EAST COAST RAILWAY
ENGINEERING DEPARTMENT

OFFICE OF THE
CHIEF ENGINEER
B-79, RAIL VIHAR
BHUBANESWAR

CE's Circular No. 10

Sub: Roof top rainwater harvesting for augmentation of ground water.

01. Background :

Water demand is increasing day by day and traditional sources of surface water in the form of rivers and streams are not able to meet this growing demand of water. Hence, pressure on ground water extraction is increasing. Ground water is a sustainable and reliable source of water. It has no turbidity and colour, less vulnerable to pollution, usually less bacteriological impurities and pathogenic organism. However, unplanned withdrawal of ground water has resulted in fall of water level and also deterioration in quality of water.

To control this declining trend of ground water availability, there is an urgent need to recycle and conserve all the available sources of surface water and also to augment the ground water recharge through artificial measures.

Roof top rainwater harvesting is a modest approach in this direction. It is imperative on our part as an engineer to remain conscious of the future constraint the country and the people at large are likely to encounter and to exhibit pragmatism and planning in face of such hard facts.

The issue of availability of ground water is particularly acute in dry areas where rainfall is scanty and surface water sources are not easily available. It has therefore, been decided to introduce and take up measures for adopting roof top rainwater harvesting for augmentation of ground water both by open line and construction organization in the areas of scarce ground water. Endeavor will be made to adopt the system in the existing building also by and by depending upon the resources available by all divisions.

Salient features of the system and technical guidance thereof have been outlined in the subsequent para hereunder.

02. Advantages :

In rooftop rainwater harvesting, rainwater is collected from the roof of a building and stored in ground water reservoir for beneficial use in future, instead of allowing it to flow as surface runoff. The scheme is better suited for

the urban areas. However, it is gaining significance even for the rural areas facing scarcity of water in spite of development activities in the form of building construction in progress. The scheme has following advantages through modest of times:

- ❖ It meets the ever increasing demanding of water.
- ❖ It augments the ground water storage and controls decline of water levels.
- ❖ It reduces storm water surface runoff thus preventing chocking of sewers and drains.
- ❖ It avoids flooding of roads and towns thus reducing flood hazards.
- ❖ In improves the quality of water. Rainwater is bacteriologically p[illegible], free from organic impurities and soft in nature. It rather improves quality of existing round water also through dilution.
- ❖ It reduces soil erosion.

03. Past Studies :

Central Ground Water Board under Ministries of Water Resources has conducted studies on rooftop rainwater harvesting in association with I.I.T, New Delhi during 1998. The roof top area of the building was 1666 m^2 and volume of water recharged to ground water was 830 m^3.

Ground water recharge from 100 m^2 of rooftop will be approximately 55000 liters in one year as per the studies. This much water is sufficient for a period of four months for a family of five members. A table based on stud[illegible] conducted by the Deptt. Of Water Resources for Delhi area as above is enclosed as Annexure - A. This table may be used as guidelines for assessment of likely augmentation of ground water storage and adoption of a suitable storage system there for. The table may be used mutatis mutandis.

04. Design Data :

Roof top rainwater harvesting involves collection of unpolluted rainwater directly from the rooftop of a building through storm water pipes flowing under gravity through open drains or storm water pipelines to a sedimentation tank to allow silt to settle down and finally flowing naturally to the ground water storage tank. Contamination of this water should be prevented not only by keeping roof of the buildings, pipelines and drains clean through out the year but also by adopting sedimentation tank of adequate size

to allow sufficient time for siltation. Disinfection of stored water to the extent possible should also form part of the total scheme. Over flow system should always be at its place as in case of any hydraulic structures.

Thus, the data required for designing various elements of the system involved are as under:

- Collection of rainfall data to assess quantity of water that would be available for storage. Intensity of rainfall and maximum duration and quantity of rainfall are required for designing size of rainwater, storm water pipes and drains and capacity of sedimentation tanks.

