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Artificial Ground Water Recharge Using Surplus Rainwater In Chidambaram Taluk

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ABSTRACT

The ground water potential of Chidambaram Taluk in general is good but the quality is the main constraint in major parts of the Taluk. In the western parts of both Keerapalayam and Bhuvanagiri unions, the quality of ground water is good. The quality of deep confined aquifers encountered at the depths of 160 to 180 meters below ground level, in and around Chidambaram town area, is fresh in nature, potable and suitable for irrigation and drinking purposes. Artificial recharge is necessary, to maintain or augment natural ground water as an economic resources, to combat progressive depletion of ground water levels, to combat unfavorable salt balance and saline water intrusion. For Balance Ground Water Potential available for development in Bhuvanagiri block are less than 70% of the annual recharge, and Parangipettai block Ground water more than 70% but less than 90% of the annual recharge. This has resulted in declining ground water levels and depletion of ground water resources in such areas. Artificial recharge efforts are basically aimed at augmentation of the natural movement of surface water into ground water reservoir through suitable civil construction techniques.

1. INTRODUCTION

To meet the increasing demand from domestic and irrigation sectors on groundwater, rain water harvesting is an efficient way of improving the situation through artificial recharge. Surplus water releases through canals in surface drainage systems under natural flow conditions with construction of check dams at suitable intervals is also known to improve the recharge of ground water (Kumar 2007). Rain water is a major source of fresh water and the activity of collecting rainwater directly for beneficial use or recharging it into the ground to improve ground water storage in the aquifer is known as rain water harvesting.Water is indispensable for any life system to exist on earth and is a very important component for the development of any society (Sharma 2000). It has been observed that the total water resources in India are estimated to be around 1869 km3 / year, while the average utilizable surface water in the country as on 2001 is 1123 km3 (EPTRI 2000). In the present scenario, the population boom along with industrialization and globalization has ensured that the abstraction of ground water has touched the peak and the use of surface water resources alone may not be enough to tide over this demand. The number of ground water wells has increased from less than 1 lack in 1960 to nearly 12 lacks in 2002. An old technology is gaining popularity in a new way. Rain water harvesting is enjoying a renaissance of sorts in the world, but it traces its history to biblical times. Extensive rain water harvesting apparatus existed 4000 years ago in the Palestine and Greece.Thereby, precious rainwater is squandered, as it is drained into the sea eventually. Rainwater is collected directly or recharged into the ground to improve ground water storage (CGWB 2000). Water that is not extracted from ground during rainy days is the water saved.

1.1 OBJECTIVE

- ✓ To maintain or augment natural ground water as an economic resources.
- ✓ To conserve excess rain water.
- ✓ To combat progressive depletion of ground water levels.
- ✓ To combat unfavorable salt balance and saline water intrusion.

1.2 ATTRIBUTES OF GROUNDWATER

1. There is more ground water than surface water.
2. Ground water is less expensive and economic resource.
3. Ground water is sustainable and reliable source of water supply.
4. Ground water is relatively less vulnerable to pollution
5. Ground water is usually of high bacteriological purity.
6. Ground water is free of pathogenic organisms.
7. Ground water needs little treatment before use.
8. Ground water has no turbidity and colour.

9. Ground water has distinct health advantage as art alternative for lower sanitary quality surface water.
10. Ground water is usually universally available.
11. Ground water resource can be instantly developed and used.
12. There are no conveyance losses in ground water based supplies.
13. Ground water has low vulnerability to drought.
14. Ground water is key to life in arid and semi-arid regions
15. Ground water is source of dry weather flow in rivers and streams.

1.2 METHODS OF ARTIFICIAL RECHARGE

1. Spreading Method
    - ✓ Spreading within channel
    - ✓ Spreading stream water through a network of ditches and furrows
    - ✓ Ponding over large area
        - ▪ Along stream channel viz. Check Dams/ Nala Bunds
        - ▪ Vast open terrain of a drainage basin viz. Percolation Tanks
        - ▪ Modification of village tanks as recharge structures.
2. Recharge Shafts
    - ✓ Vertical Shafts
    - ✓ Lateral Shafts
3. Injection Wells
4. Induced Recharge
5. Improved Land and Watershed Management
    a. Contour Bunding
    b. Contour Trenching
    c. Bench Terracing
    d. Gully Plugging

2. STUDY AREA

The study area selected is Chidambaram, It is a municipal town in Tamil Nadu and the Taluk headquarters of the Cuddalore district. The total aerial extent of this Taluk is 649 square km. Number of revenue villages 193**.** In Chidambaram Vellar river is the one of the major seasonal rivers which drains the major portion in the southern part of the district. As per the administrative setup the Chidambaram is divided into three blocks Bhuvanagiri, Parangipettai & Keerapalayam. The nearby watershed is lower Vellar sub basin. In Odaiyur village of Chidambaram Taluk, The quality of ground water is poor. Location map of the study area is shown in figure 2.1.

