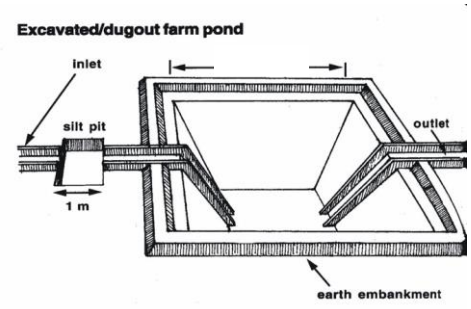
Plan on Artificial Recharge to Groundwater and Water Conservation in Usilampatti Firka, UsilampattiTaluk, Madurai District, Tamil Nadu



By

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South Eastern Coastal Region
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Chennai

Content

AT A GLANCE	
Name of Firka	Usilampatti
Taluk	Usilampatti
District	Madurai
State	Tamil Nadu
Total area (Sq. Km.)	165.16
Total area suitable for groundwater recharge (Sq. Km.)	64 (39%)
Lat. & Lon.	09° 51'34 "to 10° 00' 38" and 77° 43' 28"to 77° 49' 40"
Rainfall	1117 mm
Monsoon	893 mm
Non- Mon soon	224 mm
Geology	Crystalline metamorphic gneiss complex comprising Hornblende gneiss
WATER LEVEL	
Pre - Monsoon	5 to 8 m bgl.
Post - Monsoon	2 to 5 m bgl.
GROUND WATER RESOURCES ESTIMATION	
Replenish able ground water resources	19.240 MCM
Net ground water available	17.316 MCM
Ground water draft for irrigation	21.466 MCM
Groundwater draft for domestic & industrial water supply	0.469 MCM
Total ground water draft	21.936 MCM
Stage of ground water development (%)	126.68 %
Uncommitted surface runoff available for the Firka	22.123 MCM
Total volume of weathered zone	19.8192 MCM
Total aquifer volume available for recharge	7.4322 MCM
ARTIFICIAL RECHARGE /CONSERVATION MEASURES	
No. of Structures Proposed (tentative) Masonry Check dam – Nalla Bund – Revival, repair of pond, tanks with recharge shaft –	 7 18 20
Improving Water Efficiency /Saving (Micro irrigation system for 50 ha)	0.35 MCM
Excepted groundwater recharge	1.5934
Excepted total groundwater recharge/saving	1.9434MCM
Tentative total cost of the project	Rs. 5.07 Cr
Expected raise in water level by recharging/saving	0.59 m

Plan on Artificial Recharge to Groundwater and Water Conservation in Usilampatti firka, UsilampattiTaluk, Madurai 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 over exploited, 48 firkas critical, 235firkassemi-critical, 437 firkas 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 Usilampatti firka is 165.16 sq.km and Usilampatti firka lies between North latitudes 09° 51’34 “to 10° 00’38” and east longitudes 77° 43’ 28”to 77°49’ 40”. Location map of Usilampatti firka is given in Figure 1.

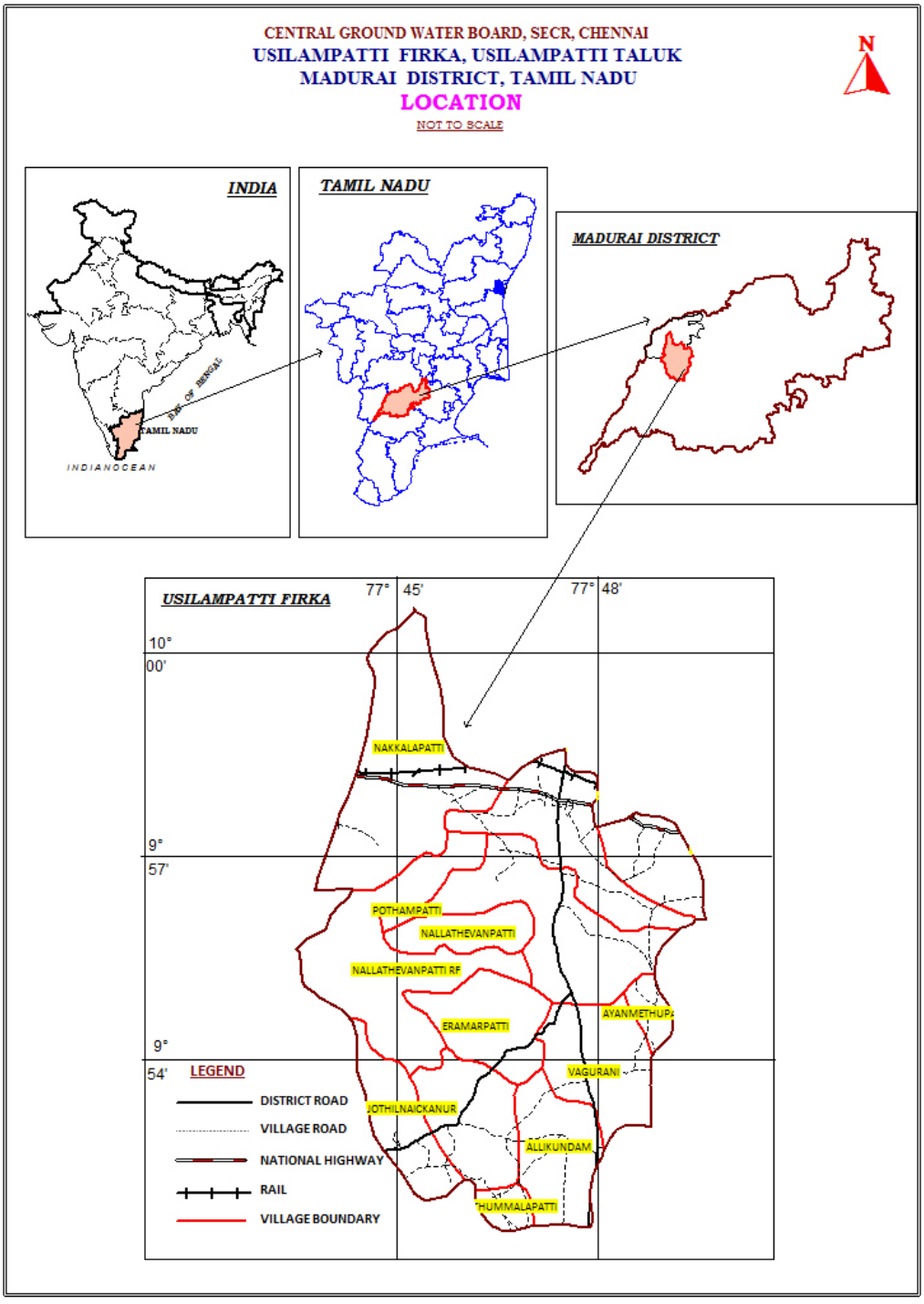


Figure 1. Location map of Usilampatti firka

3.2 Geomorphological Set up

Geomorphologically, the area consists of hills and Shallow/Moderate pediment landforms. Pediplainweathered moderate and shallow are occupied major part of the firka. These landforms are influencing the ground water recharge. Dissectted/Undissected and Hill landform like residual hills, denudation 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 shallow pediments are in about **59%** of the area, followed by Stuctural Hills.The range 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 Usilampatti firka

