List of Acronyms

BDO	Block Development Officer
BPL	Below the Poverty Line
CADA	Command Area Development Authority
CE	Chief Engineer
CEO	Chief Executive Officer
CGWB	Central Ground Water Board
CPWS	Comprehensive Piped Water Supply Scheme
CSIR	Council for Scientific and Industrial Research
CWC	Central Water Commission
DCO	Development Cooperation Office
DFID	Department for International Development
DHO	District Health Officer
EE	Executive Engineer
GOAP	Government of Andhra Pradesh
GOI	Government of India
GP	Gram Panchayat
H&FW	Health and Family Welfare
ICAD	Irrigation and Command Area Development
IWDP	Integrated Watershed Development Programme
LPM	Litres per Minute
MI	Minor Irrigation
MNP	Minimum Needs Programme
NABARD	National Bank for Agriculture and Rural Development
NGRI	National Geophysical Research Institute
NRSA	National Remote Sensing Agency
O&M	Operation and Maintenance
PRED	Panchayati Raj Engineering Department
R&D	Research and Development
PWS	Piped Water Supply Scheme
SC	Scheduled Caste
SE	Superintending Engineer
SW	Scott Wilson Kirkpatrick
SWM	Solid Waste Management
ST	Scheduled Tribe
TDS	Total Dissolved Solids
WB	World Bank
WSG	Water and Environmental Sanitation Group
ZP	Zilla Parishad

Final Report

CONTENTS

Groundwater Quality

The main problems associated with ground water quality in the State, when related to drinking water, are those of fluoride and salinity. Fluoride is considered to be the major water quality problem in the state with approximately 25% of habitations affected with unacceptable levels (over 1.5 ppm) in sources. Fluoride increases in concentration in areas of over abstraction where long solution paths are created through drawdown of the water table. Fluoride originates in certain minerals which occur in crystalline rocks, particularly granites and gneiss, which occur over much of Andhra Pradesh. Salinity problems are particularly associated with coastal intrusion of salt water through over abstraction adjacent to the coast.

Abstraction Overview

The following statistics for the state indicate the pressures on ground water resources:

- Total number of Habitations as per 1991 census .. 69,732
- Total Dug Wells .. 1,213,040
- Total Bore Wells .. 154,284
- Total Hand Pumps provided .. 218,000
- Total number of Power Pumps .. 1,273,972

Current Water Usage

Design Norm

AP rural Piped Water Supply (PWS) scheme designs are based on 40 lpcd of water supply rate and exclude any allowance for system losses or animals.

AP Comprehensive Piped Water Supply (CPWS) rate is fixed at 55 lpcd and provides for 30% of the population to take house connections and a nominal allowance of 6 lpcd for animals. No allowance is made for transmission or distribution losses which could range between 15 and 50%.

Actual Demand

From the discussions with villagers in 14 villages of the Andhra Pradesh Rural Water Supply Project visited during the Water Resources Scoping Study, there was a wide variability in actual household demand, which depends so much on the status of the members of a household and the presence of animals. Families without animals managed with 30 lpcd but this figure rose by over 50% when animal demands were to be satisfied

Losses

Wastage occurs at the handpump when the flow is allowed to run to waste during cleaning vessels, washing or drinking. The characteristics of use that apply to a handpump also apply to a stand-post but losses can be mitigated by the use of valved outlets that require lifting. Unfortunately, the pressure of water in a stand-post is much higher than in a handpump and use for washing and drinking on the spot will produce more losses. Moreover, taps are usually found to be broken or stolen, which results in considerable loss of water during the supply period and may result in the complete pipe network draining out through low points. At a majority of the villages, the stand-post was found to be a protruding pipe assembly, without any tap.

Willingness to Pay

In all the villages that were visited, people were generally prepared to pay for water supply providing:

- the supply met the actual needs in summer
- the supply was regular and planned

Executive Summary

Water Resources in the State of Andhra Pradesh

Rainfall

The climate of Andhra Pradesh is marked for its seasonality. Four distinct climatic seasons can be identified

- The pre-monsoon season or summer season (March-May)
- The south-west monsoon season or monsoon season (June-September)
- The retreating monsoon season or the autumn season (October-November)
- The winter season or cool season (December-February)

The state receives 67% of its rainfall from the South-West monsoon and 23% from the North-East monsoon. The average annual rainfall ranges from 650 mm in the semi-arid belt to about 1300 mm in the North-Eastern portion of the State. The Rayalaseema region is a zone of low rainfall, recording an average annual rainfall of 650 mm. Coastal Region receives an average rainfall of 1100 mm and the area north of the Godavari river receives 1200-1300 mm of rainfall.

Drainage

The state is drained by three major perennial rivers; Godavari, Krishna and Pennar and several other rivers of lesser significance. The majority of the rivers flow easterly towards the Bay of Bengal, while the tributaries and minor streams trend in north-south, north-west and south-easterly directions.

The characteristics of the major rivers of Andhra Pradesh are:

ref	Basin	Area (km²)	Area in AP (km²)	Yield in AP (MCM)
1	Godavari Basin	312810	73201	17839
2	Krishna Basin	258947	74381	9715
3	Pennar Basin	55195	46865	5380

Groundwater

Nearly 80 percent of the state is underlain by hard, crystalline and consolidated formations. The rest of the state is underlain by semi-consolidated formations and unconsolidated deposits like Recent Alluvium.. By and large, the occurrence of ground water in the state depends on the "geological setting, climate, rainfall, drainage and topography' and the extent of surface water bodies (see Map 5). In the hard rock formations, secondary porosity is developed by fracturing, weathering and solution. The fracture porosity is generally not uniform either laterally or with depth. It usually decreases with depth and appears to be negligible below 80 m from ground level except in highly fractured or disturbed areas.

The semi-consolidated formations in the State occupy an area of 19,200 sq.km and mainly occur in the Godavari valley and in isolated patches along the east coast in the districts of Prakasam and Guntur. Ground water occurs under water table conditions in shallow zones and under confined conditions in deeper aquifers. Flowing conditions are also common in these formations, where they are overlain by other younger formations.