- Details of level and depth of various aquifers layers in area are required for adopting proper storage system. These data may be available from the strata charts prepared during sinking of tube wells.

- The annual rainfall data and the aquifer details in the area may also be obtained from the local offices of Meteorological Department, Central Ground Water Board and such other local authorities.

05. Various System :

Above system of recharging of ground reservoir may be adopted using various storage reservoirs such as abandoned dug well, abandoned or running hand pumps, recharge pits, recharge trenches, gravity head recharge wells, recharge shafts etc. These storage systems are being described here in brief for the purpose of illustration as design thereof is governed by normal design concept of water supply.

5.1. Abandoned Dug Wells :

A dry and unused dug wells can be used as recharge structure. The recharge water is guided through a pipe to the bottom of well or below the water level to avoid scouring of bottom and entrapment of air bubbles in the aquifer. Before using the dug wells as recharge structure, its bottom should be cleaned and all the fine deposits should be removed. Recharge water should be silt free. It should be cleaned regularly. It is suitable for large building having the roof area more than 1000 m^2. Periodic chlorination should be done for controlling the bacteriological contamination. The Sketch Plan No. 1 illustrates the layout.

5.2. Abandoned/Running Hand Pumps :

An abandoned or running hand pump can be used for recharge. The structures are suitable for the small building having the roofs are up to 150m². Water is diverted from rooftop to the hand pump through pipe of 50 to 100 mm diameter for running hand pumps a closing valve is fitted in conveyance system near hand pump to avoid entry of air in suction pipe. Recharge water should be silt free. During recharging period, the water extracted from hand pump should be utilized after proper chlorination. The Sketch Plan No. 2 illustrates the layout.

5.3. Recharge Pits :

Recharge pits are constructed for recharging the shallow aquifer. These are constructed generally 1 to 2 m wide and 2 to 3 m deep. After excavation, the pits are refilled with pebbles and boulders. Water to be recharged should be silt free. Cleaning the pits should be done periodically. Recharge pits may be of any shape i.e., circular, square or rectangular. If the pits are of trapezoidal shape, the side slopes should be steep enough to avoid silt deposition. The Sketch Plan No. 3 illustrates the layout.

5.4. Recharge Tanks :

They are constructed when permeable stratum of adequate thickness is available at shallow depth. System involves trenchers of shallow depth filled with pebbles and boulder. These are constructed along the land slope. The trench may be 0.5 to 1m wide, 1 to 1.5m deep and 10 to 20m long depending upon the availability of land and roof top area. It is suitable for the buildir having roof area of 200 to 300 m². Cleaning of trench should be done periodically. The Sketch Plan No. 4 illustrates the layout.

5.5. Gravity head recharge wells :

Bore wells/tube wells can be used as recharge structure. This technique is suitable where land availability is limited. When aquifer is deep and overlained by impermeable strata (clay). The roof top rainwater is channelised to the wells and recharges under gravity flow condition. Recharge water should be silt free. The wells can also be used to pumping. Most suitable for the areas where ground water levels are deep. The number of recharging structures can be determined in limited area around the building depending upon roof top area and aquifer characteristics. The Sketch Plan No. 5 illustrates the layout.

5.6. Recharge Shafts :

Recharge shafts are dug manually or drilled by the reverse/direct rotary method. Diameter of recharge shafts varies from 0.5 to 3m depending upon the availability of water to be recharged. Recharge shafts constructed where the shallow aquifer is located below clayey surface. Recharged shaft is back filled with boulders, gravels and course sand. They should end in permeable strata (sand). Depth of recharged shafts varies from 10-15m below ground level. Recharged shafts should be constructed 10-15m away from buildings for the safety of building. They should be cleaned regularly by scraping the top layer of sand and refilling it periodically. The Sketch Plan No. 6 illustrates the layout.

