# BORE WELLS – A BOON FOR TAIL END USERS

Rajeev Kumar Goyal, M.I.E.[1]

## ABSTRACT

The efficiency of an irrigation engineer can be well judged from the canal water available at tail ends of the canals under his control. But often he finds it difficult to maintain authorised share of water at tails. In India position is particularly precarious during rice sowing period, which is monsoon season, i.e. rainy season in India at that time. It is the peak demand period for canal water. A deficit monsoon coupled with water theft makes it very difficult for authorised share to reach at tail ends. On the other hand, a good rain can cause tails to get flooded. It causes great loss to tail end users.

This problem can be solved to some extent with the help of bore wells or dug wells, dug along the canal, more of them in the last one third of the length of the canal. These dug wells will act as rechargers of ground water during the period when there is excess of supply of water in the canals by diverting excess water to these bore wells, and will act as boosters during short supply by drawing this water through tube wells and mixing it with canal water. Though conjunctive use of tube wells along with canal water is being practised since long, this technique of first recharging aquifers with surplus canal water and then withdrawing this recharged ground water through tube wells during peak demand period, is particularly useful where ground water is otherwise brackish and is unfit for use.

## INTRODUCTION AND BACKGROUND

Through this paper, an effort has been made to visualize how such a system can be developed, maintained and operated, what should be the design parameters, what problems can occur, what can be the solutions for such problems etc.

Punjab, which is known as food basket of India, is having the most developed Canal System in India. The green revolution has been possible only due to such a well developed canal system. Multipurpose projects like Bhakhra Dam project, Pong Dam project, Ranjit Sagar Project has made it possible to develop such a vast canal network. Some famous canals flowing through Punjab are Indira Gandhi National Canal, Bikaner Canal, Upper Bari Doab Canal, Bhakra main Line Canal, Sirhind Canal etc. These canals has made Punjab a basket of grains. These canals take off from Harike Headworks, Madhopur Headworks and Nangal Headworks. Figure 1 on the following page shows one such canal of vast network of canals in Punjab.

[1]Sub Divisional Officer, Punjab Irrigation Department, Rajuwala canal sub Division, Rajuwala (Faridkot), Punjab (INDIA)E-mail : goyal_rkg2003@yahoo.com

Figure 1. Photo of a canal in Punjab

Apart from canal network, a large number of tube wells are drawing underground water to fulfil water requirement of ever demanding crops. The over utilization of underground water has rendered water level to go down to drastic levels, resulting into 59 blocks out of 118 blocks of Punjab being declared as Black. In Faridkot, Mukatsar, Moga, Bathinda, Mansa, Ferozepur Districts of south Punjab, the underground water is becoming unsuitable for irrigation as over exploitation of underground water leaves behind brackish water due to increased concentration of salts in residual water.

A number of studies has been conducted to know the characteristics of ground water in this area and most of the results are shocking for the farming sector in particular and general public at large. The quality of underground water has gone so down that it is resulting into large number of health problems like spurt in cancer patients and such other medical problems. The percolation of pesticides into ground water has also resulted into rendering underground water unfit for irrigation or human use.

All this has increased dependence of farming sector more on canal water. This has increased pressure on irrigation men as they are now asked for every fluctuation in canal water. The over dependence on canals has resulted into more cases of water theft also, which hinders proper regulation of water. All this results in large fluctuations in canal water at the tail ends. Figure 2 below depicts shortage of water at tails.

Figure 2. Tails with short supply of water

Several existing canal irrigation systems suffer from inadequate water supplies. The available supply for instance is often less than half the amount needed for intensive agriculture. The total quantity of irrigation water is neither adequate nor satisfactory & in time. This calls for other measures to augment the available supplies. Tube wells are commonly used for conjunctive use of surface and ground water. The conjunctive use of surface and ground water can take form of augmenting canal supplies by direct pumping of ground water through augmentation tube wells or direct use of ground water during periods of low canal supplies or canal closures. It can also take the form of irrigating a part of the canal command area exclusively with ground water.

