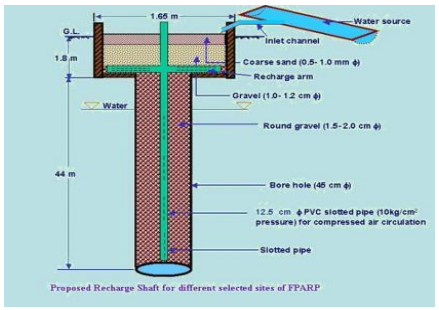
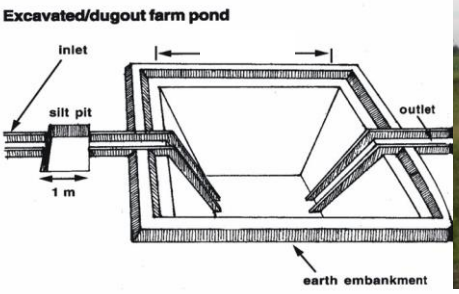
Plan on Artificial Recharge to Groundwater and Water Conservation in Sithalampattu Firka, Villupuram Taluk, Villupuram District, Tamil Nadu





By

Central Ground Water Board
South Eastern Coastal Region
Rajaji Bhawan, Besant Nagar
Chennai

AT GLANCE	
Name of Firka	Sithalampattu
Taluk	Villupuram
District	Villupuram
State	Tamil Nadu
Total area	127.93
Total suitable area	127.93
Lat. & Lon.	North latitudes 11° 55’ 3.4” to 12° 01’ 24.59” and east longitudes 79° 30’ 4.7”to 79° 43’ 26.73”
Rainfall	1064 mm
Monsoon	964 mm
Non- Mon soon	100 mm
Geology	Gneiss complex, limestone, sand stone and conglomerate .
WATER LEVEL	
Pre - Monsoon	5 to 10 m bgl.
Post - Monsoon	6 to 12 m bgl.
GROUND WATER RESOURCES ESTIMATION	
Replenish able ground water resources	42.18 MCM
Net ground water available	37.96 MCM
Ground water draft for irrigation	65.32MCM
Groundwater draft for domestic & industrial water supply	1.45MCM
Total ground water draft	66.78MCM
Stage of ground water development (%)	175.9
Uncommitted surface runoff available for the Firka	18.49 MCM
Total volume of weathered zone	25.09 MCM
Total volume available for recharge (Deepest water level – 3 m)	29.28 MCM
ARTIFICIAL RECHARGE /CONSERVATION MEASURES	
Structures Proposed (tentative) Masonry Check dam Nala Bund Revival, repair of pond, tanks with recharge shaft	 13 20 20
Improving Water Efficiency/saving Micro irrigation system for 100 ha	0.7 MCM
Expected groundwater recharge	2.355 MCM
Total expected groundwater recharge/saving	3.055 MCM
Tentative total cost of the project	Rs.6.6 Cr
Expected raise in water level by recharging/saving	2.985 m

Plan on Artificial Recharge to Groundwater and Water Conservation in Sithalampattu, Villupuram Taluk, Villupuram 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 overexploited, 48 firkas critical, 235 firkassemi-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 Sithalampattu firka is 127.93 sq.km and Sithalampattu firka lies between North latitudes 11° 55’ 3.4” to 12° 01’ 24.59” and east longitudes 79° 30’ 4.7”to 79° 43’ 26.73”. Location map of Sithalampattu firka is given in Figure 1.

