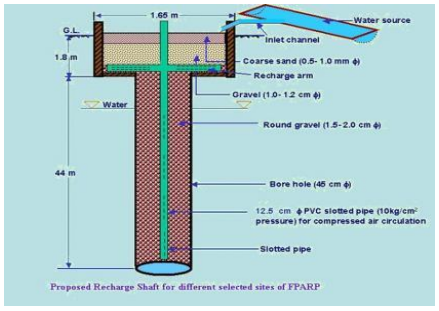
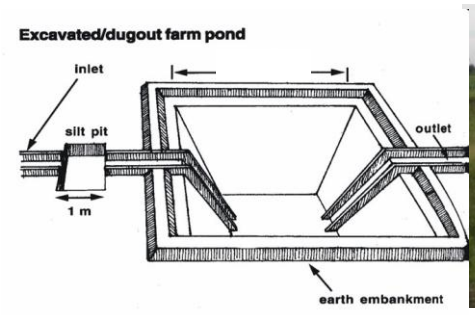
Plan on Artificial Recharge to Groundwater and Water Conservation in Bhavanisagar Firka, Sathyamangalam Taluk, Erode District, Tamil Nadu





By

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AT GLANCE	
Name of Firka	Bhavanisagar
Taluk	Sathyamangalam
District	Erode
State	Tamil Nadu
Total area in Sq.Km	88.487
Total Area Suitable for Recharge in Sq.Km	88.487
Lat. & Lon.	11°30'58 "to 11°22'42" & 77°04'08"to 77°12' 56".
Rainfall	621 mm
Monsoon	458 mm
Non- Mon soon	163 mm
Geology	Crystalline metamorphic gneiss complex comprising Hornblende gneiss
WATER LEVEL	
Pre – Monsoon (May -2015)	1.65 to 14.90 m bgl.
Post - Monsoon (Jan_2016)	1.00 to 20.07 m bgl.
GROUND WATER RESOURCES ESTIMATION	
Replenish able ground water resources	15.47 MCM
Net ground water available	13.92 MCM
Ground water draft for irrigation	19.07 MCM
Groundwater draft for domestic & industrial water supply	3.42 MCM
Total ground water draft	22.49 MCM
Stage of ground water development (%)	161 %
Uncommitted surface runoff available for the Firka	6.08 MCM
Total volume of weathered zone	708 MCM
Total volume available for recharge (considering 3 m depth from 3 m bgl	442 MCM
ARTIFICIAL RECHARGE /CONSERVATION MEASURES	
Structures Proposed (tentative) Masonry Check dam Nalla Bund Revival, repair of pond, tanks with recharge shaft Only shafts in Bigger tanks Farm Pond	 17 33 11 14 50 Unit
Improving Water Efficiency/ Saving (Micro irrigation system for 50 ha)	0.35 MCM
Expected recharge	1.50 MCM
Excepted total groundwater recharge/ saving	1.85 MCM
Tentative total cost of the project	6. 642 Crores
Expected raise in water level by recharging/saving.	1.38 m

Plan on Artificial Recharge to Groundwater and Water Conservation in Bhavanisagar Firka, SathyamangalamTaluk, Erode district, Tamil Nadu

1. Introduction

India is the largest user of groundwater in the world. Food grain security of the country is largely dependent on water resources and groundwater resources play major role in irrigation sector. Imprints of Over-Exploitation on groundwater resources are being observed as steep deepening of water levels, drying of shallow groundwater abstraction structures, ingress of salinity in fresh aquifers etc. which signal towards taking necessity of emergent action for artificial recharge and rainwater harvesting by utilizing surplus runoff and maintaining groundwater resources at sustainable stage.

In Tamil Nadu dependency on groundwater has increased many folds during the recent years and the groundwater extraction for irrigation, domestic and industries have resulted in lowering of water levels, long-term water level declining trend and even drying up of wells. In order to regulate the groundwater development, Central Ground Water Board in association with State Ground Water Departments has computed Dynamic Groundwater Resources and categorized blocks as Over Exploited, Critical, Semi Critical and Safe.

Out of 1129 firkas (assessment units) in Tamil Nadu the groundwater situation in 374 firkas are over exploited, 48 firkas are critical, 235 firkas are semi-critical, 437 firkas are safe and 35 firkas are saline. Various measures such as rainwater harvesting, artificial recharge and water use efficiency are successfully practiced by some NGOs, Central and State govts., which need replication at larger scale in close coordination with State govt. agencies and stakeholders so that capacity building of state implementing agencies and awareness of stakeholders towards artificial recharge and rainwater harvesting can be made.

2. Objectives of the scheme

Objectives of the proposed scheme are

- To upscale recharge activities, supplement additional groundwater resources by harvesting surplus runoff, sustainability of groundwater resources at shallow depths
- Recovery of over-exploited groundwater areas by implementing artificial recharge measures in groundwater stress areas.
- Conservation, development and sustainable management of natural resources including their use.

3. Study area details

3.1 Location

The total area of Bhavanisagar firka is 97.68 sq.km and Bhavanisagar firka lies between North latitudes 11°22’40 “to 11°30’39” and east longitudes 77°04’00” to 77°12’57”. Location map of Bhavanisagar firka is given in Figure 1.