Alluvium is confined mainly to the deltaic regions of principal rivers. The alluvial aquifers have high porosity and permeability and hence constitute promising aquifers. Bore wells drilled down to a depth range of 15 to 30 m bgl yield copious supplies of water. Even though in the Krishna-Godavari delta the alluvium attains a thickness of a few hundred meters, the deeper aquifers are found to contain highly saline water.

The Zilla Parishad has overall administrative control over the Mandal Parishads. The ZP has Standing Committees of a functional nature, delegated with powers, as well as a General Body. Zilla Parishad's Standing Committees are empowered to sanction works, under the State Plan, up to Rs. 5 lakhs and works up to Rs 10 lakhs are cleared by the General Body. Beyond this amount, GOAP has to issue administrative sanctions. All the Executive Engineers of PRED, working in the districts, function under the administrative control of Zilla Parishads.

Zilla Parishads review all the developmental works in the District, covering the rural areas. The administrative structure of the Zilla Parishad has a CEO under the ZP Chairman and Executive Engineer (Works) and Mandal Development Officers under the CEO.

Surface Water Development

Planning, development and management of surface water resources and hence of the river basins come under the purview of the Central as well as State Governments. At the Centre, the Union Ministry of Water Resources' role and activities include the overall planning, policy formulation, co-ordination and guidance in respect of the sector as a whole. This supports the activities of the State Ministries of Major and Minor Irrigation.

Availability of Water Resources

Reliability and Availability of Data

The data utilised during this study were provided readily and freely by all organisations involved in development of the water resources of Andhra Pradesh. In relation to surface water resources the State Irrigation Department has recently started to produce excellent internal summary reports for each district of the state covering the stage of development of surface resources and the future plans. In addition the Central Water Commission in Delhi has an overview document for the country as a whole which contains excellent information up to 1996. The underground resources of Andhra Pradesh are also well covered in recent documentation provided for the study by Central Groundwater Board and the State Groundwater Department. There is, however, no one body with authority for planning and management of all the water resources of the state and as a result the whole picture may not be accurately presented by the separate data sets. Reliability of data relates to the frequency of capture and the reliability of the capture mechanisms. Improvements in state wide resource data management will result from current World Bank interventions through the National Hydrology Project but there is a more fundamental requirement for water resource data management on a microwatershed basis, which is currently lacking.

Sources of Information

A substantial amount of information is available concerning water resources in the State from the Central Ministry of Water Resources, which provides a comprehensive overview. More detail is readily available from the State Ministry of Major Irrigation and Central Ground Water Board for both surface and underground resources.

Problem Areas

Across the state the problems are focused in the 6833 fluoride affected, 4371 salinity/brackish affected and 26976 partially covered habitations. The partial cover is mostly due to seasonal sources which are largely the results of irrigation abstraction in the rabi season. Fluoride and salinity levels are also largely due to the irrigation abstraction. The highest concentrations of problem habitations are in the districts of Nizamabad, Warangal and Nalgonda.

- people were warned of breaks in supply in order that they could conserve their storage
- quality was maintained at a high level
- system repairs were advised of so that resulting poor quality water could be kept away from potable use
- reinstatement of supply was notified to every village on the scheme after breakdown.

Villagers were actually found to be paying Rs.10-20 per household per month for a house connection to the village Panchayats as the water charges, over and above the one time connection charge of Rs. 500 to Rs. 2000.

Policy, Legislation and Institutional Responsibilities

Responsibility for Domestic Supply

PRED is responsible for conceiving, planning, preparing and executing water supply and sanitation projects in the entire State through PWS and CPWS schemes in rural areas and through urban schemes for towns up to 20,000 population.

At field level Chief Engineers are responsible for project formulation and execution, in the three Regions of the State. At the District level, Executive Engineers look after the these activities, supported by sub-divisional officers and associated field staff.

Legislative Control

GOAP has introduced legislation to stop derogation of drinking water sources and regulate the abstraction of water from wells in water scarcity areas, but there is little impact in the rural areas due to the lack of political will to implement the legislation.

The Act is meant to regulate the exploitation of ground water for the protection of public drinking water sources through licences to dig wells, distance criteria for source protection, prohibition of exploitation of water, closure of wells and payment of compensation

Water Supply

Panchayati Raj Engineering Department (PRED) is the technical department involved in implementation, operation and maintenance of developmental works like roads, buildings, bridges, MI tanks and water supply systems in rural areas of the Andhra Pradesh State. The department's objective is to improve the living conditions of the rural communities, by providing basic infrastructure facilities. In the field of rural water supply, the department's priority is to provide reliable and sustainable protected water supply systems to the problem habitations, which are affected by water quality problems like excess fluoride and salinity and by inadequate supply of water.

PRED functions under the State Ministry of Panchayati Raj and Rural Development, Government of Andhra Pradesh with Principal Secretary as the Administrative Head of PR and RD Department in the Secretariat. Within the PRED, the Department has two separate wings for Rural Water Supply and the other PR works under the control of an Engineer-in-Chief. At the Mandal and the District level, PRED is administratively responsible to the Mandal Development Officer and the Chief Executive Officer, respectively.

Local Bodies

Under the AP Panchayati Raj Act, 1994 , the following local bodies were re-formed:

- Zilla Parishad at the District level
- Mandal Parishad to cover group of villages (having total population of 30,000 approx)
- Gram Panchayat, covering a revenue village or a hamlet

resources of a village would be sufficient to provide basic subsistence needs, apart from irrigation for other than supplementary needs during the Kharif season, for all sections of society in the village. Irrigation has upset this natural state of affairs in Andhra Pradesh, as the almost hundred-fold increase in numbers of irrigation pumpsets since 1960 shows.

Project Framework

A Project should be developed with a Goal of Poverty Alleviation through Improved Livelihoods and Health, contributing to a Super Goal of Poverty Elimination in the State of Andhra Pradesh.

The Project Purpose would be that Villagers gain access to equitable, appropriate and sustainable water and environmental sanitation services.