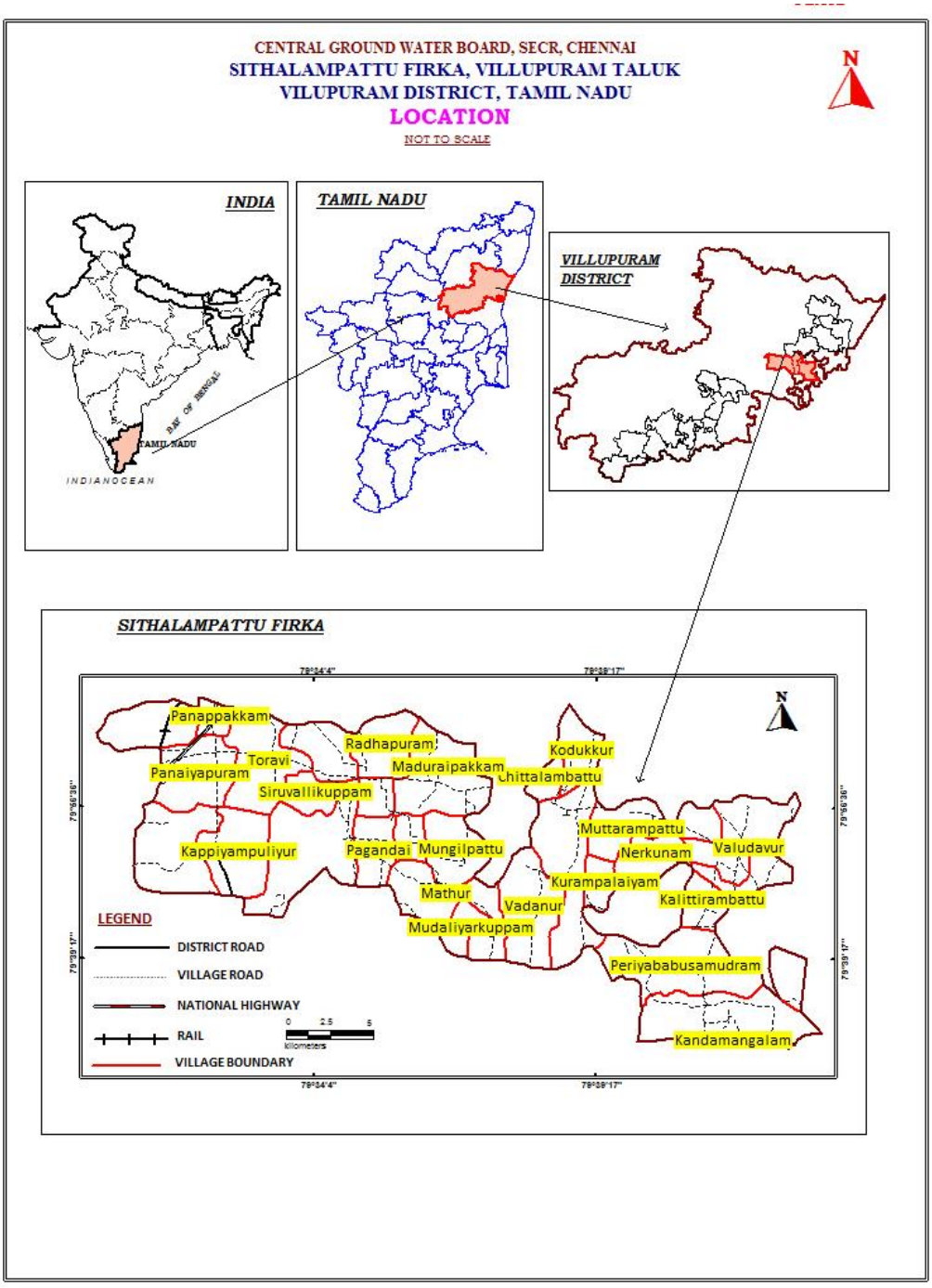


Figure 1. Location map of Sithalampattu firka

3.2 Geomorphological Set up

Geomorphologically, the area is covered by dissected /undissected pediment, buried pediment moderate and shallow, tertiary upland, Alluvial plan and flood plan. These landforms are influencing the ground water recharge. (*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 various Geomorphological units in the firka is given in table 1.

Table 1. Various Geomorphological units with its % of coverage area in Sithalampattu firka

LANDFORMS
Alluvial plan
Pediment DISSECTED/UNDISSECTED
Buried pediment - moderate
Flood plan
Buried pediment - Shallow
Tertiary