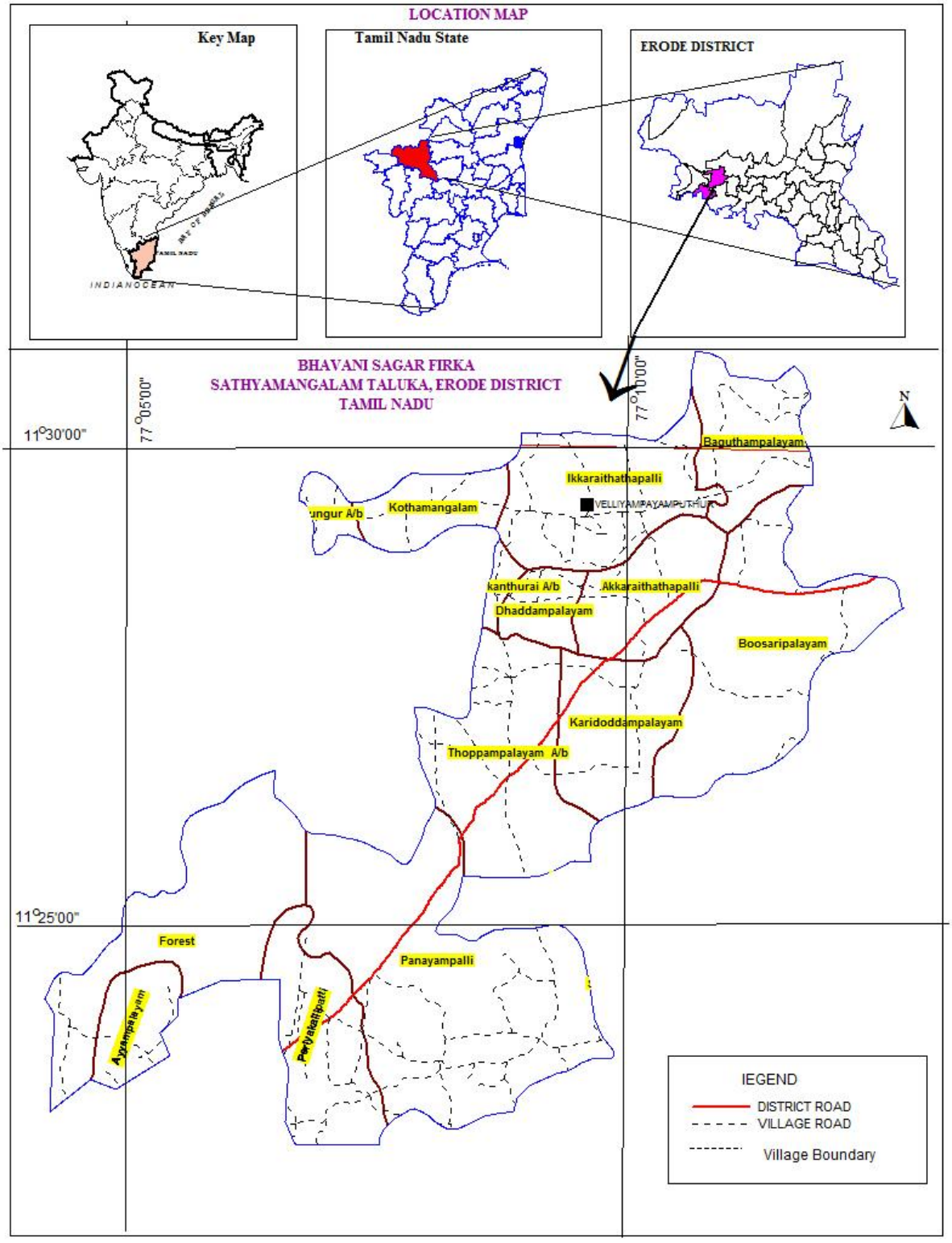


Figure 1. Location map of Bhavanisagar firka

3.2 Geomorphological Set up

Geomorphologically, the area consists of hills and plain landforms. In plain landforms, Pediplains of weathered moderate and shallow are occupied major part of the firka. These landforms are influencing the ground water recharge. Hill landform like residual hills, denudation hill and structural hills are act as runoff zone. (*Source: IRS, Anna university, Chennai Tamil Nadu). Geomorphological map prepared using IRS- 1D data on 1: 50,000 scale and units are as per NNRMS standard*s. The range consists of a series of detached hills covered by reserved forests.The various geomorphological units with its % of coverage area are given in Table 1. and shown in figure 2.

Table 1. Various geomorphological units with its % of coverage area in Bhavanisagar firka

LANDFORMS	% of Area
BAJADA	5.09
DISSECTED/UNDISSECTED	2.15
MODERATE	27.69
PEDIMENT-INSELBERG COMPLEX	44.79
SHALLOW	18.87
STRUCTURAL HILLS	0.64
TANKS	0.77

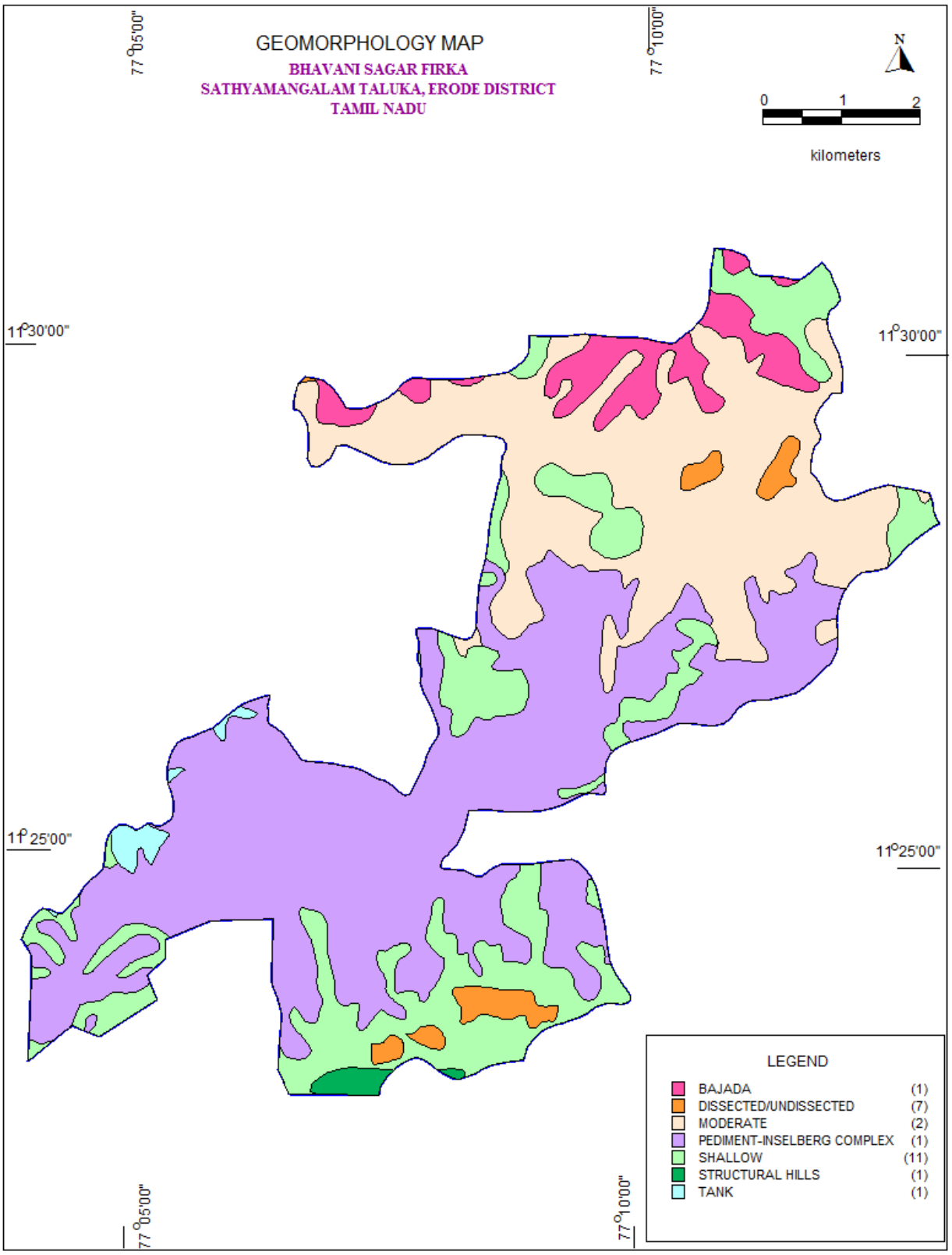


Figure 2. Geomorphology of Bhavanisagar Firka

3.3 Land use and soil

The land use pattern of the Bhavanisagar Firka is given in figure 3. Predominantly the most of the area is characterised by the plantation, Scrub forest, wet crop and dry crop (i.,e agricultural field) and accounts for 50 % of the total area of the firka(Source: IRS, Anna university, Chennai Tamil Nadu). This area is highly suitable for water conservation and recharge. The entire Firkas is occupied by rock outcrops with loamy soil. Forest cover spreads over the central and western part of the firka. The soil is mainly of Ustorthents, which covers more than 60%. The soil map is given in Figure 4.