Project Outputs would need to be focusing on:

- *Minimum Needs Supplied,* particularly aimed at the poorer sections.
- *Resources Evaluated Fully,* in order that rational allocation and planning can be undertaken in a participatory way and conflicts identified and overcome.
- *Village Develop . Economically,* within the carrying capacity of the watershed and ensuring that the needs of the poor are given priority.
- *Equity Guaranteed,* in order that the project is socially sustainable
- *Subsidies Re-orientated,* such that supported over-exploitati... of the natural resources of the village by the richer sections is curbed and this support is re-orientated to the poorer sections.
- *Water Resource Management Principles Established,* to ensure that the natural resources of the village are retained within the village and utilised to give appropriately targeted benefit.
- *Priorities Established for Selection*

The location of a project will be made against criteria set down by secondary and tertiary stakeholders. It will therefore be necessary to establish which crite.a should be used for the selection process. The following list is an indicative one of some of the most important criteria:

- Villages with the highest percentage of Below the Poverty Line households
- Villages with the lowest literacy levels
- Villages with the highest incidence of poor water quality
- Villages with the lowest level of existing water supply service
- Villages willing to contribute to costs and accept environmental sanitation sy tems

Options

Two basic options exist for PRED to provide water supply to rural villages in Andhra Pradesh, a PWS based on a local village source with standposts and a CPWS based on a remote source and covering a number of villages with both standposts and house connections.

Option 1

If it is possible to sustain a local source for village water supply by appropriate conservation, recharge and water harvesting methods within a watershed, and using an integrated, watershed based approach to water resource management with the agreement of the village population, then this is the preferred option. The scheme should be based only on the specified needs of the village and should be designed for local operation and maintenance.

Allocation of Water Resources

Current Situation

Out of a total of 69,732 habitations in the state, 38,180 habitations are currently considered not to be provided with safe drinking water throughout the year. PRED is attempting to overcome the problems of sustaining water supplies in areas where irrigation over abstraction has derogated water supplies, by taking source from irrigation canals and utilising summer storage tanks. Problems of maintenance escalate with CPWS schemes and the Gram Panchayats do not take the responsibility for O&M of the schemes which PRED hand over to them. PRED is limited to developing ground water sources on government land in villages, which often provides poor sources.

Data Gaps

Significant gaps exist in the assessment of groundwater, water quality, demand, existing source capacity and levels of use and urgent attention should be given to rectifying this situation.

Problems Identified

During the study, 1 day workshops were held in each of the three regions of Andhra Pradesh at Hyderabad, Tirupati and Visakhapatnam to consider the water resource problems in the state. Over 150 representatives of PRED, State Groundwater Board, Irrigation Department and Zilla Parishads attended the workshops. UNICEF and DFID were also represented.

The following list highlights the priority problems identified:

- **Integrated Approach to Water Resource Management is missing**
- **There is insufficient awareness of the need for better sanitation and hygiene**
- **Maintenance is not done, only repair**
- **Fluoride levels are escalating**
- **Irrigation abstraction causes drinking water source failure**
- **Legislation does not work to protect drinking water**

Recommendations for Future Water Supply

Basic Principles

Water is the key resource in ecosystem management, followed by the complimentary resources of land and people. The importance of water in India is all the more so because of the monsoon related pattern of the rainfall regime and the concentration of supply of the resource into a short period of about four months over the majority of the country. In conditions of scarcity it is evident that judicious use of the resource is essential. Disputes arise when the perceptions of one section of society regarding needs are in conflict with the water demands of other sections which have been satisfied in the past through traditional or "riparian" rights.

There is therefore a requirement to reach a concensus on norms for determination of needs and for allocation to various uses. Fixing priorities amongst a variety of needs is essentially a matter of attitudes and values at village level. Conflicts are difficult to reconcile if there is no common understanding of the needs versus the availability. A participative approach is necessary to evolve an understanding based on a scientific appraisal of resource availability within a village area and any constraints that exist, and the ways and means of overcoming these constraints by optimising use of the resource in an agreed co-operative manner.

Prior to the development of irrigation, and in particular the use of pumping plant and availability of the necessary energy to drive the pump, water availability was the reason why villages developed in a particular location. In a majority of watersheds the needs of the population were satisfied without importing water over long distances. It can be said, therefore, that the naturally occuring water

1. Introduction

As part of a preliminary investigation phase that will determine possible future investments in Andhra Pradesh, DfID Water and Environmental Sanitation Group has commissioned Jim Baldwin of Scott Wilson Kirkpatrick to carry out a scoping study of water resource issues relevant to the consideration and development of any future water and sanitation project in the State. The study has been carried out over the period between 5th July and 7th September 1998. A presentation of the Draft Final Report was made to senior staff of DFID on 7th September 1998 in New Delhi.

The author wishes to thank all supporting organisations and their officers for the tremendous assistance given during the data collection stage for the report and the three regional workshops, and particularly the Engineer-in Chief, Dr M Venkateshwarlu and his Joint Director, G&CARD, Mr M V Swamy and Executive Engineer, Mr K Sampath Rao. Also the Head Office and field staff of PRED, Irrigation Department, CGWB, NGRI, NRSA, the Zilla Parishads, APWELL, World Bank and DFID, and finally the people of the fourteen villages visited during the field programme.

The author also wishes to thank Mr S N Bhatnagar and Mr A V Appa Rao for their sterling efforts in assisting and facilitating in the data collection, analysis and presentation, and without whom the report could not have been prepared. Also the author wishes to thank Mr D Batthacharjee, DFID, for his valuable contribution during the workshops in Hyderabad and Tirupati.

2. Water Resources in the State of Andhra Pradesh

2.1 General Characteristics of Andhra Pradesh

Particulars	Unit	
Area (1991 census)	1000 sq.Kms.	275.0
Districts	(No)	23
Revenue Divisions	-do-	74
Mandals	-do-	1,110
Gram Panchayats	-do-	19,499
Inhabited villages (1991 census)	-do-	26,586
Towns "	-do-	264
Population "	(lakhs)	665
Males "	-do-	337.25
Females "	-do-	327.83
Rural population "	-do-	486.21
Urban Population "	-do-	178.87
Literacy "	(percentage)	44.09
Scheduled Castes " Population	(lakhs)	105.92
Scheduled Tribes " population	-do-	41.99
State Net Domestic product at factor cost by Industry of origin (at current prices) 1994 - 95	(Rs.in crores)	50,679
Percapita Income (at current prices)1994-95	Rs.	7,155
Members of Legislative Assembly	(Nos.)	295

Source: Directorate of Economics and Statistics, A.P.