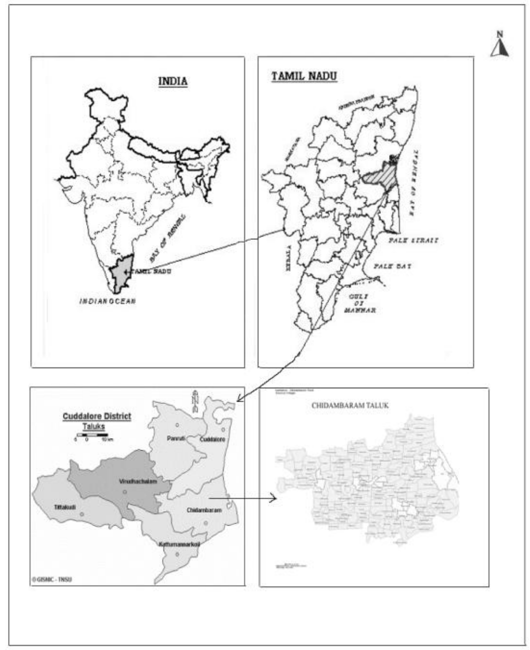

Figure 2.1 Chidambaram taluk location map (Source: www.tn.gov.in)

2.1 Lower Vellar sub-basin

There are ten observation wells located in this minor basin. Good quality of ground water in noticed in villages. The concentration of all ions lies within the desirable limit. The geochemical type is calcium chloride and calcium bicarbonate showing suitability for all purpose. There are thirteen observation wells in the Sub basin. The winter water level various from 2.5m to 6.5m and the summer water table ranges from 3.5m to 9.5m below ground level.

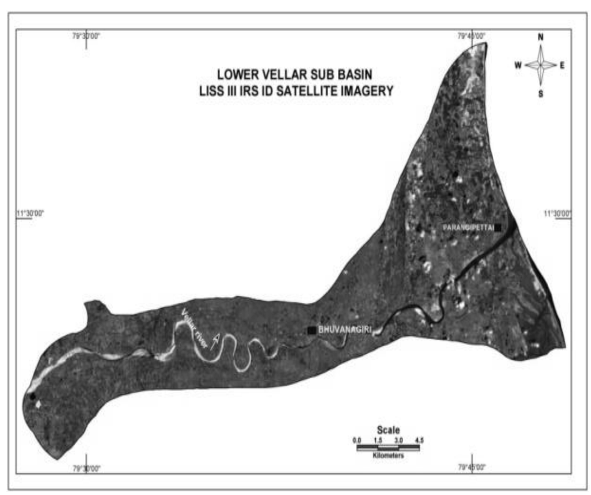

Figure 2.2 lower Vellar sub basin (Source: Water resources Organization, PWD)

3. METHODOLOGY

- To collect rainfall data for the past 14 years in Chidambaram taluk.
- To estimate run off for the study area.
- To identify the feasible areas for ground water recharge.
- To suggest suitable artificial ground water recharge structure to increase the ground water level.

3.1 Data collected

The following data has been collected from Water Resources Organization, Tamil Nadu PWD and Public Works Department Chidambaram.

⇔ Past 14 year rainfall data,

⇔ Lower Vellar river basin

- Satellite image for the study area, presented in figure 2.2
- Soil map, presented in figure 3.1
- Land use map, presented in figure 3.2

⇔ Lithology map for Bhuvanagiri and Paragepettai blocks.