LANDFORMS	Area (Sq.km)	% of Area
Denudational Hills / Residual Hills	2.732	2.12
Moderate	10.91	8.48
Dissected/Undissected	11.77	9.15
Structural Hills	26.77	20.81
Shallow	76.45	59.43

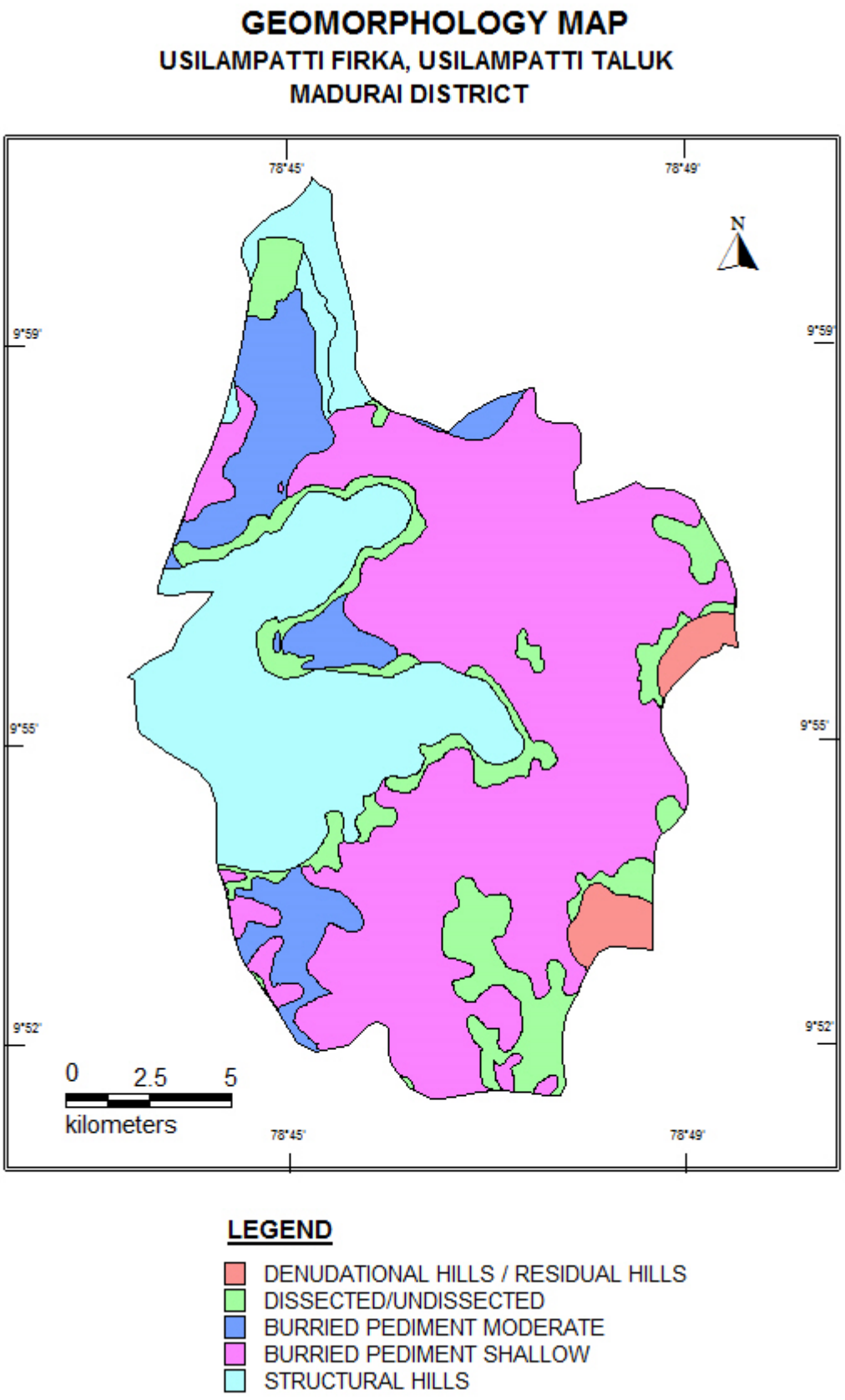


Figure 2. Geomorphology of Usilampatti Firka

3.3 Land use and soil

The land use pattern of the Usilampatti Firka is given in figure 3. Predominantly the most of the area is characterised by the Plantation in about 38 Sq. Km covering an area of 34% of the total area of the firka. The wet crop and dry crop is spread over an 21% area. (i.e., agricultural field) Overall the agricultural activity is carried out in 55 % 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 Firka is occupied by Red and forest soil, a small patch of clayey soil occur in the south eastern part of the firka. A table 1-a is given on details of Land Use and area for each category and the percentage of category is given below.

Table 1-a. Details of Land Use

Land Use	Area (Sq.km)	% Area
LAND WITHOUT SCRUB	0.008686771	0.01
RIVER / STREAM	0.146871783	0.13
BARREN ROCKY / STONY WASTE	0.19299933	0.18
FALLOW	0.436403379	0.40
SALT AFFECTED	0.997776016	0.92
RURAL SETTLEMENTS VILLAGES	1.450228106	1.33
FOREST PLANTATIONS	1.734026607	1.59
TOWN AND CITIES	2.393894479	2.20
RESERVOIR / LAKE / TANK	2.959836688	2.72
LAND WITH SCRUB	6.219095339	5.71
OTHER FOREST	7.402469794	6.80
DECIDUOUS	8.15306488	7.49
WET CROP	10.89243889	10.01
DRY CROP	12.44460041	11.43
SCRUB FOREST	15.34383332	14.09
PLANTATION	38.0847351	34.98