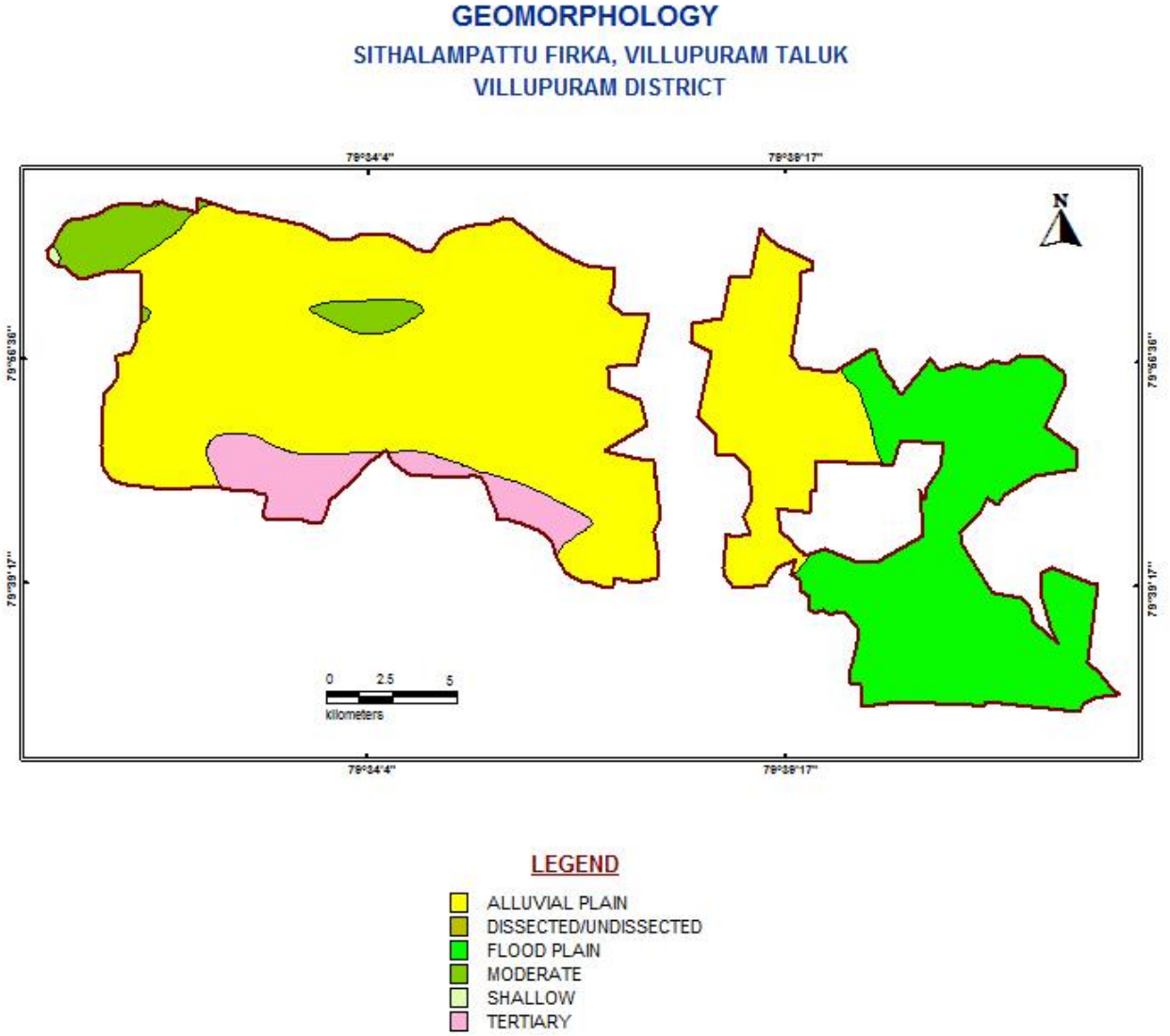


Figure 2. Geomorphology of Sithalampattu Firka

3.3 Land use and soil

The land use pattern of the Sithalampattu Firka is given in figure 3. Predominantly the most of the area is characterised by the wet crop, plantation and dry crop (i.,e agricultural field)and accounts for 50 % of the total area of the firka. Northwest part of firka is covered with small pockets of salt affected units and central and east part of the firka is covered by the reservoir/lake/tank (Source: IRS, Anna University, Chennai Tamil Nadu).

3.4 Drainage

The entire Firka area is within the Varahanadhi basin and small portion in south is falling Pennnaiyar. Numbers of small streams originate from the hills located in the Sithalampattu 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. The drainage pattern is the dendritic and sub-dendritic. The drainage map of Sithalampattu firka is given in Fig 4.

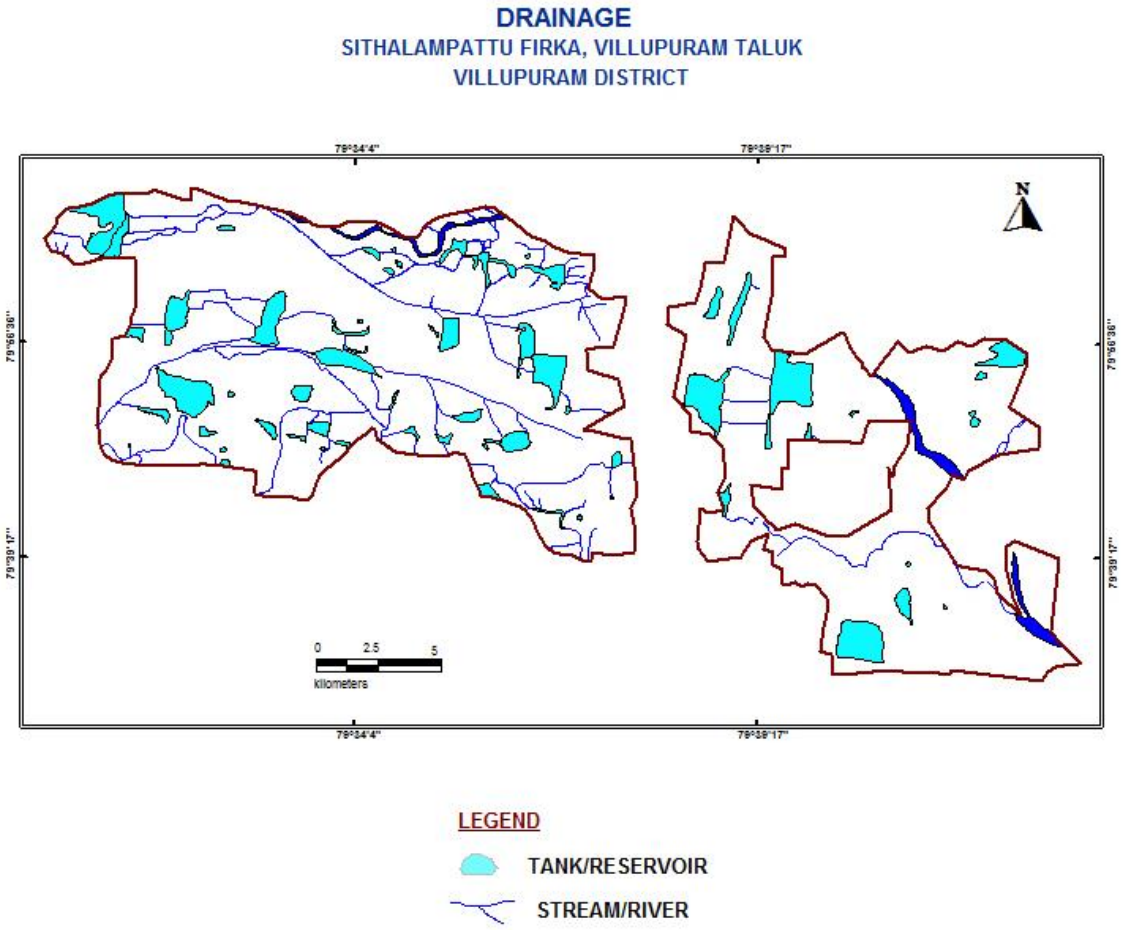


Figure 4.Drainage map of Sithalampattu Firka

3.5 Rainfall

Sithalampattu 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. Sithalampattu 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 824 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
Villupuram	Sithalampattu	127.93	0.964	0.100	1.064

3.6 Hydrogeology

Sithalampattu firka is is covered by of limestone, sand stone and conglomerate formation. A small portion (North West) is underlined by the gneissic complex. The cretaceous formations are very compact and yield prospects are low. The dug wells of 6 m diameter and 10 m bgl depth in sandy tracts give about 3.5 lps. The yield of tube wells in the sedimentary formation ranges from 2.4 to 37 lps. The diameter of the dug well in hard rock formation 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.