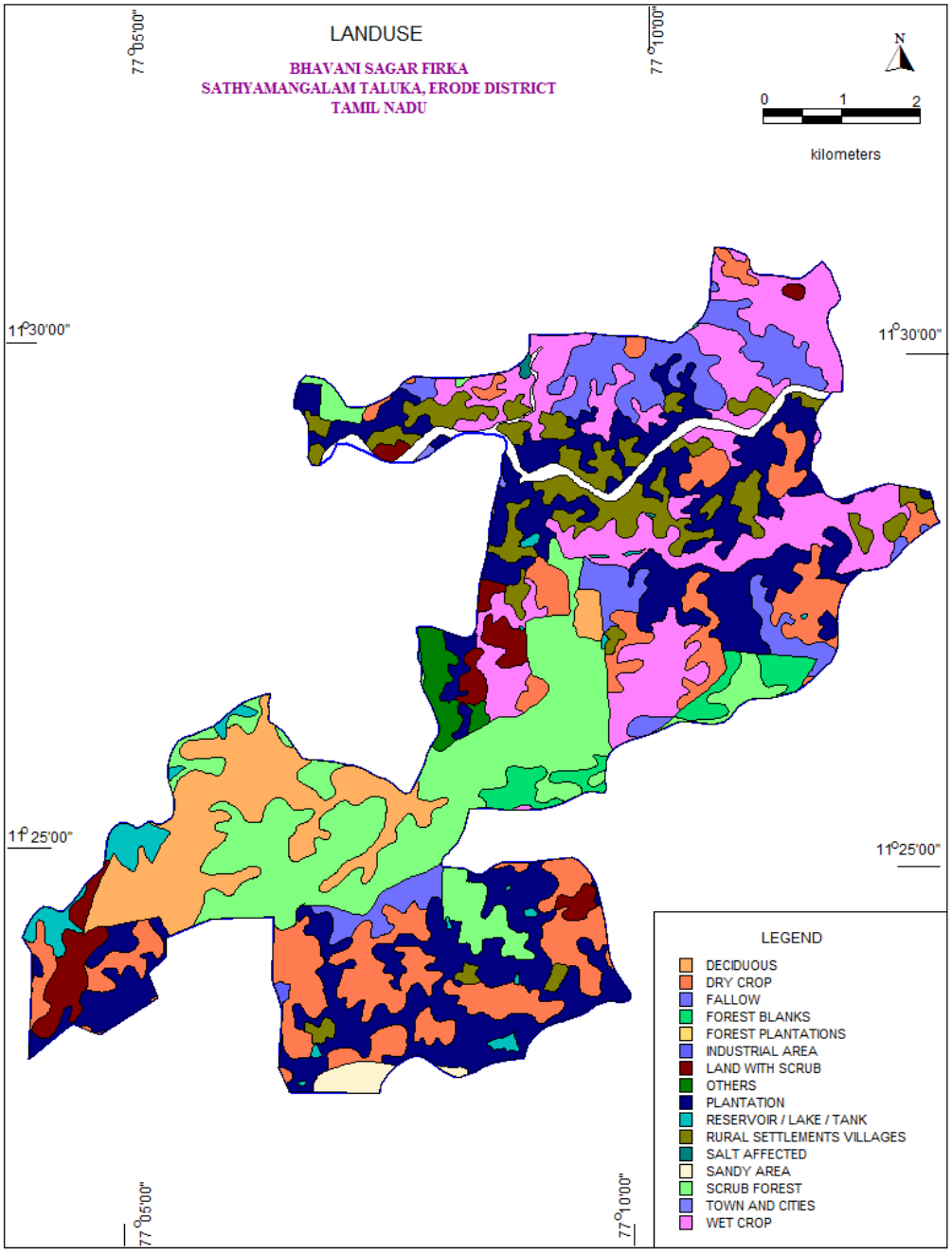


Figure 3.Landuse map of Bhavanisagar Firka

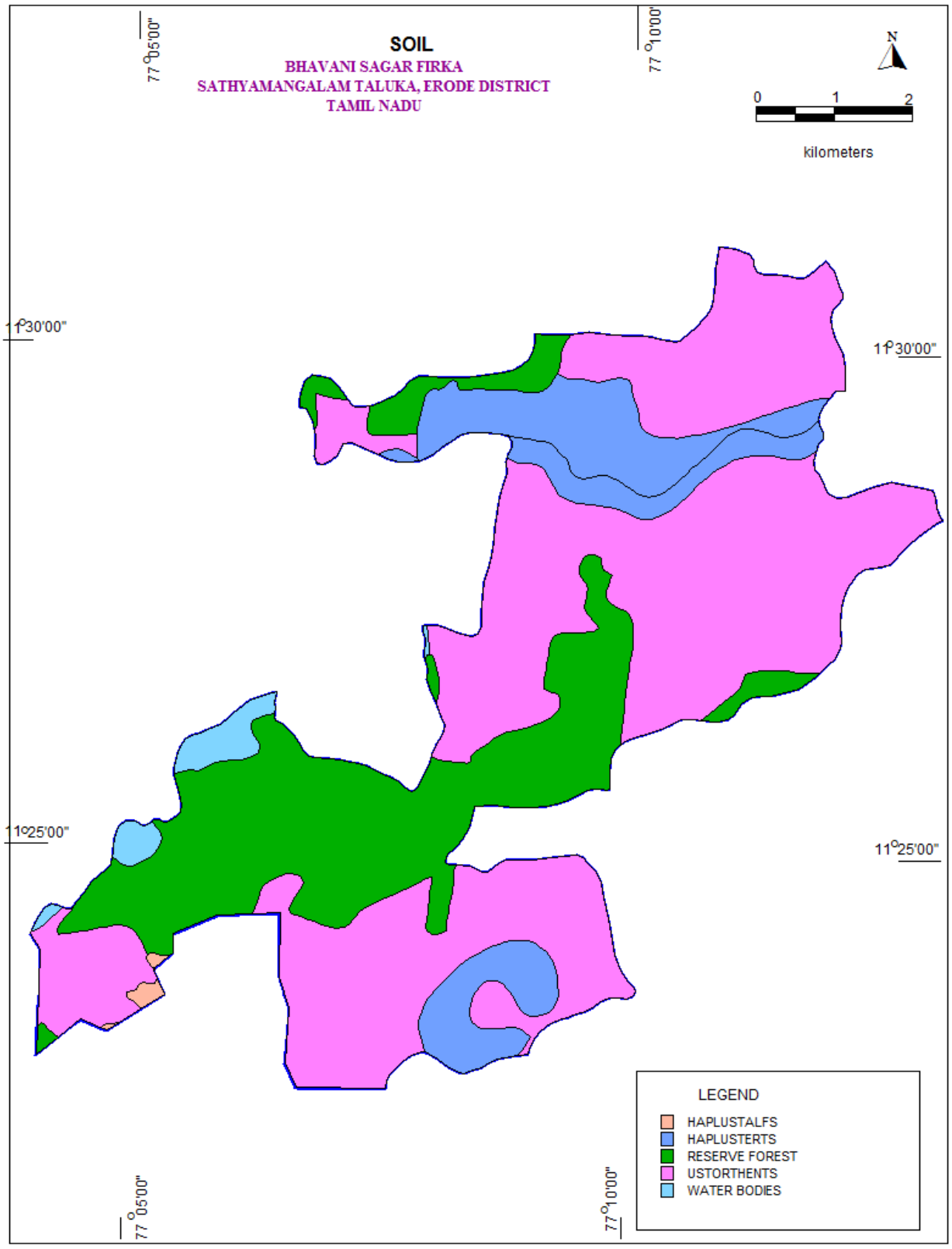


Figure 4. Soil map of Bhavanisagar Firka

3.4 Drainage

The entire Firka area is within the Bhavani sub basin which falls in the Cauvery river basin. River Bhavani flows through this firka and later joins River Cauvery and only seasonal floods inundate the basins. Basin sub soil water is used to irrigate the lands. Tanks and surface water bodies are spread over the entire firka. The drainage pattern is the dendritic and sub- dendritic. The drainage map of Bhavanisagar firka is given in Fig 5.

