CHAPTER - V

WATER HARVESTING – PRESENT PRACTICES

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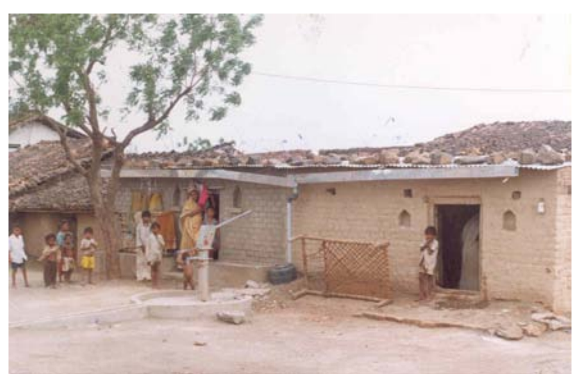
5.0 PRACTICES IN VOGUE

Inspite of large-scale development of surface and ground water through major, medium and minor projects by the government, the rural people in different parts of the country still have to depend on traditional water harvesting to meet their water requirements. The techniques and methods used vary from region to region depending upon their specific problems, nature of terrain, climate, hydrogeological conditions etc. Though the objective of water harvesting in most cases is to augment water availability for irrigation, these also afford indirect benefits for recharging drinking water wells and hand pumps. In many areas, where water harvesting has been practiced together with afforestation and other methods of watershed development and land improvement, dried up aquifers have been charged and water is available in abundance from ground water sources. In some arid and semi-arid regions rain water is harvested only for drinking purposes. Various methods of water harvesting presently in vogue in different parts of the country are discussed in the following paras.

5.1 ROOF TOP HARVESTING

This system is useful mainly for drinking water purposes. In this system, rain water falling on roofs of houses and other buildings is collected through a system of pipes and semi-circular channels of galvanized iron or PVC and is stored in tanks suitably located on the ground or underground. The practice is in vogue at the individual household level in remote hilly areas with high rainfall and also in some semi-arid areas in the plains.

This system can be seen in the northeastern states of Arunachal Pradesh, Assam, Meghalaya, Manipur and Nagaland. This is also in use in Bikaner, Jaisalmer and Jodhpur districts of Rajasthan. In recent years, at the initiative of the Central and State Governments, the practice has been increasingly adopted in many cities and towns in different parts of the country.

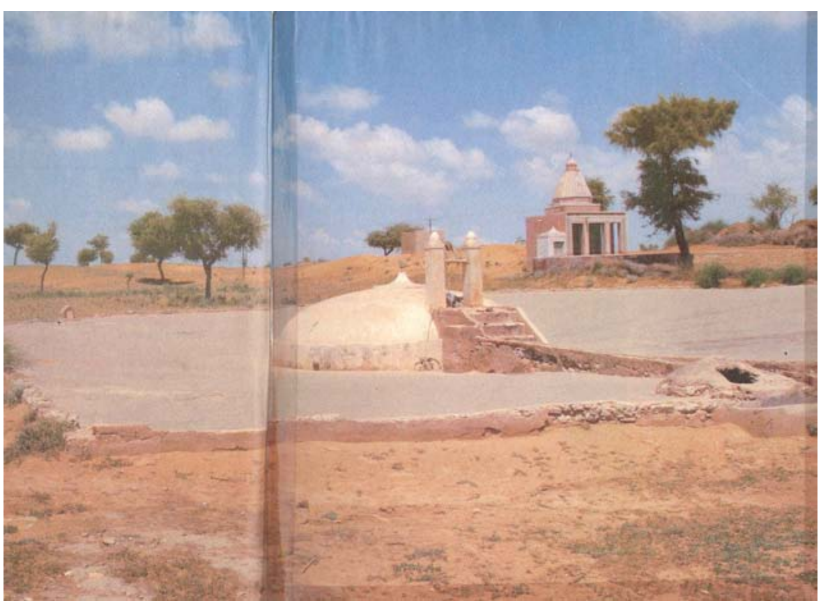
Roof Top Rain Water Harvesting in Villages of Madhya Pradesh

5.2 TANKA/ KUND/ KUNDI

In the desert and arid areas of Rajasthan people build unique underground structures of various shapes and sizes to collect rain water for drinking purposes. These structures called Tankas, Kunds or Kundis are constructed in a variety of places like court yards, in front of houses and temples, in open agricultural fields, barren lands etc. These are built both for individual households as well as for village communities using locally available materials. While some structures are built in stone masonry with stone slab coverings, others are built with only rudimentary plastering of bare soil surfaces of the tank with cement or lime and covering with Zizyphus Numularia thorns. Some Kuccha structures have a convex covering of local wood with mud plaster. Inlet holes are provided in the convex covering at the ground level to facilitate entry of rain water into the tank. In case of Pacca structures (called Tanka) the wall of the tank is kept projecting above the ground to provide inlet holes.

Though this rain water harvesting method is said to be in vogue since time immemorial, the first known construction of a Kund in western Rajasthan was in 1607 by Raja Sur Singh in village Vadi-ka-Melan. In the Mehrangarh Fort in Jodhpur, a Kund was constructed in 1759 by Maharaja Udai Singh. Subsequently, during the famine of 1895-96 construction of Kunds was taken up on a large scale. Today these are the primary sources of drinking water in the water scarce areas of Churu, Bikaner, Jodhpur, Jaisalmer and Barmer districts.

Since Tankas are the main source of drinking water in these areas, people zealously protect and maintain them. Just before the on-set of the monsoon, the catchment area of the Tanka is cleaned up to remove all possible pollutants, and human activity and grazing of cattle in the area is prohibited. Even though the average annual rainfall in these areas varies from 200 mm to 300 mm with minimum of as low as 120 mm, these structures provide enough drinking water to tide over the water scarcity during the summer months. In many cases the stored water lasts for the whole year. These simple traditional water harvesting structures are useful even during years of below-normal rainfall.



Traditional Tanka with Treated Catchment in Churu District

An Improved Tanka Designed and Constructed by CAZRI

5.3 PONDS/ TANKS

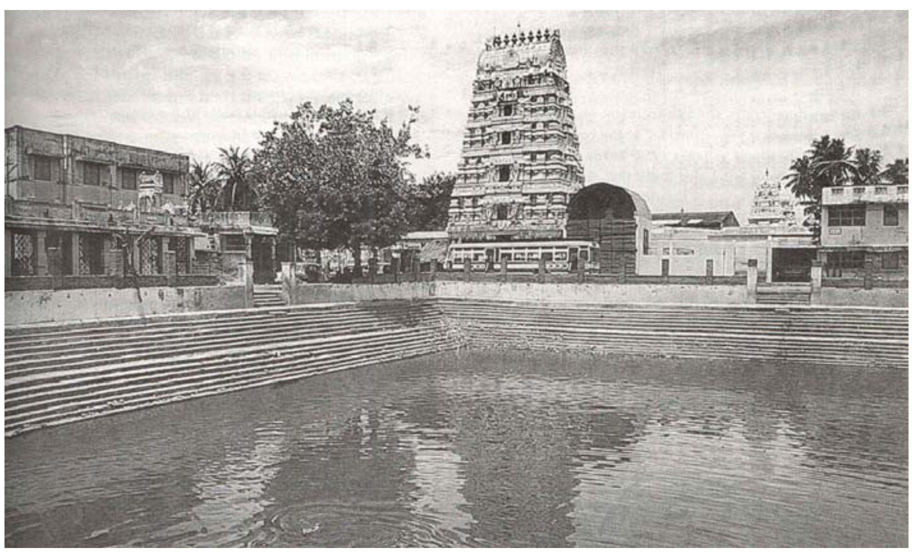
This is by far the most commonly used method to collect and store rain water in dug ponds or tanks. Most ponds have their own catchments, which provide the requisite amount of water during the rainy season. Where the catchments are too small to provide enough water, water from nearby streams is diverted through open channels to fill the ponds. In some places water from irrigation canals is also used to fill ponds.