The conjunctive use of surface and ground water has been in practice in India to a limited extent. The practice has been prevalent in the Cauvery delta in Tamilnadu, the Godawari canal system in Maharashtra, Yamuna canal system in Haryana and parts of Punjab. In the Cauvery delta, privately owned filter points have been constructed on a large scale to raise paddy seedlings early in June before the canal system is opened. The filter points also provide irrigation to the rice crop after the canals are closed, thus ensuring a rich harvest. Some farmers also raise summer crops of cotton or ground nut with the help of filter points and give irrigation support to sugarcane crops.

In U.P. conjunctive use of surface & ground water started as early as 1930, when batteries of tube wells were installed in the tail end of some of the Ganga canal in Meerut District to meet great demand for water during low canal supply. In western Yamuna canal system in Haryana, tube wells have been constructed along the canal bank to augment canal supplies and lower the ground water table.

Tube wells are commonly used for conjunctive use of surface water and ground water. During their canal water turns, farmers pump tube well water into the canal to augment supplies to their fields. Farmers use a cluster of strainers to capture the canal seepage from shallow depths & pump it to mix with canal water for irrigation orchards. Farmers realized that they cannot pump for long periods at a stretch because brackish water would be pumped out after long period. But at times you need to pump water for longer durations. In such cases, to solve the problem of brackish water being pumped out after long periods, recharging of aquifers with surplus canal water could be effectively used. This will help in recharging of aquifers with good quality of water, thus increasing time period for pumping.

Another remedy to fluctuation in canal water as well as a solution to ever decreasing water table in this area has been found in Dug wells or bore wells being dug along the canals as well as at other common village lands. The runoff of excess rainfall, as well as excess canal water during lean demand period of canal water, is fed to these dug wells. Good results have been received from them, which are very encouraging. But this method is still in the early stage and a lot needs to be done in this regards. For this we will first study various types of recharge dug wells, their suitability in various circumstances, their design parameters, various arrangements to use this recharged ground water to supplement short supply of canal water at tail ends etc.

## TYPES OF DUG WELLS/ RECHARGE SHAFTS

These are the most efficient and cost effective structures to recharge the aquifer directly. These can be constructed in areas where source of water is available for some time or perennially. Following are suitable site characteristics and design parameters:

- If the strata is non caving, it can be dug manually.
- If the strata is caving, proper permeable lining in the form of open work, boulder lining should be provided.
- The diameter of the well/shaft should normally be more than 2m to accommodate more water and to avoid eddies in the well. In the areas where water is having silt, it should be filled with boulder, gravel and sand to form an inverted filter. The upper-most sandy layer must be removed and cleaned periodically. A filter should also be provided before the source water enters the shaft.
- If the water is put directly into the recharge well through pipes, air bubbles are also sucked into the shaft through the pipe, which can choke the aquifer. To avoid this shaft should be lowered below the water table.

The advantage of the dug wells is that it requires only a small piece of land and water losses are less as it can be constructed close to the canal. Old unused wells can also be used for the purpose. Even operational bore wells can also be used as recharge shafts. It saves extra investment. Due to simple in design, it is easy to use even ever excess canal water flow is available for a limited period only. The effect is fast and immediately delivers the benefit.

Further these can be constructed in two different ways ─ vertical and lateral.

**Vertical Shafts**

The vertical recharge shaft can be provided with or without injection well at the bottom of the shaft. The recharge shaft without injection well is well suited for deep water levels (up to 15m bgl), if clay is encountered with in 15 m, effective if there is less vertical natural recharge and it is effective with silt water also by using inverted filter. The rate of recharge depends upon on the aquifer material and the silt content in the water. The depth and diameter of the dug well depends upon the depth of aquifer and volume of water to be recharged.