Option 2

Where a village or group of villages does not have a local source of water which can, by whatever means, be made sustainable in quality and quantity, a scheme based on a remote source may become necessary. This will be an option of last resort because the cost of water and the impositions regarding maintenance will be difficult for the village to manage. The scheme should be based only on the specific needs of the village and should be designed for local operation and maintenance.

In Nalgonda District, where Dutch Aid Agencies have been working for some years, and have now accepted that a solution to the massive fluoride problems there cannot be based sustainably on better developed groundwater sources, a CPWS is clearly the only realistic option. Proposals presented by PRED for a standard CPWS scheme, for these fluoride affected villages, are not prepared to a high enough design or specification standard and a key element of any support project will have to be capacity building in PRED. This capacity building should also extend to cover better standards of tendering and contract supervision.

Additional Project Outputs

Essential Sub-Projects

Sub-project studies are recommended in the following areas, to improve the quality of data used to design specific projects and support better water supply and resource management:

- The effects of annual recharge on groundwater quality determined
- Groundwater movement resulting from natural recharge assessed
- Regional and watershed based hydrographs of groundwater movement produced
- Summer Storage Tank pollution and water quality changes observed
- Minor Irrigation tank recharge systems developed
- Water supply system material and equipment quality monitoring and control methods established
- Water Treatment system design, operation and maintenance improved and rationalised

Integrated Water Management

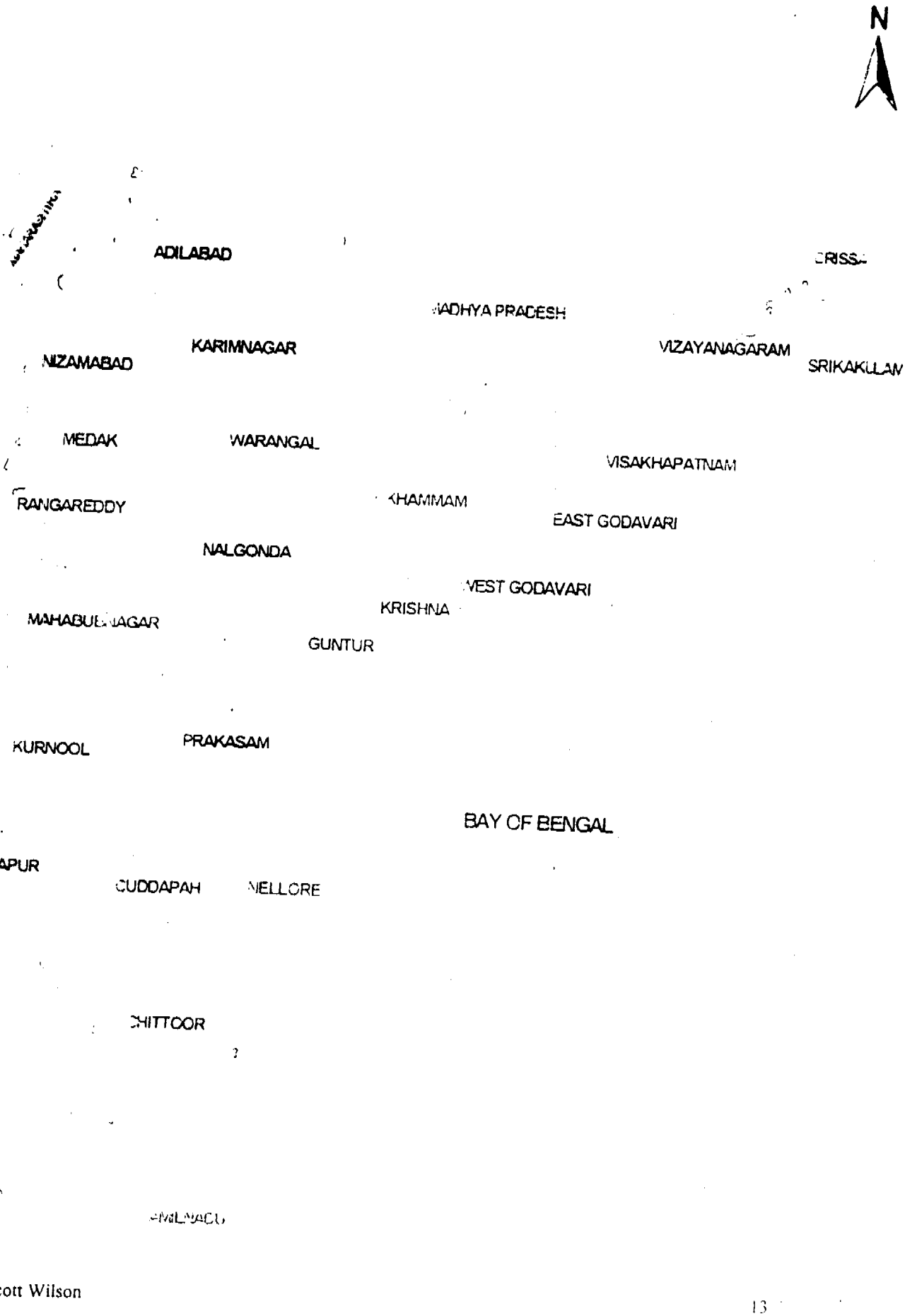
PRED has responsibility for rural water and sanitation within the Panchayati Raj and Rural Development Ministry. Watershed development is the responsibility of the Commissioner for Rural Development in the same Ministry. To guarantee an integrated approach to water resource management at watershed level, which is essential for sustainable water supply, means that there is the need for a district level authority for water resource management on a watershed basis, including representatives of the above departments and including additional representatives from the Ministry of Minor Irrigation which includes both the AP State Ground Water Department, the AP State Irrigation Development Corporation and AP State Rural Irrigation Corporation.

A new project should therefore set out to develop and create this organisation and apply water resource management techniques in the project area in an integrated way and define a successful methodology for future replication.