Ponds are excavated in different shapes and sizes depending upon the nature of the terrain, availability of land, water requirements of the village community etc. These are known by different names in different regions viz. Dong in Bodo area of Assam, Talab, Johad or Pokhar in Uttar Pradesh. In Rajasthan these are called Johad or Nadi. Talab is a popular word for a pond in a valley or natural depression. Other variants are called Dhab, Toba or Talai. Small tanks in Ladakh are called Zing. In Jammu region, these are called Chhapris. The people of Sikkim call them Khup. In Bihar rectangular catchment basins called Ahars are built by building earthen embankments to impound rain water. Some times these are built at the lower end of a small seasonal rivulet. The channels for drawing water from the Ahars are called Pynes. Large storages across streams are called Katas, Mundas and Bandhas. In other areas, the ponds are called by names as follows :

Nagaland	–	Zabo
Gujarat	–	Kunda (Sacred Ponds)
	–	Jheel
Orissa	–	Katas, Mundas (As in Bihar)

Maharashtra	–	Bandharas (Bunds across small streams)
Karnataka	–	Volakere (Small pond fed by shallow channel)
	–	Katte or Kunte (Pond with bund mainly for bathing)
	–	Kola or Kunda (Natural Pond)
	–	Kalyani (Temple Pond)
Andhra Pradesh	–	Tank (Mainly for irrigation)
Kerela	–	Tank (Mainly for irrigation)

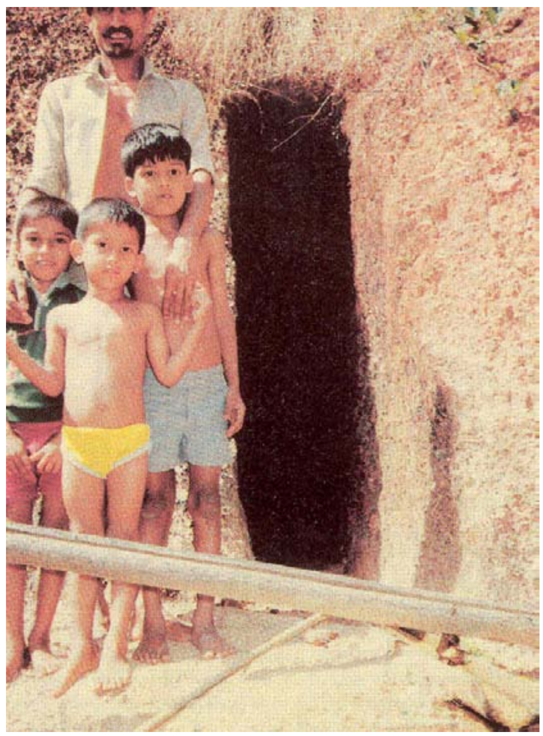
Pond/ Tank



Temple Tank

5.4 GROUND WATER HARVESTING

In hilly areas of Uttaranchal, the people harvest ground water by making stonewall across ground water streams. These are called Naula or Hauzi. For various reasons, there has been a steady decline in the construction of these structures, the main reason being drying up of underground streams due to large-scale deforestation and increased human activity in the hills. Similar practice is in vogue in parts of Kerela where the ground water is collected by excavating long deep trenches across a gentle slope. These are called Surangam. In Punjab shallow wells called Jhalars are dug near streambeds to trap seepage water. In Rajasthan these are called Beris. In earlier times, Baolis were built by kings but now these are not in vogue. In Gujarat shallow wells dug in depressions to tap ground water are called Virdas. In Tamil Nadu Ooranis were built earlier but are not built any more.



Surangam in Kasaragod Taluka in Kerela

5.5 KHADIN

Khadin is a system basically innovated for runoff farming by the Paliwal Brahmin Community in Jaisalmer area in the 15th Century. In Jaisalmer the ruler used to encourage people to develop this system at suitable sites for agriculture and share the part of crop with ruler, who would remain the owner of those structures. There are as many as 500 big and small Khadins in Jaisalmer district, which are productive, even with 40 mm rainfall.

Rocky-hill-terrain around a valley including the valley slopes, constitute the catchment area of a Khadin. Stony gravels, wasteland with gentle slope in the form of valley can also form the catchment area of such structures.

At the lower point of the valley, earthen bund is constructed to arrest the runoff. The stored water helps the crops as well as recharging of ground aquifer. Spillway of stone masonry is provided in the bund to let out the excess runoff. A sluice is provided at bed level to drain out standing water, if any at the time of bed cultivation.

Khadin is a system of storing rain water in an agricultural field by building a “U” shaped earthen bund at the lower end of the field. A drainage pipe is provided in the embankment to evacuate surplus water. The practice is very common in the arid and semi-arid areas of Jaisalmer and Barmer districts of Rajasthan. A dug well is often provided immediately downstream of the earthen bund to take advantage of the water seepaging into the ground. Some people dig the well within the Khadin. The parapet wall around the well is kept sufficiently high to prevent entry of muddy water into the well.

A similar system called Haveli is used in some parts of Madhya Pradesh. In this system, the field is enclosed on all four sides by earthen bunds called Bandhan to retain rain water. This practice is also in vogue in the drought prone districts of Orissa especially Kalahandi, Bolangir and Koraput.

5.6 HILL SLOPE COLLECTION

In this system, which is in vogue in many hilly areas with good rainfall, lined channels are built across the hill slopes to intercept rain water. These channels convey water for irrigating terraced agricultural fields. The water is also used to fill small ponds for domestic use and the cattle. These practices can be seen in Uttaranchal, Himachal Pradesh, Meghalaya, Arunachal Pradesh etc.

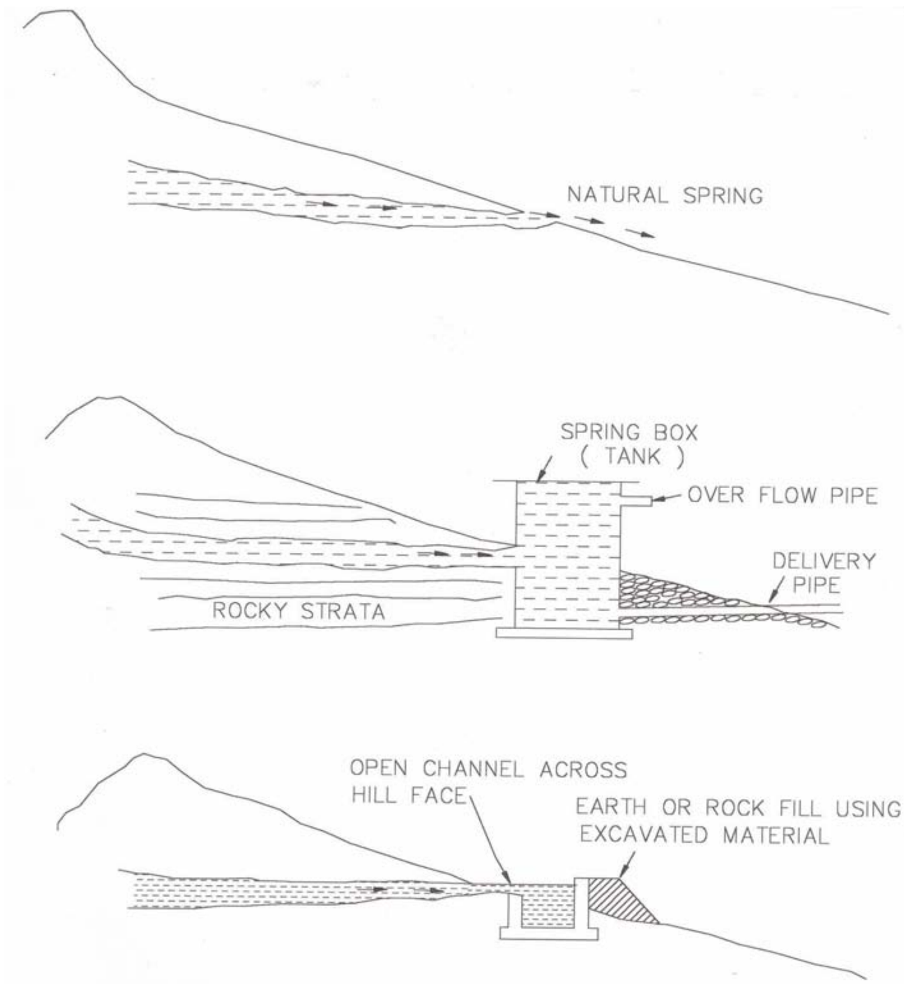
5.7 SPRING WATER HARVESTING

In the Lahaul and Spiti areas of Himachal Pradesh, water from hill streams are diverted through small excavated channels, called Kuls, for domestic use and irrigation. In Jammu region they pronounce it as Kuhals. This practice can also be seen in Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Sikkim and Darjeeling area of West Bengal. Where the springs are merely in the form of water trickling through layers and joints in rocks, split bamboo channels are used to trap and convey water upto the village/ hamlet for drinking purposes.

