ARTIFICIAL GROUNDWATER RECHARGING FOR ARID REGIONS

by

MAHENDER CHOUDHARY

Centre for Rural Development & Technology

Submitted

in fulfillment of the requirements

of the degree of

Doctor of Philosophy

to the

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

AUGUST 2007

CERTIFICATE

This is to certify that the thesis entitled, "**ARTIFICIAL GROUNDWATER RECHARGING FOR ARID REGIONS**" being submitted by **Mr. Mahender Choudhary** to the Indian Institute of Technology, Delhi for the award of the degree of **Doctor of Philosophy** is a bonafide record of research work carried out by him under our supervision and guidance. The thesis work, in our opinion, has reached the requisite standard fulfilling the requirement for the degree of **Doctor of Philosophy**.

The results contained in this thesis have not been submitted, in part or full, to any other University or Institute for the award of any degree or diploma.

6/8/07

Dr. B. R. Chahar
Department of Civil Engineering
Indian Institute of Technology, Delhi

6/8/07

Prof. Santosh Satya
Centre For Rural Development & Tech
Indian Institute of Technology, Delhi

ACKNOWLEDGEMENT

I wish to express my sincere thanks and deep sense of gratitude to my supervisors Prof. Santosh Satya and Dr. B. R. Chahar for providing guidance, inspiration and constant motivation at every stage of this research work. It's an honor to be their student and no amount of appreciation can be good enough to express my gratitude.

I am grateful to Prof. P.L. Dhar, Head, C.R.D.T. and Prof. A.K. Nagpal, Head, Civil Engg. for providing all necessary facilities and support. My special thanks to Prof. A. K. Gosain, Dr. A. K. Keshari and Dr. V. K. Vijay for their critical review, valuable suggestions and support to this work.

I am indebted to Prof R.P. Dahiya, Director, MNIT, Jaipur and Q.I.P. Centre I.I.T. Delhi for sponsoring my Ph.D. I would like to thank Prof. B.L.Swami, Dr. Sudhir Kumar, Pawan Kalla and all my colleagues at Civil Engineering Department for their support and encouragement.

I have a galaxy of friends who have been the source of my continuous strength during the course of this work. Some of the outstanding names amongst those are- Pradeep, Ranveer, D.L. Parmar, B. K. Singh, Deepak, A. K. S. Bhaduria, Geetanjali, Ashees Yadav, Amitav Srivastav, Sandeep Choudhary, G. P. Vadodaria, Sishir, Sushil Poddar, Sanjay Patil and Mr. N.R. Gehlot. I express my thanks towards all my friends who made this arduous task a pleasant experience indeed. I would like to specially thank Sanjay Bhatter, Sanjay Gupta, Mahesh K. Jat and Yogi Prasad for being there whenever I needed them.

I would like to submit that this work is the outcome of blessings of my parents, elders and teachers. Finally, I can not forget to mention the continuous support and patience shown by my wife Jasoda and son Harsh.

I would like to thank all those who have rendered help directly or indirectly during the entire research work.

(MAHENDER CHOUDHARY)

ABSTRACT

The water scarcity faced by the arid and semi arid parts of Rajasthan in western India has led to a systematic study of the water crisis and search for a pragmatic solution through technical intervention. The traditional water management systems respecting water as life force had supported and sustained the population for the past so many years. In the last 2-3 decades, due to changing life style, advancement in agriculture and rapid industrialization, the pressure on natural resources especially water has increased many folds. This has also resulted in groundwater mining, depletion of water table and pollution of water resources.

Consequence to this situation, many related problems like regular falling of water level in wells, drying up of wells, saline water intrusion and drying of trees have occurred. The traditional systems of groundwater recharging like ponds, lakes, bunds etc. are unable to cope with the ever increasing water demand in the current paradigm of development. Therefore, technical intervention in the form of Artificial Groundwater Recharging (AGR) is explored to handle this acute situation. To begin with, a field survey in two selected area of Jodhpur and Jhunjhunu district in Rajasthan has been done to understand the ground realities with respect to water demand, available water resources and depletion status, prevailing potential and status of traditional water management system, awareness among the people etc. The survey revealed some amazing hidden facts and has also helped in finding the freshwater area and evaluating the suitability of various recharge methods.

From the field survey and available literature it has been noted that channels provide cost effective and efficient recharge method. It has also been found that though the seepage quantification through channels had been studied since long but its application as recharge method has not yet been explored. In this study recharge

quantification through an array of rectangular, trapezoidal and triangular channels underlain by a drainage layer at shallow/large depth has been done analytically using inverse hodograph and conformal mapping.

The analytical solution has been used in designing a recharge system for the study area in which recharge water is taken from a small stream flowing in the area. The runoff computation has been done by SCS (Soil Conservation Service) method using satellite image, maps and other data obtained from the field and government records. Minimum flow in the stream is allowed keeping in view the ecological considerations. It is interesting to note that only 0.37% area of agriculturable land is required for proposed AGR design which is applicable both for individual and common land. The proposed array of rectangular channels requires 40% less water spread area as compared to basins for recharging the same quantity of water indicating the significance of new design that permits less evaporation losses and no wastage of land. The space between the channels can be used for growing plants thus generating additional biomass for fuel, fodder, wood etc. It is hoped that proposed AGR design in addition to enriching the water sources, would help in generating employment, enhancing agricultural productivity and family income of the selected villages of Rajasthan.

CONTENTS