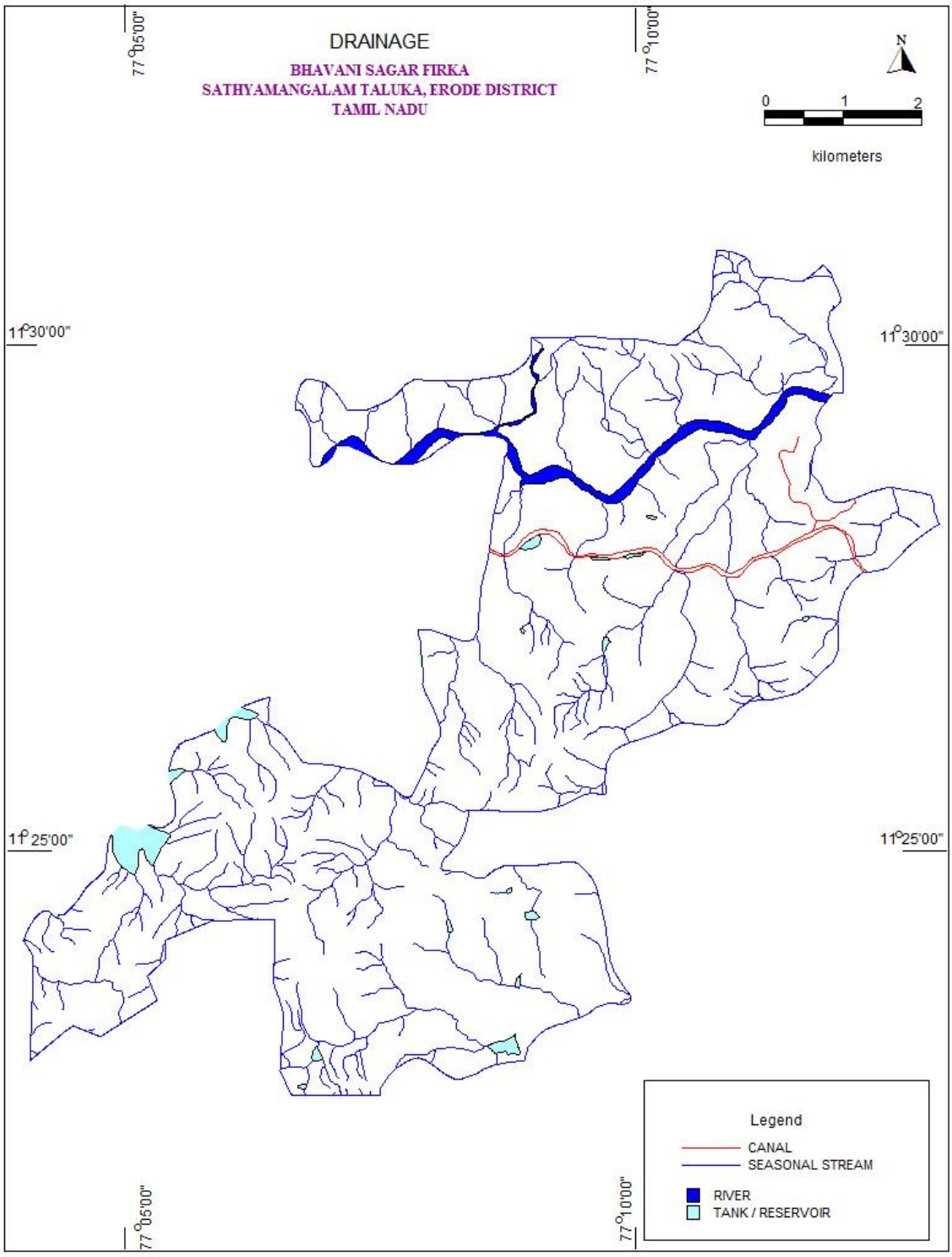


Figure 5.Drainage map of Bhavanisagar Firka

3.5 Rainfall

Bhavanisagar area falls under tropical climate with temperature in the summer months of March to May. The average temperature varies from 26 to 41° C. The humidity is also high in the order of 80%. The wind speed is high during the months of July and August. The wind speed ranges from 7.4 to 12.6 km/hr, which increases from 100 to 120 km/hr during cyclone period. Bhavanisagar Firka receives rainfall from southwest monsoon (June – September), northeast monsoon (October – December) and non-monsoon periods (January – May). The area receives the major rainfall from northeast monsoon. Rainfall is generally heavy during low-pressure depressions and cyclones during the northeast monsoon period. The normal annual rainfall is 621 mm and the higher is towards coast i.e, east part of the firka.

Taluk	Name of Firkas	Area in sq.km	Monsoon rainfall (Jun to Dec) In m	Non monsoon rainfall (Jan – May) In m	Total Rainfall In m
Sathyamangalam	Bhavanisagar	97.68	0.458	0.163	0.621

3.6 Hydrogeology

The entire firka is underlain by the crystalline metamorphic gneiss complex consisting Hornblede –Biotite gneiss, Epidote-Hornblede gneiss and Charnockite with minor exposures of Ultra mafic and basic rocks. Ground water is occurring in phreatic conditions in weathered and fractured gneiss rock formation.The weathering is highly erratic and the depth of abstraction structures is controlled by the intensity of weathering and fracturing. Large diameter dug well is more common ground water abstraction structures in the area. The diameter of the dug well is in the range of 3 to 10 m and depth of dug wells range from 6 to 18 m bgl. The dug wells yield up to 1 lps in summer months and few wells remains dry. The yield is adequate for irrigation for one or two crops in monsoon period.

The depth of wells varies from 6.64 to 17 m bgl. The present water levels in tn the firka is in the range of 1.7 to 14.90 m bgl during pre- monsoon (May 2015) and from 1.00 to 20.07 m bgl during post monsoon (January 2016) . The hydrogeological map of Bhavanisagar firka is given in Figure 6. Decadal mean water level ofpre-monsoon and post monsoon are given in fig 7a & b. The decadal maps reveal that, mean water level during pre-monsoon in majority area is < 6 m bgl likewise during post monsoon majority part is under < 5m ground water level.