Spring water is a highly desirable source of community water supply. Since the water emerges at the ground surface through cracks and loose joints in rocks under internal pressure of the ground water system, no pumping is required. More over the water is fresh and free from pollution obviating the need for artificial purification. However, such sources are available mostly in hilly terrain, foothill areas or intermontane valleys.

A typical spring water harvesting system is shown in Figure 3.1.

Figure 3.1 : A Typical Spring Water Harvesting System



One relatively easy means of storing and distributing spring water is through a device known as a spring box. Built usually into a hillside and deep enough to access the spring-water source, this device allows water to enter from the bottom (as depicted in Figure 3.1) and fill upto a level established by an overflow or vent pipe. Hydraulic pressure then maintains the level in the spring box. The outflow pipe near the base of the device may be connected via pipe to a larger storage system (such as a tank) closer to the point of use or tapped directly at the location of the box. This device can be constructed using local materials, and if built carefully and protected can provide many years of reliable operation. Depending on local water requirements and conditions, a number of these spring boxes may be constructed to provide year-round supply or used to recharge other community water storage systems.

Alternatively, a variation on the spring box concept may also be employed known generally as an infiltration gallery. A long perforated pipe or box (3 to 6 inches or more in diameter) may be placed across the water-bearing layer of the hillside to gather spring water. Back-filled with gravel or another sufficiently porous medium, the pipe or box is connected to an outflow pipe(s).

5.8 MODERN STRUCTURES

During the last 100 years there has been considerable technological development, interalia, in the design and construction of water harvesting structures for various purposes. The structures, which are commonly built for surface storage and/ or ground water recharge are :

(i) Check Dams : These are concrete or masonry structures built across small streams for surface storage and incidental benefit of ground water recharge. The design of these structures are done taking into consideration the volume of water that can be stored in the stream channel upstream, the surplus flood discharge that must be evacuated safely, stability of the structure against various forces and the likely ground water recharge.

These are usually built by the State Government agencies like the departments of Irrigation/ Water Resources, Agriculture and Forests. These are the modified and improved versions of the traditional temporary or semi-permanent structures that people in the villages usually build across natural streams or drainage channels.

Check Dam

(ii) Percolation Tanks : These are built mainly to impound monsoon runoff over a large area to augment ground water recharge. Moderate to high porosity of soil and/ or underlying rocky strata is the main criteria for the choice of percolation tanks. Ponding is achieved in much the same way as is done in case of check dams except that the height of the bund is low but the length is large.

The design aims at filling the pond as many times as possible during the rainy season in such a way that most of the water impounded during one spell of rain percolates into the ground before the next spell starts. In actual field conditions, however, this ideal operation is rarely achieved. These are also built by the government agencies since these require special skills in hydrogeology.

Percolation Tank

(iii) Sub-Surface Dykes : These are impermeable walls or barriers in masonry, concrete and/ or clay built below the bed level across natural streams to arrest sub-surface flow of water to improve the yield of existing wells and hand pumps in the upstream.

Besides these direct methods of water harvesting some indirect methods have also been developed. These aim at augmenting soil moisture retention and preventing soil erosion and land degradation. These are :

(i) Contour Bunding : These are small earthen bunds built horizontally in parallel rows across the hill slope. These help in augmenting soil moisture and prevent erosion of topsoil.

(ii) Gully Plugging : These are soil and water retaining structures built across gullies in hilly areas. These are built with locally available materials like stone boulders, earth, brushwood etc.

Both contour bunding and gully plugging are part of watershed improvement works. The other works in this category are :

- Bench Terracing
- Contour Cropping
- Contour Trenching

Gully Plugging using Boulders

Contour Trenching

Various water harvesting and watershed improvement measures mentioned above are discussed in greater detail in Chapter IV and V.

5.9 SOME CASE STUDIES OF RAIN WATER HARVESTING

Though there are many sporadic studies, but some studies that need special mention are given below for purpose of reference and information:-

5.9.1 General Studies by State Govt. Organisation/NGOs

- Watershed management programme launched by the Govt. of Madhya Pradesh in 1995 has led to rising water levels in many areas. More than 1000 check dams, 1050 tanks and 1100 community lift irrigation schemes have been implemented in Jhabua district. Food production in the district has gone up by 38% in the past five years.
- A micro-watershed project implemented in Ghelhar Choti village in Jhabua district Madhya Pradesh has led to recharging of ground water. Because of this, the cultivate area has increased and the yield per ha has doubled. This has only been possible due to people's participation.
- District Rural Development Administration in Rajkot implemented 50 micro-watershed projects under the watershed management project launched by the Govt. of Gujarat in 1995-96. Rise in ground water levels has been reported from wells in areas, where these projects have been implemented.
- A number of percolation tanks and check dams have been constructed in Andhra Pradesh. About 80 percent of these structures were constructed in four chronincally drought affected districts of Rayelseema region.
- An experiment on low cost small farm reservoirs along with improved crop and soil management systems was conducted in Chhattisgarh region, Madhya Pradesh. The rain water thus collected helped in saving paddy from water stress during extended dry spells in 1990-91 and 1991-92. Crops in the micro-catchment of the reservoir did not face drought due to their ability to exploit subsoil moisture reserves. The reservoir water also contributed to ground water storage.
- More than 70,000 percolation tanks have been built in Maharashtra after the severe drought of 1971-72. All such small catchments of percolation tanks have been converted into green patches. A study conducted by Central Ground Water Board on the effectiveness of 12 percolation tanks is lost as evaporation, 40% as seepage and 50% recharges ground water. The study indicated that the recharge to ground water can go upto 70% by selecting the site and designing the tank properly.
- Underground bandharas have been constructed in various parts of Maharashtra, viz. 87 tehsils of DPAP areas with 400-700 mm annual rainfall located in parts of Sangli, Satara, Pune, Sholapur, Ahmednagar, Nashik, Aurangabad, Usmanabad, Beed and Buldana districts; Vidarbha and Amravati divisions where there are no surface sources and parts of Konkan area with high well density. Assessment of benefits from recharged ground water indicates that cost benefit ratio would not be less than 1:1:5.
- Sadguru Water & Development Foundation who is functioning in Dahod district of Gujarat has constructed a number of concrete check dams with the help of local residents to impound rain water for irrigation in Thunthi Kankasiya village. The Foundation has also implemented watershed management measures such as trenching, bunding, terracing and planting trees. With the result, water is available to the villagers round the year and ground water levels have risen considerably. The average household income has been raised from Rs. 8,000 per year to Rs. 35,000 per year. Entire population of the village is above poverty line now.
- In Dhoraji village of Rajkot district, Gujarat, the farmers have started recharging their wells. They are able to cultivate crops even during drought and the crop production has also increased several time.
- Saurashtra Jaldhara Trust is working in about 100 villages in Amravati, Bhavnager, Jamnagar, Junagarh and Rajkot districts. The trust has motivated the villagers to build rain water harvesting structure, In Khopala village of Bhavnagar district, the villagers

have built 210 low cost check dams on streams in and around the village. Despite less than average monsoon in 1999, the streams were seen overflowing.

- In parts of Dhar district, Madhya Pradesh, where watershed management measures have been implemented, crops and ground water table have not been much affected by the drought.
- Micro-watershed projects implemented by Development Support Centre in Gujarat have helped in solving the problem of drinking water to a great extent.
- Raj-Samadhiyala village in Rajkot district, which was once declared a desert area is not a water scarce village now. This has been possible due to watershed management projects taken up by the villagers under the leadership of their Sarpanch. The villagers built 12 check dams between 1986 and 1988. This has brought prosperity and social well being to the village.
- Residents of Gandhigram village in Mandvi taluk of Kutch district, Gujarat have been facing drinking water crisis for the past 10 years. The over-exploration of ground water has led to sea water ingress making the ground water aquifers saline. The villagers have constructed a dam on Khari river and have undertaken a micro-watershed project. With the help of rain water harvesting, the district Administration in Dewas, Madhya Pradesh has banned tubewell drilling and made roof top rain water harvesting mandatory for all houses having tubewells. The water thus harvested is recharged into the aquifers. The dugwells were recharged, existing tanks were repaired and deepened and fresh ponds were constructed to maintain water level during summers. This has helped in improving the moisture content in soil and recharging shallow aquifer. Roof top rain water harvesting, nallah bunding and percolation pits have proved to be effective measures.
- In Chennai, Chennai Metro Water Board has made it mandatory under the city's building regulations for all new buildings to have water harvesting mechanisms primarily to recharge ground water aquifers. Implementation of rain water harvesting measures have resulted in rising trends of ground water levels.
- The town of Avadi in Tamil Nadu is using rain water harvesting to augment its source ground water resources. This is being practiced not only where ground water levels are declining but also where ground water quality has deteriorated. The total cost for a small system is Rs. 5,000/- which includes a cost of Rs. 3000/- towards sinking percolation pit. The houses have started employing rainwater harvesting.
- The Delhi Administration has also made Roof top rainwater harvesting mandatory in Delhi for atleast in new buildings measuring 500 sq.ft. or more.