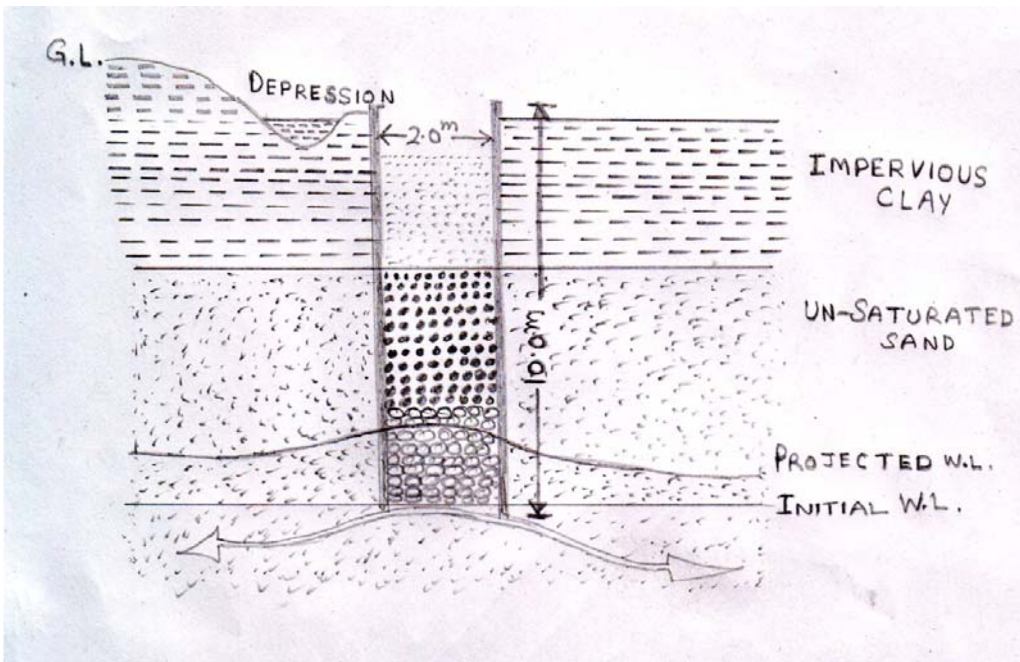


Figure 3. Vertical dug well/recharge shaft without injection well

This type of recharge shaft has been constructed at following places and good results have been received at all these places:

- Brahm sarovar, Kurukshetra – Silt free water
- Dhuri Drain and Dhuri link drain, District Sangrur, Punjab
- Nurmahal Block, Punjab

**Vertical shaft with injection well**

In this technique an Injection well of 100-150 mm diameter is constructed at the bottom of shaft piercing through the layers of impermeable horizon to the potential aquifers to be reached about 3 to 15 m below the water table. Such a structure is ideally suitable for very deep water levels (more than 15 m), aquifer is overlain by impervious thick clay beds etc. The injection well with assembly should have screen in the potential aquifer at least 3-5m below the water level. The injection well without assembly is filled with gravel to provide hydraulic continuity so that water is directly recharged into the aquifer. Depending upon the volume of water to be injected, number of injection wells can increased to enhance the recharge rate. The efficiency of such well is very high and recharge can go up to 15 lps at certain places.

