contribute in saving ground water by 145 ham and thus enhancing the cumulative net availability of ground water from 2573 ham to 2718 ham. However, in long run the practice of efficient irrigation techniques will add to the ground water resource in large extent.

Ground Water Quality – Nitrate contamination can be addressed by improving quality by proper drainage of sewage and Limited usage of Nitrogenous fertilizers

Ground Water Regulation - Strict regulation has to be enforced by KGWA like protecting/notifying the deeper aquifers below 100 m depth for drinking and domestic use.

The change in stage of ground water extraction after effective implementation of above proposed interventions will be reduced from 145% to 108%.

Annexure-I: Tentative Location Details of Proposed Check Dams.

S. No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	77.4743	12.9537	K.G.Ullalu	Bangalore (North)	Bangalore (North)
2	77.4709	12.9553	J.I.Manganahalli	Kodige Halli	Bangalore (North)
3	77.4683	12.9595	J.I.Manganahalli	Kodige Halli	Bangalore (North)
4	77.4740	12.9602	J.I.Manganahalli	Kodige Halli	Bangalore (North)
5	77.4866	12.9618	Mallathahalli	Bangalore (North)	Bangalore (North)
6	77.4550	12.9624	Kannalli	Kodige Halli	Bangalore (North)
7	77.4701	12.9629	J.I.Manganahalli	Kodige Halli	Bangalore (North)
8	77.4592	12.9634	Kannalli	Kodige Halli	Bangalore (North)
9	77.4657	12.9643	Kannalli	Kodige Halli	Bangalore (North)
10	77.4459	12.9643	Kannalli	Kodige Halli	Bangalore (North)
11	77.4518	12.9654	Kannalli	Kodige Halli	Bangalore (North)
12	77.4765	12.9670	K.G.Ullalu	Bangalore (North)	Bangalore (North)
13	77.4916	12.9688	Gidadhakonenahalli	Bangalore (North)	Bangalore (North)
14	77.4664	12.9697	Kodigehalli	Kodige Halli	Bangalore (North)
15	77.4830	12.9705	K.G.Ullalu	Bangalore (North)	Bangalore (North)
16	77.4712	12.9736	Kodigehalli	Kodige Halli	Bangalore (North)
17	77.4943	12.9742	Gidadhakonenahalli	Bangalore (North)	Bangalore (North)
18	77.4458	12.9745	K.G.Sheegehalli	Kodige Halli	Bangalore (North)
19	77.4659	12.9745	Kodigehalli	Kodige Halli	Bangalore (North)
20	77.4817	12.9767	Herohalli	Bangalore (North)	Bangalore (North)
21	77.4615	12.9777	Kodigehalli	Kodige Halli	Bangalore (North)
22	77.4572	12.9788	Kodigehalli	Kodige Halli	Bangalore (North)
23	77.4727	12.9794	Kodigehalli	Kodige Halli	Bangalore (North)
24	77.4499	12.9796	K.G.Sheegehalli	Kodige Halli	Bangalore (North)
25	77.4924	12.9803	Herohalli	Bangalore (North)	Bangalore (North)
26	77.4826	12.9817	Herohalli	Bangalore (North)	Bangalore (North)
27	77.5021	12.9827	Srigandhakavalu	Bangalore (North)	Bangalore (North)
28	77.4628	12.9837	Kodigehalli	Kodige Halli	Bangalore (North)
29	77.4550	12.9840	Kodigehalli	Kodige Halli	Bangalore (North)
30	77.4953	12.9853	Herohalli	Bangalore (North)	Bangalore (North)
31	77.4709	12.9854	Kodigehalli	Kodige Halli	Bangalore (North)
32	77.4342	12.9865	Kadabagere	Kadabagere	Bangalore (North)