5.9.2 Results of Water Harvesting & Recharging Experiments by CGWB

Results obtained by water harvesting & recharging structures through joint efforts of CGWB and state Govt. agencies are given below. Only some case example-results are quoted.

Name of the scheme	Structures constructed	Cost on lakhs	Additional recharge	Rise in water level	Area benefited
Watershed TE-17, Yaval Taluka, Jalgaon, Maharashtra	Percolation tanks-6 Subsurface shaft-2 Injection well-1 Dug-cum-recharge well-1	23.55 1.38 4.50 0.10	681.38 CTM 12.00 TCM 3.77 TCM 6.58 TCM	1-5 meters	545 ha 4.70 ha 0.75 ha 1.30 ha
Watershed WR-2 Warud	Percolation tank-3 Cement Plug-10	76.98 9.32	298.32 TCM 46.743 TCM	4-10 m 0.5 to 4	280 ha 86-105 ha

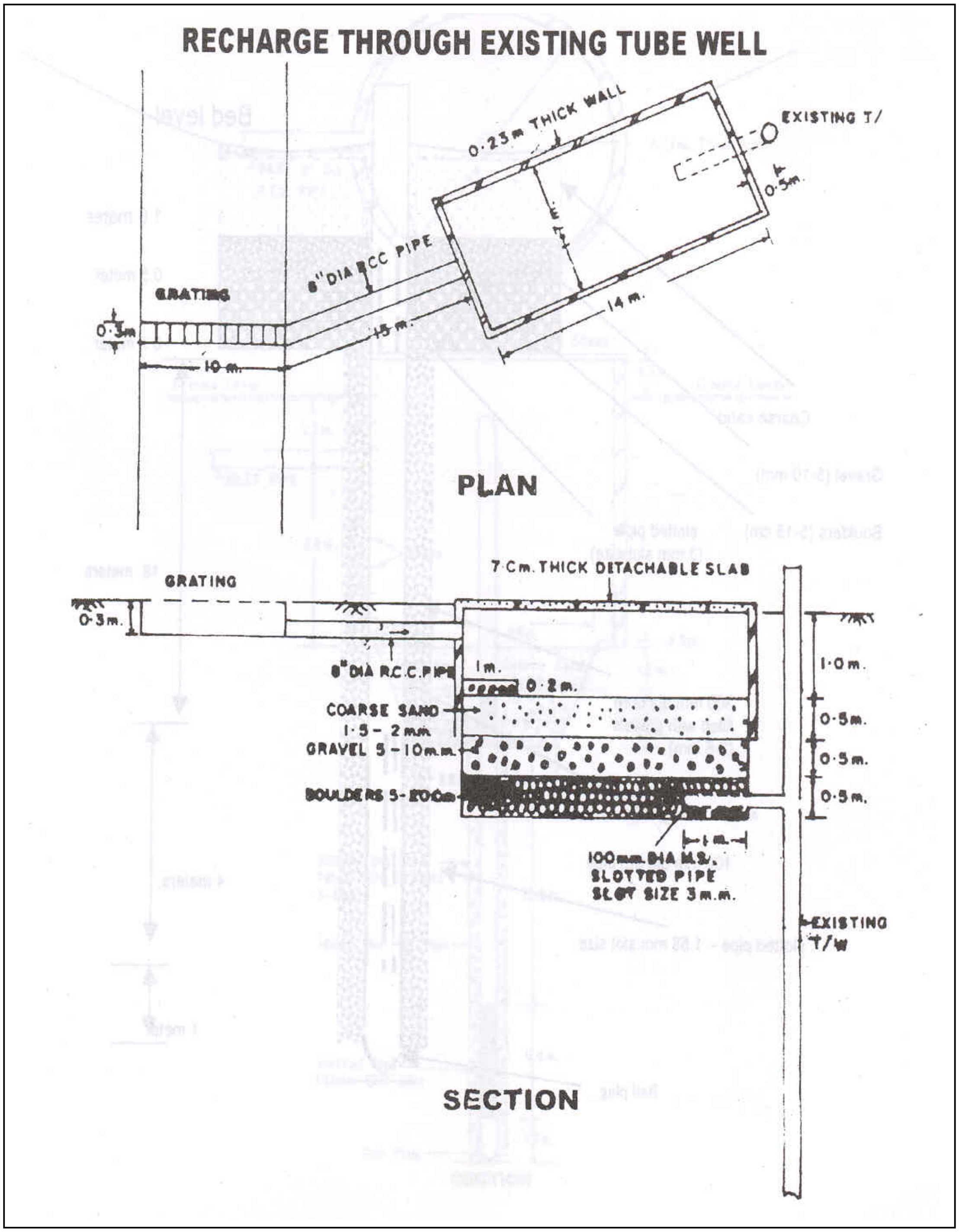
Taluka, Amravati district, Maharashtra				meters	
JNU, IIT and Sanjay Van Area of NCT Delhi	Check dam-4 Rooftop rain water harvesting-1	43.58 2.47	75.72 TCM 830 cum	0.33-13.7m 2.29-2.87	75 ha 1 ha
Roof top rain water harvesting at CSIO complex, Chandigarh	Rooftop rain water harvesting		3794 cum	2 m	
Artificial recharge studies in Karnataka	Percolation tank-1 Watershed treatment Gravity recharge well-2 Point recharge structure-4 Roof top rain water harvesting at Gauribindinaur Percolation tank Watershed treatment Point recharge structure At Mulbagal	10.35 8.45 4.05 0.80 17.50 1.94 1.03	These structures provided additional ground water recharge and sustainability of ground water extraction structures 2 to 3 times. Crop intensity increased to 2 to 3 crops annually	1-3.5 meters	Crop intensity increased to 2 to 3 crops annually and cash crops are now being grown in the area
Artificial recharge in TE-11, Watershed Jalgaon, Maharashtra	Wadri Percolation tank Sanghavi percolation tank	9.02 17.58	14000 cum 24000 cum	0 to less than 1 m 0 to less than 1 m	0.5 sqkm 1.0 sqkm
Artificial Recharge to ground water from Dhuri link drain, Dhuri Block, district Singrur, Punjab	Lateral shaft 250 meter length with three injection wells & 28 vertical shafts	34.20	Yet to be assessed	0.22-1.38 meters	Average rate of recharge through the Dhuri link drain is 16.51 lps
Artificial recharge to ground water from Dhuri drain II, Dhuri block, Sangrur, Punjab	10 lateral shaft, 20 shafts & 30 injection wells in 295 meters lateral shaft	39.10	To be assessed	0.15 to 0.33 meters	Average rate of recharge through the Dhuri link drain is 94 lps
Artificial recharge studies on the impact of different recharge	10 farm ponds, 8 nala bunds and 2 subsurface dykes	50.54	Net volume of water available is 65 TCM	0.15 meters average	Direct benefit for agriculture purpose is 28.44 ha of land during Kharif and Rabi over and above sustainable greenery

structures constructed in Purulia I,II, Mainbazar and Jhala blocks, Purulia district, West Bengal					in an area of 110 ha due to increase in ground water level by constructing 10 farm ponds and 8 nala bunds
Recharge of ground water by constructing sub surface dykes in Tulin, Jhalada-I block, Purulia	5 sub surface dykes	0.38	0.82 MCM	0.15 meters	Area benefited 0.21 ha
Artificial recharge studies on the impact of subsurface dykes constructed for improvement of watershed in part of Saltora block, Bankura district, West Bengal	Subsurface dyke Gully plug Nala bund Farm pond	0.992	2.6 MCM	0.45 meter	Area benefited 195 ha
Roof top rain water harvesting in Dewas city, Madhya Pradesh	At roof of 1000 buildings	6.00	Due to deficit rainfall in Dewas district, full impact could not be assessed		There is marked increase in discharge of tubewells and improvement in quality of water obtained from tubewells utilising roof top rain water harvesting