Ground water is occurring in Pheratic conditions in weathered and fractured Charnokite 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 Sithalampattu firka is given in Figure 5. Decadal mean water level of pre-monsoon and post monsoon are given in fig 6 a & b. In Pre and post monsoon, majority area is having water level in the range of 5-10 m bgl.

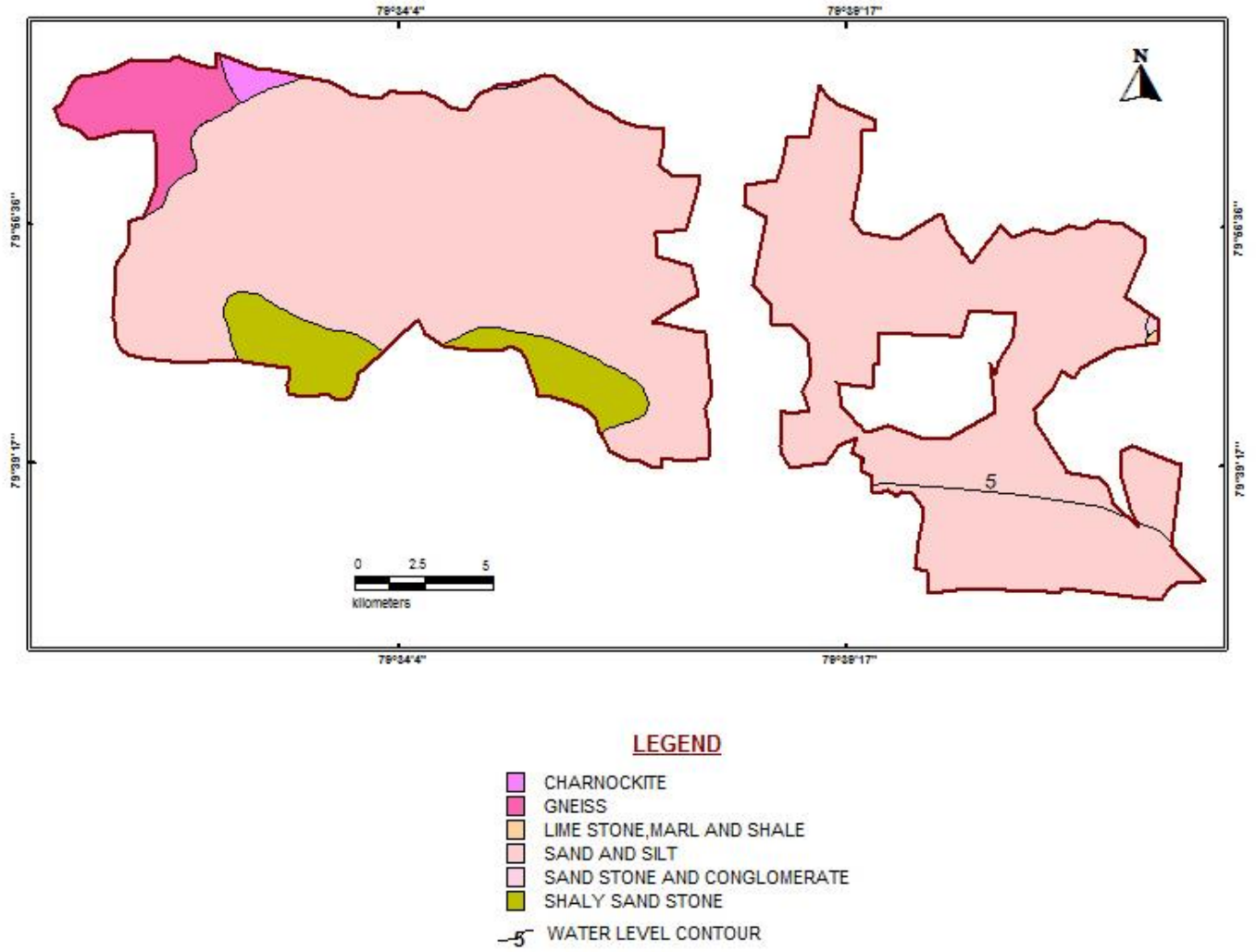


Figure 5 Hydrogeological Map of Sithalampattu Firka

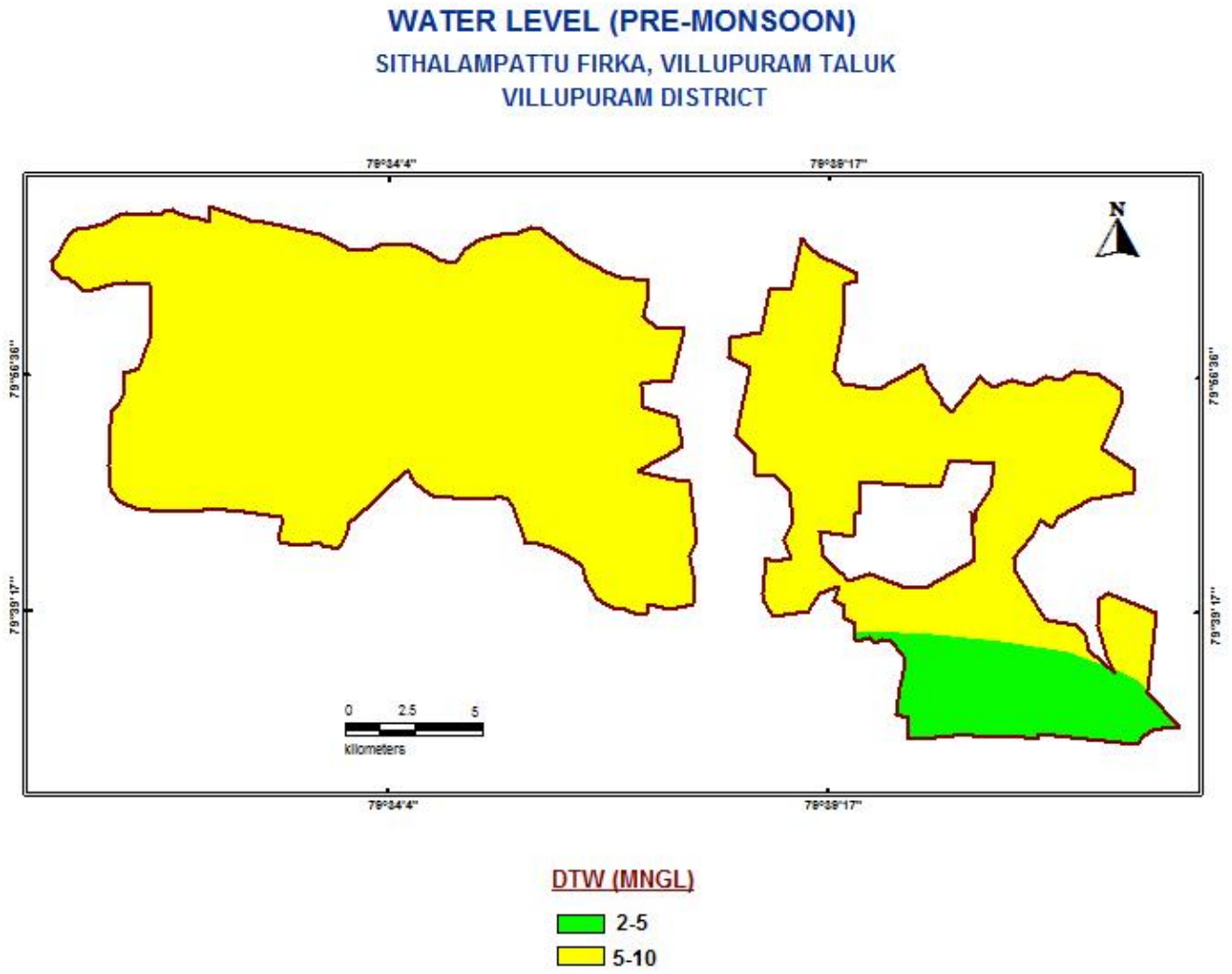


Figure 6a. Pre -monsoon water level in Sithalampattu firka (Decadal)