33	77.4678	12.9871	Kachohalli	Kachohalli	Bangalore (North)
34	77.4547	12.9880	Machohalli	Maachohalli	Bangalore (North)
35	77.4647	12.9886	Kachohalli	Kachohalli	Bangalore (North)
36	77.4395	12.9887	Kadabagere	Kadabagere	Bangalore (North)
37	77.4908	12.9909	Herohalli	Bangalore (North)	Bangalore (North)
38	77.4206	12.9917	K.G.Giddenapalya	Kadabagere	Bangalore (North)
39	77.4998	12.9918	Srigandhakavalu	Bangalore (North)	Bangalore (North)
40	77.4934	12.9934	Herohalli	Bangalore (North)	Bangalore (North)
41	77.5072	12.9936	Srigandhakavalu	Bangalore (North)	Bangalore (North)
42	77.4565	12.9942	Machohalli	Maachohalli	Bangalore (North)
43	77.4473	12.9955	Kadabagere	Kadabagere	Bangalore (North)
44	77.4660	12.9958	Kachohalli	Kachohalli	Bangalore (North)
45	77.4861	12.9974	Herohalli	Bangalore (North)	Bangalore (North)
46	77.4977	12.9975	Herohalli	Bangalore (North)	Bangalore (North)
47	77.4365	12.9978	Kadabagere	Kadabagere	Bangalore (North)
48	77.4790	12.9983	Hosahalli Gollarapalya	Bangalore (North)	Bangalore (North)
49	77.4276	12.9985	Kadabagere	Kadabagere	Bangalore (North)
50	77.4067	12.9985	J.I.Ghattasiddanahalli	Kithana Halli	Bangalore (North)

51	77.4617	12.9991	Machohalli	Maachohalli	Bangalore (North)
52	77.4566	12.9995	Machohalli	Maachohalli	Bangalore (North)
53	77.4169	12.9998	K.G.Giddenapalya	Kadabagere	Bangalore (North)
54	77.3949	13.0003	Mallasandra	Kithana Halli	Bangalore (North)
55	77.5021	13.0010	K.G.Hegganahalli	Bangalore (North)	Bangalore (North)
56	77.3787	13.0012	Nagasandra	Sondekoppa	Bangalore (North)
57	77.4386	13.0018	Kadabagere	Kadabagere	Bangalore (North)
58	77.4320	13.0019	Kadabagere	Kadabagere	Bangalore (North)
59	77.4870	13.0020	Lingadeeranahalli	Bangalore (North)	Bangalore (North)
60	77.4468	13.0022	J.I.Byyandahalli	Maachohalli	Bangalore (North)
61	77.3744	13.0025	Nagasandra	Sondekoppa	Bangalore (North)
62	77.4092	13.0027	J.I.Ghattasiddanahalli	Kithana Halli	Bangalore (North)
63	77.4189	13.0036	J.I.Kitthnahalli	Kithana Halli	Bangalore (North)
64	77.4821	13.0036	Lingadeeranahalli	Bangalore (North)	Bangalore (North)
65	77.4972	13.0040	K.G.Hegganahalli	Bangalore (North)	Bangalore (North)
66	77.3829	13.0041	Kondekoppa	Sondekoppa	Bangalore (North)
67	77.4625	13.0044	Bylakonenahalli	Maachohalli	Bangalore (North)
68	77.4684	13.0046	Kachohalli	Kachohalli	Bangalore (North)
69	77.4925	13.0062	K.G.Handrahalli	Bangalore (North)	Bangalore (North)
70	77.4151	13.0067	J.I.Kitthnahalli	Kithana Halli	Bangalore (North)
71	77.4066	13.0073	J.I.Ghattasiddanahalli	Kithana Halli	Bangalore (North)
72	77.4774	13.0077	K.G.Handrahalli	Bangalore (North)	Bangalore (North)
73	77.4409	13.0080	J.I.Byyandahalli	Maachohalli	Bangalore (North)
74	77.3930	13.0082	Kondekoppa	Sondekoppa	Bangalore (North)
75	77.4230	13.0094	J.I.Kitthnahalli	Kithana Halli	Bangalore (North)
76	77.3991	13.0095	Mallasandra	Kithana Halli	Bangalore (North)