6.0. Maintenance :

The system should be kept in best condition of repair. It should also be periodically cleaned and kept free from contamination of water from sewerage system. The storage tank should be periodically disinfected to ward off pathogenic bacterial impurities. Periodical desilting of bed of the tanks, wells and pits including that of the sedimentation tank would also required to be done. Adequacy of size of various elements of the system should be annually reviewed after monsoon and remedial action should accordingly be taken. The system should be always ready to store casual rains during summer and winter.

7.0. Precautions :

Efficacy of the entire system is dependant on the permeability of the bottom layer of the storage reservoirs and consequent rate of percolation. Area where natural reservoirs such as tank and ponds get inundated during rainy season and the area gets flooded every year is not suitable for adopting this scheme.

10/6/04

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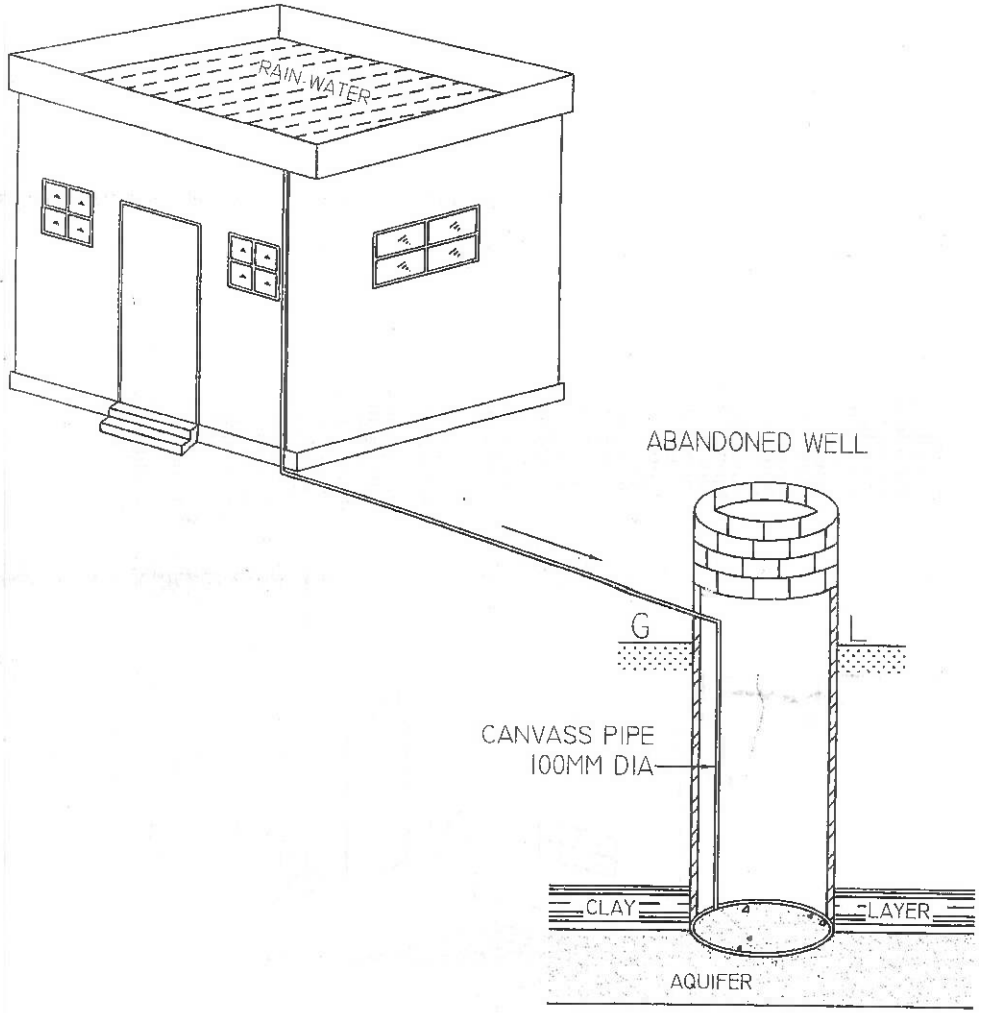
Annexure - A