3.1.1 SOIL MAP

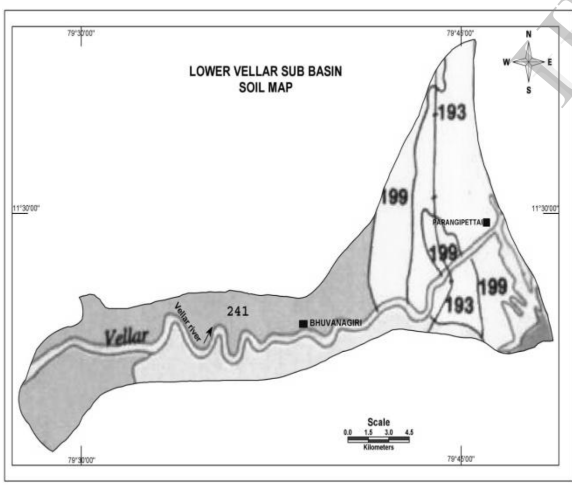

Figure 3.1 lower Vellar sub basin – Soil map (Source: Water resources Organization, PWD)

LEGEND

Soil type number 199

Very deep, imperfectly drained, Sandy soils on nearly level lands, moderately eroded associated with very, deep excessively grained, sandy soils.

Soil type number 193

Very deep, somewhat excessively drained sandy soil on gently sloping plains slightly eroded.

Soil type number 241

Very deep, moderately well drained cal carious, clayey soils of nearly level lands, moderately eroded, associated with very deep, imperfect drained, calcareous, and calking clay soils.

3.1.2 LAND USE MAP

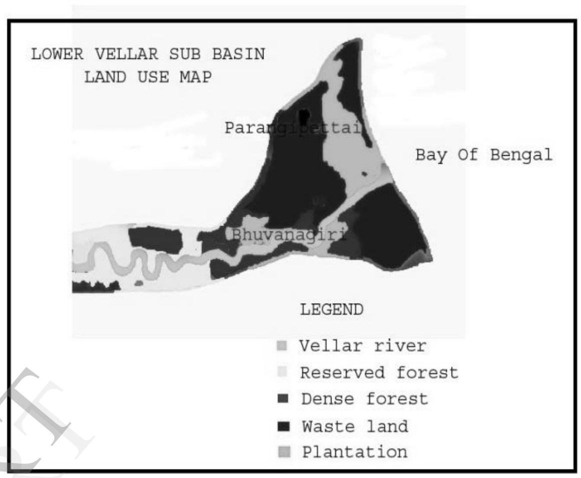

Figure 4.3 lower Vellar sub basin – land use map (Source: Water resources Organization, PWD)

4. CALCULATION OF RUN OFF

4.1 Runoff Estimation based on Land Use and Treatment

$$R = KP$$

Where,

R = Runoff in mm.
P = Rainfall in mm.
K = Runoff Coefficient.

Land use data for the study area

Waste land	= 50%
Forest	= 35%
Plantation	= 15%

Runoff coefficient

The runoff coefficient depends on factors affecting runoff.

Runoff coefficient for waste land (Ranges 0.05-0.3)	=0.3
Runoff coefficient for forest (Ranges 0.05-0.2)	= 0.2
Runoff coefficient for Plantation (Ranges 0.05-0.3)	= 0.3
Total runoff coefficient	= 0.8
Average runoff coefficient	= 0.267

Solution

The runoff has been computed for the year 1996

Runoff for the month of January $R_{jan} = KP_{jan}$

$= 0.267 * 0$

$= 0$ mm

Runoff for the month of April $R_{apr} = KP_{apr}$

$= 0.267 * 32.18$

$= 8.59$ mm

Runoff for the month of June $R_{jun} = KP_{jun}$

$= 0.267 * 282$

$= 75.294$ mm

Similarly Runoff for the year 1996 to 2009 has been calculated.

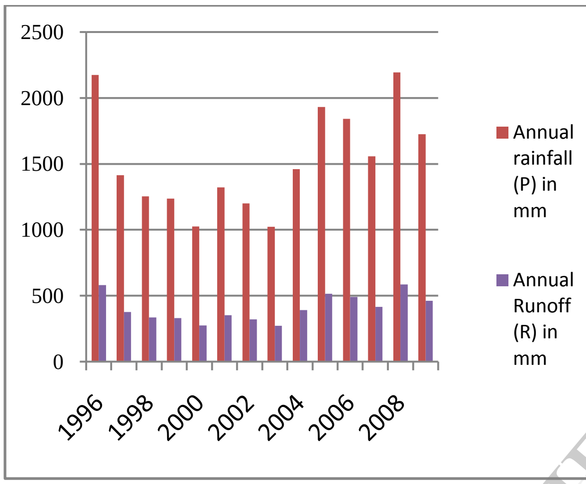

Fig.4.1 Annual Rainfall and Runoff Variation chart

4.2 BALANCE GROUND WATER POTENTIAL AVAILABLE FOR DEVELOPMENT

Table 4.1 Balance Ground Water Potential available for development

Name of Block	Total Block Area Sq.km	Block Net Potential in Sub Basin (M^3)	Block Gross Extraction in Sub-Basin (M^3)	Balance Potential available in block (M^3)	Balance Potential available in Sub-basin (M^3)
Bhuvanagiri	201.37	34.786	19.259	15.526	148.33
Parangipettai	299.0	41.178	4.183	36.99	148.33