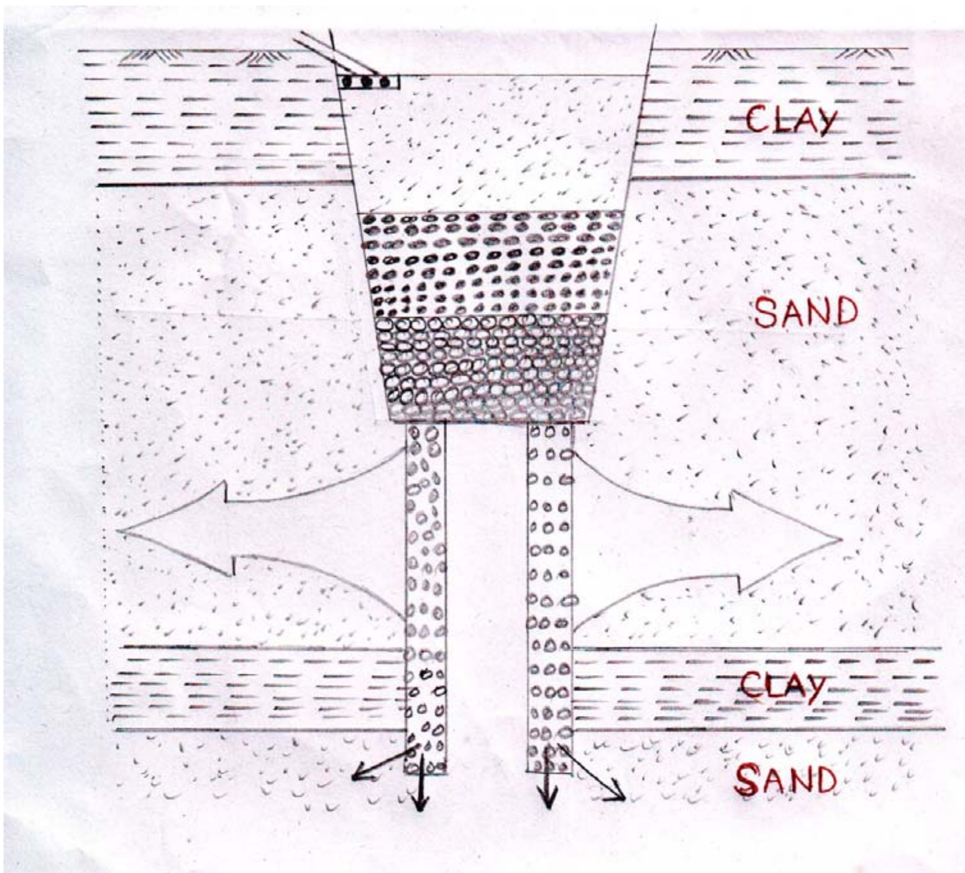


Figure 4: Recharge shaft with injection well

Such structures have been constructed at the following places in Punjab

Injection well without assembly:

- Dhuri drain, Sangrur district, Punjab
- Khana block, Ludhiana district, Punjab
- Samana block, Patiala district, Punjab

Injection well with assembly:

- Dhuri link drain, Sangrur district, Punjab
- Kalasinghian, Jalandhar district, Punjab

**Lateral recharge shaft**

Such a structure is ideally suited where permeable sandy horizon is within 3m below ground level and continues up to the water level – under unconfined conditions. The copious water available can be easily recharged due to large storage and recharge potential. It is well suited for silt water. These are constructed by excavating a 2 to 3 m wide and 2 to 3 m deep trench, length of which depends upon volume of water to be handled. These can be constructed with or without injection wells.

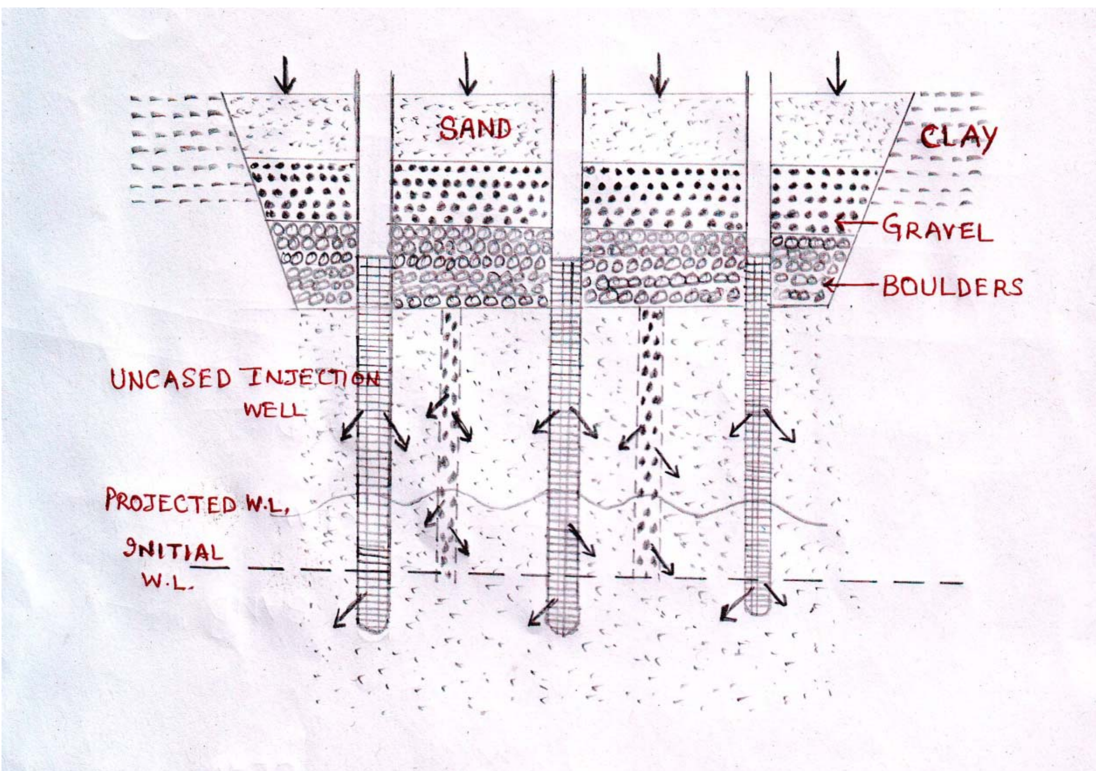


Figure 5. Lateral recharge shafts

This type of structures has been constructed at the following places:

- Dhuri drain with 6 injection wells (length 300 m)
- Dhuri link drain with 3 injection wells (length 250 m)
- Samana block Punjab - 4 lateral shafts with injection wells

## CASE STUDY

Village Mukand Singh Wala falls in Hithar area of Faridkot District in Punjab. Hithar area is notorious for shortage of water. The land profile is such that on top of the soil is sandy strata, the depth of which varies from 5 m to 10 m, which is followed by an impervious layer of clay which is about 10 to 20 m wide. Due to sandy strata at the top, any rainfall or irrigation water fed to fields goes down very fast leaving fields again dry. And the clay strata beneath does not allow rain water to recharge underground water which lies below impervious clay strata. Due to this, the underground water is brackish and hence unfit for use. Figure 6 below depicts various layers of soil in one typical section:

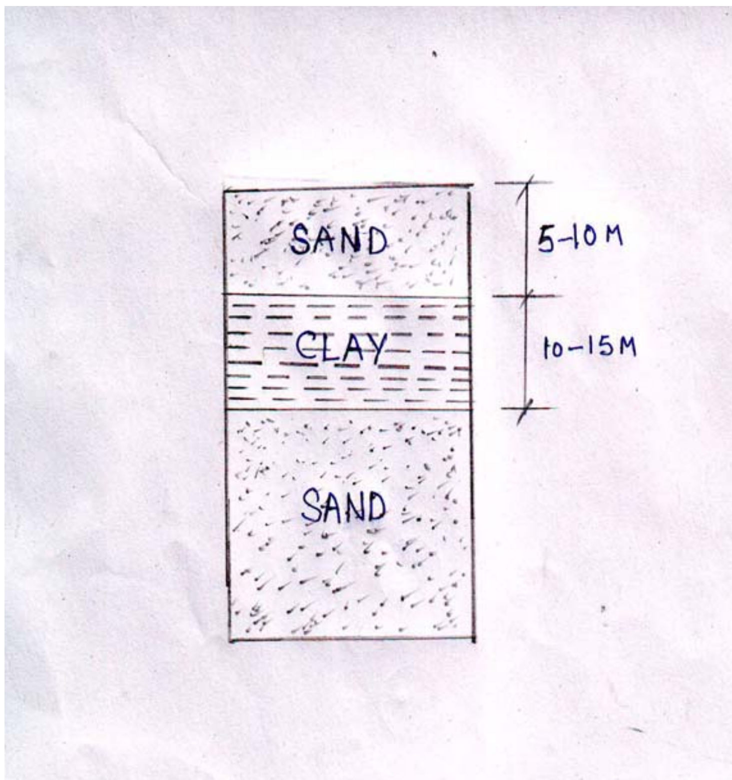


Figure 6. A typical section of Earth profile at Village Mukand singh wala

This village is supplied canal water for irrigation through Golewala distributary. Golewala distributary, which has a design discharge of 290 cusecs at the head, has a length of 40 km and combined length of minors off taking from it is 75 km. Hence it is a big canal system which feed about an area of 1,00,000 acres (Approx.) or say 40,000 hectares. This canal system suffers from chronic shortage of water at tail ends. The quantity of rainfall is also less than desired. Due to brackish nature of under ground water, the conjunctive use of underground water is not use full. So, it was decided to dug a recharge well adjacent to canal with depth about 50 m, going well down the impervious layer. A vertical recharge shaft with dia of 2 m was dug 25 feet away from the canal, so that canal does not face any breach or any other harm in future due to the recharge well. It was dug near outlet R.D.115000-L of Golewala distributary adjacent to an already existing tube well with an idea that recharged underground water will be pumped through this tube well and mixed with canal water flowing through the water course of outlet R.D. 115000-L.