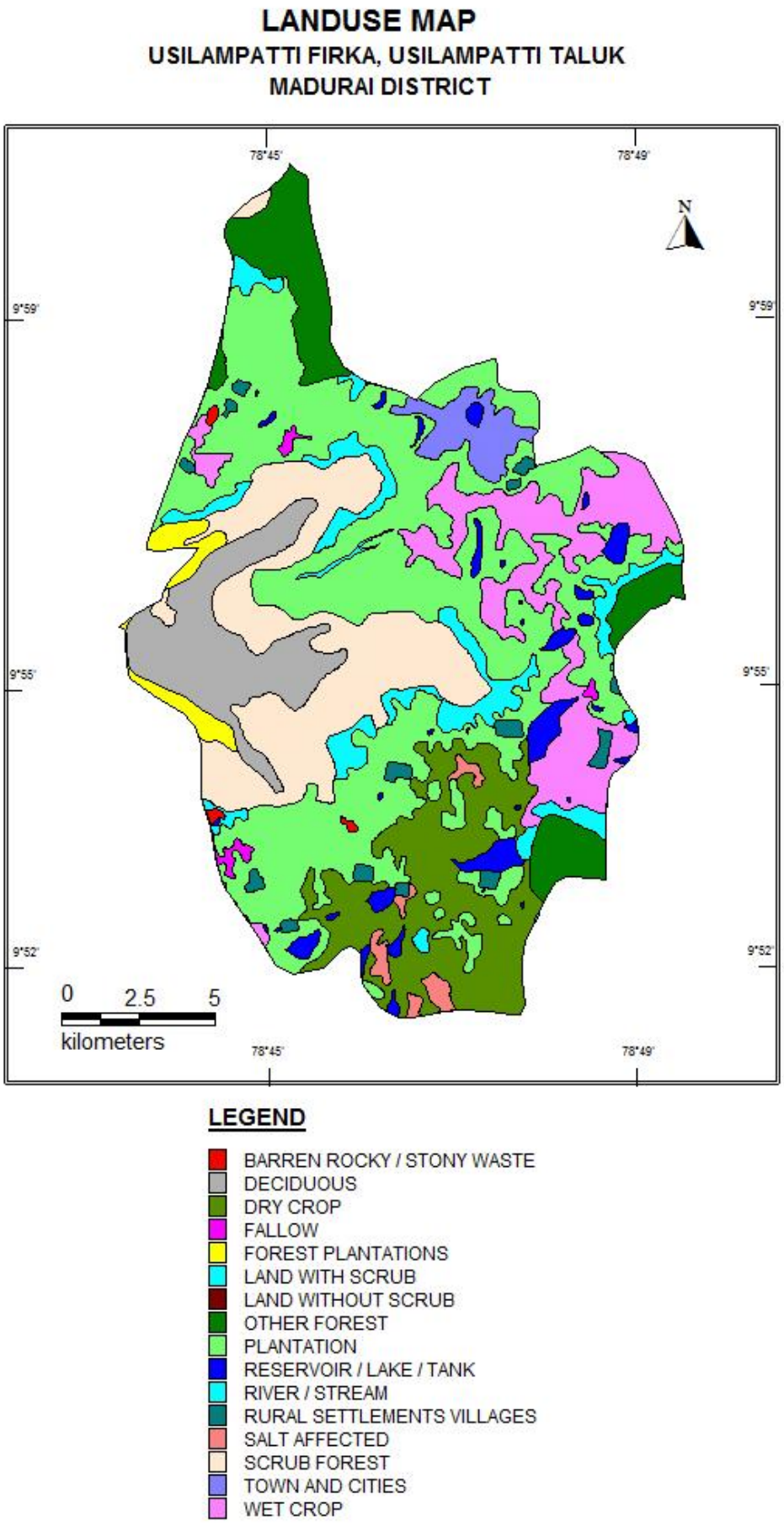


Figure 3. Land use map of Usilampatti Firka

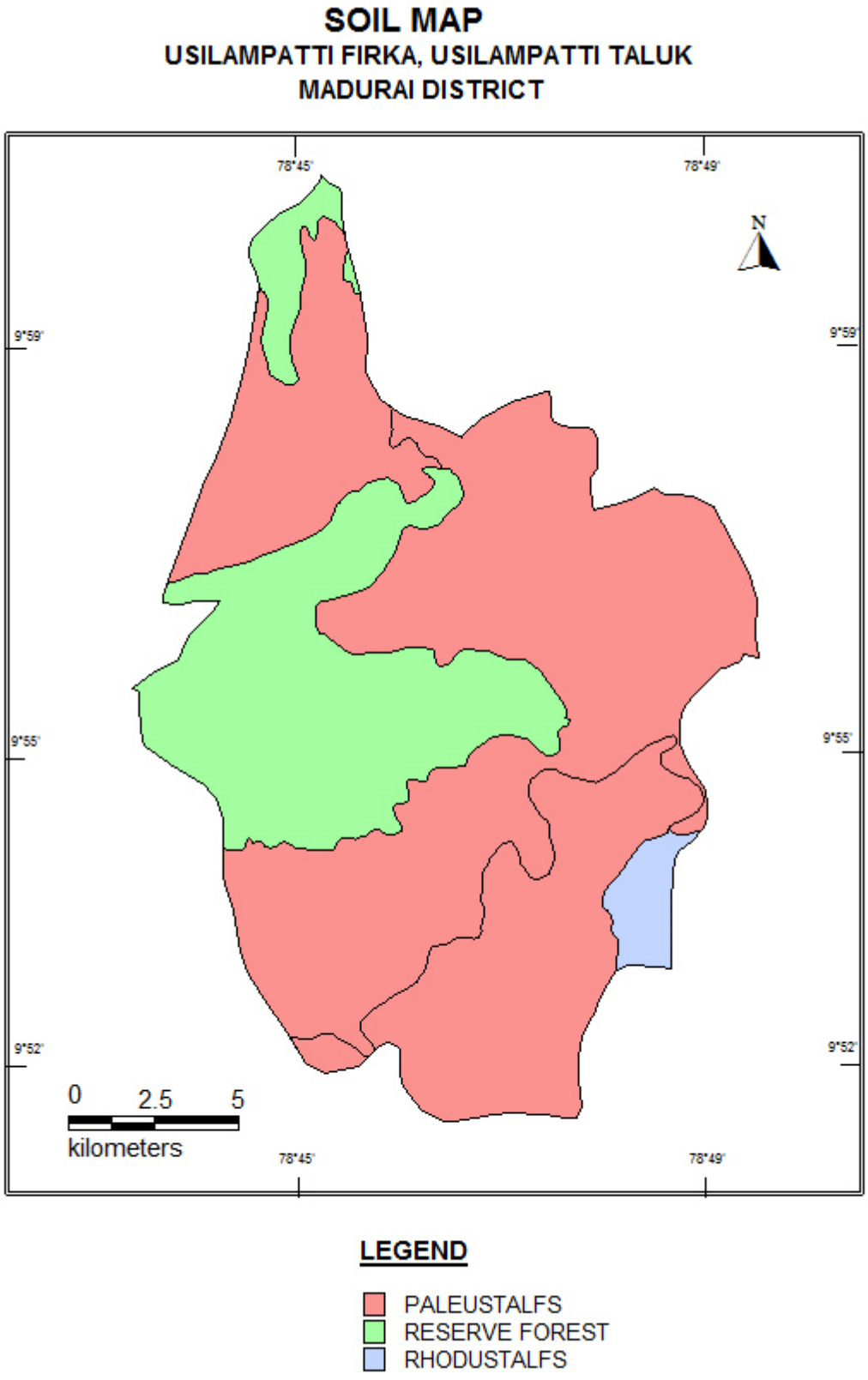


Figure 3 a. Soil distribution in Usilampatti Firkka

3.4 Drainage

The entire Firka area is within the Vaigai river basin and number of small streams originate from the hills located in the West and Northwest of firka. Only seasonal floods inundate lower parts of the basins. Basin sub soil water is used to irrigate the lands. Tanks and surface water bodies are spread over the entire firka. Most of the drainage is from east to west and northwest to southeast. The drainage pattern is the dendritic and sub- dendritic. The drainage map of Usilampatti firka is given in Figure4.