Model Approach

An important output of a new project should be a fully documented model approach for each of the main options undertaken in order that PRED has a manual that will ensure replicability throughout the state. It is also vital that training needs are evaluated and met by appropriate training programmes as the project develops that support replicability.

Andhra Pradesh District Map
Map 1



2.1.1 *Location of the State*

Andhra Pradesh, with a geographical area of 274,998 km^2, is the fifth largest state in India. It lies between North Latitudes 12^0 37' and 19^0 54' and East Longitudes 76^0 46' and 86^0 46' and is bounded on the East by about 1000 Km of coast line along the Bay of Bengal, on the south by parts of Tamilnadu and Karnataka States, on the west by parts of Karnataka and Maharashtra states and on the north by parts of Maharashtra, Madhya Pradesh and Orissa states (see Map1).

There are 23 districts in the State, as shown on Map 1, grouped under three distinct administrative and socio-economic regions; Coastal Andhra, Telangana and Rayalaseema. The coastal Andhra region comprises Srikakulam, Vizianagaram, Visakhapatnam, East and West Godavari, Krishna, Guntur, Prakasam and Nellore districts. The Telangana region consists of Adilabad, Nizamabad, Karimnagar, Hyderabad, Ranga Reddy, Warangal, Khammam, Nalgonda, Mahabubnagar and Medak districts. The Rayalaseema region comprises Chittoor, Anantapur, Kurnool and Cuddapah districts.

2.1.2 *Physiography*

Bounded by Bay of Bengal in the east, Andhra Pradesh has a long arcuate shaped smooth coast line protruding into the sea around the Godavari and Krishna deltas. From this coast line, the land gently rises through plains, passes through low-lying uplands, reaches the maximum height in the hilly section, followed by vast tracts of rolling peneplains. The Godavari, Krishna and other rivers rise in the west, flow towards coast and empty into the Bay of Bengal.

Physiographically, the State falls into three distinct zones; coastal plains, eastern ghats and western peneplains. In each zone the land form, altitude and river pattern are different, clearly demarcating one zone from the other. The first two units stretch from N.E. to S.W. in narrow strip while the western peneplains occupy the rest of the area.

Coastal Plains

The plains stretch from Kalingapatnam in the north to Pulicat in the south, along a narrow strip which broadens in the middle along the Godavari-Krishna deltas (up to 80 km). The coastal plains are dotted with several isolated hill features. The plains to the north and south of the deltas are composed of coastal alluvium enriched by recent river silt in the small valleys of Pennar, Vamsadhara, Nagavali and other rivers. The altitude in this region ranges from sea level at the coast to about 150-200 m amsl on the west.

Eastern Ghats

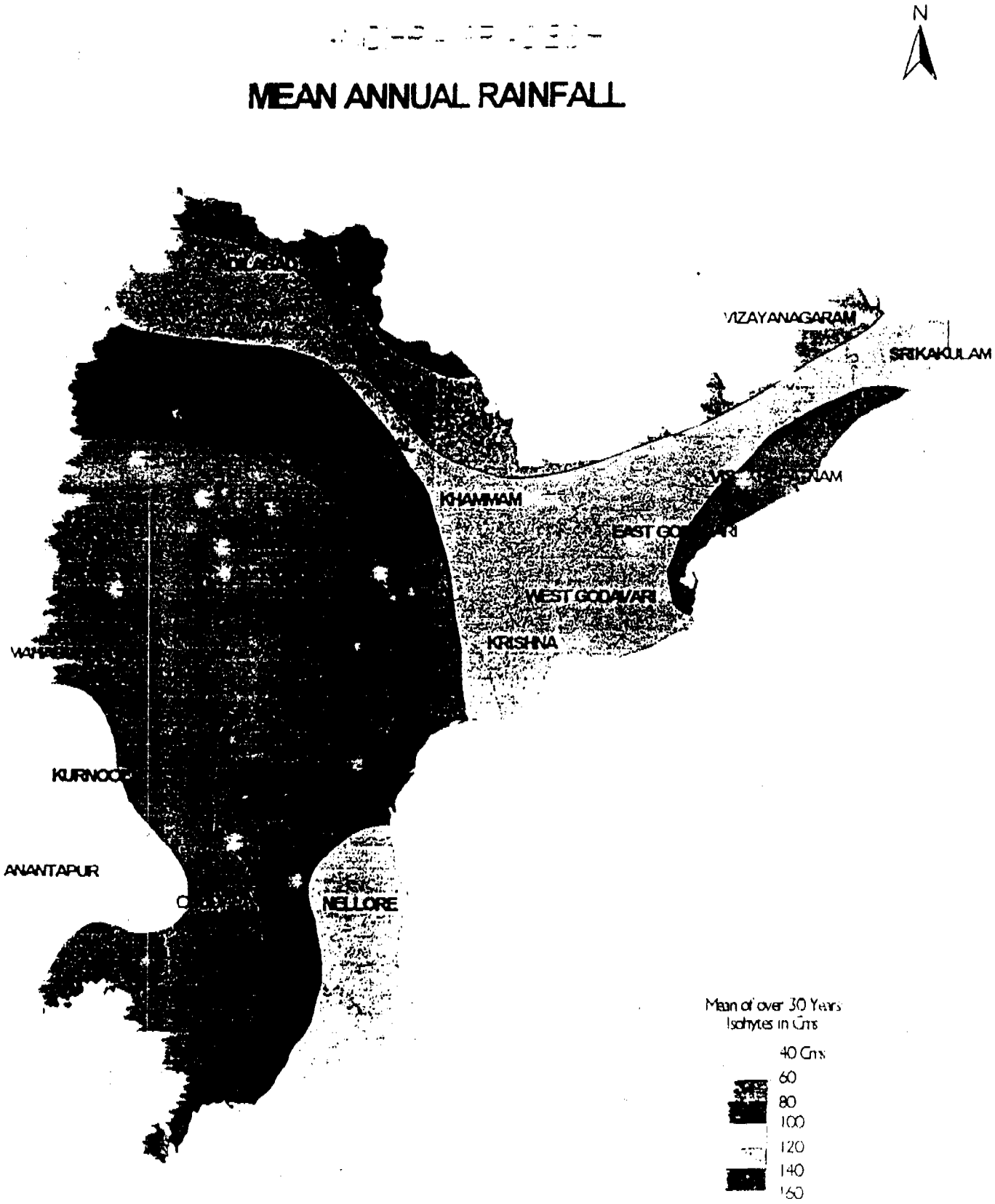
The Eastern Ghats follow the coastal plains stretching closely from one end to the other except in the area between the Godavari and Krishna rivers. The hill ranges run NE-SW and reach elevations of 610 to 1200 m amsl. The Nallamala, Erramala, Seshachalam, Velikonda and Palakonda hills falling in the Rayalaseema region cover the southern section of the ghats. These ghats have a profound influence on the climate of the State.