T A B L E

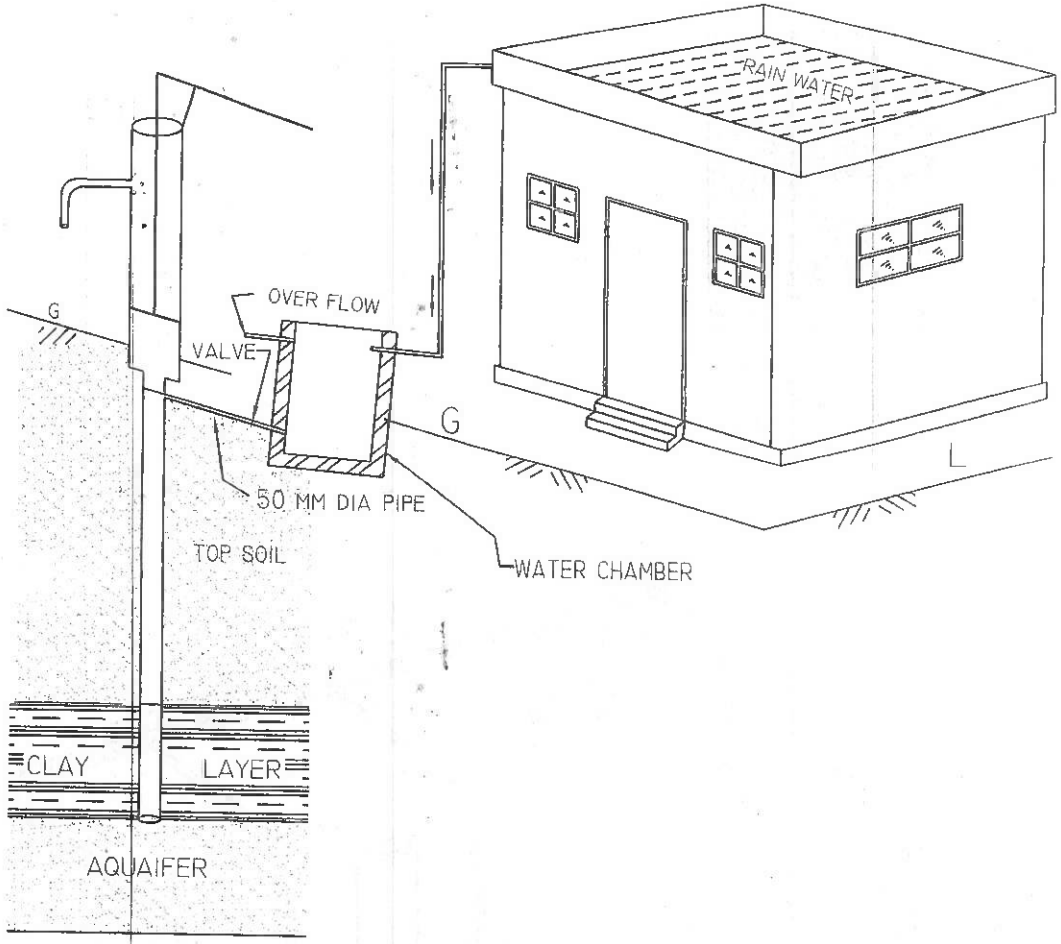
Rainwater availability for different roof top area in Delhi