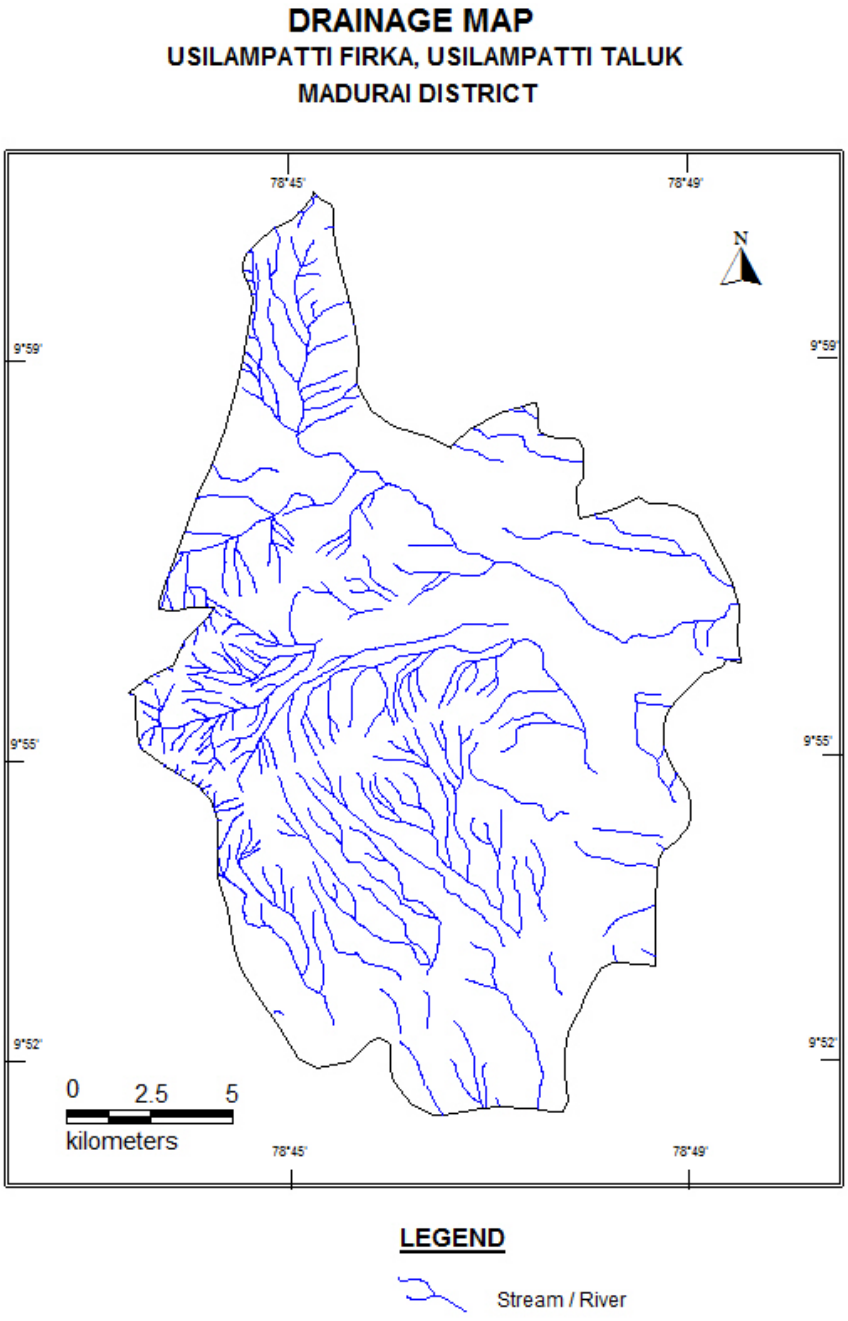


Figure 4.Drainage map of Usilampatti firka

3.5 Rainfall

Usilampatti 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. Usilampatti 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 1.117 mm.

Taluk	Name of Firka	Area (Sq. Km.)	Monsoon rainfall (Jun to Dec) (m)	Non monsoon rainfall (Jan – May) (m)	Total Rainfall (m)
Usilampatti	Usilampatti	165.16	0.893	0.224	1.117

3.6 Hydrogeology

The entire firka is underlain by the crystalline metamorphic gneiss complex consisting of charnockite and gneiss. Ground water is occurring in pheratic 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 7 to 10 m and depth of dug wells range from 15 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 hydrogeological map of Usilampatti firka is given in Figure 5.Decadal mean water level of pre-monsoon and post monsoon are given in fig 6 a & b. The decadal maps reveal that, mean water level during pre-monsoon in majority area is 5 to 10 m bgl like-wise during post monsoon majority part is under 2-5 m ground water level, while 5-10 m bgl water level occurs in southern part of the firka and < 2 m bgl water level is prevalent in the west and northwest. The present water level in the firka is in the range of 5 to 8 mbgl (May).