Western Peneplain

The western peneplains occupy a large part of the State. Whole of Telangana and considerable portion of Rayalaseema in Kurnool and Anantapur districts fall under this physiographic unit. The peneplain has a rolling topography with flat or gently undulating tracts. This plateau in the interior of Andhra Pradesh extends largely between the 150 and 600 m contours, except at places where it is ove[illegible]in by Basaltic lava, the elevation of which ranges from 600 to 900 m.

Weathering of granite along joints has produced the typical "Tor and Boulder" topography. The undulating topography of the peneplain has facilitated the damming of rivers which are beaded with tanks along their courses. In the lava areas, its "Trappean topography" replaces the "Tor-Boulder-Tank topography of the peninsular peneplain.

Andhra Pradesh
Mean Annual Rainfall
Map 2



2.1.3 Climate

The State of Andhra Pradesh has a typical tropical climate. The summers are hot, but winters are relatively pleasant, especially on the plateaus of the interior. A greater part of the State falls under tropical "Savannah" while the humid coastal belt and the comparatively dry inland districts are classified as "Moist Tropical" and "Dry steppe" respectively. The entire State falls under the semi-arid region of Peninsular India.

The climate of Andhra Pradesh is marked for its seasonality. Four distinct climatic seasons can be identified

- The pre-monsoon season or summer season (March-May)
- The south-west monsoon season or monsoon season (June-September)
- The retreating monsoon season or the autumn season (October-November)
- The winter season or cool season (December-February)

2.1.4 Distribution of Rainfall & Temperature

The state receives rainfall mainly from South-West monsoon (about 67%) and partly from North-East monsoon (about 23%). The average annual rainfall ranges from 650 mm in the semi-arid belt to about 1300 mm in the North-Eastern portion of the State. The Rayalaseema region is a zone of low rainfall, recording an average annual rainfall of 650 mm. The coastal area receives an average rainfall of 1100 mm and the area north of the Godavari river receives 1200-1300 mm of rainfall.

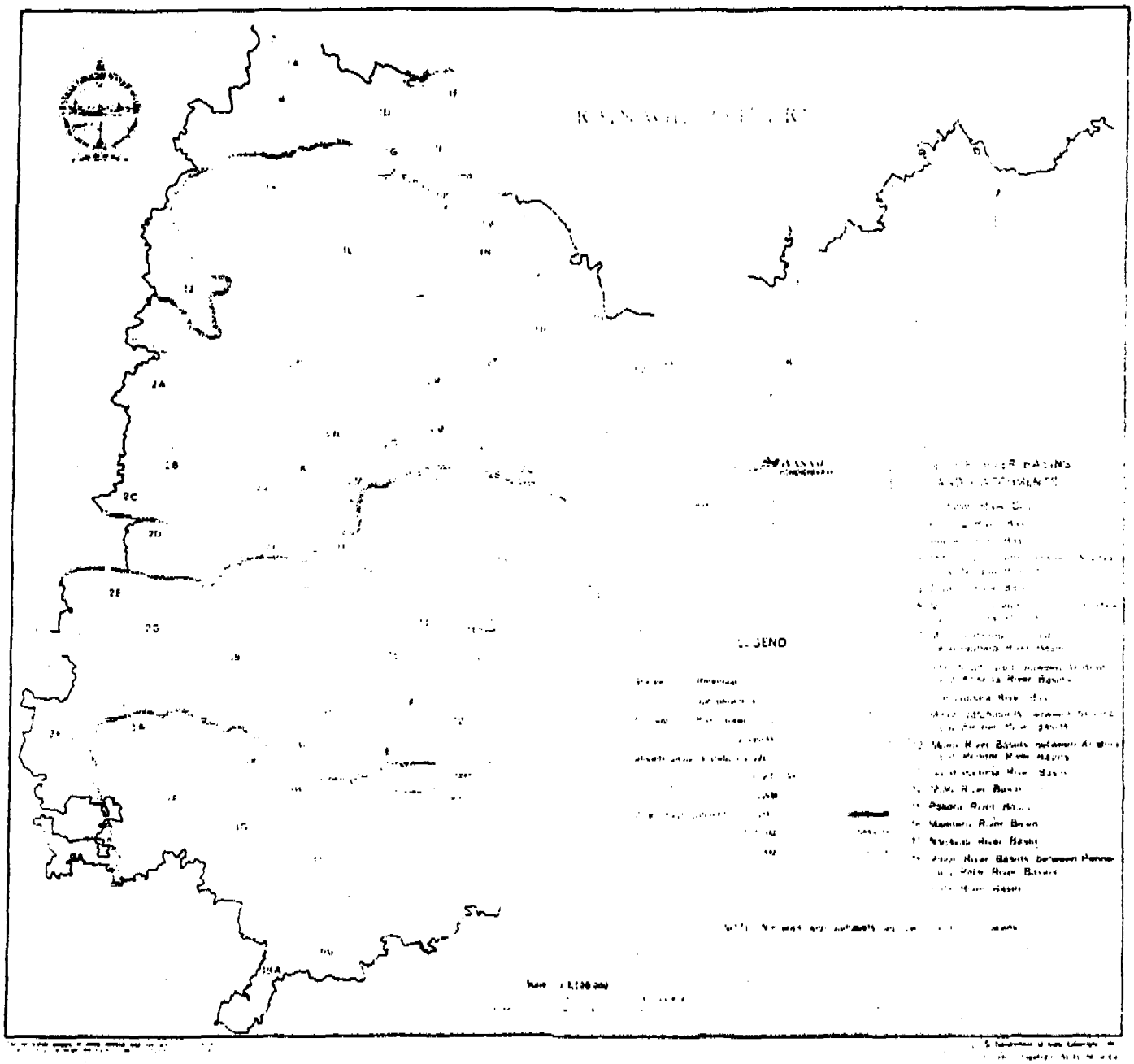
The South-West monsoon is the main rainy season for the State and all the districts excepting Nellore and parts of Prakasam and Chittoor receive their largest share of rain during this season. The heaviest rainfall from the south-west monsoon is received in a hilly forested belt, all along the northern boundary of the state comprising the Pranhita-Godavari valley in the eastern and northern Telangana and in the Eastern Ghat section of Srikakulam and Visakhapatnam districts. Almost every station in Telangana gets over 75% of its mean annual rainfall between June and September. In many cases the proportion exceeds over 90%. In the interior Rayalaseema; Anantapur and Western parts of Kurnool and Cuddapah districts and in the Circar area of Coastal Andhra, 50% to 75% of the mean annual rainfall is received during the south-west monsoon season. South of the Krishna river, Nellore and eastern part of Chittoor districts receive only 25% to 50% of their annual rainfall during this season. In general, all areas south of the Krishna river receive under 600 mm annually and all areas to the north, excepting a few isolated pockets, receive over 700 mm of rainfall during this monsoon period. Heavy rains are often associated with depressions and storms occurring generally during September-November in the Bay of Bengal.