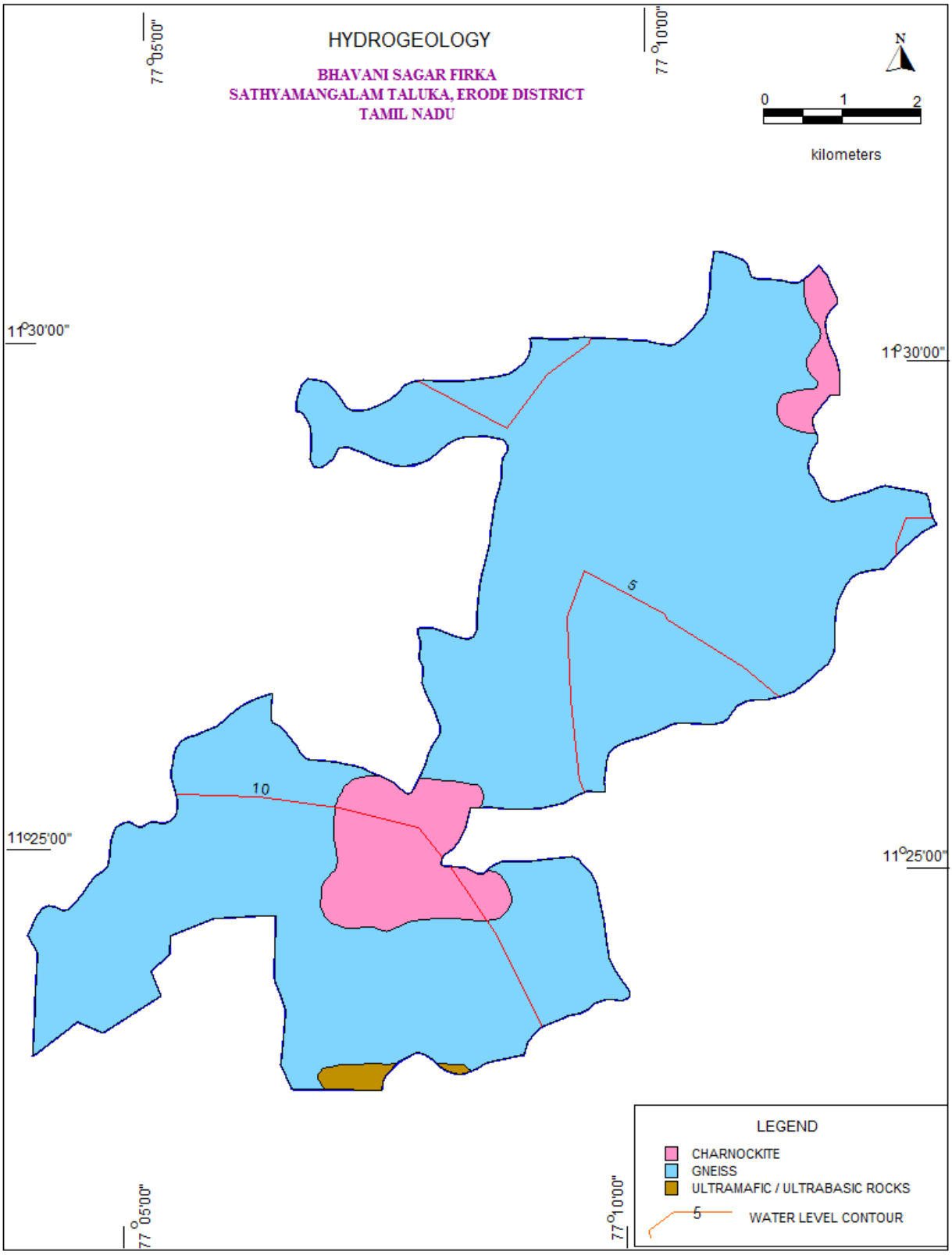


Figure 6 : Hydrogeological Map of Bhavanisagar Firka

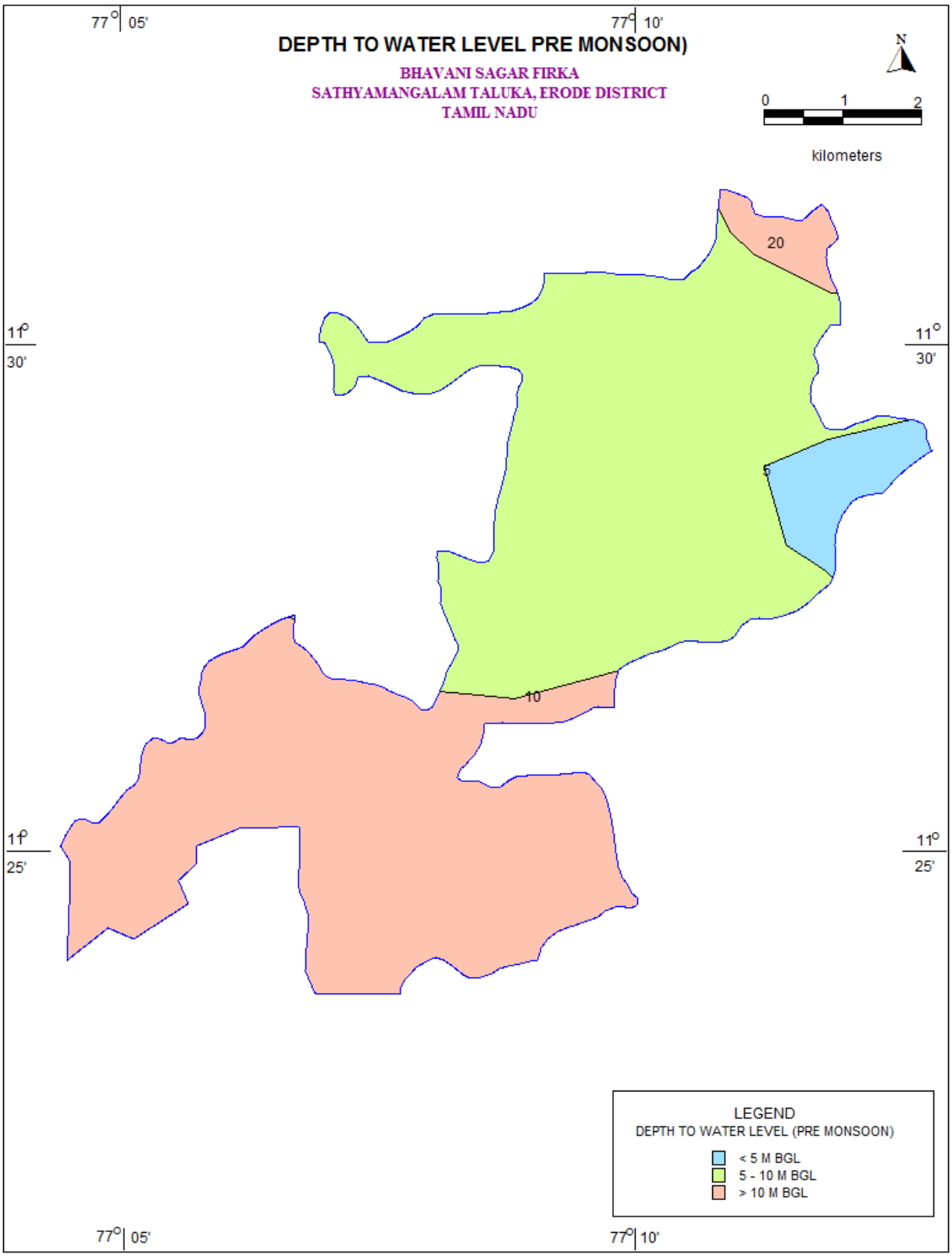


Figure 7a. Pre –monsoon (Decadal) water level in Bhavanisagar firka

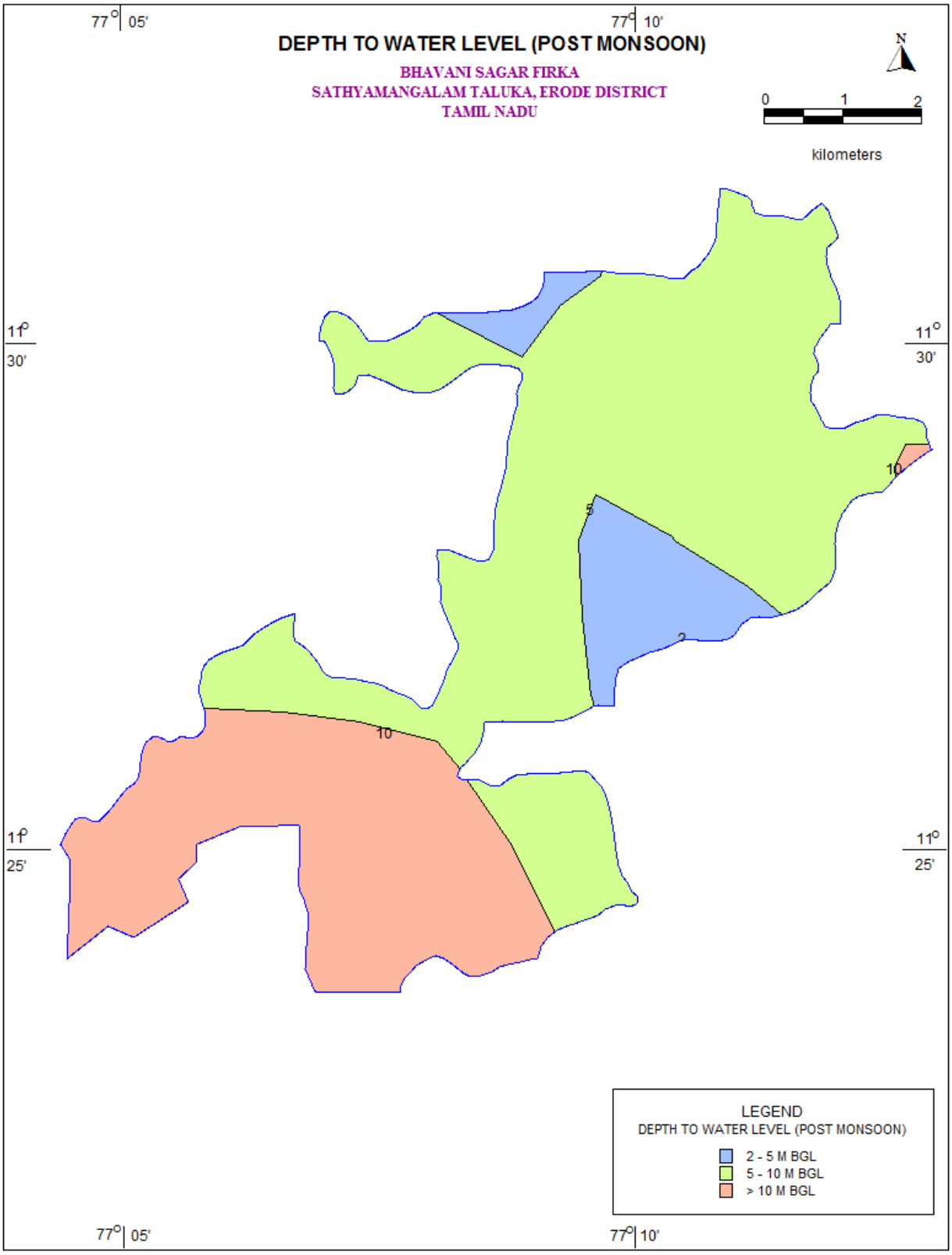


Figure 7b. Post-monsoon (Decadal) water level in Bhavanisagar firka

3.7 Dynamic Ground water Resources

The ground water resources have been computed jointly by Central Ground Water Board and State Ground Water Resources Data Centre (PWD, WRO, Govt. of Tamil Nadu) as on 31st March 2011. The computation has been done using GEC1997 methodology. The salient features of the computations are furnished in table 2.