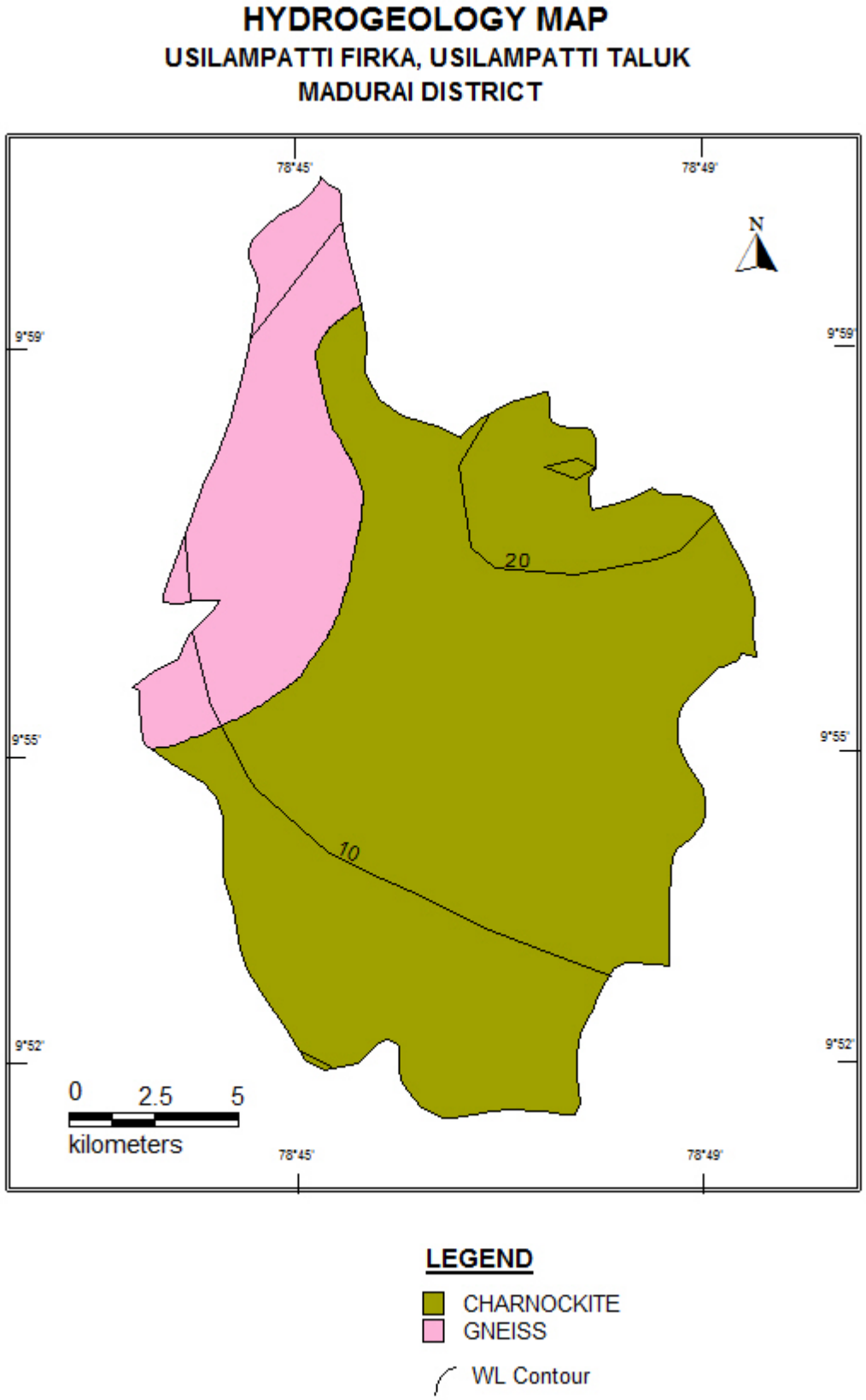


Figure 5Hydrogeological Map of Usilampatti firka

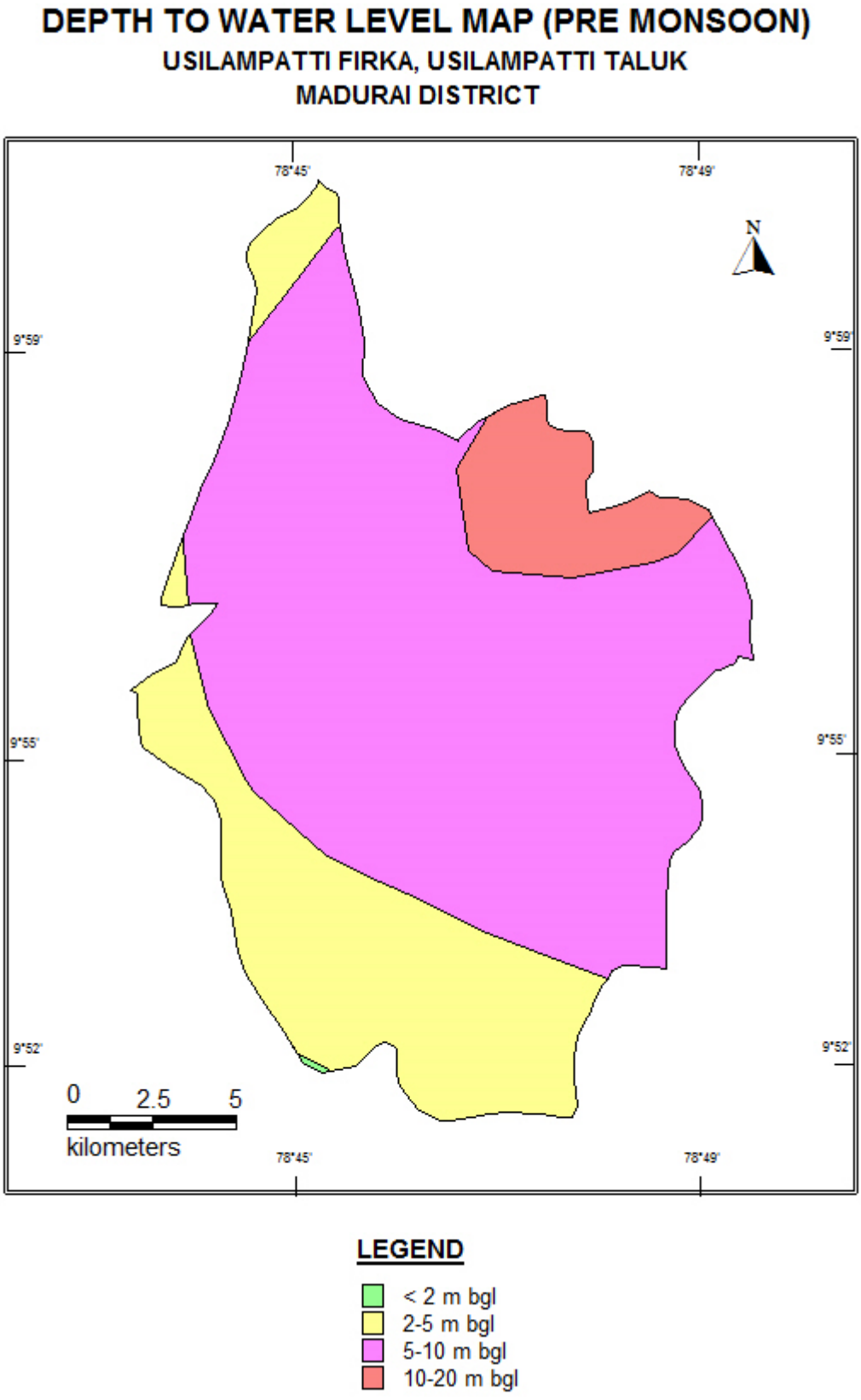


Figure 6a. Decadal Pre -monsoon water level in Usilampatttifirka

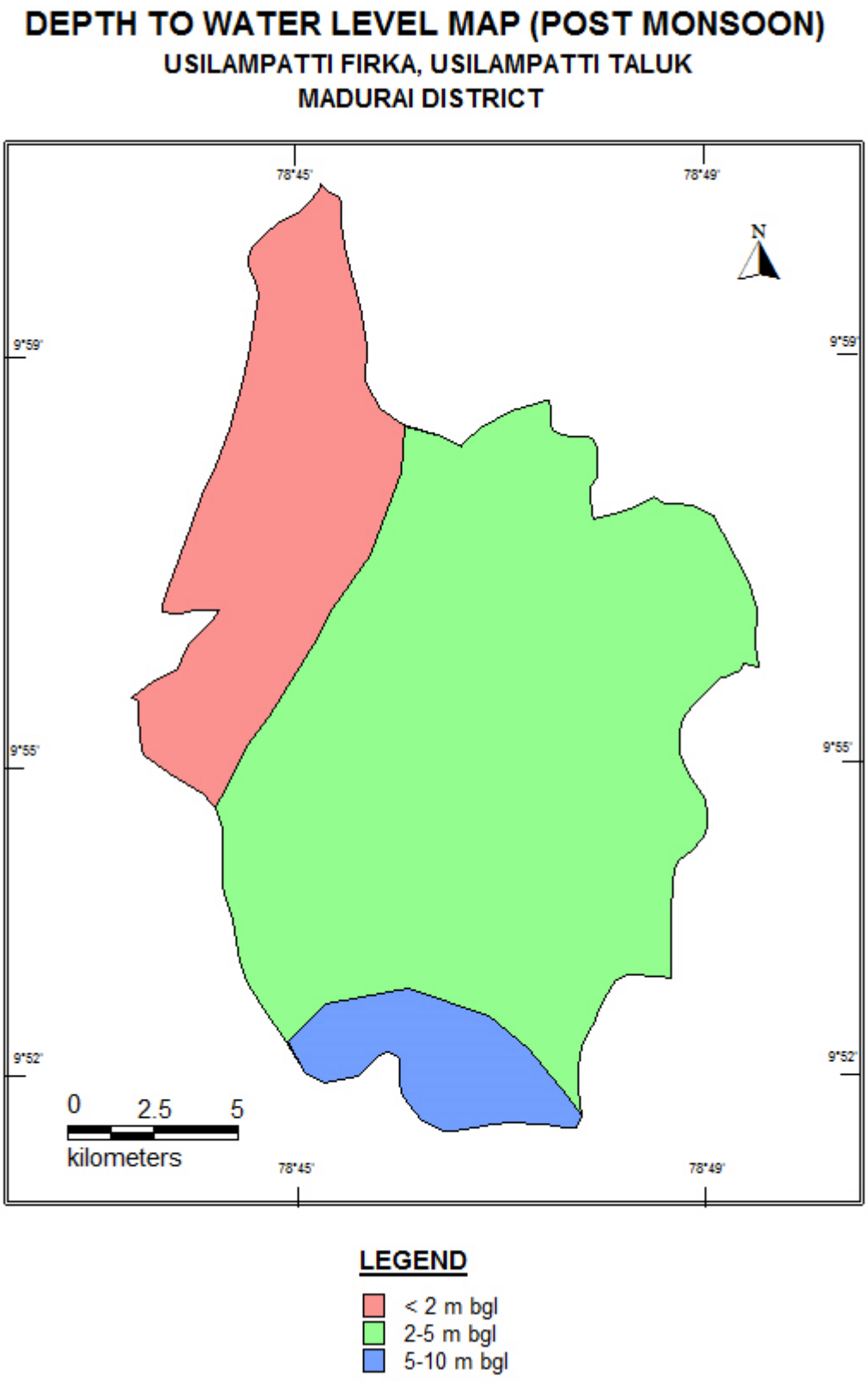


Figure 6 b. Decadal Post-monsoon water level in Usilampatti firka

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 Usilampatti firka

Firka	GEOGRAPHICAL 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)	(MCM)					%	
Usilampatti	165.16	19.24	17.316	21.466	0.469	21.936	126.68	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	0.10	Suitable for all major recharge structures like Percolation pond and stop dam, check dam etc.,
High	4.04	Suitable for all major recharge structures like stop dam, check dam etc.,