77	77.3786	13.0100	Nagasandra	Sondekoppa	Bangalore (North)
78	77.4894	13.0100	K.G.Handrahalli	Bangalore (North)	Bangalore (North)
79	77.4551	13.0108	Machohalli	Maachohalli	Bangalore (North)
80	77.4820	13.0109	K.G.Handrahalli	Bangalore (North)	Bangalore (North)
81	77.5036	13.0116	K.G.Nelakadharanahalli	Bangalore (North)	Bangalore (North)
82	77.4720	13.0119	Bylakonenahalli	Maachohalli	Bangalore (North)
83	77.4613	13.0119	Bylakonenahalli	Maachohalli	Bangalore (North)
84	77.3905	13.0124	Kondekoppa	Sondekoppa	Bangalore (North)
85	77.4942	13.0125	Karihobanahalli	Bangalore (North)	Bangalore (North)
86	77.3739	13.0126	Kondekoppa	Sondekoppa	Bangalore (North)
87	77.4156	13.0127	J.I.Kitthnahalli	Kithana Halli	Bangalore (North)
88	77.4995	13.0133	K.G.Nelakadharanahalli	Bangalore (North)	Bangalore (North)
89	77.3961	13.0136	Kondekoppa	Sondekoppa	Bangalore (North)
90	77.4525	13.0142	Vaddarapalya	Lakshimipura	Bangalore (North)
91	77.4091	13.0144	J.I.Kitthnahalli	Kithana Halli	Bangalore (North)
92	77.4442	13.0145	Vaddarapalya	Lakshimipura	Bangalore (North)
93	77.4766	13.0146	Gangondanahalli	Lakshimipura	Bangalore (North)
94	77.4234	13.0150	J.I.Kitthnahalli	Kithana Halli	Bangalore (North)
95	77.4020	13.0152	Kondekoppa	Sondekoppa	Bangalore (North)
96	77.5044	13.0156	K.G.Nelakadharanahalli	Bangalore (North)	Bangalore (North)
97	77.4382	13.0170	Bettahalli	Kithana Halli	Bangalore (North)
98	77.4868	13.0188	Karihobanahalli	Bangalore (North)	Bangalore (North)
99	77.4962	13.0193	Karihobanahalli	Bangalore (North)	Bangalore (North)
100	77.4532	13.0196	Vaddarapalya	Lakshimipura	Bangalore (North)
101	77.4127	13.0197	Ravuthanahalli	Kithana Halli	Bangalore (North)
102	77.4641	13.0203	Gangondanahalli	Lakshimipura	Bangalore (North)

103	77.4701	13.0203	Gangondanahalli	Lakshimipura	Bangalore (North)
104	77.4012	13.0207	J.I.Gollanapalya	Kithana Halli	Bangalore (North)
105	77.4766	13.0207	Gangondanahalli	Lakshimipura	Bangalore (North)
106	77.4283	13.0209	Ravuthanahalli	Kithana Halli	Bangalore (North)
107	77.4477	13.0216	Vaddarapalya	Lakshimipura	Bangalore (North)
108	77.4924	13.0217	Karihobanahalli	Bangalore (North)	Bangalore (North)
109	77.4821	13.0219	Karihobanahalli	Bangalore (North)	Bangalore (North)
110	77.4206	13.0220	Ravuthanahalli	Kithana Halli	Bangalore (North)
111	77.3825	13.0231	Kondekoppa	Sondekoppa	Bangalore (North)
112	77.4579	13.0232	K.G.Lakkenahalli	Lakshimipura	Bangalore (North)
113	77.5064	13.0235	K.G.Nelakadharanahalli	Bangalore (North)	Bangalore (North)
114	77.4373	13.0235	Bettahalli	Kithana Halli	Bangalore (North)
115	77.4136	13.0252	Ravuthanahalli	Kithana Halli	Bangalore (North)
116	77.4838	13.0261	Karihobanahalli	Bangalore (North)	Bangalore (North)
117	77.4019	13.0266	Hunnegere	Sondekoppa	Bangalore (North)
118	77.5056	13.0268	K.G.Nelakadharanahalli	Bangalore (North)	Bangalore (North)
119	77.4991	13.0273	K.G.Nelakadharanahalli	Bangalore (North)	Bangalore (North)