Typical Case Studies of Water Harvesting & Recharging in NCT Delhi

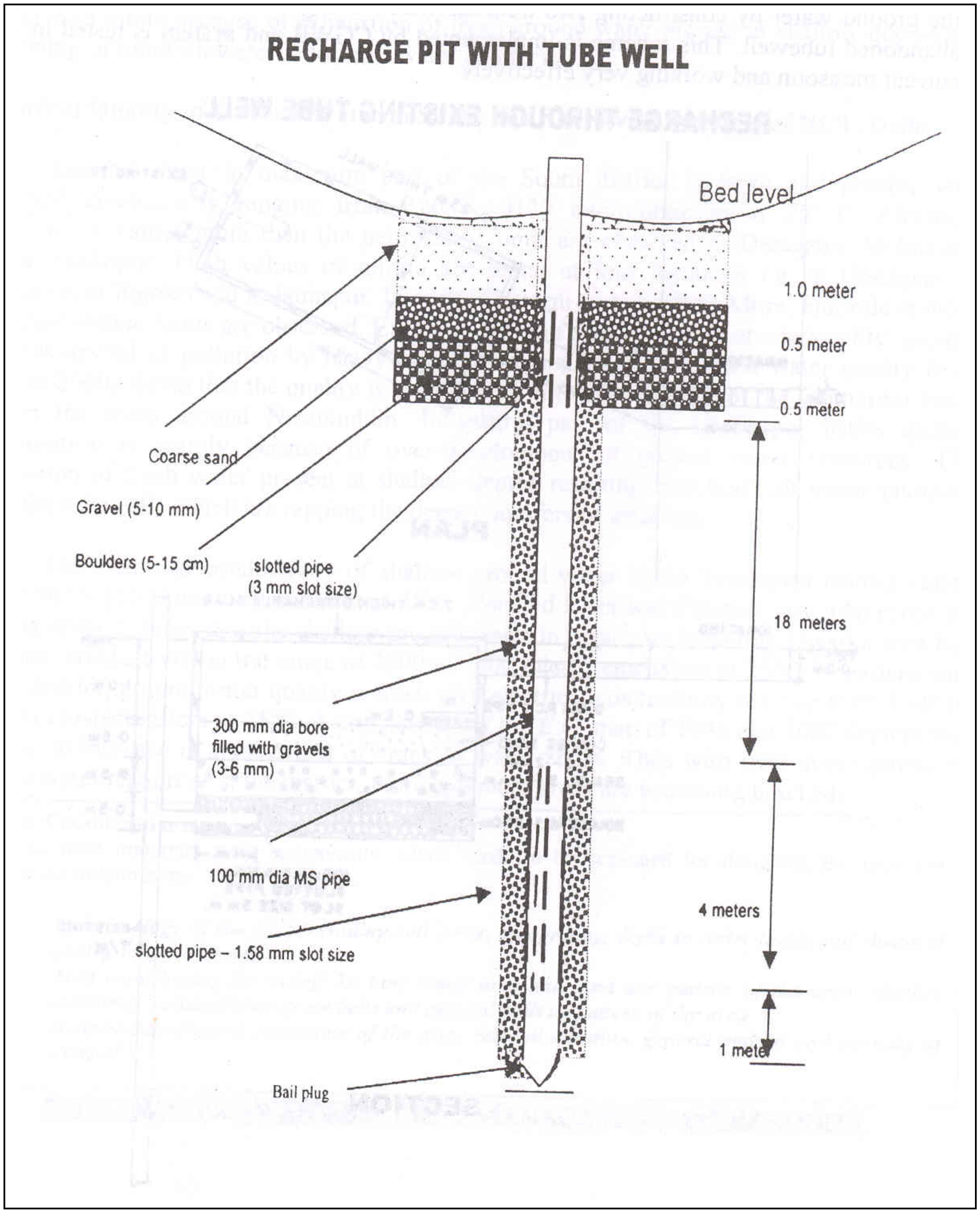
1) Central Park, D-Block, Vasant Vihar, Southwest district

Vasant Vihar is a residential Porsche colony consisting of six blocks with utility services including shopping complex, parks etc. Water supply in this colony is mainly based on ground water resulting into alarming rate of decline in ground water levels. To arrest the decline ground water levels, CGWB has taken up Artificial recharge to Ground water in D-block. Rainfall Runoff generated i.e. 9400 cum. from the catchment area of 36375 sq.m. comprising of houses and roads in the vicinity of central park is utilised to recharge the ground water by constructing two trenches with recharge wells and one trench with abandoned tubewell. This scheme is implemented by CGWB and system has been tested and found to be working very effectively.


RECHARGE THROUGH EXISTING TUBE WELL
0·23m THICK WALL
EXISTING T/
0·5m.
8" DIA RCC PIPE
GRATING
0·3m
15 m.
14 m.
10 m.
PLAN
7 Cm. THICK DETACHABLE SLAB
GRATING
0·3m.
8" DIA R.C.C. PIPE
1 m.
0·2 m.
COARSE SAND 1·5 - 2 mm
GRAVEL 5 - 10 mm.
BOULDERS 5 - 20Cm.
1·0 m.
0·5 m.
0·5 m.
0·5 m.
1 m.
100 mm DIA M.S. SLOTTED PIPE SLOT SIZE 3 m.m.
EXISTING T/W
SECTION

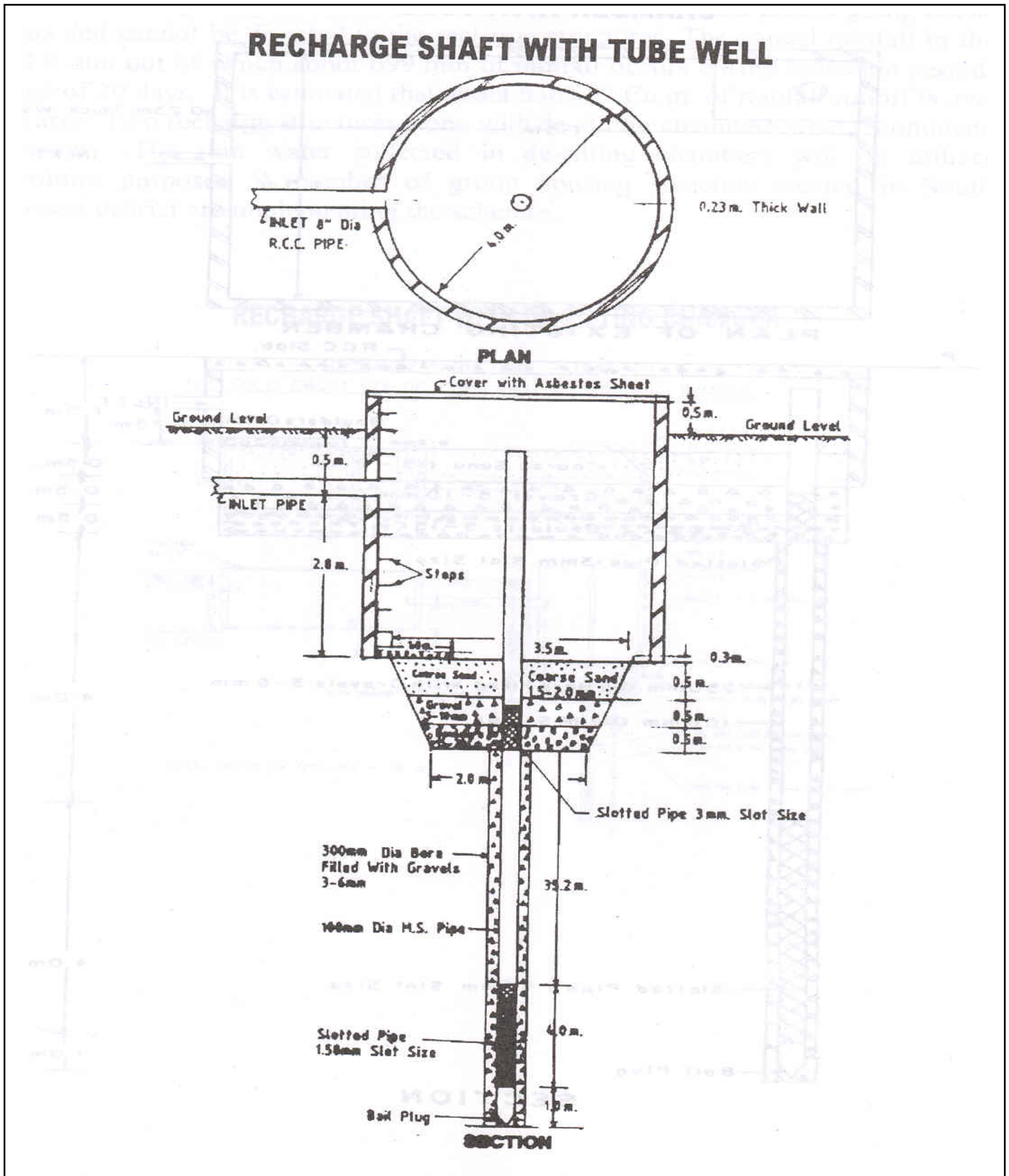
2) Sultan Garhi Tomb, South of Vasant Kunj