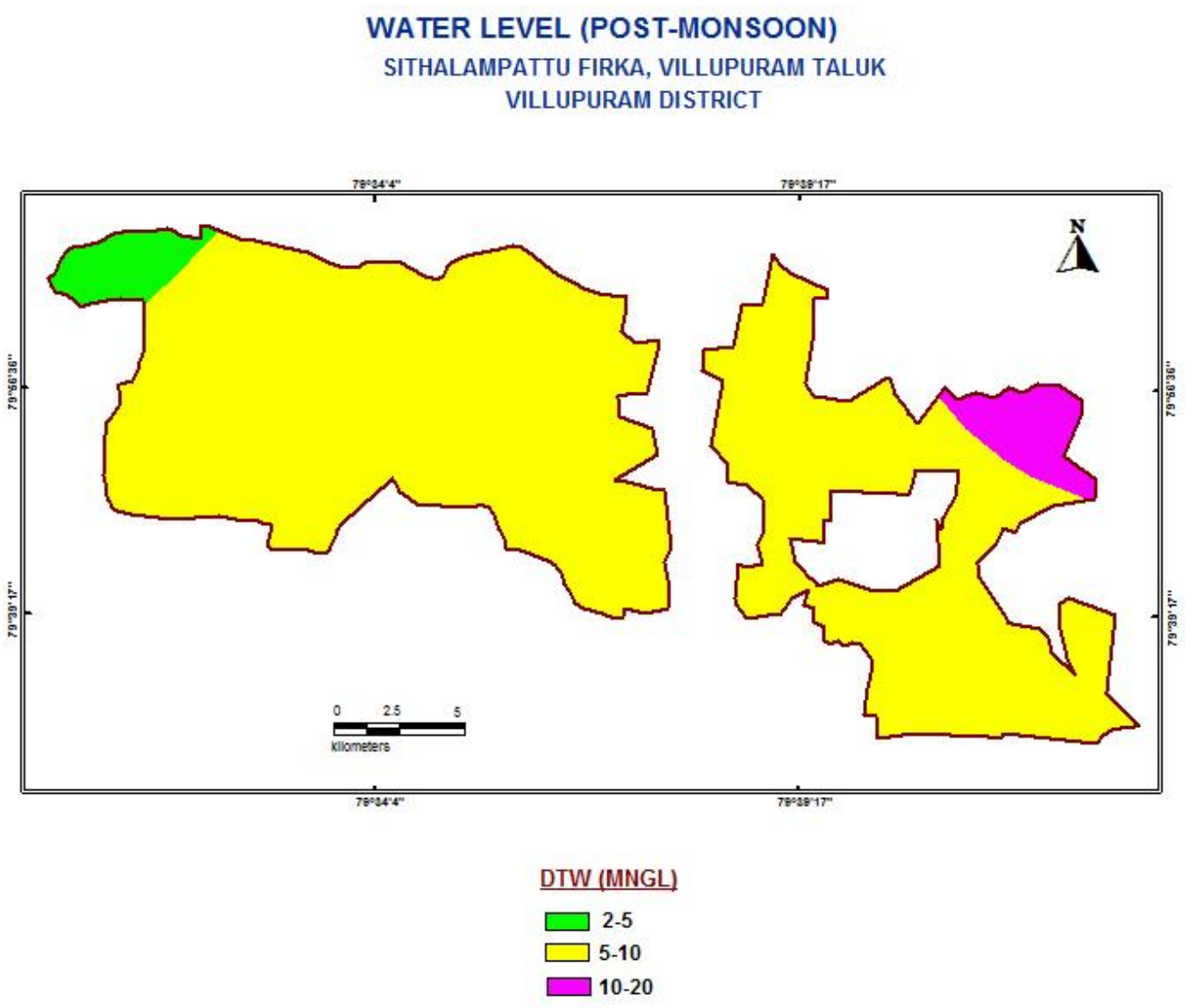


Figure 6 b. Post-monsoon water level in Sithalampattu firka (Decadal)

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 Sithalampattu **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)					%	
Sithalampattu	127.93	42.18	37.96	65.33	1.45	66.79	175.91	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 by assigning weightage for the theme having scale of 1-100 and sub-classes of the theme between 1 & 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	11	Suitable for all major recharge structures like Percolation pond and stop dam, check dam etc.,
High	45	Suitable for all major recharge structures like stop dam, check dam etc.,
Moderate	44	Suitable for all major recharge structures like earthen check dam, Boulder check dam and Nala bund etc.,
Poor	0	Hilly/Forest /Catchment area

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

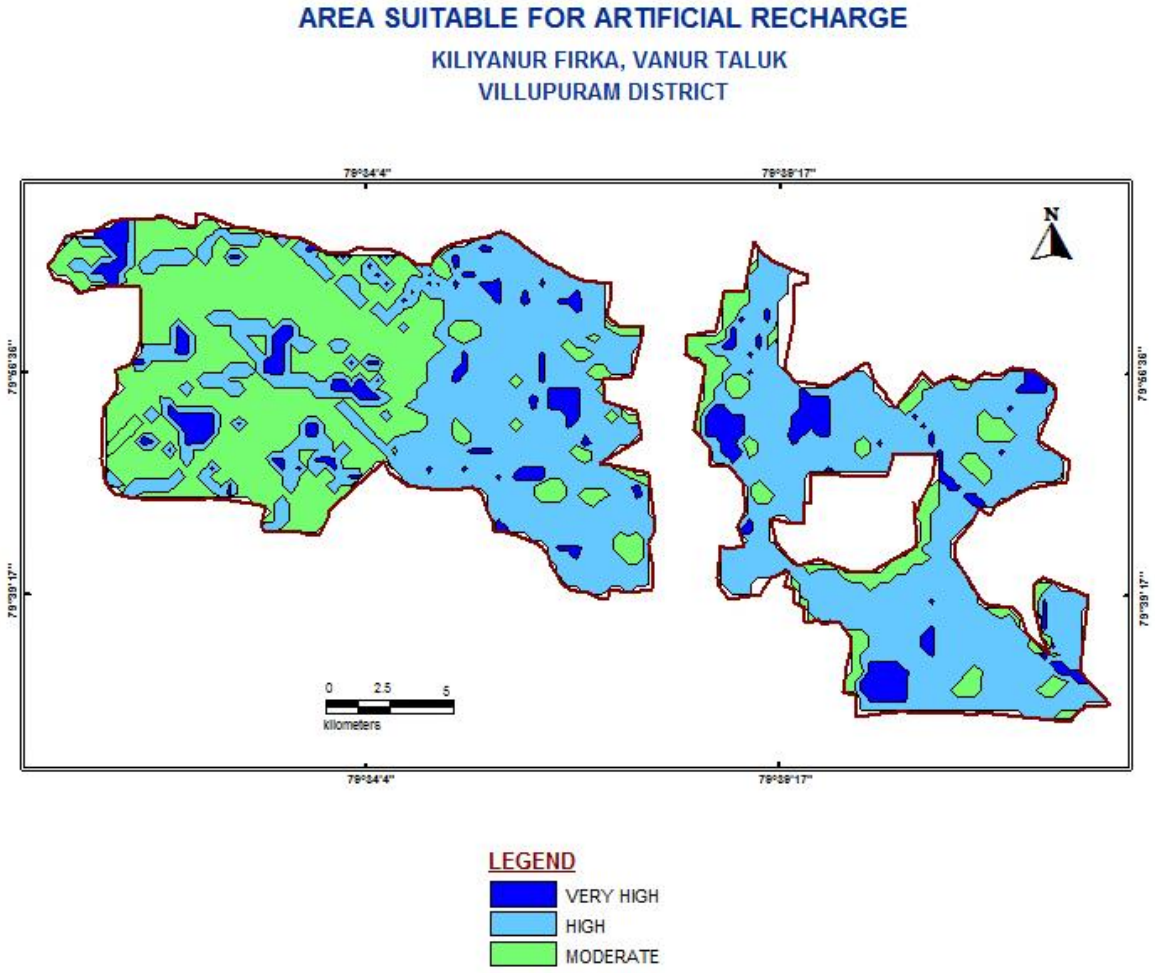


Figure 7showing the recharge worthy area Sithalampattu firka

5. Planning for groundwater recharge /conservation

5.1 Justification of the artificial recharge & conservation measures

- The Sithalampattu firkas is with high stage of groundwater development i.e, 127.93 % and with sufficient amount of uncommitted surface runoff/flow of 18.49 MCM.
- The total weathered zone available beneath the ground in the firka is 25.09 MCM. Out of these total volume available for recharge is 29.28 MCM.
- The Sithalampattu firka consists of number of 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 Sithalampattu areas reveals that more than 80 % of areas are suitable for recharge.
- In Sithalampattu firka more than 60 % 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 Sithalampattu 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 Sithalampattu firka is 18.49 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