120	77.4537	13.0277	Lakshmipura	Lakshimipura	Bangalore (North)
121	77.4182	13.0287	Ravuthanahalli	Kithana Halli	Bangalore (North)
122	77.4335	13.0293	J.I.Kammasandra	Lakshimipura	Bangalore (North)
123	77.4683	13.0303	Lakshmipura	Lakshimipura	Bangalore (North)
124	77.4429	13.0304	J.I.Kammasandra	Lakshimipura	Bangalore (North)
125	77.4909	13.0308	J.I.Doddabidarakallu	Bangalore (North)	Bangalore (North)
126	77.4603	13.0308	Lakshmipura	Lakshimipura	Bangalore (North)
127	77.4779	13.0317	J.I.Doddabidarakallu	Bangalore (North)	Bangalore (North)
128	77.4525	13.0319	Lakshmipura	Lakshimipura	Bangalore (North)
129	77.4058	13.0321	Hunnegere	Sondekoppa	Bangalore (North)
130	77.4131	13.0327	Avverahalli	Kithana Halli	Bangalore (North)
131	77.4179	13.0332	Avverahalli	Kithana Halli	Bangalore (North)
132	77.3978	13.0342	Hunnegere	Sondekoppa	Bangalore (North)
133	77.4403	13.0343	J.I.Kammasandra	Lakshimipura	Bangalore (North)
134	77.4970	13.0346	J.I.Doddabidarakallu	Bangalore (North)	Bangalore (North)
135	77.4364	13.0349	J.I.Kammasandra	Lakshimipura	Bangalore (North)
136	77.4290	13.0351	Ravuthanahalli	Kithana Halli	Bangalore (North)
137	77.5030	13.0355	Nagasandra	Bangalore (North)	Bangalore (North)
138	77.5086	13.0356	Chokkasandra	Bangalore (North)	Bangalore (North)
139	77.4868	13.0356	J.I.Doddabidarakallu	Bangalore (North)	Bangalore (North)
140	77.4568	13.0358	Lakshmipura	Lakshimipura	Bangalore (North)
141	77.4914	13.0362	J.I.Doddabidarakallu	Bangalore (North)	Bangalore (North)
142	77.4712	13.0366	Lakshmipura	Lakshimipura	Bangalore (North)
143	77.4663	13.0387	Lakshmipura	Lakshimipura	Bangalore (North)
144	77.4934	13.0389	J.I.Doddabidarakallu	Bangalore (North)	Bangalore (North)
145	77.5015	13.0397	Nagasandra	Bangalore (North)	Bangalore (North)
146	77.4541	13.0403	Lakshmipura	Lakshimipura	Bangalore (North)
147	77.4776	13.0407	J.I.Kodagi Thirumalapura	Chikkabidarakallu	Bangalore (North)
148	77.4181	13.0409	Avverahalli	Kithana Halli	Bangalore (North)
149	77.4287	13.0415	Shivanapura	Daasanapura	Bangalore (North)
150	77.4076	13.0426	Avverahalli	Kithana Halli	Bangalore (North)
151	77.4255	13.0427	Shivanapura	Daasanapura	Bangalore (North)
152	77.4366	13.0433	Gowdahalli	Kithana Halli	Bangalore (North)
153	77.4612	13.0434	Lakshmipura	Lakshimipura	Bangalore (North)

154	77.4007	13.0440	Lakkenahalli	Sondekoppa	Bangalore (North)
155	77.4483	13.0445	Kadharanahalli	Lakshimipura	Bangalore (North)
156	77.4921	13.0449	J.I.Doddabidarakallu	Bangalore (North)	Bangalore (North)
157	77.4433	13.0453	K.G.Harokyathanahalli	Adakamaarana Halli	Bangalore (North)
158	77.4109	13.0457	Kengenahalli	Kithana Halli	Bangalore (North)
159	77.4641	13.0462	Dombarahalli	Siddanahosahalli	Bangalore (North)
160	77.5035	13.0464	Nagasandra	Bangalore (North)	Bangalore (North)
161	77.4325	13.0466	Gowdahalli	Kithana Halli	Bangalore (North)