The rainfall distribution over the Andhra Pradesh is shown in the form of "Isohyets" on Map 2.

From early March, temperatures rise rapidly all over the state, reaching the peak values in the later part of May. During this month the mean temperature seldom falls below 29^0 C. The minimum and maximum temperatures for Andhra Pradesh vary from 13.4^0 C to 19.7^0 C and 33.9^0 to 42.8^0 C respectively. Regional variations in temperature are noticeable. The lowest mean temperatures are found in the north-eastern and southern extremes of the State, along the narrow coastal strip of Srikakulam district and parts of Chittoor and Anantapur districts adjoining the Mysore plateau. On the other hand due to the combined effect of inland location, low elevation and radiation from surrounding hilly areas, the highest temperatures (over 35^0 C) are recorded in the Godavari valley in eastern Telangana and in the lower Krishna valley in the interior parts of Guntur and Prakasam districts. Compared to the Godavari and the Krishna valleys, the peninsular plateau on the west is only moderately hot with temperatures staying below 33^0 C. These moderate temperature conditions are also found to exist in a belt in the east, along the coast, and in the eastern hills. South of Krishna river even the coastal belt is very hot and the high humidity of this belt adds to the discomfort experienced by the people during summer season. The highest average annual temperature in the state is experienced by Rentachintala (34.7^0 C), Ramagundam (34.5^0 C) and Cuddapah (34.5^0 C).

Drainage Pattern

Map 3



2.2 Geology of Andhra Pradesh State

Andhra Pradesh contains a wide variety of Geological formations ranging from the oldest Dharwar Schist to the Recent Alluvium (see Map 4).

Dharwars: Consist mainly of Schist which are highly folded and metamorphosed. These formations extend in a N-S band about 30 to 40Kms wide from interior of Nellore district, through Ongole and Guntur districts into Krishna and Khammam districts. In Ananatapur and Mahabubnagar districts Dharwars occur in very narrow and elongated patches.

Archeaens or Peninsular Gneisses : This rock formation dominates in the nine districts of Telangana and four districts of Rayalaseema regions. These are Igneous rocks partially metamorphosed, which have remained stable. The Gneisses appears to have been highly weathered over millions of years. The rock formation consists of Granites, Grano-Diorite and Banded Gneisses. These are traversed by a number of Dolerite Dykes.

Charnockites & Khondalites : These are folded formations which due to great pressure and heat have metamophosed from sedimentary to metamorphic rocks. These are found in an extensive bed in the Srikakulam and Visakhapatnam districts and the upland areas of East and West Godavari districts. The Charnockites occur in parallel narrow bands between the much wider band of Khondalites and are usually found on the higher ridges of the hills on account of their resistance to erosion. These rocks also occur as narrow discontinuous belts adjoining the coastal alluvium in Krishna, Guntur and Prakasham districts. Small patches of Khondalites occur in the West Godavari and Guntur districts.

Puranas (Cuddapahs & Kurnools) : These are almost flat-bedded sedimentary rocks including Limestones, Sandstones, Shales and Slates which were originally deposited in a crescent shaped island sea which occupied the area presently covered by the Cuddapah basin extending from the Tirupathi Hills in the south to Huzurnagar of Nalgonda district in the north. The Cuddapahs are the widest in the middle covering the entire Cuddapah district. Another belt of Cuddapah formation occurs in Telangana in the Godavari trough in the northern parts of Adilabad district, Narsampet of Warangal district and Burgampad and Yellandu of Khammam district. The Kurnool formation is restricted in its occurrence, covering the eastern part of Kurnool district and Jammalamadugu of Cuddapah district. Narrow elongated patches also occur in Karimnagar, Warangal and Khammam districts.

Gondwanas : Occurring in a faulted trough occupied by the Pranhita and the Godavari rivers, along the eastern margin of Telangana region. This is a belt about 50 miles wide running in a North-West – South-Easterly direction for nearly 300 miles from Chandrapur in Maharashtra to the area between Kovvur and Elur in West Godavari district. This formation is free from folding though it has undergone faulting, particularly in the Godavari valley.