PARANGIPETTAI - SAFE : Ground water less than 70% of the annual recharge.

BHUVANAGIRI - SEMI-CRITICAL: Ground water more than 70% but less than 90% of the annual recharge.

5 DESIGN ARTIFICIAL RECHARGE STRUCTURES

5.1 Earthen Embankment for Percolation Tank in Sandy loam soil

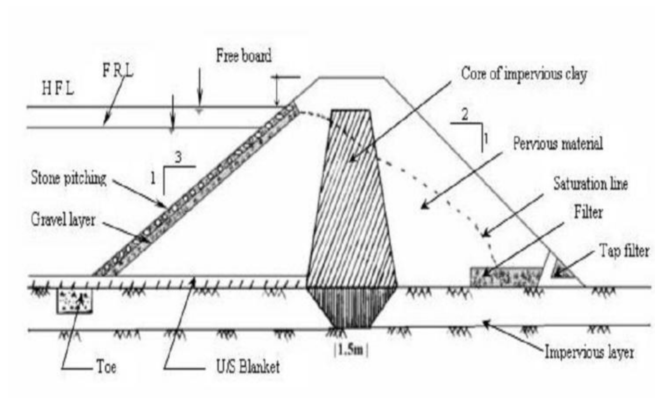

Figure 5.1 Key feature of an earthen embankment

5.2 Flooding

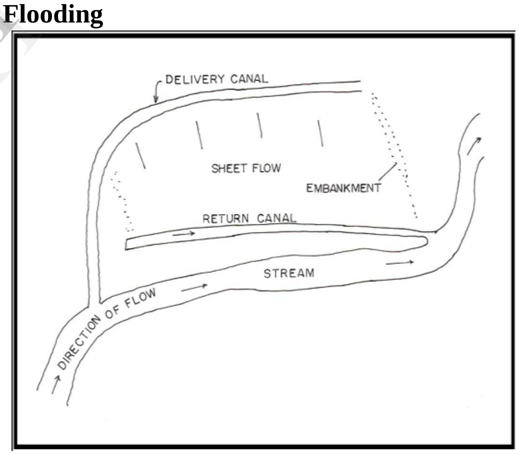

Fig 5.2 Schematic diagram of a Typical Flood Recharge System

5.3 Ditch and Furrows method

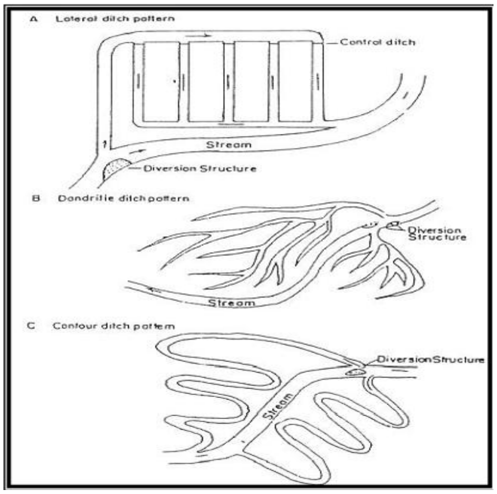

Fig 5.3 Common Patterns of Ditch and Furrow Recharge Systems.

5.4 Recharge Basins

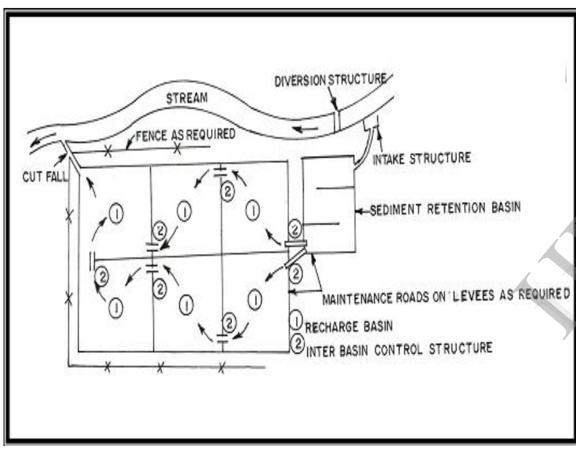

Fig 5.4 Common Patterns of Recharge Basin

5.5 Design of recharge structures and settlement tank

Generally, the recharge tank is designed to retain run-off from at least 15 minutes rainfall of peak intensity.