Table 2. Dynamic Ground water resources estimation of Bhavanisagar firka

Firka	GW WORTHY AREA	REPLENISHABLE GROUND WATER RESOURCES	NET GROUND WATER AVAILABLE	GROUND WATER DRAFT FOR IRRIGATION	GROUNDWATER DRAFT FOR DOMESTIC & INDUSTRIAL WATER SUPPLY	TOTAL GROUND WATER DRAFT	STAGE OF GROUND WATER DEVELOPMENT (%)	CATEGORY
	(Sq.Km)	(In MCM)					%	
Bhavanisagar	88.487	15.47	13.92	19.07	3.42	22.49	161	OVER EXPLOITED

4. Spatial Data Integration

The potential area for groundwater recharge is highly influenced by Geology, Geomorphology, Land use /land cover, Drainage, Surface Water Body, Weathered Thickness and first fractured Depth in the area. In order to ascertain the suitable area for groundwater recharge in firka, spatial data integration of have been attempted using index overlay model in GIS environ. In this model,above seven layers have been integrated byassigning weightage for the theme having scale of 1-100 and sub-classes of the theme between 1 to 10 scales.The resultant map has been reclassified into four classes(High-low integrated values) indicating the suitable area for artificial recharge and given in fig-7 and described below.

ZONE	% OF AREA COVERAGE	SIGNIFICANCE*
Very high	24	Suitable for all major recharge structures like Percolation pond and stop dam, check dam etc.,
High	34	Suitable for all major recharge structures like stop dam, check dam etc.,
Moderate	40	Suitable for all major recharge structures like earthen check dam, Boulder check dam and Nala bund etc.,
Poor	2	Hilly/Forest /Catchment area

*However, the field verification is required to confirm above potential area for groundwater recharge.

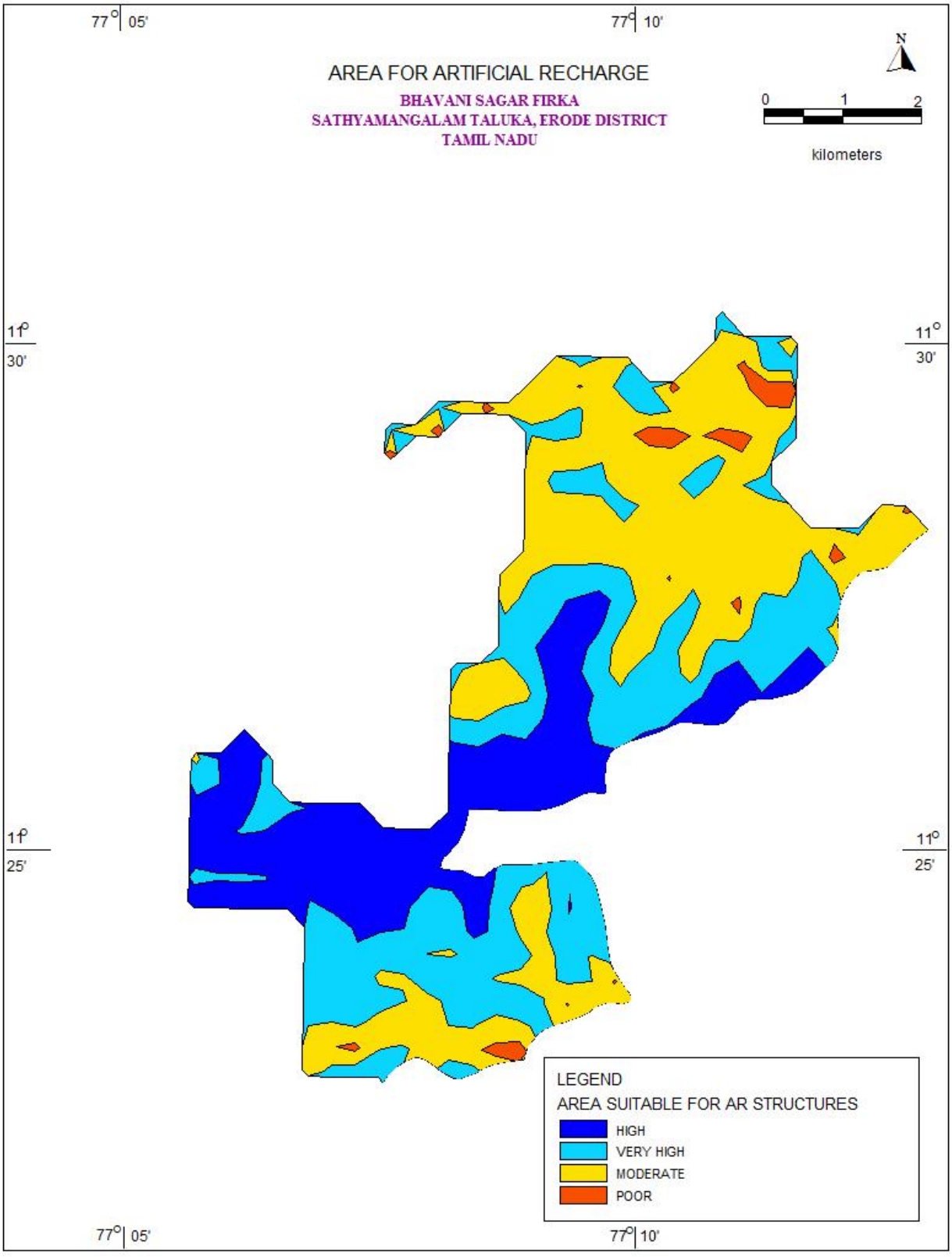


Figure 7: Showing the recharge worthy area Bhavanisagar firka

5. Planning for groundwater recharge /conservation

5.1 Justification of the artificial recharge & conservation measures

- The Bhavanisagar Firkas is with high stage of groundwater development i.e, 161 % and with sufficient amount of uncommitted surface runoff/flow of 6.08 MCM.
- The total weathered zone available beneath the ground in the firka is 708 MCM. Out of these total volume available for recharge considering 3.5 m depth from 3 m) is 482 MCM.
- The Bhavanisagar Firka consists of 14 surface water bodies /lakes which are well connected by the drainage. Revival and Recharge of these ponds will enhance the sustainability of the ground water abstraction structures.
- However, most of the ground water developments for agricultural purposes are met through dug-cum bore well and bore wells only. Hence, there is sufficient scope of recharge.
- Model generated in the Bhavanisagar areas reveals that about 98 % of areas are suitable for recharge.
- In Bhavanisagar firka around 65 % area is characterised by the agricultural activities, there is sufficient scope for the water conservation measures for enhance the crop production and better ground water development.

5.2 Availability of surplus surface water for artificial recharge or conservation

The uncommitted surface flow for Bhavanisagar Firka is estimated as per the norms followed by State Ground & Surface Water Resources data centre, PWD, Taramani, Chennai (Aug 2015). The available of surplus surface water for Bhavanisagar Firka is 6.08 MCM.