Moderate	35.04	Suitable for all major recharge structures like earthen check dam, Boulder check dam and Nala bund etc.,
Poor	60.82	Hilly/Forest /Catchment area

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

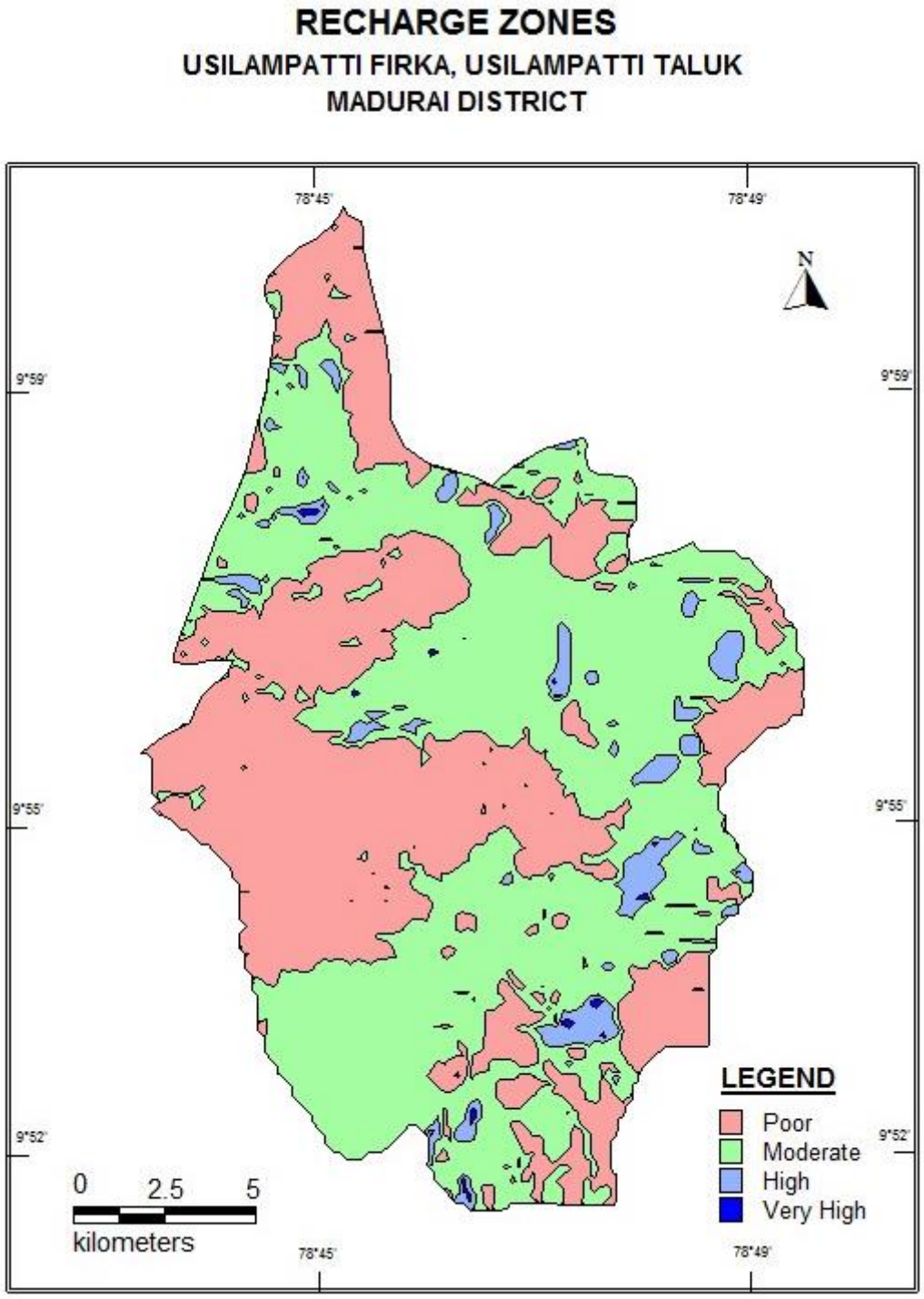


Figure 7showing the recharge worthy area Usilampatti firka

5. Planning for groundwater recharge /conservation

5.1 Justification of the artificial recharge & conservation measures

- The Usilampatti firka is with high stage of groundwater development i.e,**126.68**% and with sufficient amount of uncommitted surface runoff/flow of **22.123** MCM.
- The total weathered zone available beneath the ground in the firka is **19.819**MCM. Out of these total volume available for recharge considering 6m bgl water level is **7.432** MCM.

