EXECUTIVE SUMMARY

Water is a vital natural resource which forms the basis of all life. With ever increasing pressure of human population, there is severe stress on water resources. From the increased activities in the water sector overall awareness about importance of water has increased. The solution to the water scarcity lies in efficient use of available water by good water management. Water harvesting through check dams is one of the very popular approach of harnessing water. During last one decade Government of Gujarat has promoted movement of construction of rainwater harvesting micro structures like check dams and percolation tanks. Only in last ten years more than 5 lacs check dams have been constructed throughout the Gujarat.

Study area Machhan river basin falls in Dahod district in the North-East direction of Gujarat. The overall topography of the region is highly undulating and of varying slopes. The catchment area of Machhan river is 431 km^2. Efforts of harnessing water in the study area started in 1974 with construction of check dam at Sutharvasa by Government of Gujarat. In 1979 construction of dam under a medium irrigation scheme named "Machhannala Irrigation Scheme" started by the Government of Gujarat which started functioning in 1985-86. After that a NGO named N.M.Sadguru Water & Development Foundation constructed number of check dams on the river Machhan within a period 1990 to 1999. After passage of more than a decade period positive results of this water harvesting efforts have started appearing. It was, however a long felt requirement to carry out systematic technical evaluation study of effects of check dams on ground water table, recharging and particularly in increasing base flow of the river.

Here an attempt made to study the effect of check dams constructed in series on Machhan River. To accomplish this objective rainfall and its pattern, morphology of the study area and ground water table fluctuations are analysed and studied. A conceptual mathematical model named "Tank Model" is developed to study effect of number of check dams on runoff and base flow.

Mathematical models are frequently used tools in studying groundwater systems. Here a conceptual model is developed known as Tank Model. It was originally developed by M. Sugawara of Japan in 1967. In its original form the Tank Model consisted three tanks laid vertically in series which was suitable to humid regions like Japan. Later on Sugawara suggested m x n structure of model for non-humid regions. Here The 4x4 Tank model is developed for the study area. The basin is divided into four zones. Each zone is represented by series of four tanks laid vertically. So, a basin contains totally 16 tanks. The outer most zone represents hill side of the basin while inner most zone represents river side. Each tank has side outlet and except last or bottom most tank in vertical series, each of first three tanks consists bottom outlet also. Outflow from side outlets represents surface runoff, inter flow, sub base flow and base flow respectively and out flows from the bottom outlets represents interception, infiltration and deep percolation. The model simulates outflow hydrographs.

Study of rainfall pattern and its characteristics shows that rainfall in the study area is highly erratic. The region found to have suffered mild to severe drought conditions for more than 75 % of period out of more than two decades period studied. Morphometric analysis suggests that the study area represents undulating topography and the Machhan basin contains numerous drains of stream orders ranging from 1 to 6 with 6^{th} order stream as Machhan River itself.

The study of ground water levels indicate that ground water flow pattern in the basin broadly follows the topography and drainage pattern of the basin. After construction of check dams, even during less rainfall for many consecutive days post-monsoon water table shows reasonably stable behavior. In general a rise has been observed in overall water table condition. Post-monsoon water table which was varying by following the pattern of rainfall appears to vary at much steeper rate showing more rise in response of small increase in rainfall.

Analysis of Tank Model indicates that, model is sensitive to parameters like time constant T_c, areal ratio (proportion) and storages of primary and secondary soil moistures. The basin is divided in to four zones. Runoff is found decreasing more in case of check dam in internal zone compared to that when a check dam is provided in outer zone. Increasing trends noticed for the base flow in spite of decrease in average rainfall. This is due to construction of check dams. Several trials were made to analyze effect of check dams by considering single check dam in different zone and by considering number of check dams in series. The study shows that on increase in number of check dams total runoff decreases. There is also significant increase in base flow with drastic change in base flow pattern. This clearly indicates that construction of number of check dams in series on a river reduces runoff greatly with significant rise in base flow causing more recharging.

From the study carried out it can be concluded that the Tank Model is best suitable to predict rainfall-runoff co-relationship and to establish relationship between surface and groundwater storage, particularly for an undulating topography like Machhan river basin. It can be successfully used to evaluate effect of artificial recharge structures, like check dams, in a river basin.