5.3 Proposed interventions including tentative location of artificial recharge /conservation measures

On basis of above description the following three type of approach have been made to propose artificial recharge or conservation structures.

a. Artificial recharge
b. Water conservation measure
c. Water Efficiency

5.3.1 Artificial recharge

The details of artificial recharge structure proposed along with justification are given below.

5.3.1.1 Check dam/Nala bund

Bhavanisagar firka area is covered by the seasonal nallas/drains which carry heavy discharge during monsoon period. As per the integrated model prediction around 30 % of the firkas areas are suitable for these structures. It is proposed to construct 17 Check dam and 33 Nala bunds. The tentative location of these 50 ARs are given below and shown in Plate 1. The size and location of

these structures are tentative and details field survey is essential to ascertain the exact size and location.

Tentative location of proposed 17 Check dam in Bhavanisagarfirka

S. NO.	LONGITUDE	LATITUDE	TYPE OF ARS
1	77.123	11.417	Check Dam
2	77.181	11.476	Check Dam
3	77.149	11.460	Check Dam
4	77.185	11.452	Check Dam
5	77.172	11.445	Check Dam
6	77.160	11.445	Check Dam
7	77.117	11.430	Check Dam
8	77.087	11.411	Check Dam
9	77.101	11.412	Check Dam
10	77.137	11.448	Check Dam
11	77.145	11.446	Check Dam
12	77.168	11.459	Check Dam
13	77.190	11.464	Check Dam
14	77.209	11.475	Check Dam
15	77.146	11.397	Check Dam
16	77.143	11.387	Check Dam
17	77.146	11.397	Check Dam

Tentative location of proposed 33 Nalla bund in Bhavanisagarfirka

SL.NO	LONGITUDE(DD)	LATITUDE (DD)	TYPE OF ARS
1	77.10	11.44	Nala Bund
2	77.12	11.41	Nala Bund
3	77.11	11.43	Nala Bund
4	77.10	11.42	Nala Bund
5	77.12	11.43	Nala Bund
6	77.12	11.42	Nala Bund
7	77.08	11.40	Nala Bund
8	77.10	11.43	Nala Bund
9	77.11	11.42	Nala Bund
10	77.10	11.41	Nala Bund
11	77.10	11.42	Nala Bund
12	77.12	11.41	Nala Bund
13	77.15	11.43	Nala Bund
14	77.15	11.43	Nala Bund
15	77.13	11.42	Nala Bund
16	77.09	11.41	Nala Bund
17	77.07	11.40	Nala Bund
18	77.16	11.44	Nala Bund
19	77.14	11.45	Nala Bund
20	77.12	11.40	Nala Bund
21	77.07	11.41	Nala Bund

22	77.17	11.44	Nala Bund
23	77.10	11.43	Nala Bund
24	77.15	11.45	Nala Bund
25	77.16	11.44	Nala Bund
26	77.19	11.45	Nala Bund
27	77.18	11.46	Nala Bund
28	77.20	11.45	Nala Bund
29	77.10	11.43	Nala Bund
30	77.15	11.46	Nala Bund
31	77.10	11.43	Nala Bund
32	77.10	11.43	Nala Bund
33	77.20	11.47	Nala Bund

5.3.1.2. Revival, repair of water bodies

The existing ponds and tanks in loose their storage capacity as well as the natural ground water recharge through these water bodies has also become negligible due to siltation and encroachment by farmers for agriculture purposes. There are several such villages where ponds/ tanks are in dilapidated condition. These existing village tanks which are normally silted and damaged can be modified to serve as recharge structure in case these are suitably located to serve as percolation tanks. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structure. Several such tanks are available in the area which can be modified for enhancing ground water recharge. Studies, however, are needed to ascertain whether the village tanks are suitably located to serve as recharge structures. The locations of about 11 existing ponds/tanks have been identified with latitude and longitude given below and marked on **Plate 1**. The above 11 tanks/ponds could be taken up for the renovation with recharge. Moreover 14 more recharge shafts are proposed to construct in the larger tanks, which will in turn recharge about 5.92 lakh cu.m

Tentative location of proposed de-siltation of pond/tanks with recharge shaft in Bhavanisagar firka.

Sl.NO	LONGITUDE	LATITUDE	STRUCTURE	ACTION
1	77.18	11.50	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
2	77.17	11.47	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
3	77.17	11.47	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
4	77.16	11.47	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
5	77.19	11.46	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
6	77.15	11.45	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
7	77.16	11.45	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
8	77.15	11.41	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
9	77.14	11.41	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
10	77.15	11.40	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
11 12-14	77.11	11.38	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT ONLY RECHARGE SHAFTS IN THE LARGER TANKS

5.3.2 Water conservation measure

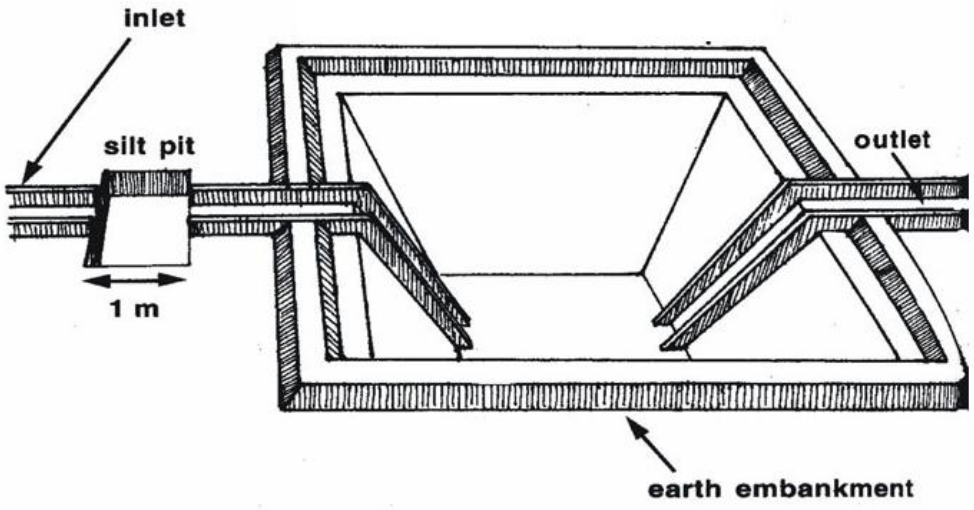
5.3.2.1 Farm Pond

A farm pond is a large dug out in the earth, usually square or rectangular in shape, which harvests rainwater and stores it for future use. It has an inlet to regulate inflow and an outlet to discharge excess water. The pond is surrounded by a small bund, which prevents erosion on the banks of the pond. The size and depth depend on the amount of land available, the type of soil, the farmer's water requirements, the cost of excavation, and the possible uses of the excavated earth. Water from the farm pond is conveyed to the fields manually, by pumping, or by both methods.

Advantages of Farm Ponds

- They provide water to start growing crops, without waiting for rain to fall.
- They provide irrigation water during dry spells between rainfalls. This increases the yield, the number of crops in one year, and the diversity of crops that can be grown.
- Bunds can be used to raise vegetables and fruit trees,thus supplying the farm household with an additional source of income and of nutritious food.
- Farmers are able to apply adequate farm inputs and perform farming operations at the appropriate time, thus increasing their productivity and their confidence in farming.
- They check soil erosion and minimize siltation of waterways and reservoirs.
- They supplies water for domestic purposes and livestock
- They promote fish rearing.
- They recharge the ground water.
- They improve drainage.
- The excavated earth has a very high value and can be used to enrich soil in the fields, levelling land, and constructing farm roads

As per the Landuse classification of the firka, majority of the area is covered by the agricultural field. Hence it is proposed to construct 100 farm ponds as per the specification of AED, Govt. of Tamil Nadu (30 x 30 x 1.5 m).