- The Usilampatti firka consists of **20** surface water bodies /lakes (cover almost 10 % of the total area of the firka) 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 Usilampatti areas reveals that only about**39** % of areas are suitable for recharge.
- In Usilampatti firka more than **56** % 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 Usilampatti 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 Usilampatti firka is **22.123** 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

5.3.1.1 Check dam/Nala bund

Usilampattti firka area is covered by the seasonal nallahs/drains which carry heavy discharge during monsoon period this is debauched into the water bodies within a short duration. It is proposed that such seasonal nala will be identified and the rain water will be harnessed through construction of series of check dams, nala bund and gabion structures so as to harness this water thereby increasing the resident period of the water in these channels and to increase the soil moisture content. As per the integrated model prediction around 30 % of the firka areas are suitable for these structures. It is proposed to construct **7** Check dam and **18**Nala bunds. The tentative location of these **25** 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 7 Check dam in Usilampatti firka

S. No.	Longitude	Latitude	Type of ARS
1	77.7357	9.9512	Check Dam
2	77.7795	9.9479	Check Dam
3	77.8187	9.9519	Check Dam
4	77.7862	9.9336	Check Dam
5	77.8134	9.9170	Check Dam
6	77.7911	9.8737	Check Dam
7	77.7521	9.9913	Check Dam

Tentative location of proposed 18 Nalla bund in Usilampatti firka

S. No.	LONGITUDE(DD)	LATITUDE (DD)	TYPE OF ARS
1	77.7444	9.9980	Nala Bund
2	77.7562	9.9912	Nala Bund
3	77.7522	9.9932	Nala Bund
4	77.7532	9.9990	Nala Bund
5	77.7443	9.9814	Nala Bund
6	77.7555	9.9856	Nala Bund
7	77.7447	9.9772	Nala Bund
8	77.7462	9.9586	Nala Bund
9	77.7402	9.9539	Nala Bund
10	77.7420	9.9507	Nala Bund
11	77.8048	9.9528	Nala Bund
12	77.8055	9.9565	Nala Bund
13	77.7769	9.9527	Nala Bund
14	77.7948	9.9245	Nala Bund
15	77.7865	9.9298	Nala Bund
16	77.7731	9.9481	Nala Bund
17	77.8097	9.9278	Nala Bund
18	77.7834	9.8607	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 **20** existing ponds/tanks have been identified with latitude and longitude given below and marked on Plate 1.

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

S. No.	Longitude	Latitude	Structure	Action
1	77.7489	9.9698	Tank / Reservoir	De-siltation And Recharge Shaft
2	77.7998	9.9544	Tank / Reservoir	De-siltation And Recharge Shaft
3	77.7941	9.9397	Tank / Reservoir	De-siltation And Recharge Shaft
4	77.7975	9.9329	Tank / Reservoir	De-siltation And Recharge Shaft
5	77.7978	9.9293	Tank / Reservoir	De-siltation And Recharge Shaft
6	77.8118	9.9141	Tank / Reservoir	De-siltation And Recharge Shaft
7	77.7882	9.9096	Tank / Reservoir	De-siltation And Recharge Shaft
8	77.7814	9.9092	Tank / Reservoir	De-siltation And Recharge Shaft
9	77.7726	9.8974	Tank / Reservoir	De-siltation And Recharge Shaft
10	77.8068	9.8975	Tank / Reservoir	De-siltation And Recharge Shaft
11	77.7975	9.8959	Tank / Reservoir	De-siltation And Recharge Shaft
12	77.7424	9.8919	Tank / Reservoir	De-siltation And Recharge Shaft
13	77.7915	9.8807	Tank / Reservoir	De-siltation And Recharge Shaft
14	77.7987	9.8783	Tank / Reservoir	De-siltation And Recharge Shaft
15	77.7521	9.8736	Tank / Reservoir	De-siltation And Recharge Shaft
16	77.7543	9.8732	Tank / Reservoir	De-siltation And Recharge Shaft
17	77.7942	9.9397	Tank / Reservoir	De-siltation And Recharge Shaft
18	77.8116	9.9139	Tank / Reservoir	De-siltation And Recharge Shaft
19	77.7727	9.8973	Tank / Reservoir	De-siltation And Recharge Shaft
20	77.7429	9.8927	Tank / Reservoir	De-siltation And Recharge Shaft

5.3.2 Water conservation measure

5.3.2.1 Farm Pond

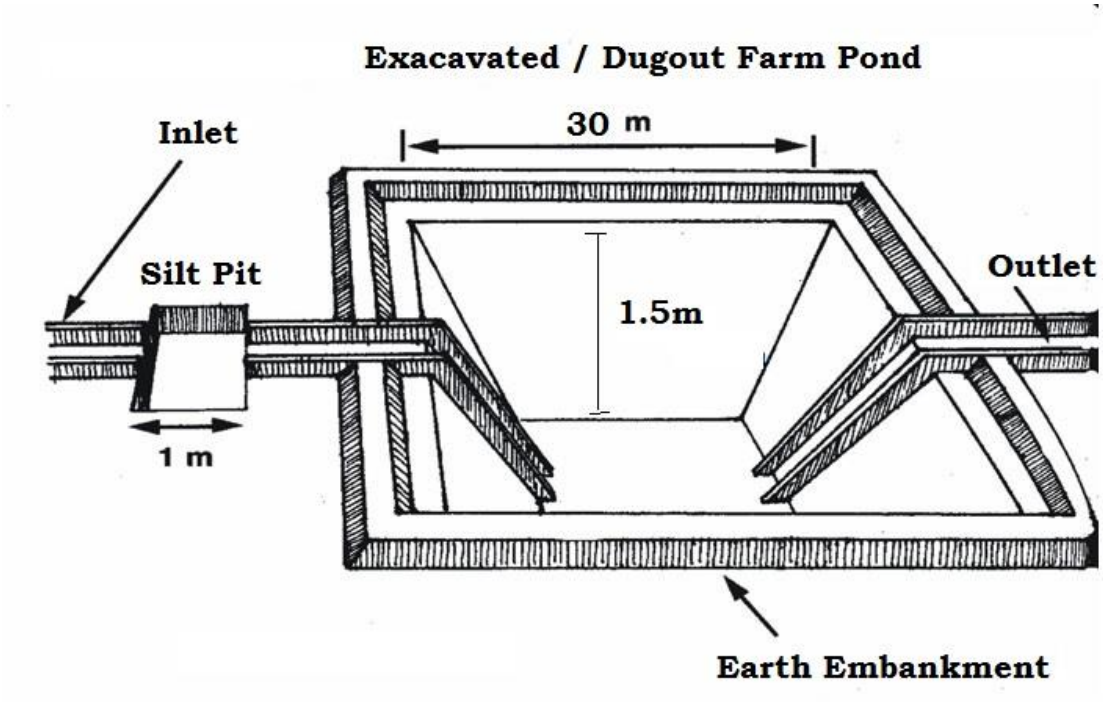
A farm pond is a large dug out in the earth, usually square or rectangular in shape, which harvests rainwater and stores it for future use. It has an inlet to regulate inflow and an outlet to discharge excess water. The pond is surrounded by a small bund, which prevents erosion on the banks of the pond. 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 Land use classification of the firka, majority of the area is covered by the agricultural field. Hence it is proposed to construct **50** 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.

