Grenze International Journal of Engineering and Technology, Special Issue

Command Area Development using Artificial Recharge System - A Practical Case Study

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***Abstract*— The extraction of ground water is increased for agricultural, municipal and industrial needs. Consequently ground water is withdrawn from storage and water levels in ground are declining.**

Artificial Recharge is the method of modifying, hydrological cycle and their by providing water in excess of that available by natural process. Generally the favorable conditions for Artificial Recharge are formations of sand, gravel, highly fractured rocks, the presence on caverns, fractured or faulted zones or numerous small cavities in rock formations, feasible locations for insulation of recharge wells, diversion or other recharge structure.

Several methods of Artificial Recharge or in vogue the choice of being dictated by local conditions. The methods may be classified as follows (Muckel 1948, Todd 1959, Chow 1964).

1. **Spreading Method**
2. **Pit Method**
3. **Induced Recharge Method**
4. **Well Method**

Artificial Recharge is planned by rev charging through well.

The suitable site select for Artificial Recharge is at Nallavelly (V) of YACHARAM (Mandal), R.R. District.

The total command area under M.I. tank is 75 hectares under normal pattern the irrigated area is about 34 hectares. Using Artificial Recharge the total command area may be irrigated.

A computer program is developed to get the variations of water levels of irrigation wells with recharging rate at recharge wells taking into consideration of transmissivity of aquifer.

***Index Terms*— Artificial Recharge systems, Conditions for Artificial Recharge, Methods of Artificial Recharge, Computer program on Artificial Recharge through Recharge well method**

I. INTRODUCTION

Throughout time man has exploited nature's resources in order to ensure the comfort and well being. Not long ago it was considered inconceivable by him that the demand for our natural resource could ever exceed the supply. This attitude led to consume his natural resources with little regard for observation and economy. Man can no longer retain this selfish and uncontrol attitude towards his natural resources and our Water Resources cannot be excluded from this reality. The adequacy of our natural resources must be determined

Grenze ID: 01.GIJET.4.3.12

through detailed comparison of present water supply to current and anticipated demands. On the basis of natural average consumption the water resources is adequate for present in some areas but marginal in some other areas such as arid and semi-arid lands. The possibility of increasing supplies of useful water no longer exists through the exploitation of new sources but rather and integration of technological, political, social and economic factories will be necessary. One of the technological factors involved presently being wasted which could be stored in ground water formations that is mechanism for Artificial or induced recharge were developed the purpose is to illustrate various forms of recharge and to indicate their significance as a means of managing water resources especially in areas were present water resources shortage exists

There are two distinct modes of ground water recharge. the first is the natural recharge were by water infiltrates through porous media to the aquifer naturally that is under the effects of its own head as in case of seepage from canals, lakes and perception etc.

The second artificial replenishment could be either induced recharge or artificial recharge

Artificial recharge is may be defined as augmenting the natural movements of surface water into underground formations by some methods of constructions by spreading of water or by artificially changing natural condition

The main purpose of Artificial recharge is water conservation often with improves quality as a second aim. The source of recharge may be storm runoff, river water, water used for cooling purposes, industrial waste water and treated sewage water. In general recharge will be efficient only after some kind of pre-treatment of raw water either of chemical natural or through rapid sand filter or both.

II. Literature Review

The annual extraction of ground water is increased for agricultural, municipal, industrial needs consequently ground water is withdrawn from storage and water levels in ground are declining resulting in crop failures. Artificial Recharge is the method of modifying, hydrological cycle and their by providing water in excess of that available by natural process. The purpose of the recharge vary widely ranging from well-field management to waste disposal. The greatest number of systems are relatively small and are used to reduce the rate of water-level

Decline in order to avoid water rationing or to supplement the yield from existing well fields

Artificial Recharge is very effective tool in ground water management. Artificial Recharge projects are designed to serve one or more of the following purposes:

1.Maintain or agument the natural ground water as an economic resource 2. Coordinate operation of surface and ground water reservoir 3.combat adverse conditions such as progressive lowering of ground water levels, unfavourable salt balances and saline water intruition 4. Provide subsurface storage for local or imported surface water 5. Reduce or stop significant land subsidence 6. Provide a localized subsurface distrubution system for established wells 7. Provide treatment and storage for reclaimed waste water for subsequent reuse. 8. Conserve or extract energy in the form of hot or cold water

Thus, in most situation Artificial Recharge projects not only serve as water conservation mechanism but also assist in overcoming problem associated with overdrafts.

To place water underground for future use require that adequate amount of water be obtained for this purpose. In some localities storm runoff is collected in ditches , basins or reserviours for subsequent recharge elsewere recharge water is imported in to the region by pipeline or aquaduct by distance surface water source. A third possibility involves utilization of treated waste water whatever be the aim of Artificial Recharge it helps in conserving groumd water resources

Recharging began in Europe early in 19 century and in United States near the end of century. Since then recharge instillation have steadily increased throughout the world. Recharge basin from the integral part of Swedish municipal water supply systems. Artificial Recharge is widely practised in Germany to meet industrial and municipal water demands. In the Netherlands water supply systems for Amsterdam, Leiden, and The Hagur include basin for recharging surface water into coastal sand dunes. Today, in California alone some 300 artificial recharge projects operate in areas where groundwater has been extensivey exploited

The technique of Artificial Recharge of groundwater through surface storage is Practiced in Maharashtra state and Rajasthan state. Tank irrigation is used in south India. For small tanks, sometimes the loss of water by evapouration and seepage from irrigation Canals as well as tank bund is larger in relation to storage. This if combined with porous sand make irrigation tanks unattractive. Further if the terrain is mountain, alignment of canals will become a problem. Under such conditions tanks can be built up with sole purpose to recharge of ground water. Sandy or rocky soils provides favourable condition for success of such tank. Since water

can percolate underground through porous in soil or fissures in rocks. This water is stored in aquifer below and can be pumped out of wells constructed on the downstream side. This type of tank evolved over a long period in Rajasthan state especially in Ajmeer district.