Sultan Garhi Tomb, a monument is located near Rangpuri, South of Vasantkunj area having rugged topography and is underlain by hard rock. Depth to water level is ranging between 20-40 meter below ground level. Whole area is considered as a watershed having catchment area of 0.99 sq.km. which generates 64925 cum. runoff in a normal rainfall year. The runoff generated is diverted to the ground water system through three existing quarries with two recharge pits with tubewell/borewell. This scheme is jointly implemented by CGWB and DDA. This type of projects are also implemented in other colonies like Jorbagh colony and Pushp Vihar colony.



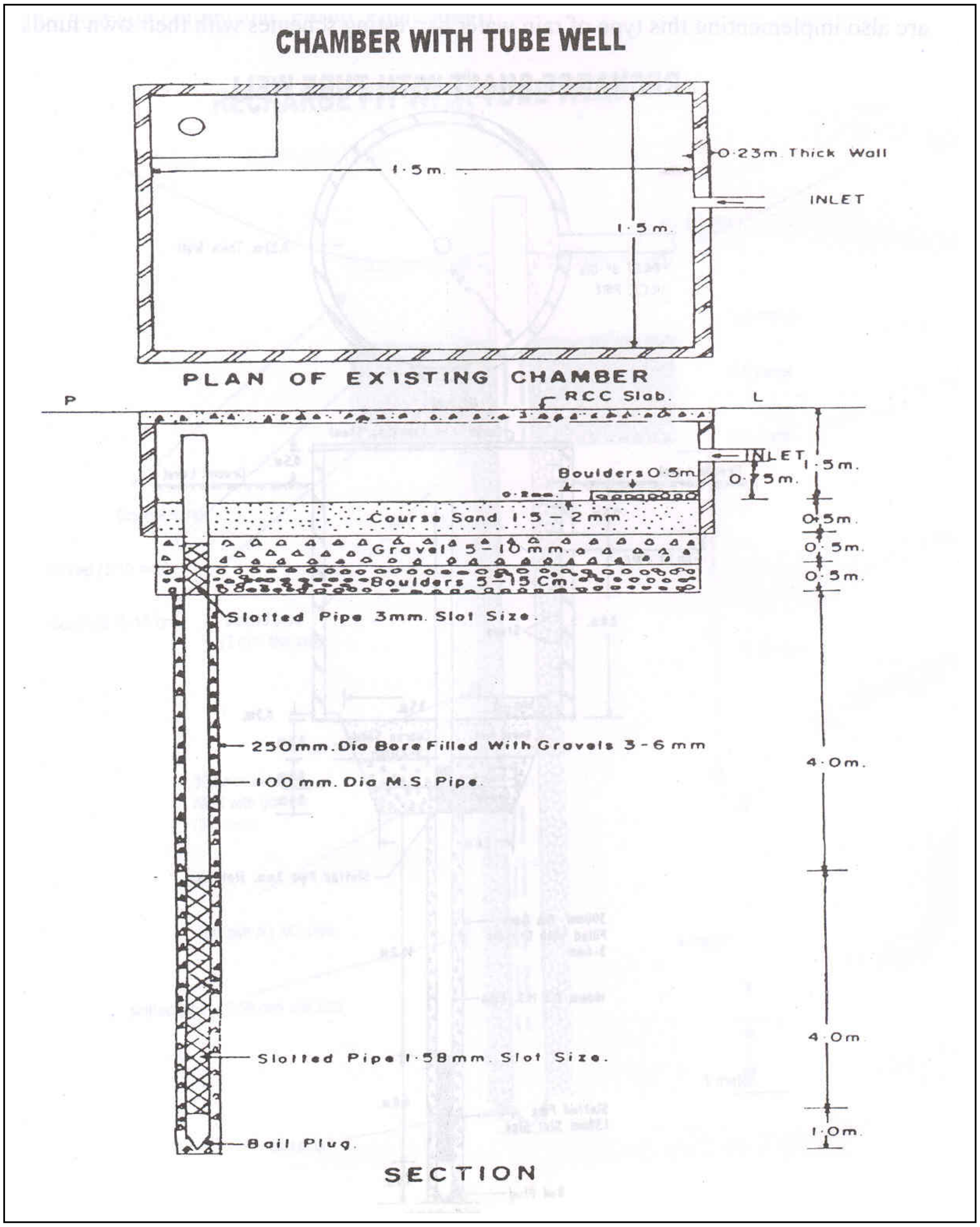
3) **DTC Central Workshop-II, Okhla**

CGWB has prepared a proposal for rain water harvesting and artificial recharge to ground water for Central Workshop-II, Okhla of Delhi Transport Corporation. DTC workshop having catchment area of 6.18 hectares is underlain by weathered and fractured quartzites and generates about 10355 cum runoff annually. Depth to water level in the area varies from 35-40 meters below ground water level. The proposed recharge structures are one trench and four shafts with recharge well. This pilot scheme is funded by CGWB and to be implemented by DTC. Other industrial establishments like Nirula's production centre in Okhla, Q-H Talbros, Gurgaon are also implementing this type of rain water harvesting schemes with their own funds.



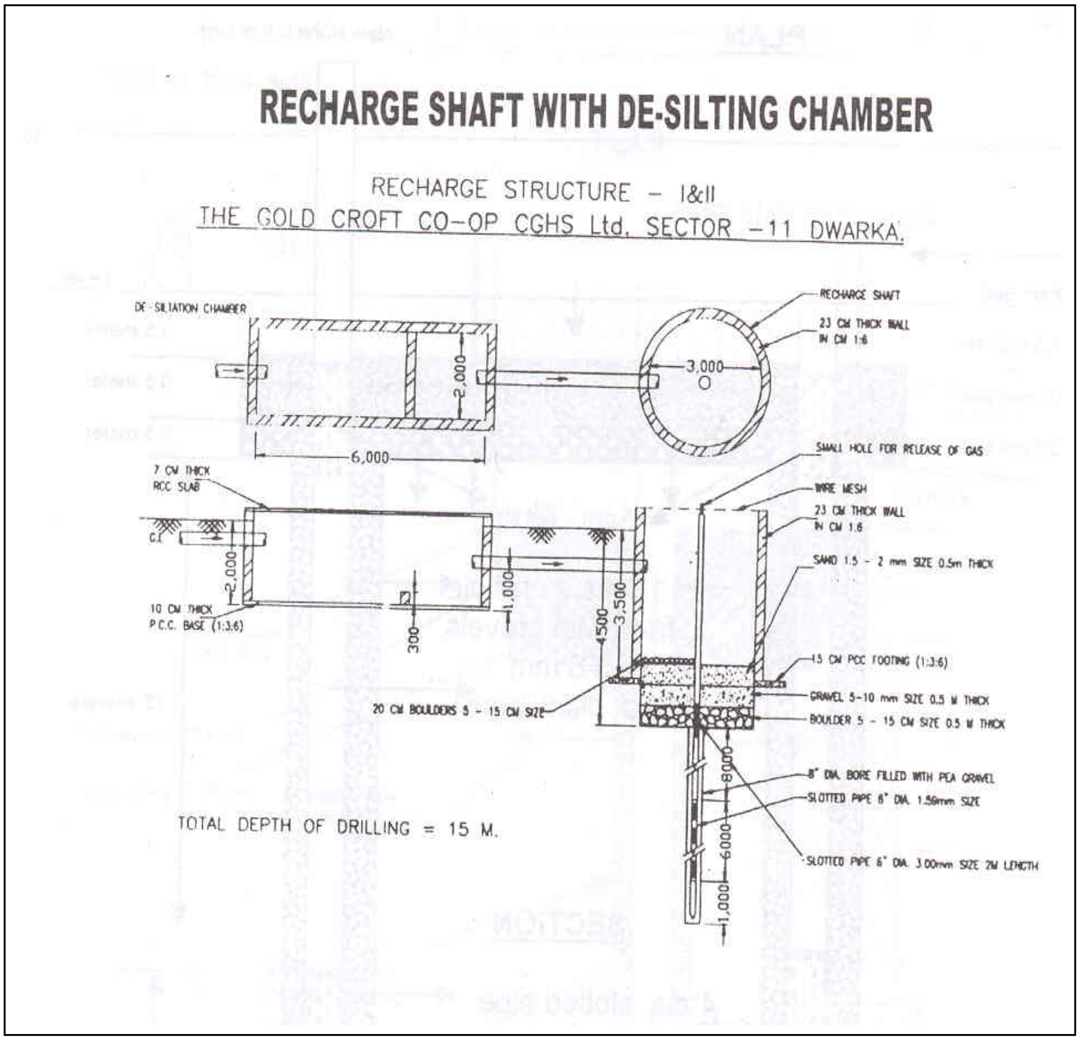
4) Abhiyan apartments, Plot no. 15, Sector-12, Dwarka, South West district, New Delhi