Sithalampattu firka area is covered by the seasonal nallahs/drains which carry heavy discharge during monsoon period 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 25 % of the firkas areas are suitable for these structures. It is proposed to construct 13 Check dam and 20 Nala bunds. The tentative location of these 33 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 13 Check dam in Sithalampattu firka

S. NO.	LONGITUDE	LATITUDE	TYPE OF ARS
1	79.54	12.02	Check Dam
2	79.58	12.01	Check Dam
3	79.61	12.01	Check Dam
4	79.60	12.00	Check Dam
5	79.57	11.97	Check Dam
6	79.58	11.98	Check Dam
7	79.60	11.98	Check Dam
8	79.66	11.95	Check Dam
9	79.71	11.97	Check Dam
10	79.62	11.95	Check Dam
11	79.52	11.98	Check Dam
12	79.56	12.01	Check Dam

13	79.57	12.00	Check Dam

Tentative location of proposed 20 Nala bund in Sithalampattu firka

SL.NO	LONGITUDE(DD)	LATITUDE (DD)	TYPE OF ARS
1	79.51	12.01	Nala Bund
2	79.54	12.02	Nala Bund
3	79.52	12.01	Nala Bund
4	79.54	12.00	Nala Bund
5	79.55	12.00	Nala Bund
6	79.54	11.99	Nala Bund
7	79.55	11.97	Nala Bund
8	79.54	11.97	Nala Bund
9	79.56	12.00	Nala Bund
10	79.60	12.00	Nala Bund
11	79.61	11.97	Nala Bund
12	79.58	11.97	Nala Bund
13	79.62	11.96	Nala Bund
14	79.61	11.95	Nala Bund
15	79.65	11.98	Nala Bund
16	79.65	11.97	Nala Bund
17	79.66	11.95	Nala Bund
18	79.71	11.97	Nala Bund
19	79.60	11.99	Nala Bund
20	79.62	11.99	Nala Bund

5.3.1.3. 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. The above 21 tanks/ponds could be taken up for the renovation with recharge shaft.

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

Sl. No.	LONGITUDE	LATITUDE	STRUCTURE	ACTION
1	79.58	12.01	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
2	79.60	12.01	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT

3	79.58	12.01	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
4	79.57	11.99	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
5	79.58	11.99	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
6	79.60	11.98	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
7	79.58	11.98	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
8	79.54	11.98	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
9	79.58	11.98	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
10	79.61	11.98	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
11	79.67	11.98	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
12	79.70	11.98	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
13	79.60	11.97	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
14	79.52	11.97	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
15	79.56	11.97	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
16	79.54	11.97	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
17	79.62	11.96	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
18	79.62	11.95	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
19	79.69	11.94	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT
20	79.70	11.93	TANK / RESERVOIR	DESILTTAION AND RECHARGE SHAFT

5.3.2 Water conservation measure

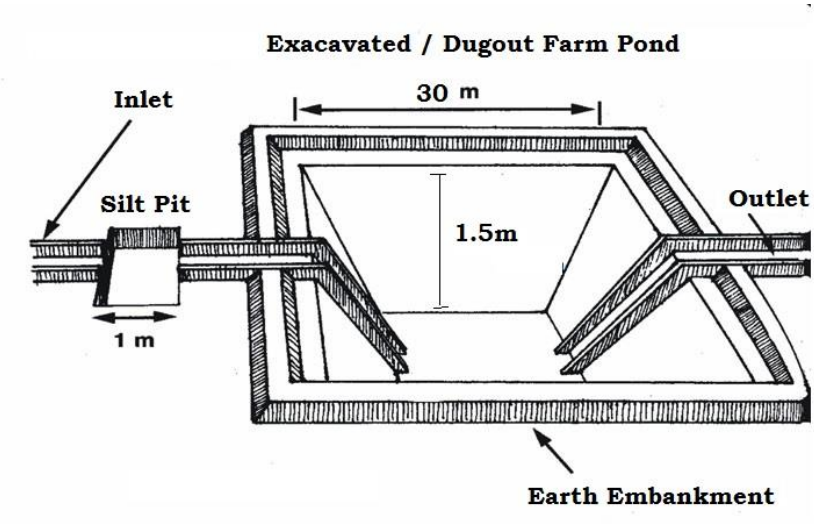
5.3.2.1 Farm Pond

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 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