Average rain fall = 611.8mm

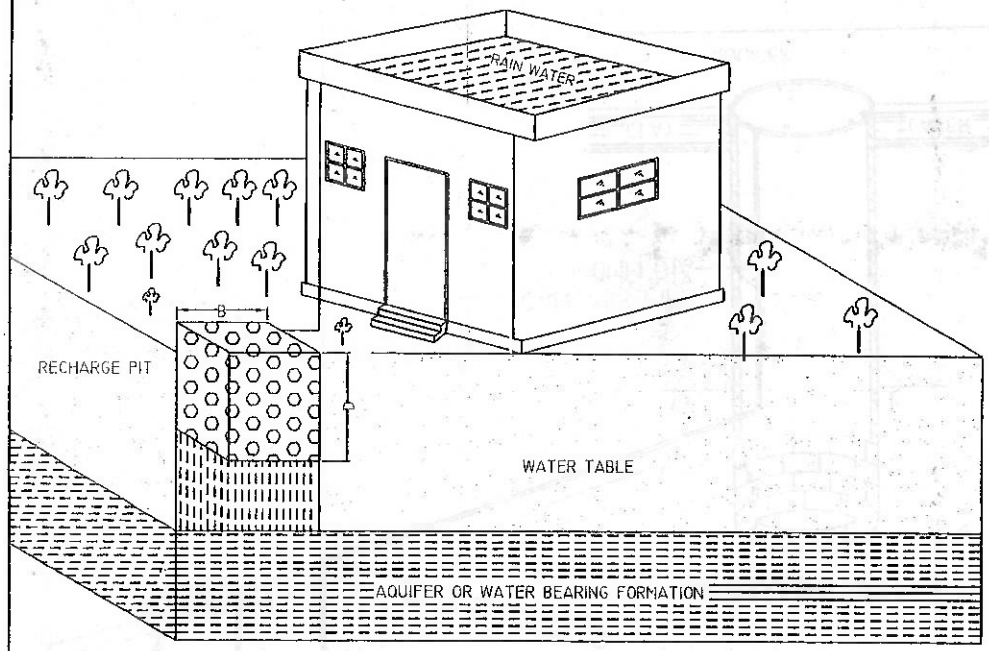
Roof area in m^2	Total rainfall volume M^3	Volume available for recharge in m^3 (Assuming 10% wastage)	Type of structure recommended for recharge	
			Alluvial area	Hard rock area
50	31	20	Recharge pit/ hand pump	Recharge pit/ Hand pump
100	61	55	Recharge pit/ hand pump	Recharge pit/ Hand pump
150	92	83	Recharge pit/ hand pump	Recharge pi / Hand pump
200	122	110	Trench	Trench
300	184	166	Trench	Trench
400	245	221	Gravity head recharge well	Gravity head recharge well
500	306	275	Gravity head recharge well	Gravity head recharge well
600	367	330	Gravity head recharge well	Gravity head recharge well
800	489	440	Gravity head recharge well	Gravity head recharge well
1000	612	551	Gravity head recharge well	Gravity head recharge well
1500	918	826	Gravity head recharge well	Recharge shaft dug well
2000	1224	1102	Gravity head recharge well	Recharge shaft dug well
2500	1530	1377	Recharge shaft dug well	Recharge shaft dug well
3000	1835	1652	Recharge shaft dug well	Recharge shaft dug well
4000	2447	2202	Recharge shaft dug well	Recharge shaft dug well
5000	3059	2753	Recharge shaft dug well	Recharge shaft dug well