CGWB has taken up one pilot project in Group Housing Society i.e. Abhiyan apartments, Sector-12 Dwarka. The area is underlain by alluvium formation and depth to ground water level varies from 6 to 8 meters below ground level. This is a multi-storied housing complex having campus area of 6355 sq.m. which generates 3050 cum annual runoff. CGWB has constructed two trenches with recharge well, one pit with borewell and one existing storage chamber with recharge well. System is under study.



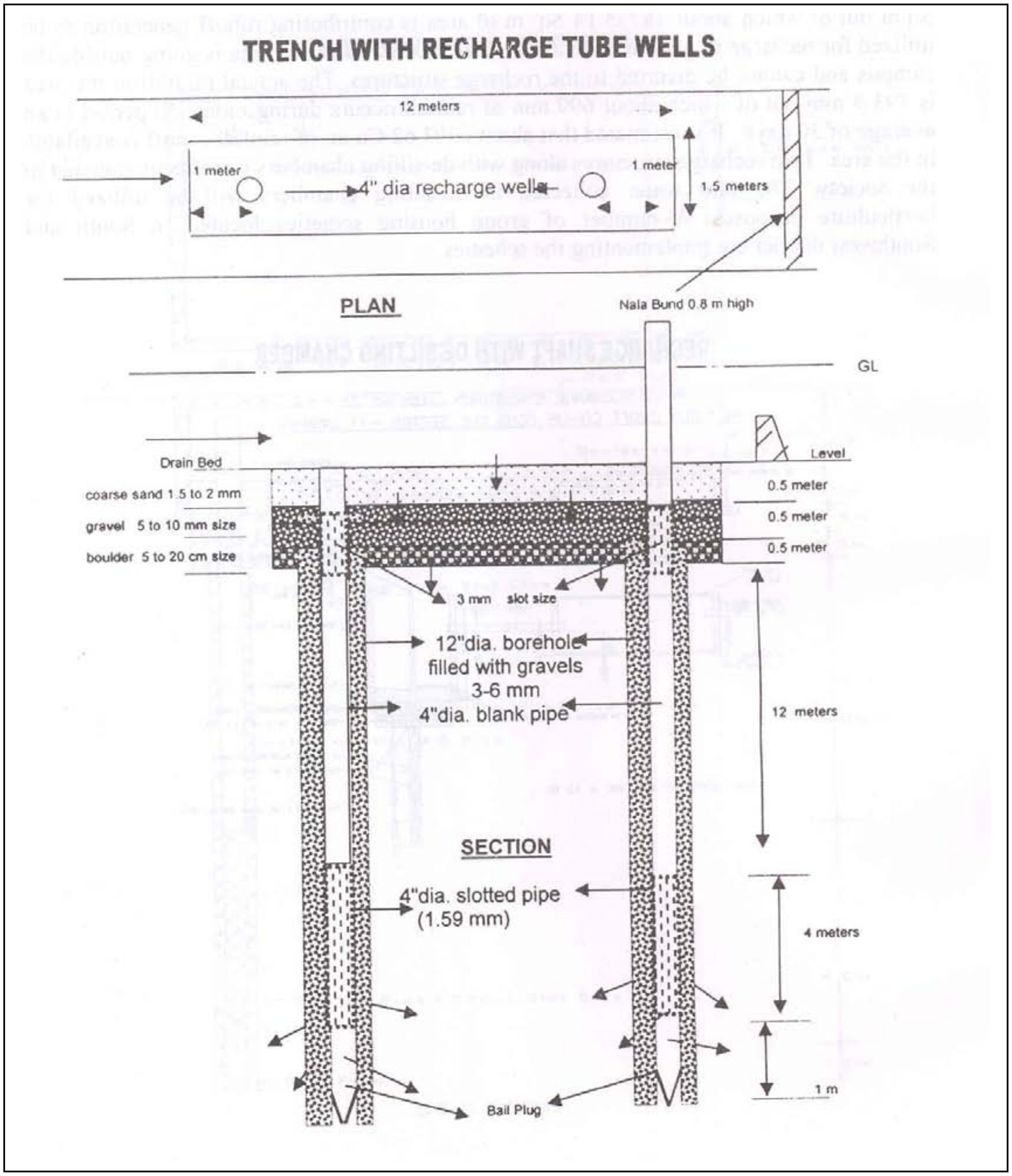
5) Gold Croft Co-Operative Society Ltd. At plot no. 4, sector-11, Dwarka, Delhi

The Gold Croft Co-Operative Society is under construction in Sector-11, Dwarka. The area is underlain by older alluvium mainly consist of unconsolidated inter-bedded sand, clay and silt mixed with varying proportions of gravel and kankar. Depth to ground water ranges from 10 to 11 m. bgl. The total area of the society plot is 19,771 sq.m. out of which about 18735.14 sq.m. of area is contributing runoff generation to be utilised for recharge to ground water. Runoff from the rest of the area is going outside the campus and cannot be diverted to the recharge structures. The annual rainfall in the area is 793.9 mm out of which about 699 mm of rainfall occurs during monsoon period in an average of 30 days. It is estimated that about 6303.62 cu.m. of rainfall runoff is available in the area. The two recharge structures along with de-silting chambers were recommended in the society. The rainwater collected in de-silting chambers will be utilised for horticulture purposes. A number of group housing societies located in South and Southwest district are implementing the schemes.



6) IGI Airport South West district, New Delhi

Area is underlain by alluvium and hard rock formation. Depth to ground water varies from 15-24 meters below ground level. The campus area of the airport is 5.59 sq.km. which generates about 6,14,125 cu.m. rainfall runoff. Considering the amount of runoff and nature of catchment 24 trenches with recharge wells are proposed to harness the available runoff in the area. Scheme is being implemented by Airport Authority of India.



7) Location: JNU, New Delhi

	Catchment Area (Km^2)	Height of check Dam (m)	Storage Capacity (m^3)	Submergence Area (Sq. m)	Approximate Cost (lakh)
Check Dam I	0.45	4.0	15,333	17,140	12.00
Check Dam II	0.58	3.6	22,180	20,243	14.00
Check Dam III	0.66	2.0	6,925	11,300	13.50

8) Location: IIT, New Delhi (Civil Engg., Deptt.)

Roof Top Catchment (Sq. m)	Rainfall (mm)	Volume of water recharged (m3)	Water level rise (m)	Area benefited (Hectare)
1,666	821	830	0.29-0.87	1 ha

Case-Study of a Percolation Tank at Dangard-I, TE-11 Watershed, Jalgaon district, Maharashtra

A tank was constructed by CCWB at Dangarda village in 2001. The catchment have medium to coarse teetered soils & the site is located in piedmont plain fringing Satpura foot-hills. The tank is located on 2^{nd} order stream with catchment area of 0.425 sqkm.