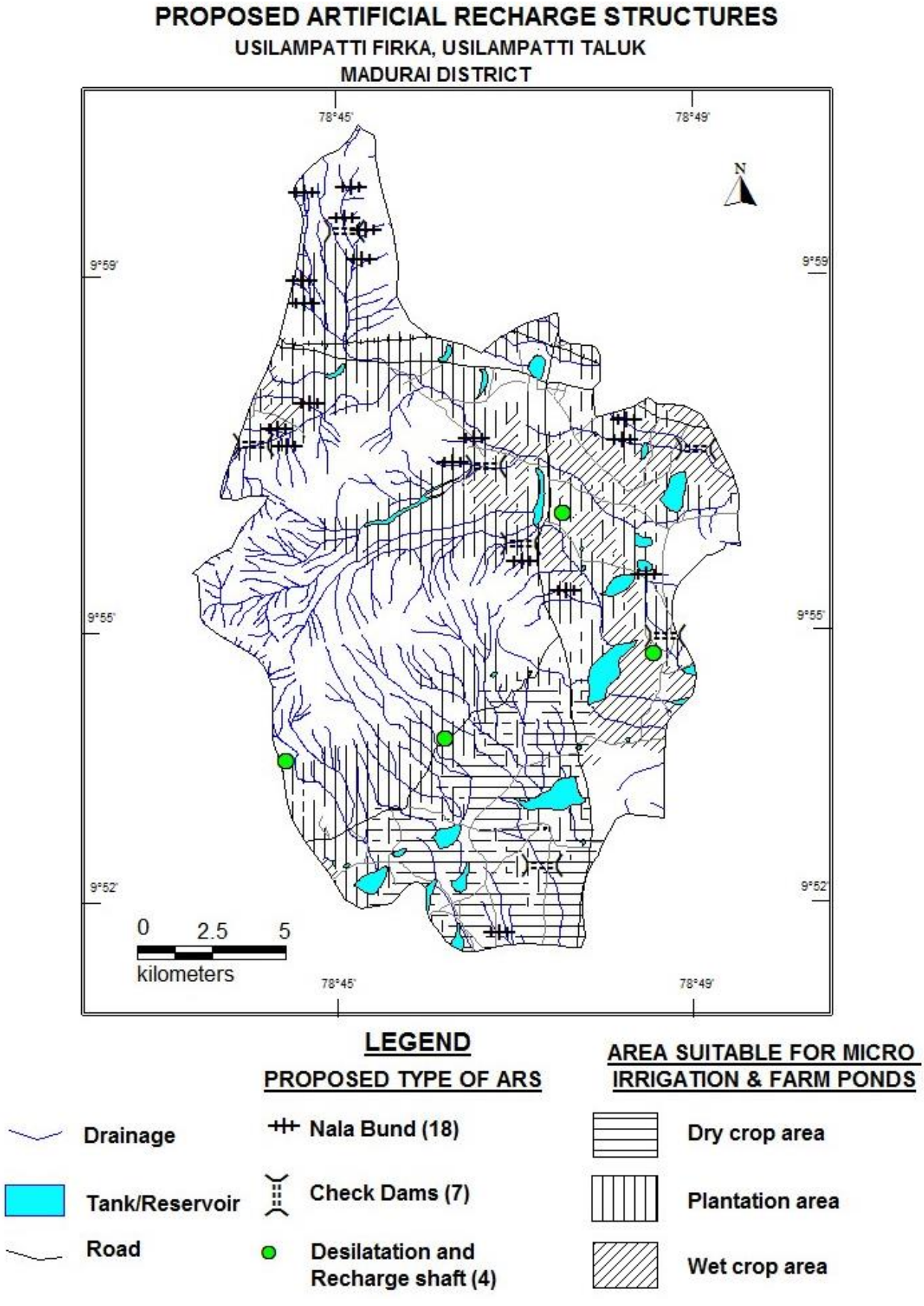


Plate 1. Location map showing the proposed AR Structures in Usilampatti firka

6. Tentative Cost Estimation

A 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 Tamil Nadu (Sources: Schedule of rates, Govt. of Tamil Nadu 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 – 1.5m	7	119000	9	63	95200
Nala bunds/ Gabion (4 Fillings)	Width: 10 m	18	54000	2.0	36	43200
Revival, repair of water bodies (3 Fillings)	(100mx100mx2.5m)	20	150000	12.0	240	1200000
Recharge shaft with the pond /tanks	Recharge shaft of 1.5 m dia. With 2m depth with filter media in lower 1 m Bore dia 10" Casing 6" Depth 30m	20		2.0	40	
Water Conservation Activities						
Farm Pond (in ha) (5Fillings)	(30 m x 30m x 1.5 m)	50 Units	300000	1	50	255000
Sprinkler/ drip/ HDPE pipes for 300 ha select area	For 1 ha with 5 m interval HDPE pipe	50 ha	500000	0.6 /ha	30	350000
Subtotal - I					**459**	**1943400**
Impact assessment and O & M						
Piezometers Up to 50 m bgl –3 nos. @ 0.6 lakh					**1.8**	
Subtotal - II					**460.8**	
O & M - 5 % of Subtotal - II					**23.04**	
Impact assessment to be carried out by the implementing agencies @ **5 % of Subtotal - II**					**23.04**	
TENTATIVE TOTAL COST OF THE PROJECT					**506.88**	

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 surrounding areas for enhancing 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 made between National Rural Employment Guarantee Act (NREGA) (Ministry of Rural Development) & Programmes of Water Resources (MoWR , RD & GR).

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 to have impact assessment at rate of 5 % of the total cost of the project for 5 years from the completion of artificial recharge.