RECHARGE THROUGH ABANDONED DUG WELL
SKETCH NO.1

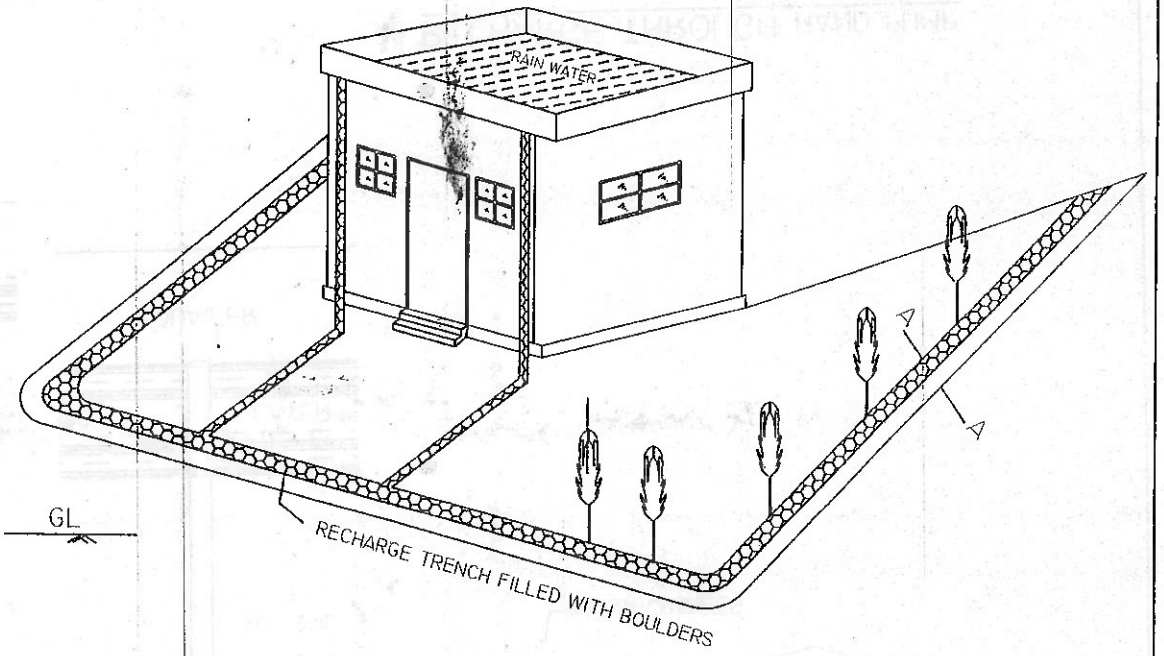


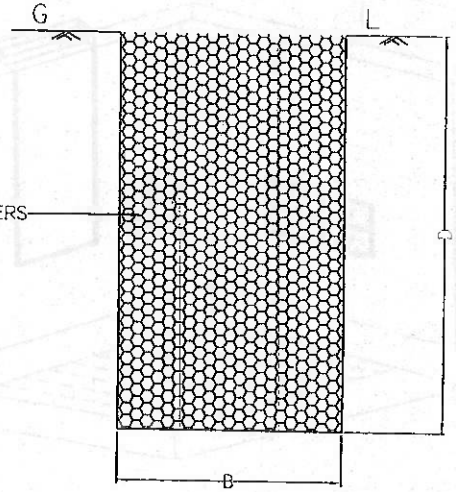
RECHARGE THROUGH HAND PUMP
SKETCH NO.2



B = 1 TO 2M
D = 2 TO 3M

IMPERMEBLE FORMATION
SKETCH NO.3