The tank was to measured for daily water level. The area capacity curves were drawn showing gauge reading, water spread and storage capacity. A water balance was compiled based on data analysed as given in table below:

Table – Water Balance of Dongard –I Percolation tank, T.E. – 11 Watershed, Jalgaon

Period	Water Content in tank (m^3)	Infiltration in the tank (Th M^3)	Net Storage (Th M^3)	Evaporation losses (Th M^3)	Net percolation (Th M^3)
June	6.6	9.1	15.7	0.19	15.51
July	0.3	1.3	1.6	0.007	1.593
August	Dry	Nil	Nil	Nil	Nil
September	Dry	Nil	Nil	Nil	Nil
October	2.6	5.0	7.6	0.10	7.5
Total	9.5	15.4	24.9	0.279	24.603

It can be seen that maximum storage and percolation of water took place in the month of June followed by July and October. The net percolation from the tank is estimated as 24.6.03 TCM. The ground water levels exhibited a rize of 1 to 4 meters. An area of 0.3 km^2 was observed to be benefited from percolation tank causing farmers the availability and opportunity to use water for initiated agriculture. Similar Percolation Ponds were constructed by State Government in Collaboration with CGWB, and the features as well as cost of construction of such water harvesting and recharging structures in TE 11, Watershed in Jalgaon district of Maharashtra is given in following table.

Percolation Tanks in Jalgaon district, Maharashtra (features and appropriate cost of construction) (Watershed TE-11)

		Percolation Tanks				
S. No	**Features**	**Wadri**	**Sangvi**	**Dongarda (i)**	**Dongarda (ii)**	**Dongarda (iii)**
1	Rainfall (mm)	674.37	674.37	678.942	678.688	767.652
2	Run-off (TCM/mm)	75.50	75.55	76.72	76.72	76.24
3	Catchment Area (km2)	4.27	1.30	0.43	1.00	1.24
4	Submergence Area (mm2)	42.00	34.76	14.9	12.35	26.96
5	Terrain	Piedmonts	Piedmonts	Piedmonts	Piedmonts	Piedmonts
6	Storage Capacity (TCM at FSL)	98.03	71.7	32.32	25.56	58.28
7	Max. Flood Discharge (m3/sec)	178.26	36.12	11.90	28.00	35.00
8	Dam Wall Total length (m)	510	510	195	270	380
9	Max Height (m)	9.5	8.5	9.54	9.52	13.86
10	Top Width (m)	2.00	2.00	3.00	3.00	3.00
11	Waste Weir Length (m)	60.00	45.00	15.00	17.00	29.00
12	Flood Height (m)	1.45	0.60	0.60	1.00	1.00
13	Cost of construction (Rs.)	8,96,825	10,75,252	9,87,120	10,75,510	24,84,055
14.	Year of construction	2000	2001	2001	2001	2001

The Case Study from Gujarat State

The Mehsana area in Gujarat in severely affected by ground water over exploitation leading to declines in the levels of ground water. Two main experimental studies lead to construction of water spreading basin & injection wells. The shallow aquifer below Saraswati river bed was used as a source water for pressure injection well recharge test. The injection well experiment was done for 225 days by a UNDP aided CCWB Pilot Recharge Project. A quantity of water at the rate of 225 m^3/day was pressure-injected. A rise in water level of 5 meters in injection well & of 0.5 to 1.0 meters in observative wells at 150 meters distance from injection well site was observed. A continuous high rate of pressure injection was sustained by storage space created by contemporaneous withdrawal of ground for irrigation in the area.

The water spreading method of recharge was done using canal water. A spreading channel of 3.3 m width x 400m length with 1:1 side slope was constructed in which canal water was fed for 4 days. A build up of ground water of about 1.4 to 2 m was noticed upto 15m from recharge channel and of 0.20m at a distance of 200m. Using an infiltration rate of 17 cm/day, a recharge rate of 260 m^3/day was achieved. The recharge method of 1.42m was dissipated in 15 days.

An experiment through a recharge pit (1.7m x 1.7m x 0.75m) at Dabhu in central part of Mehsana was also done using canal water as source water. The recharge was affected at the rate of 17.3m^3/day with an infiltration of 0.5 m/day. A rise of 4 meters in levels of ground water was observed at a distance of 5 meters from the experimental recharge pit.

Location: Braham Sarovar Area, Kurukshetra, Haryana

- Source Water : Surplus Sarovar Water
- Available water from Sarovar : 0.63 MCM
- Expected Recharge : 0.44 MCM
- Recharge Structure constructed by CGWB :

  a) Recharge 2 nos.
  b) Injection Wells 2 nos.
  c) Implementation cost: Rs. 10.00 lakhs

Some Case Examples of Foreign Countries

1.	Japan :	Some 25 local governments in Japan are subsidising rain-water-harvesting projects as a way to prevent Urban floods and to overcome water shortages. One of these is the Sumida Ward of Tokyo which offers subsidies ranging from JPY 25,000 to JPY 1 million depending on the size of rainwater storage tanks. Rainwater harvesting is being promoted by the council for Local Governments on Rainwater utilisation, which was set up in 1996. Tokyo Metropolitan Government is promoting the use of RWH in the city.
2.	Canda :	In certain parts of Canadian Province of Nova Scotia ground water quality for individual dwellings is not reliable. In these situations rainwater cistern system have been used and as such 500 dwellings are severed by rainwater cistern systems. The system consists of a roof, which severs as a collection surface and gutters and downspouts that are connected to storage reservoir.
3.	Australia :	A survey over South Australia determined that rain water is the main source of water for drinking. In the Metropolitan area, 25% households use rain water for drinking whereas in rural areas 81% of households use rain water.
4.	Argentina :	Artificial recharge has been widely used in Latin American Countries. In Argentina, a system of canals and infiltration basin has been used in the provinces of San Juan, Mendoza and Santa Fe with success.
5.	Texas, USA:	According to Texas Water Development Board, the rainwater quality always exceeds that of surface or ground water. Their experiences of guttering houses and use of storage tanks have simply found the best as alternative to available water supply. For bathing and cleaning UV-light filters or disinfectant are used and for drinking and cooking Reverse Osmosis is practiced.

Cost Estimate for Trench with Injection Well

S. No	Description of items of work	Quantity	Unit Rate (Rs.)	Amount (approx. in Rs.)
A	**Trench: (10m x 2m x 3m)**			
1.	Earthwork (3m x 2m x 1m	60 m^3	100	6000.00
2.	Back filling with pebbles (10 x 2 x 1m)	20 m^3	1000	20000.00
3.	Back filling both gravel (10 m x 2 x 1 m)	20 m^3	1000	20000.00
4.	Filling with coarse sand (10 m x 2 x 1m)	20 m^3	1000	20000.00
5.	Provisioning of Nylon Net between gravel and sand bad	20 m^2	50	1000.00
6.	Providing Heavy duty HDPE sheet along side wall	96 m^2	100	9600.00
7	Brick work (0.23m at periphery of trench 0.50 m deep & 0.25 m over ground)	4m^3	1000	4000.00
8.	Earth Work for (7) above	3.6 m^3	100	360.00
9.	RCC Slab cover for trench	1.55 m^3	2500	3875.00
			Sub total (A)	**84835.00**
B.	**Injection Well Bore**			
1.	Pilot Borehole (380 mm dia of 30 m depth)	30m	400.00	12000
2.	Lowering 22 m Ms Pipe	22m	400	8000
3.	Lowering of 152 mm dia Johnson Screen 1 mm Slot size-8m	8m	1500.00	12000
4.	Lowering of 152 mm M.S pipe bail plug-3m	3m	500.00	1500
5.	Grave filling	2.70 m^3	1000.00	2700
6.	Wall development (10 hrs.)	10 Hrs.	500.00	5000
7.	Misc (Lump Sum)	-	1000.00	1000
			Sub Total	**43000**
C	**Providing & Fixing of PVC Pipes (80 m)**	80m	250	20,000
D	**Desilting Chamber (1.5m x 1.5m x 1.5m)**		1500	15000
E	**Cost of Channelising Rainwater & connecting to shafts (Lumpsum)**		15000	15000
			Grand Total (A+B+C+D+E)	**177835**

Say Rs. 1.75 lakhs approx

Cost Estimate for Groundwater Recharge Structures by CGWB

S. No.	Type of Recharge Structures	Approximately Cost (Rs.)
1.	Recharge Pit	5000
2.	Recharge Trench	5000-10000
3.	Recharge using handpump	2500
4.	Recharge through Dug Well	5000-8000
5.	Injection Well	50000-80000
6.	Recharge Shaft-Vertical with performed boreholes	60000-85000
7.	Lateral recharge shaft with performed boreholes as recharge well	Trench cost : 2000-4000 Recharge well : 25000-35000