162	77.5104	13.0471	Dasarahalli (Peenya)	Bangalore (North)	Bangalore (North)
163	77.4566	13.0476	Dombarahalli	Siddanahosahalli	Bangalore (North)
164	77.4877	13.0486	Chikkabidarakallu	Chikkabidarakallu	Bangalore (North)
165	77.4694	13.0488	Madhavara	Maadavaara	Bangalore (North)
166	77.4184	13.0493	Shivanapura	Daasanapura	Bangalore (North)
167	77.4400	13.0495	K.G.Harokyathanahalli	Adakamaarana Halli	Bangalore (North)
168	77.4938	13.0504	J.I.Doddabidarakallu	Bangalore (North)	Bangalore (North)
169	77.4751	13.0517	Madhavara	Maadavaara	Bangalore (North)
170	77.5002	13.0522	Bagalakunte	Bangalore (North)	Bangalore (North)
171	77.4897	13.0534	Chikkabidarakallu	Chikkabidarakallu	Bangalore (North)
172	77.4088	13.0541	Kengenahalli	Kithana Halli	Bangalore (North)
173	77.4436	13.0542	K.G.Harokyathanahalli	Adakamaarana Halli	Bangalore (North)
174	77.4289	13.0544	Shivanapura	Daasanapura	Bangalore (North)
175	77.4011	13.0544	Hullegowdanahalli	Sondekoppa	Bangalore (North)
176	77.4220	13.0549	Shivanapura	Daasanapura	Bangalore (North)
177	77.5010	13.0554	Bagalakunte	Bangalore (North)	Bangalore (North)
178	77.4613	13.0555	Shiddanahosahalli	Siddanahosahalli	Bangalore (North)
179	77.5070	13.0556	Bagalakunte	Bangalore (North)	Bangalore (North)
180	77.4662	13.0580	Madhavara	Maadavaara	Bangalore (North)
181	77.3976	13.0583	Venkatapura	Sondekoppa	Bangalore (North)
182	77.5008	13.0595	Bagalakunte	Bangalore (North)	Bangalore (North)
183	77.5144	13.0596	J.I.Mallasandra	Bangalore (North)	Bangalore (North)
184	77.4483	13.0600	K.G.Harokyathanahalli	Adakamaarana Halli	Bangalore (North)
185	77.4319	13.0600	J.I.Gajagadhakuppe	Daasanapura	Bangalore (North)
186	77.4398	13.0602	K.G.Harokyathanahalli	Adakamaarana Halli	Bangalore (North)
187	77.4717	13.0612	Madhanayakanahalli	Maadanaayakana Halli	Bangalore (North)
188	77.4054	13.0619	Hullegowdanahalli	Sondekoppa	Bangalore (North)
189	77.4225	13.0625	Shivanapura	Daasanapura	Bangalore (North)
190	77.4594	13.0627	Madhanayakanahalli	Maadanaayakana Halli	Bangalore (North)
191	77.3873	13.0636	Byregowdanahalli	Sondekoppa	Bangalore (North)
192	77.4165	13.0637	Hullegowdanahalli	Sondekoppa	Bangalore (North)
193	77.5113	13.0641	J.I.Shettyhalli	Bangalore (North)	Bangalore (North)
194	77.5200	13.0651	J.I.Shettyhalli	Bangalore (North)	Bangalore (North)
195	77.4992	13.0659	Shidedhahalli	Bangalore (North)	Bangalore (North)
196	77.4815	13.0659	Thotadhaguddadahalli	Shrikantapura	Bangalore (North)
197	77.4400	13.0662	Adikemaranahalli	Adakamaarana Halli	Bangalore (North)
198	77.4628	13.0664	Madhanayakanahalli	Maadanaayakana Halli	Bangalore (North)
199	77.4942	13.0670	Shidedhahalli	Bangalore (North)	Bangalore (North)
200	77.4867	13.0672	Thotadhaguddadahalli	Shrikantapura	Bangalore (North)
201	77.4025	13.0687	Hullegowdanahalli	Sondekoppa	Bangalore (North)
202	77.5100	13.0694	Chikkasandra	Bangalore (North)	Bangalore (North)