To save recharge well from any future choking with silt water, inverted filter with layers of sand, gravel and boulder has been laid. A special open flume outlet has been made in the canal with crest at full supply level, Width of outlet (Bt) being 60 cm (2 ft). So that whenever there is excess supply in the canal, extra water available automatically flows into recharge well. The seepage from canal as well as surface runoff during rainy season also helped in recharge of the aquifer below the impervious layer.

The tube well has a casing of 15 cms and delivery pipe of 10 cms capable of supplying about 1.0 cusecs of water with depth of 50 m, reaching down to recharged aquifer. The tube well was about 25 m away from recharging well and water from it was directly fed to the water course carrying water from outlet R.D. 115000. The plan showing location of recharging well and the tube well with respect to the Golewala Distributory and the water course of outlet R.D. 115000 is shown below.

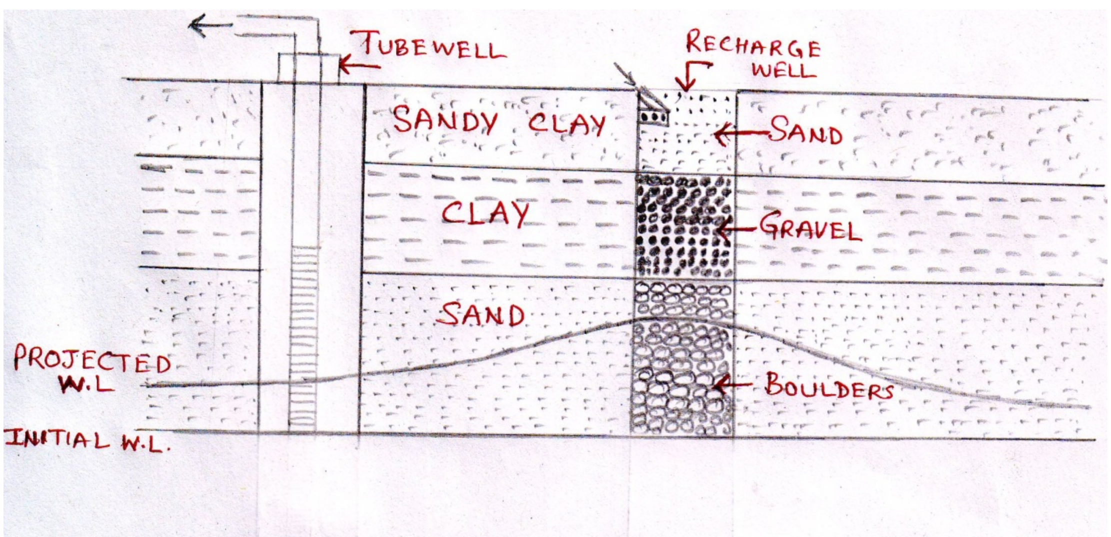


Figure 7. Picture showing section of recharge well and tube well

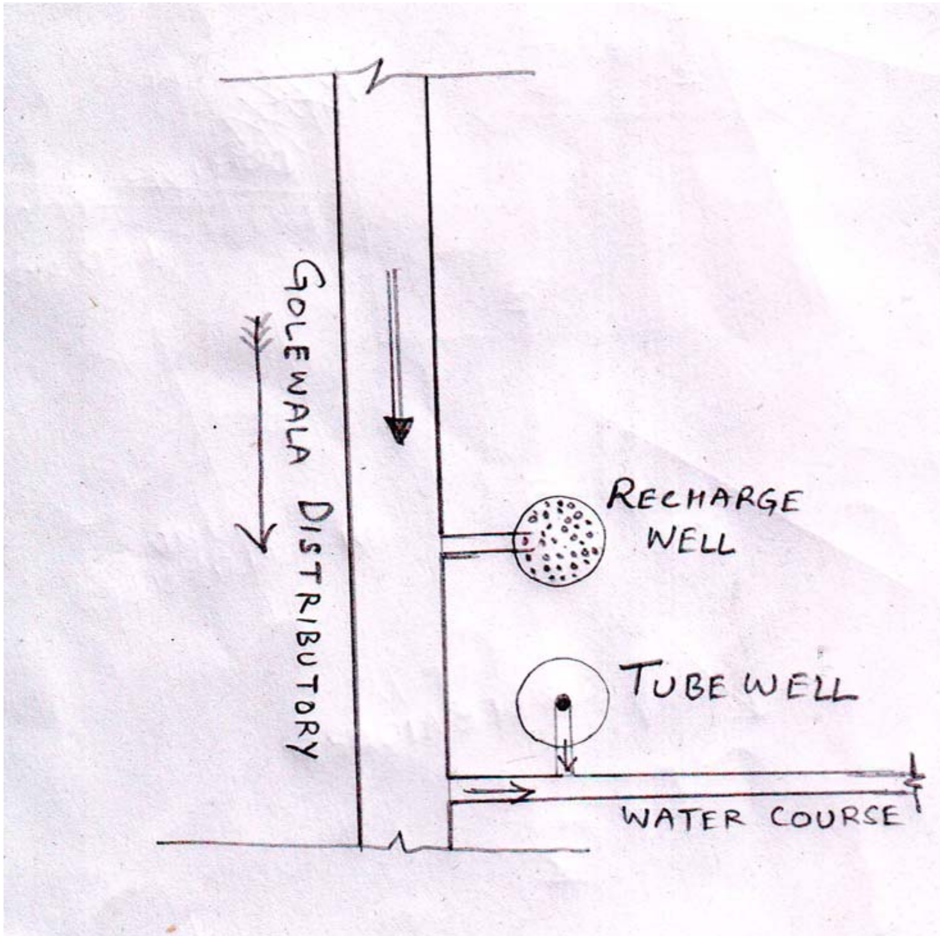


Figure 8. Picture showing plan of recharge well and tube well

Under the guidelines of Command area development authority (CADA), the shareholders of each outlet has formed individual water user associations, which deal with construction and maintenance of the water course of that particular outlet including all its branches. Initially each shareholder as per his land holding on that outlet, contributes 10% share of total budget and rest is contributed by centre government through CADA. The operation and management of the present system was also handed over to the same Water user association.

The construction of recharge well was completed by September 2008. From the end of October 2008, recharge well started receiving excess canal water through the special out let. A few rains in winter also helped recharge well to receive water to recharge aquifer below the impervious layer. During the period from November 2008 to March 2009, the water level of underground water rose by one foot. The recharge shaft got surplus canal water, rainfall runoff as well as seepage from canal running along, to recharge the aquifer. Due to limited demand of water during this season (Wheat season), the running of tube well was not much required. This helped the aquifer to be charged to a good extent, so as to be useful in the coming rice sowing season.

