CHAPTER II

LITERATURE REVIEW
Since the objective of the thesis is to carry out Groundwater level studies of Upper Musi Catchment of Andhra Pradesh and to assess the volume changes of groundwater, the review of literature is planned in three parts. First part deals with earlier works on ground water studies in India. Second part deals with ground water studies with special reference to water level fluctuations. The third part deals with hydrogeological works of hard rocks with a focus on water table fluctuations.

EARLIER WORKS ON GROUND WATER STUDIES IN INDIA

Ground water studies in India related to the local spots were commenced as early as in 1804, but it was Geological Survey of India, which promoted the ground water investigations since 1851 (Oldham, 1893). The ground water surveys were initially conducted by measuring water levels at selected open wells and collection of water samples for chemical analysis. The exploratory drilling was done for locations of aquifers (Pascoe, 1917). The ground water studies as part of the systematic geohydrological investigations started in the post-independence period under the regular field programme of the Geological Survey of India (chaterjee, 1967).
The Exploratory tube wells organization was created in the Ministry of Agriculture, Government of India to carry out the systematic exploratory drilling in alluvial basin under the first all India Ground water Exploration Programme during 1953-1959 (Prasad, 1962). The Programme continued in phases and the Geological Survey of India prepared the geohydrological map of India in 1969 based on the classical work done by the organization. It emphasizes the geohydrological conditions of the important ground water basins of the country (Chaterjee, 1969). The Exploratory Tube wells Organization was recognized as Central Ground Water Board (CGWB) during 1972 by merging ground water wing of the Geological Survey of India. The Central Ground Water Board, now as an apex body at the national level, has covered the systematic hydrogeological surveys in an area of 1.92 million sq.km of the country (Pathak, 1975, 1982). The ground water assessment made by CGWB indicate the ultimate scope of the installation of ground water structures as 12 million dug wells, 4 million private shallow tube wells and 60,000 public tube wells. As per Groundwater Estimation 2004 the well population has increased from 8 lakhs to 30 lakhs since three decades.

The National Bank for Agriculture and Rural Development (NABARD), formerly known as the Agriculture Refinance Development corporation (ARDC) as a subsidiary to the Reserve Bank of India has been playing an important role in providing the financial support for the ground water development since, 1965. This agency has emphasized for proper collection of hydrogeological data and dependable studies of ground water balance (ARDC, 1970). Subsequently, the Ground Water Estimation Committee (1984) is also established to assess the ground water balance in the country.

The Central Board of Irrigation and Power created in 1927 has been contributing for some ground water research programmes and has published the useful information.

The Indian Committee on International Hydrological Programme has also been publishing various articles on water resources including ground water. Ground water Departments of various states which were came into existence during 1956-1970 has also initiated detailed ground water surveys for the water balance assessment and public tube well programme in the respective regions. The States of Andhra
Pradesh, Haryana, Punjab, Gujarath, Orrisa, Bihar, West Bengal, Uttar Pradesh, Maharashtra and Karnataka have set up ground water boards for exploration implementation and monitoring of the ground water development programmes. In Andhra Pradesh, the state government has established another separate corporation i.e., the Andhra Pradesh State Irrigation Development corporation (APSIDC) in 1974 for constructing wells and lift irrigation schemes.

The earliest contributions to ground water studies in India were that of Taylor (1959) dealing with the classification of ground water regime into different provinces. Nagaraja (1972) gave an account of evaluation of ground water resource in hard rock area of Mysore. Pathak and Prasad (1973) discussed ground water resources and their exploitation in arid zones of South India. Karanth (1977) made a general appraisal of ground water and obtained information on additional ground water development possibilities in Upper Luni Basin, Rajasthan.

EARLIER WORKS ON GROUND WATER STUDIES IN ANDHRA PRADESH

Several workers in Andhra Pradesh contributed on various aspects of ground water studies.

Athavale et al. (1983) revised the data on recharge measurements in different Hydrogeologic situations and attempted to correlate the recharge with water level fluctuations. Narayana swamy (1980) studied the horizontal ground water flow in Visakhapatnam basin using water table and hydraulic gradient-as criteria. Karanth (1987) tried to focus on multifacious types of hydrogeological environmental problems, related to human beings.

Ground Water Table of Kakinada Town, Andhra Pradesh

To understand the fundamental concepts of describing ground water flow, the combined study of water table and hydrochemistry in a regional scale could provide more useful information than an individual study. Keeping this in view, ground water table and hydrochemistry evaluation has been carried out by Satyaji Rao, Vijay and Seethapathi (1996) in and around Kakinada town of Andhra Pradesh. Water levels were measured for 29 shallow observation wells and water quality parameters were analyzed.
From the ground water levels it is observed that the gradient of ground water table is a replica of ground surface except the wells located nearby salt creek and boat club, and the authors opined that it may be due to the back water effect in salt creek.