Area of the Catchment (A) = 100 m
Peak Rainfall in 15 minutes (r) = 25 mm (0.25m)
Run-off Coefficient (C) = 0.85
Required Capacity of recharge tank
= (A x r x C)
= (100 x 0.025 x 0.85)/0.5
= 4.25 m3 (4,250 liters)

5.6 Design of a recharge trench

The void ratio of the filler material varies with the kind of material used, but for commonly used materials like brickbats, pebbles and gravel, a void ratio of 0.5 may be assumed, using the same method as used for designing a settlement tank (IWR 1998).

Assuming a void ratio of 0.5, the required capacity of a recharge tank

= (A x r x C) / void ratio
= (100 x 0.025 x 0.85)/0.5
= 8.50 cu. m. (8500 liters)

In designing a recharge trench, the length of the trench is an important factor. Once the required capacity is calculated, length can be calculated by considering a fixed depth and width (Subramaniyam 2009)

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6. RESULT AND CONCLUSION

Artificial recharge locations and structures are selected and shown in Fig 6.1 and Recommended Artificial recharge srtucture on Lower Vellar river Basin in Table 6.1 Based on soil properties.

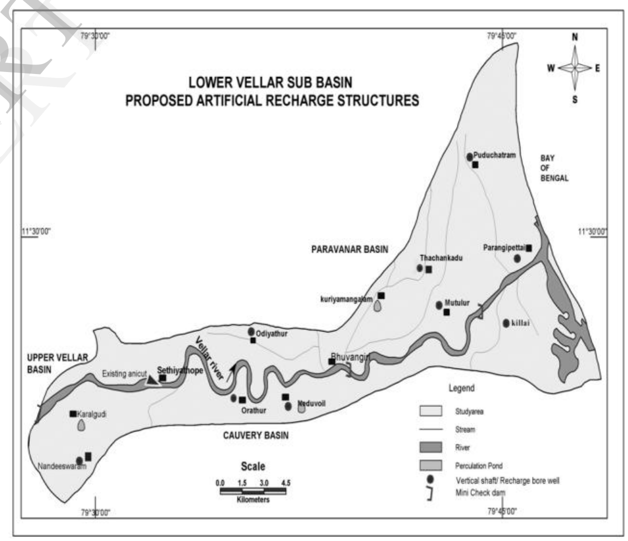

Figure 6.1 Proposed Artificial Recharge Structure Locations
(Source: Water resources Organization, PWD)

Table 6.1 Recommended Artificial recharge srtucture on Lower Vellar river

Name of the area	Soil types	Remarks
Nandeeswaram,	Very deep, moderately well drained cal carious.	Bore up to 100m for reaching medium grained sand stone with shells.
Karalgudi	Very deep, moderately well drained cal carious.	Level land up to 30m fine sand.
Orathur	Very deep, moderately well drained cal carious.	Bore up to 100m for reaching medium grained sand stone with shells.
Odiyathur	Very deep, moderately well drained cal carious.	Bore up to 100m for reaching medium grained sand stone with shells.
Bhuvanagiri	Very deep, moderately well drained cal carious.	Level land
Neduvoil	Very deep, moderately well drained cal carious.	Level land up to 30m fine sand and for vertical structure Bore up to 100m.
Kuriyamangalam	Very deep, imperfectly drained, Sandy soils	Level land up to 30m fine sand.
Thachakadu	Very deep, excessively drained sandy soil	Up to 100m clay and mixed clay sand so bore above 100m.
Mutlur	Very deep, imperfectly drained, Sandy soils	Bore above 100m
Killai	Very deep, excessively drained sandy soil	Up to 100m clay and mixed clay sand so bore above 100m.
Parangipettai	Very deep, excessively drained sandy soil	Bore above 100m.
Puduchtram	Very deep, excessively drained sandy soil	Bore above 100m.

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