5.3.2.2. Micro Irrigation System (Sprinkler/ drip/ HDPE pipes)

Micro irrigation is defined as the frequent application of small quantities of water directly above and below the soil surface; usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line

In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant. While through drip & sprinkler irrigation wastage of irrigational water could be minimized. The studies on different crops, has revealed that irrigation water is saved drastically. The conveyance losses (mainly seepage & evaporation) can be saved up to 25 to 40% through utilization of HDPE pipes. Initially the scheme is proposed to be implemented in worst affected areas showing deepest water levels and significant declining trends.

It is proposed to take up micro irrigation system in 50 ha. The cost estimation for this component has been taken from SOR of Agricultural Engineering Department (AED), Govt. of Tamil Nadu. Tentative locations of proposed micro irrigation are shown in **Plate 1**.

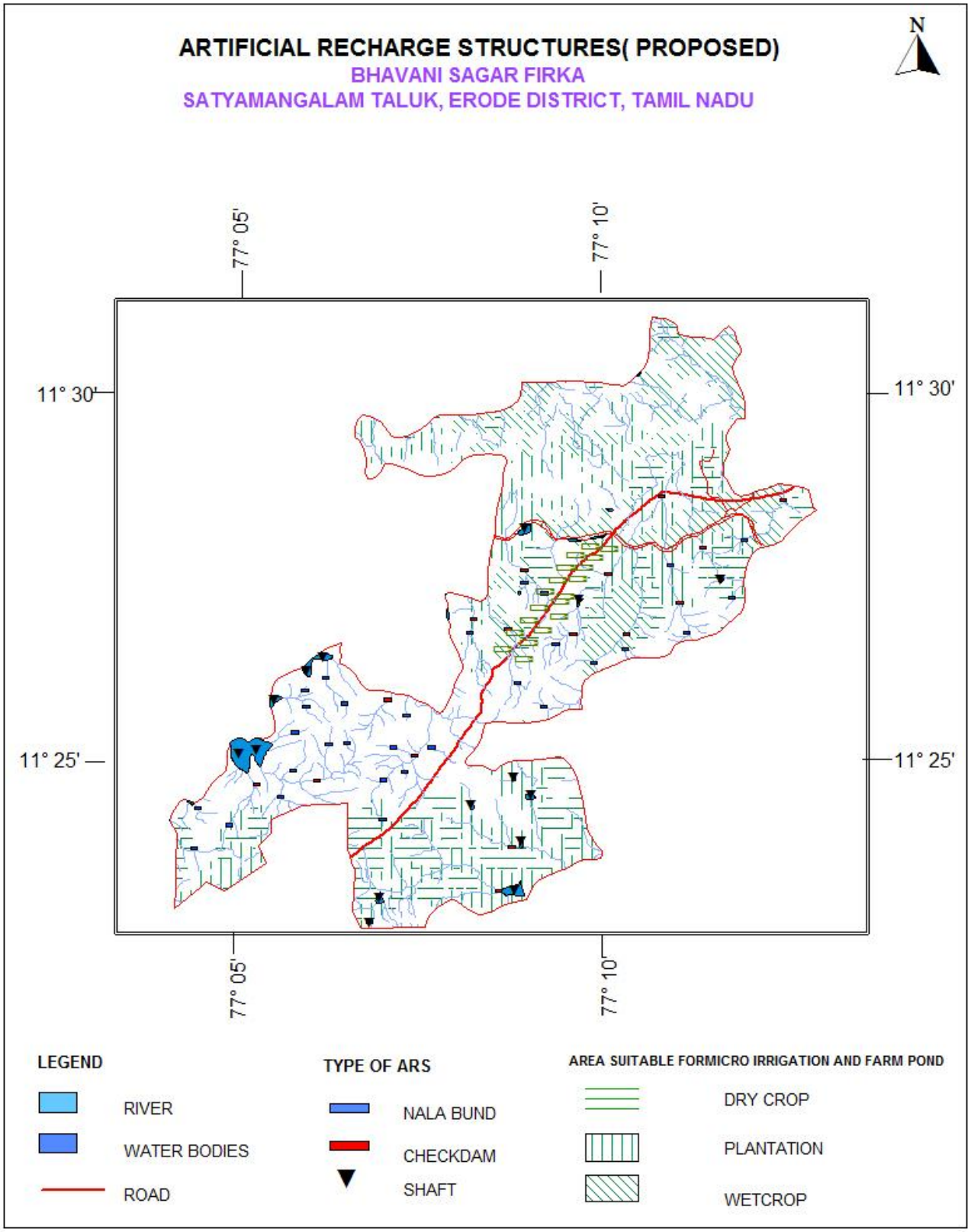


Plate 1. Location map showing the proposed AR Structures in Bhavanisagar firka

6. Tentative Cost Estimation

The tentative number of feasible structures, its cost and expected annual groundwater recharge/water saving is given in the table 7. The unit rates are as followed by the PWD, Govt. of Tamilnadu (Sources: Scheduled rates, Govt. of Tamilnadu 2015).

Table - 7. Showing the Cost Estimation of proposed Artificial Recharge Structures

Feasible Artificial Recharge & Water Conservation structures/ activities	Tentative Design	quantity (in nos. or area in sq. m)	Total volume (cu.m)	Tentative unit cost (in Rs lakh)	Total tentative cost (in Rs lakh)	Expected Annual GW recharge/ Saving (cu.m))
Recharge Structures/ Activities						
Masonry Check dams (5 Fillings)	Crest- 10 -15 m; Height- 1.0 m to 1 .5 m	17	3400 (80%)	9.0	153	231200
Nala bund/Gab ion (4 fillings)	Width: 5 to 15 m)	33	3000	2.0	66	79200
Revival, repair of water bodies (3 fillings)	(~150 m x150 m x1.5m)	11	33750 (80%)	25.0	275	891000
Recharge shaft within the pond /tanks	Shaft = 1.5 m dia x 2m depth with filter media in lower 1 m . Bore dia =10", Casing = 6" Depth = 30 m)	14		2.0	28	
Farm Pond (in ha)(5 filling)	(30 m x 30m x 1.5 m)	50 unit	1150(85%)	1	50	300000
				Sub total	**572**	1501400
Water Conservation Measure						
Sprinkler/ drip/ HDPE pipes	For 1 ha with 5 m interval HDPE pipe	50 ha		0.6 /ha	30	350000
				Total	**602**	1851400
Impact assessment and O & M						
Piezometers Up to 50 m bgl – 3nos. @ 0.6 lakh					**1.8**	
				Total cost of the Project	**603.80**	
O & M - 5 % of total cost of the scheme					**30.19**	
Impact assessment to be carried out by the implementing agencies @ 5% of Total cost					**30.19**	
				TOTAL	**664.18**	

Note:

- The type, number and cost of structure may vary according to site, after the ground truth verification.
- CD, PC- the storage of Check-dams and percolation ponds is also proposed for irrigating the surrounding areas for enhancing the groundwater recharge as well as effective utilization of the artificial recharge structures.

7. Implication modalities

The implementation of the scheme will be done by the line department of the state selected by the respective State authority. Further, it is to add that more than 50 % MGNREGA works related to water conservation/sustainable management,accordingly a convergence guideline has been madebetween National Rural Employment Guarantee Act (NREGA) (Ministry of Rural Development) & Programmes of Water Resources (MoWR , RD & GR). The district Erode is one among the list of districts identified for Convergence between NREGS and schemes of MoWR. The details of permissible works under convergence are envisaged in the Joint Convergence Guideline.

a.) Time schedule

Steps	1st Quarter	2th Quarter	3rd Quarter	4th Quarter	5th Quarter	6th Quarter	7th Quarter	8th Quarter
❖ Identification of line department /implementing agency and preparation of DPR								
❖ Approval of scheme and release of sanction of funds								
❖ Implementation of ARS								

Phase = one quarter or 3 months or equivalent to financial quarter

b.) Operation and maintenance

In all projects Impact assessment has to be carried out to ensure that projects is economically viable, socially equitable and environmentally sustainable by inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. Accordingly it is proposed a have impact assessment at the rate of 5 % of the total cost of the project for 5 years from the completion of artificial recharge structures.