**Trend Analysis of Ground water Fluctuations in Nalgonda, Ranga Reddy and Kurnool districts, Andhra Pradesh**

Analysis of Ground water fluctuations has been carried out by Pradeep Raj (1996), Ground water department, Hyderabad. He has concluded that, well hydrographs during monsoon period show rising trend, indicating that monsoon recharge occurs in short bursts. The hydrographs during non-monsoon period show simple linear trend, but some hydrographs during non-monsoon period show curvilinear trend, this is due to effect of complex aquifer system. Such hydrographs indicate that the aquifer is leaky and derives its water from an overlying aquifer. A considerable potential recharge is lost in early parts of the monsoon season in certain areas where build up of the water level is within 3m bgl.

**Studies of Piezometer well hydrographs in A.P.**

Pradeep Raj (1996) has studied Piezometer well hydrographs in A.P. and gave a scheme for classification of hydrograph on a standard scale. Using this he concluded that, acute rising segment of hydrograph is dominant during monsoon season. This is common in hard rocks, where water table fluctuations are very high (about 10m). Obtuse rising (or) flat segments are common in Recent and Mesozoic sediments. These are noted in aquifers with large transmissivities and aquifers that are confined. Obtuse falling is dominant during non-monsoon season. Homoclinal rising and plateau forms of hydrographs are observed in areas where canal irrigation is introduced (section of theoretical back ground gives details).
HYDROGEOLOGICAL ASPECTS OF HARD ROCK AREAS

Occurrence of Ground water in Hard Rocks

Ramachandra Rao (1971) and Dixit (1972) have expressed the view that the aquifers in hard rocks are generally isolated in nature. Zhdankus (1972) has made the observation that groundwater existed mainly in upper weathered layer. The deeper this weather layer, the greater is the amount of available water (Sakthivadivel and Krishna Swamy, 1972). Radhakrishna (1970) has conducted that the surfacial weathered layer and underlying fractured granites constitute two distinct aquifers not connected with each other. Krishna Rao (1989) observations in hard rocks of Andhra Pradesh and Karnataka states have revealed that fracture intensity is the highest in quartz veins followed by granites and granitic gneisses and related rocks. Mafic rocks are generally found to be massive with sporadic fracturing. He noticed the weathered residue from felsic rocks to be relatively more permeable than that from mafic rocks.

Studies on Rainfall infiltration (R.I.) rate in Hard rock areas

Athavale (1985), using tracer techniques has arrived at an infiltration factor between 8 to 10% of total annual rainfall in A.P. Gupta and others (1985), using modeling techniques have arrived at 8.5% in shadnagar basin. Reddy (1994) using computer generated model estimated a 10.4% R.I. around Hyderabad. Raghava Rao et.al., (1969) has arrived R.I. to be around 10%. Ranga Rao (1977) computed average R.I. as 15.9% for granitic terrain in musi catchment in Nalgonda district. Janardhan Rao et.al., (1975) using rain simulation method has obtained a value of 15%. Anantha Reddy (1983) has reported an infiltration value of 19% for Hayatnagar area. C.G.W.B. (1975) in the Canadian assisted ground water project in Hyderabad and medak district has reported that R.I. ranges from 15% to 20% of rainfall in granitic areas.

Studies on Trends of water level fluctuations

Todd (1980), Karanth (1987), Fetter (1994) dealt with Water level fluctuations in time frames as short as a few minutes to very long periods involving a few decades or even more. They dealt with causes of fluctuations, use of fluctuations in estimation of evapotranspiration losses and recharge to Ground water. Healy and cook (2002) made use of water level fluctuations for estimation of recharge to Ground water.
Taylor and alley (2001) dealt with relative merits of frequency of water level monitoring, drought indexing using hydrographs, canal stages and water levels, saline water intrusion etc.

Todd (1980) and Karanth (1987) presented physical effects like land subsidence due to long-term decline of water levels, i.e. desaturation of aquifers.

The seasonal fluctuations of water table are observed by Subba Rao (1974), Prasad (1980), Narayana swamy (1980) in different parts of Eastern Ghats. On the average the maximum fluctuation seems to be 3m. The water table raise is observed to be linearly related to the amount of rainfall. About a third of the rainfall percolates through the soil surface to recharge the ground water.

The water level fluctuations are found to follow the physiography. It is observed that an increase in terrain elevation by one meter results in a fluctuation of 0.5m in ground water level (Sharma et.al., 1983).

The Analysis of Ground water fluctuations in Kandivalasa river sub-basin of Vijayanagaram district, A.P. was carried out by Venkateswara Rao (1995) and he concluded that in the Kandivalasa river sub-basin potential areas are identified with less Ground water fluctuations. More infiltration is occurring and filling all the pores because of less drainage and consequently less Ground water fluctuations are observed in Ground water potential zones.