CHAPTER-9

INTEGRATED APPROACHES

9.1 INTRODUCTION

All methods of groundwater exploration when exclusively applied and utilized, for a regional basin-wise water resource assessment, have some ultimate limitations. One of the modern methods is the application of an integrated approach, to the particular problem, which amalgamates different varieties of results obtained from the standard hydrogeological investigations. It gives a detailed insight into the possible solutions which are of use in development. This type of orientation, to the solution of groundwater problems, enables one in minimizing the cost of investigation, maximising the results by covering large aerial extent with reduced input of scientific personnel, time and money. Further, this approach is found to be very essential to the present day developments in view of the sharp increase in the cost of groundwater exploration thereby rapidly changing the loading conditions on the aquifer system.

9.2 INTEGRATED APPROACH USED IN THE PRESENT WORK

In the earlier chapters of this work detailed characterisation of the Upper Amaravathi basin with reference to geology, geomorphology, meteorology, hydrogeology, groundwater geophysics, hydrogeochemistry and modelling the groundwater system, has been attempted. An analysis is now made to integrate the individual or paired results of this work to arrive at possible decisions.
9.2.1 Lineaments, Topography and Drainage

The study of lineaments (Fig 2.7), topography (Fig 2.5) and the drainage network (Fig 2.3) of the basin, shows that the flow of the main river and many of its major and minor tributaries are controlled by the direction of lineaments and the general topography. The easterly change in the flow direction of the river is found to be due to the Palghat shear.

9.2.2 Topography, Rainfall and Grid Deviation Water Table

Areas of heavy rainfall (Fig 3.1) and positive zone of the grid deviation water table map (Fig 4.3) synchronise in the upper reaches of the catchment denoting the effect of topography and forests (Fig 2.5) on precipitation.

9.2.3 Precipitation, Surface Runoff and Grid Deviation Water Table

A careful study of the precipitation record (Table 3.1), the monthly streamflow volumes of the river at Nallamarapptti (Table 3.3), the grid deviation water table figure and its contours (Fig 4.3) show that (i) the river is not perennial and the contribution to runoff from precipitation is very high, denoting a poor percentage of recharge possibilities.

9.2.4 Grid Deviation Water Table and Transmissivity

A few high transmissivity zones (Fig 4.9) lie with in the negative areas of the grid deviation water table map (Fig 4.3) indicating that the wells are discharging the groundwater flowing from the recharge areas of the basin towards the negative zones. This is also coinciding the areas of Palghat Shear in the north western parts.
9.2.5 Geology, Morphometry and Aquifer Parameters

The interrelationship of surface drainage network and transmissivity of subsurface aquifers has been very clearly demonstrated by (Carlston, 1963). The areas adjoining the main river (Fig 2.3), where the stream frequency, drainage density and relief are expected to be low, are confined to the alluvial zones of the basin (Fig 2.4). This belt however does not coincide with the potential zones of high transmissivity (Fig 4.9) and optimum yield (Fig 4.13).

9.2.6 Lineaments and Aquifer Parameters

As the river course is controlled by major lineaments (Fig 2.7) the zones adjoining the river show a very high transmissivity (Fig 4.9), optimum yield (Fig 4.13) and low tfr areas (Fig 4.12). There are some exceptions to this, due to the poor thickness of the aquifer regolith.

9.2.7 Aquifer Parameters and Potential Zones of Geoelectrical Studies

The study of vertical Electrical Sounding data revealed that the groundwater potential zones (Fig 5.5) fall over the areas of higher transmissivity (Fig 4.9), optimum yield (Fig 4.13) and low tfr areas (Fig 4.12) in certain parts. All these correlate well over the shear zones in the northern part.

9.2.8 Lineaments and Depthwise Behaviour of Potential Zones

The study of iso-apparent resistivity variations with reference to depth (Fig 5.4) indicates that the potential zones die out within 20 to 30 mts below ground level. This also denotes that the lineaments are clogged up with finer particles at deeper horizons especially in the areas adjacent to Palghat shear.
9.2.9  Salinity, Sodium Hazard and TDS

The areas of higher TDS concentration in groundwater (Figures 6.8 and 6.9) and waters with $C_4S_2$ or $C_5S_3$ characteristics (Figures 6.12, 6.13, 6.14 and 6.15) coincide signifying that (i) the waters of black cotton soil and red clayey soil area are only suitable for salt tolerant crops and (ii) the groundwater in such areas has stayed for a longer time in the aquifers to acquire this quality.

9.2.10  Grid Deviation Water Table (Fig 4.3) Index of Base Exchange (Figures 6.18 and 6.19) and $CaCO_3$ Saturation Indices (Figures 6.20 and 6.21)

Figures of these characters behave synonimously provided there is no modification of the rocks during their emplacement. Such synonimous behaviour has been noted by Sharma (1982). This is not true in this area because of the retrograded character and chemistry of the crystalline rocks (Sec. 2.3.1).

9.2.11  Potential Zones, Groundwater Hardness and TDS

Superposition of the groundwater potential zones prepared out of geoelectrical investigations (Fig 5.3) over the groundwater hardness zones (Figures 6.10 and 6.11) shows that most of the potential zones contain permanent hardwaters. However, these zones lie within the tolerable limits of TDS concentration (Figures 6.8 and 6.9).

9.2.12  Hydrogeochemical Model and TDS

The zones of Principal Components I, II, III and IV model (Figures 6.31 A, B, C and D) and high TDS concentration (Figures 6.8 and 6.9) areas adjacent to the trunk stream Amaravathi and its catchment zone denote that the waters might have stayed in the aquifer for a longer time to have experienced the metasomatic effects due to rockwater interaction.
9.2.13 Hydrogeochemical Model, Corrosivity Ratio

The zones of Principal Component I, II, III and IV (Figures 6.31 A, B, C and D and Tables 6.11 and 6.12) coincide in a few places with the zone of corrosion (Figures 6.34 and 6.35) signifying that the waters, which have stayed in the aquifers for a longer time, in order to show this corrosive tendency and high TDS concentration.

9.3 GROUNDWATER POTENTIAL ZONES OF UPPER AMARAVATHI RIVER BASIN

Superposition of the (i) drainage network (Fig 2.3), (ii) aquifer transmissivity (Fig 4.9), (iii) aquifer optimum yield (Fig 4.13), (iv) tfr (max) (Fig 4.12), (v) high yielding zones marked by geoelectrical studies (Figures 5.3 to 5.9) over, the

(i) TDS of groundwaters (Figures 6.8 and 6.9), (ii) zones of groundwaters hardness (Figures 6.10 and 6.11), (iii) salinity (Figures 6.12 and 6.13) and sodium hazard (6.14 & 6.15) and (iv) the safe zone of corrosivity ratio of groundwaters (Figures 6.34 and 6.35) reveals that the groundwater potential zones of the Upper Amaravathi river basin have a quality with less than 3000 (ppm) TDS, C2S1 and C3S1 water class, permanent hardness at certain localities and non-corrosive tendencies in general. The promising potential zone would be the aquifer horizon belonging to the Palghat Shear and the areas adjacent to the river courses, and at the junction between the lineaments.