Artificial recharge by wells has been attempted in India only during lost decades, in 1976, the NRPL(1977) carried out experiment at Hansol, near Ahmedabad, to study feasibility of adapting Siphon principle to recharge over exploited confirned aquifer from phreatic aquifer recharged by Sabarmathi river

As a part of studies in Ghaggar River Basin covering Punjab, Haryana and Rajasthan under a UNDP – Assisted project, artificial recharging through injection wells was carried out and experimental basis in areas facing an overdraft problems and from experiment it was concludes that through recharge wells canal water could be recharged into aquifer by gravity flow.

In 1994, the NGRI has successfully carried out Pilot project using Artificial Recharge techinique in Ketol areas of Nagapur District covered by Deccan trep basalts

In Andhra Pradesh the Artificial systems was implemented in Rishi Valley Sub basin, Chittor District and some areas in Ananthapur District

In Telangana State Mahaboobnagar District and Nalgonda District are implementing Artificial Recharge systems successfully.

III. Research Methodology

An aquifer that is tapped by high yield wells should be suitable for Artificial Recharge. The Recharge must be lie within in the influence of well cone of depression so that Recharge water has an opportunity of flow down gradient in the direction of pumping rather elsewhere.

The thickness and permeability of earth's material overlying in dewatered aquifer exert a strong influence on the type of Recharge materials are thick and of low permeability Recharge wells are in order but thin or more permeable, spreading in basins, large shafts may be satisfactory.

The water level in the aquifer must be lower than the operational water level in recharge system so that the water will infiltrate

The difference in water level or depth of water in basin is the driving force that allows the water to infiltrate.

The declining water levels in drought prone districts have become focus of attention as public interest's involved the dark and other grey areas which are prone to become dark are studied in detail for the feasibility of taking of Artificial recharge structures for increasing ground water resources in these areas.

Out of identified sites, the present case study of recharge through wells located at M.I. tank at Nallavelly of R.R District duly converting into percolation tank.

A Recharge well is the one that is used for the purpose of increasing the ground water supply by feeding surface water into an aquifer.

The Recharge rate depends on the specific capacity of well and the available pressure head.

For a confined aquifer, with water being recharged into a completely penetrating well at a rate $Q_r = 2\pi Kb\ (h_w - h_0)/\log(r_0/r_w)$

MI tank named as Nallavelly M.I. tank is the main source of water for recharge through well to tap deep aquifer.

Length of the tank = 850 M

Top width of tank = 310 M

Depth of tank = 5.2 M

The ayacut available to irrigate is about 70 – 75 hectares. The aycutdars are in the practice for irrigating in their fields is only for paddy for both the seasons.

The plan showing the details for ayacut and irrigation wells under pumping are indicated in the figure.

A Computer program in C language has been developed for Recharge well method of Artificial Recharge system for water levels differences with the help of available data.

IV. Results and Discussions

The data input and results are presented in the Annexure of the paper.
Before implementing Artificial recharge system storage capacity of M.I. tank is 1.4 Mm^3
Daily evaporation is 8.18 mm/day.
Total average estimate evaporation is 0.42 Mm^3 is 30%
Wastage and other operation losses is 10%
Then useful quantity of water = 1.4-0.56 =0.84Mm^3.
Probable area of irrigation for each season is 36.5 hectraes
After implementation of Artificial Recharge system through recharge well method the probable area of irrigation is 1.4/1.152 =1.22Mm^3. area of irrigation for each season is 61 hectares. Increase in area of ayacut due to artificial recharge is 36 hectares to 61 hectres that is 70% increase in ayacut.

s.no	Well no.	Using numerical technique Results according to Ruston, 1985	Results using Computer programming in C language
1	4	12.26 m	12.435997 m
2	7	15.30 m	15.604563 m
3	12	17.13 m	17.505703 m
4	14	17.73 m	18.139418 m

V. Conclusions

Artificial ground water recharge by whatever method appears to have a significant role in water resource management, in our quest for conservation and maximum beneficial utilization of present water supplies.
All methods are mechanisms posses limitation with the primary being adherent characterstic of sediments content present in the most available source of water for recharge, run off water. Clarification techniques are available to certain extent although the cost may deem the water economically suitable for recharge.
Most of the limitations in Artificial recharge or also other water resource activities are in surmountable.
In the case studied, the parameter T transmissivity of aquifer is calculated with pump test data and solved using Jacob's method. The transmissivity of aquifer is 263 m^3/day/m.
The rise in water table level is 5 to 6 meters. The range of discharges through irrigation wells were improved from 10-15 m^3/hr to 30-50m^3/hr.
The area irrigated improved from 36-61 hectares.
By implementing the Artificial Recharge system additional increase in command area is 70%.

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