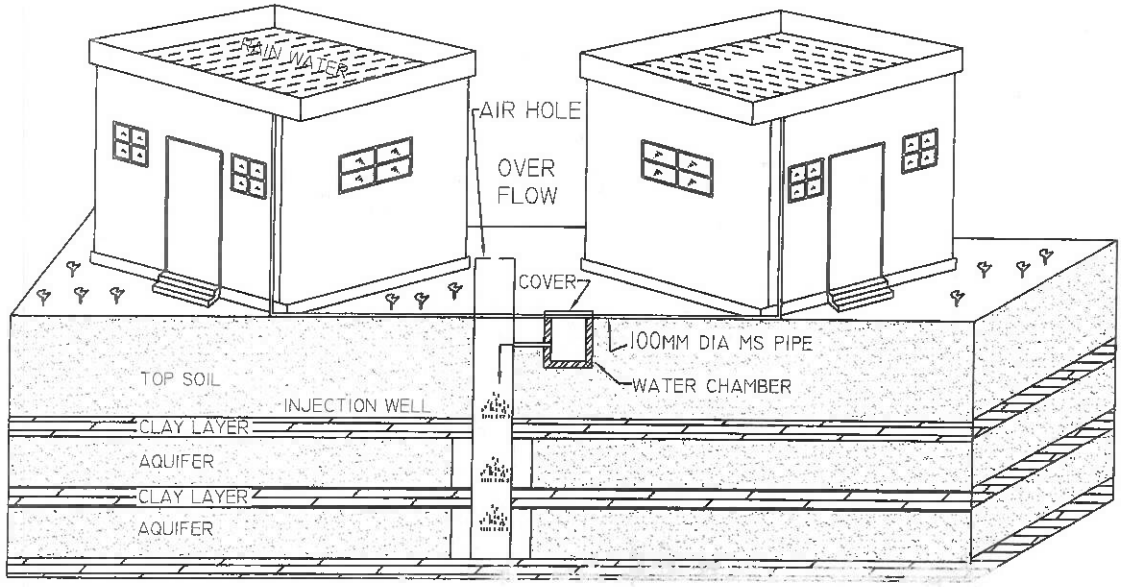




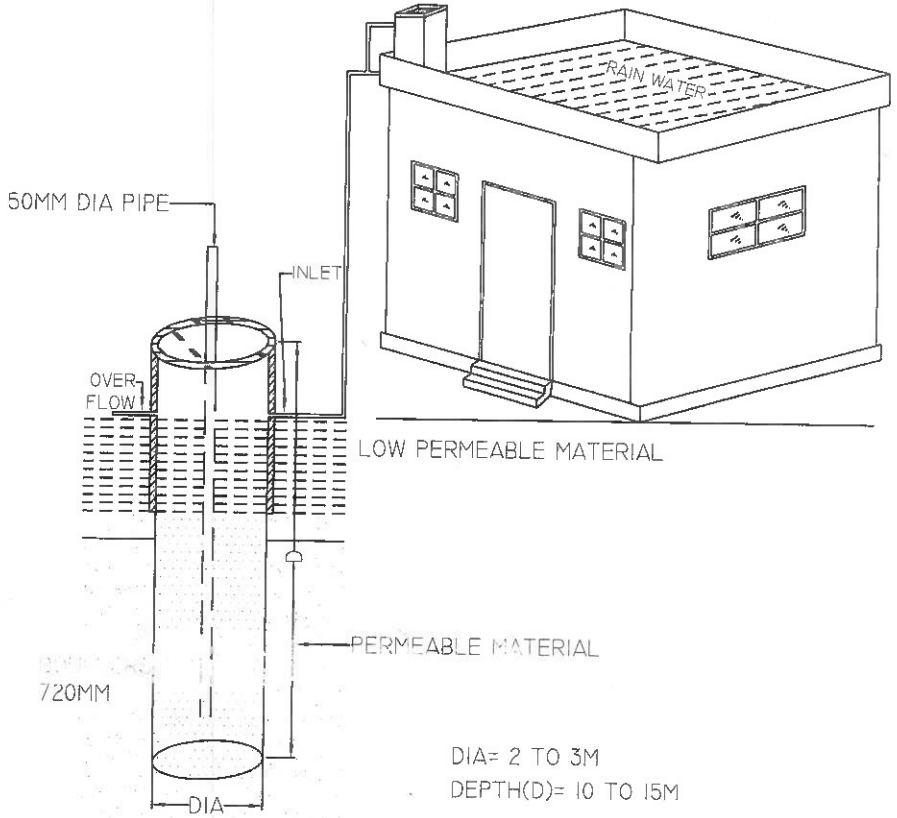
SEC=A-A

B = 0.5 TO 1M
D = 1 TO 1.5M

RECHARGE THROUGH TRENCH
SKETCH NO.4



GRAVITY HEAD RECHARGE TUBE WELL
SKETCH NO.5



RECHARGE SHAFT
SKETCH NO.6