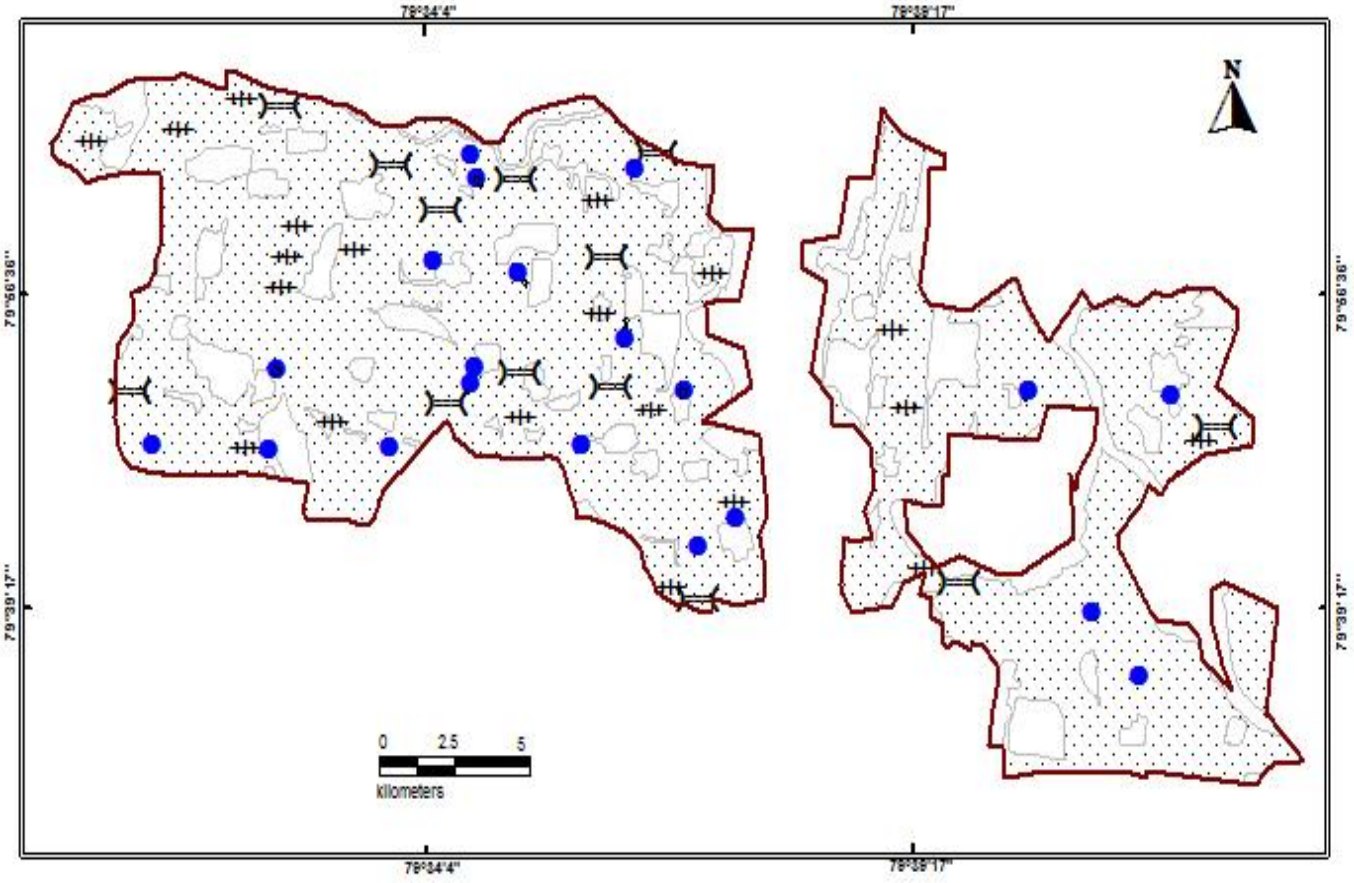
In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant. While through drip & sprinkler irrigation wastage of irrigational water could be minimized. 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 100 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.

LOCATION OF ARTIFICIAL RECHARGE STRUCTURES

SITHALAMPATTU FIRKA, VILLUPURAM TALUK

VILLUPURAM DISTRICT



LEGEND

- NALA BUND
- CHECK DAM
- REVIVAL OF WATERBODIES
- AREA SUITABLE FOR FARMPOND AND IRRIGATION SYSTEM

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

6. Tentative Cost Estimation

A tentative number of feasible structures, its cost and expected annual ground water 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 m to 1.5 m	13	221000	9	117	176800
Nala bunds/ Gabion (4 Fillings)	Width: 5 to 15 m	20	60000	2.0	40	48000
Revival, repair of water bodies (3 fillings)	(~150mx150mx1.5m)	20	2025000	12	240	1620000
Recharge shaft with the pond /tanks	Recharge shaft of 1.5 m dia. with 2 m depth with filter media in lower 1 m Bore dia 10” Casing 6” Depth 30 m	20		2	40	
Water Conservation Activities						
Farm Pond (in ha) (5 filling)	(30 m x 30m x 1.5 m)	100 unit	600000	1	100	510000
Sprinkler/ drip/ HDPE pipes	For 1 ha with 5 m interval HDPE pipe	100 ha	1000000	0.6 /ha	60	700000
				Sub total	**597**	**3054800**
Impact assessment and O & M						
Piezometers Up to 50 m bgl – 5 nos. @ 0.6 lakh					**3**	
Total cost of the project					**600**	
O & M - 5 % of total cost of the scheme					**30**	
Impact assessment to be carried out by the implementing agencies @ 5 % of total cost					**30**	
				GRAND TOTAL	**660**	

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 ground water recharge as well as effective utilisation 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). The district Villupuram 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 to have impact assessment at the rate of 5 % of the total cost of the project for 5 years from the completion of artificial recharge.