It was in the beginning of June 2009, when the sowing of Rice (PADDY) started, that necessity to run tube well was felt to augment low supplies of canal water in the water course of out let RD 115000-L. Due to delay in Monsoon over the region, the flow of water at the tails has reduced to half. Hence the full running of tube well was started. The tube well water was mixed with canal water flowing in the water course. This helped shareholders to receive full share of good quality water. This continued for the full month of June till the rains started in the beginning of July. This improved the situation of water in the canal at the tail end. The running of tube well was reduced. During the whole of the paddy season, conjunctive use of under ground water was done along with canal water and the shareholders of outlet R.D.115000 received authorized share of water for the full season. This has helped the production of the rice to increase on an average by 15% as compared to last year.

**Advantages of the System**

- Loss of crops at tail ends due to shortage or excess supply of water reduced.
- Shareholders received full share of water for irrigation regularly.
- Best suited to circumstances where underground water is otherwise unfit for conjunctive use, but with the recharging of aquifer with canal water and rainwater, it allows underground water to become fit for use.

## SUMMARY

From the above discussion, we can well find out that to reduce fluctuations of canal water at tail ends, bore wells or recharge dug wells are a boon which help in mitigating woes of farmers by controlling both – excess and short supply of water in canals at the tail ends. Conjunctive use of underground water by pumping is possible only where quality of underground water is good. So to have a good quality of underground water, the best solution is to recharge such aquifers with the help of recharge shafts of different types as per requirement. The alternate use of bore wells, i.e., first for recharging the aquifers and then for withdrawing water from them can help in a big way to mitigate problems of tail end users. So we can well say that bore wells are a boon for tail end users.

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