203	77.4108	13.0697	Hullegowdanahalli	Sondekoppa	Bangalore (North)
204	77.4332	13.0699	Dasanapura	Daasanapura	Bangalore (North)
205	77.4772	13.0716	Kuduregere	Aalooru	Bangalore (North)
206	77.4694	13.0717	K.G.Hanumanthasagara	Maadanaayakana Halli	Bangalore (North)
207	77.4491	13.0723	Dasanapura	Daasanapura	Bangalore (North)
208	77.4394	13.0723	Dasanapura	Daasanapura	Bangalore (North)
209	77.4558	13.0727	J.I.Heggadadevanapura	Aalooru	Bangalore (North)
210	77.4619	13.0732	K.G.Hanumanthasagara	Maadanaayakana Halli	Bangalore (North)
211	77.5093	13.0741	Chikkasandra	Bangalore (North)	Bangalore (North)
212	77.4838	13.0752	K.G.Thammenahalli	Aalooru	Bangalore (North)
213	77.4310	13.0753	Dasanapura	Daasanapura	Bangalore (North)
214	77.5036	13.0766	Chikkabanavara	Chikka Baanavaara	Bangalore (North)
215	77.4726	13.0771	Kuduregere	Aalooru	Bangalore (North)
216	77.5216	13.0772	Abbigere	Bangalore (North)	Bangalore (North)
217	77.5273	13.0777	Abbigere	Bangalore (North)	Bangalore (North)
218	77.4371	13.0780	Dasanapura	Daasanapura	Bangalore (North)
219	77.4943	13.0784	Chikkabanavara	Chikka Baanavaara	Bangalore (North)
220	77.5006	13.0792	Chikkabanavara	Chikka Baanavaara	Bangalore (North)
221	77.4421	13.0797	Dasanapura	Daasanapura	Bangalore (North)
222	77.4863	13.0801	K.G.Thammenahalli	Aalooru	Bangalore (North)
223	77.4754	13.0806	Kuduregere	Aalooru	Bangalore (North)
224	77.4549	13.0807	J.I.Heggadadevanapura	Aalooru	Bangalore (North)
225	77.5041	13.0824	Chikkabanavara	Chikka Baanavaara	Bangalore (North)
226	77.5278	13.0843	K.G.Lakshmipura	Somashettihalli	Bangalore (North)
227	77.4952	13.0857	Chikkabanavara	Chikka Baanavaara	Bangalore (North)
228	77.5153	13.0859	Somashettyhalli	Somashettihalli	Bangalore (North)
229	77.5223	13.0860	Somashettyhalli	Somashettihalli	Bangalore (North)
230	77.4604	13.0877	Alur	Aalooru	Bangalore (North)
231	77.4276	13.0879	Nagaruru	Daasanapura	Bangalore (North)
232	77.5334	13.0880	K.G.Lakshmipura	Somashettihalli	Bangalore (North)
233	77.4490	13.0884	Alur	Aalooru	Bangalore (North)
234	77.4407	13.0887	Nagaruru	Daasanapura	Bangalore (North)
235	77.5008	13.0890	Chikkabanavara	Chikka Baanavaara	Bangalore (North)
236	77.5278	13.0894	K.G.Lakshmipura	Somashettihalli	Bangalore (North)
237	77.4667	13.0898	Alur	Aalooru	Bangalore (North)
238	77.4549	13.0899	Alur	Aalooru	Bangalore (North)
239	77.4212	13.0925	Nagaruru	Daasanapura	Bangalore (North)
240	77.4326	13.0943	Nagaruru	Daasanapura	Bangalore (North)
241	77.4675	13.0954	Alur	Aalooru	Bangalore (North)
242	77.4405	13.0967	J.I.Kodipalya	Huskoor	Bangalore (North)
243	77.4558	13.0984	Vaderahalli	Huskoor	Bangalore (North)
244	77.4502	13.1031	Vaderahalli	Huskoor	Bangalore (North)
245	77.4369	13.1034	J.I.Sheshagiriraopalya	Huskoor	Bangalore (North)
246	77.4626	13.1042	K.G.Narasipura	Huskoor	Bangalore (North)
247	77.4697	13.1043	Muniyanapalya	Huskoor	Bangalore (North)
248	77.4241	13.1043	Pillalli	Huskoor	Bangalore (North)
249	77.4405	13.1075	Pillalli	Huskoor	Bangalore (North)
250	77.4630	13.1082	K.G.Narasipura	Huskoor	Bangalore (North)
251	77.4460	13.1083	Mutthahalli	Huskoor	Bangalore (North)
252	77.4292	13.1093	J.I.Hucchanapalya	Huskoor	Bangalore (North)

253	77.4558	13.1094	Mutthahalli	Huskoor	Bangalore (North)
254	77.4048	13.1103	Betthanagere	Huskoor	Bangalore (North)
255	77.4129	13.1114	Betthanagere	Huskoor	Bangalore (North)
256	77.4720	13.1119	K.G.Thorenagasandra	Huskoor	Bangalore (North)
257	77.4211	13.1133	J.I.Ramapalya	Huskoor	Bangalore (North)
258	77.4294	13.1151	Huskuru	Huskoor	Bangalore (North)
259	77.4674	13.1155	K.G.Narasipura	Huskoor	Bangalore (North)
260	77.4529	13.1166	Honnasandra	Huskoor	Bangalore (North)
261	77.4610	13.1167	K.G.Narasipura	Huskoor	Bangalore (North)
262	77.4431	13.1179	Honnasandra	Huskoor	Bangalore (North)
263	77.4209	13.1184	J.I.Ramapalya	Huskoor	Bangalore (North)
264	77.4256	13.1192	Huskuru	Huskoor	Bangalore (North)
265	77.4312	13.1201	Huskuru	Huskoor	Bangalore (North)
266	77.4130	13.1205	Betthanagere	Huskoor	Bangalore (North)
267	77.4586	13.1230	J.I.Govindapura	Gopalapura	Bangalore (North)
268	77.4535	13.1249	Agraharapalya	Gopalapura	Bangalore (North)
269	77.4277	13.1253	Huskuru	Huskoor	Bangalore (North)
270	77.4019	13.1254	Betthanagere	Huskoor	Bangalore (North)
271	77.4375	13.1265	Huskuru	Huskoor	Bangalore (North)
272	77.4195	13.1286	J.I.Bommashettihalli	Gopalapura	Bangalore (North)
273	77.4340	13.1291	Huskuru	Huskoor	Bangalore (North)
274	77.4587	13.1319	K.G.Hosahallipalya	Gopalapura	Bangalore (North)
275	77.4434	13.1324	Thotagere	Gopalapura	Bangalore (North)
276	77.4227	13.1324	J.I.Bommashettihalli	Gopalapura	Bangalore (North)
277	77.4287	13.1341	Gopalapura (Sayappanahalli)	Gopalapura	Bangalore (North)
278	77.4507	13.1383	Thotagere	Gopalapura	Bangalore (North)
279	77.4246	13.1385	Gopalapura (Sayappanahalli)	Gopalapura	Bangalore (North)
280	77.4377	13.1391	J.I.Shamabhattarapalya	Gopalapura	Bangalore (North)
281	77.4467	13.1399	Thotagere	Gopalapura	Bangalore (North)
282	77.4451	13.1460	Thotagere	Gopalapura	Bangalore (North)
283	77.4398	13.1464	J.I.Shamabhattarapalya	Gopalapura	Bangalore (North)
284	77.4288	13.1492	Gopalapura (Sayappanahalli)	Gopalapura	Bangalore (North)
285	77.4325	13.1496	Gopalapura (Sayappanahalli)	Gopalapura	Bangalore (North)
286	77.4504	13.1530	Kukkalahalli	Gopalapura	Bangalore (North)
287	77.4449	13.1550	Kukkalahalli	Gopalapura	Bangalore (North)
288	77.4571	13.1568	Kukkalahalli	Gopalapura	Bangalore (North)
289	77.4458	13.1589	Kukkalahalli	Gopalapura	Bangalore (North)
290	77.4379	13.1594	Kukkalahalli	Gopalapura	Bangalore (North)
291	77.4516	13.1594	Kukkalahalli	Gopalapura	Bangalore (North)
292	77.4431	13.1617	Kukkalahalli	Gopalapura	Bangalore (North)
293	77.4378	13.1627	Kukkalahalli	Gopalapura	Bangalore (North)

Annexure-II: Tentative Location Details of Proposed Percolation Tanks.

S. No	Longitude	Latitude	Village	Gram Panchayath	Taluk
1	77.4787	12.9562	K.G. Ullalu	Bangalore (North)	Bangalore (North)
2	77.4732	12.9670	Kodigehalli	Kodige Halli	Bangalore (North)
3	77.4482	12.9697	Kannalli	Kodige Halli	Bangalore (North)
4	77.4880	12.9801	Herohalli	Bangalore (North)	Bangalore (North)
5	77.4797	12.9835	Herohalli	Bangalore (North)	Bangalore (North)
6	77.4463	12.9870	Kadabagere	Kadabagere	Bangalore (North)
7	77.4986	12.9876	Srigandhakavalu	Bangalore (North)	Bangalore (North)
8	77.4708	12.9902	Hosahalli Gollarapalya	Bangalore (North)	Bangalore (North)
9	77.4588	12.9916	Machohalli	Maachohalli	Bangalore (North)
10	77.4903	12.9984	Herohalli	Bangalore (North)	Bangalore (North)
11	77.4417	12.9992	Kadabagere	Kadabagere	Bangalore (North)
12	77.4117	13.0059	J.I.Kitthnahalli	Kithana Halli	Bangalore (North)
13	77.5048	13.0080	K.G.Hegganahalli	Bangalore (North)	Bangalore (North)
14	77.4663	13.0094	Bylakonenahalli	Maachohalli	Bangalore (North)
15	77.4045	13.0125	Mallasandra	Kithana Halli	Bangalore (North)
16	77.3795	13.0141	Kondekoppa	Sondekoppa	Bangalore (North)
17	77.4173	13.0188	Ravuthanahalli	Kithana Halli	Bangalore (North)
18	77.4626	13.0256	Gangondanahalli	Lakshimipura	Bangalore (North)
19	77.4787	13.0260	Karihobanahalli	Bangalore (North)	Bangalore (North)
20	77.4455	13.0260	J.I.Kammasandra	Lakshimipura	Bangalore (North)
21	77.4083	13.0270	Avverahalli	Kithana Halli	Bangalore (North)
22	77.5019	13.0312	K.G.Nelakadharanahalli	Bangalore (North)	Bangalore (North)
23	77.4782	13.0371	J.I.Kodagi Thirumalapura	Chikkabidarakallu	Bangalore (North)
24	77.4695	13.0434	Madhavara	Maadavaara	Bangalore (North)
25	77.4205	13.0446	Shivanapura	Daasanapura	Bangalore (North)
26	77.4040	13.0468	Lakkenahalli	Sondekoppa	Bangalore (North)
27	77.4984	13.0494	Nagasandra	Bangalore (North)	Bangalore (North)
28	77.4351	13.0548	Gowdahalli	Kithana Halli	Bangalore (North)
29	77.5077	13.0604	J.I.Mallasandra	Bangalore (North)	Bangalore (North)
30	77.4697	13.0647	Madhanayakanahalli	Maadanaayakana Halli	Bangalore (North)
31	77.3974	13.0647	Hullegowdanahalli	Sondekoppa	Bangalore (North)
32	77.4285	13.0665	J.I.Gajagadhakuppe	Daasanapura	Bangalore (North)
33	77.4823	13.0706	Thotadhaguddadahalli	Shrikantapura	Bangalore (North)
34	77.5033	13.0720	Chikkasandra	Bangalore (North)	Bangalore (North)
35	77.4944	13.0737	Chikkabanavara	Chikka Baanavaara	Bangalore (North)
36	77.4485	13.0811	J.I.Heggadadevanapura	Aalooru	Bangalore (North)
37	77.5192	13.0896	Somashettyhalli	Somashettihalli	Bangalore (North)
38	77.4270	13.0966	Nagaruru	Daasanapura	Bangalore (North)
39	77.4461	13.0966	Vaderahalli	Huskoor	Bangalore (North)
40	77.4660	13.1012	Muniyanapalya	Huskoor	Bangalore (North)
41	77.4493	13.1114	Mutthahalli	Huskoor	Bangalore (North)
42	77.4396	13.1131	Honnasandra	Huskoor	Bangalore (North)
43	77.4076	13.1134	Betthanagere	Huskoor	Bangalore (North)
44	77.4226	13.1228	Betthanagere	Huskoor	Bangalore (North)

45	77.4149	13.1236	Betthanagere	Huskoor	Bangalore (North)
46	77.4537	13.1303	Agraharapalya	Gopalapura	Bangalore (North)
47	77.4399	13.1354	Thotagere	Gopalapura	Bangalore (North)
48	77.4252	13.1435	Gopalapura (Sayappanahalli)	Gopalapura	Bangalore (North)
49	77.4503	13.1486	Kukkalahalli	Gopalapura	Bangalore (North)
50	77.4343	13.1555	Gopalapura (Sayappanahalli)	Gopalapura	Bangalore (North)