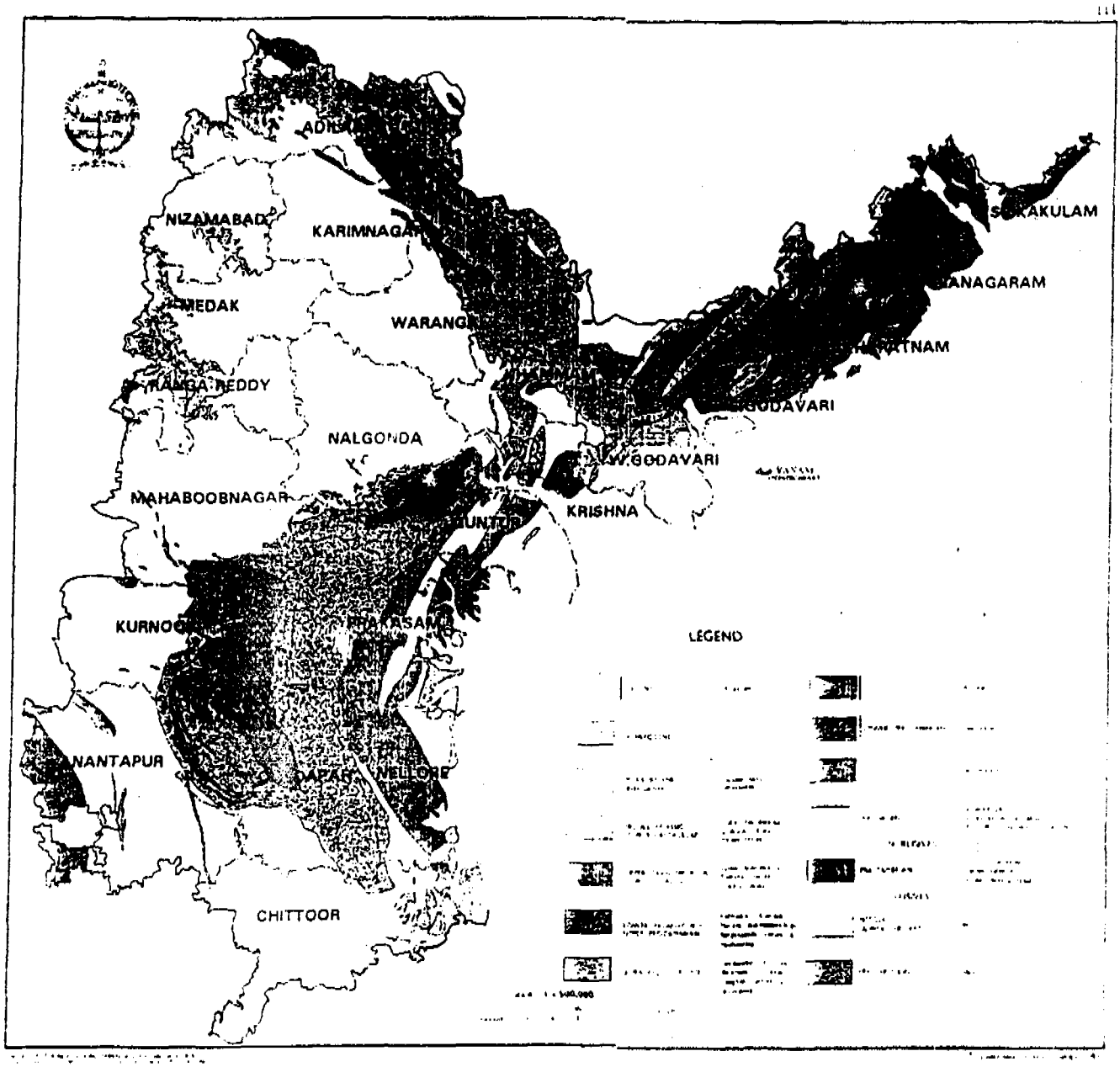
The Lower Gondwana formations are economically the more important of the two series as they contain the coal seams in the Sandstones and Shales. The Upper Gondwanas consists mostly of Shales and Sandstones extending from Rajahmundary to Vijayawada and also outcropping in several patches along the Godavari trough in eastern Adilabad and Karimnagar districts. These are fossiliferous deposits.

Deccan Trap formation : These formations occur in the western and northwestern parts of the state adjoining to Karnataka and Maharashtra states. These are mostly remnants of huge lava flows which poured out from extensive fissures in the western part of the Deccan. They form flat topped hills with step like shapes. Due to a typical topography its weathered product is black cotton soil. The formations are composed mostly of greyish or greenish basaltic rocks with occasional Limestone beds as inter-trappeaens.

Tertiary Formations : They are represented by the low hills composed of Rajahmundary Sandstones and Conglomerates covering small areas in East Godavari district and West Godavari district and along the coast line under the recent alluvium between the Krishna and Godavari deltas. Some of the Sandstones are highly ferrugeous. At the contact zone of these formations with alluvium a number of aquifers are found.

Geology

Map 4



The stratigraphic succession of geological formations in the State is given as follows:

Age	Geological Unit	Geographical distribution in the State
Recent, Sub-recent and Pleistocene	Alluvium, Laterite	Recent in Dists. of Krishna, East & West Godavari Laterites in Dists. of Medak & Ranga Reddy Districts.
Lower Eocene-Upper cretaceous	Deccan Trap, volcanic Lava flows with inter-trappaean beds. Lametas and Bagh beds	Dists. of Ranga Reddy & Medak
Jurassic (Upper - Limestone Gondwana)	Chikiala and Kota Stages	Dists of Adilabad, Karimnagar
Triassic	Panchmari and Maleri stages; clays, sand-stones	Khammam and Warangal
Permian (Lower Gondwana)	Mangali beds, sandstones Kamathi series sandstone shales and coal barker series, sand stone shales and coal	Khammam and Warangal
Upper Carboni-Ferous, Pre-cambrian	Talchir series Vindhyan system - Limestones, Shales Sandstones, Cuddapah System – Limestone and Shales Kaladgi Series - Sandstones, Conglo-morates and Shales	Cuddapah, Chittoor, Nalgonda, Adilabad Kurnool and Mahabubnagar
Dharwar Lower Dharwar	Iron Ore series Sauser series	Prakasam, Krishna, Guntur & Khammam
Archeans	Older Schists and unclassified Crystallines	Mahabubnagar, Ranga Reddy, Medak, Nizamabad, Adilabad, Karimnagar, Warangal, Khammam, Nalgonda, Chittoor Anantapur, Cuddapah and Kurnool

Laterites : Laterites are found under a warm, humid climate with a good rainfall and good drainage conditions. These Laterites occur as caps (50-60m in thickness) over the Deccan Traps in western Telangana (Vikarabad, Zahirabad and Narayankhed areas). They also occur as patches along the junction of the coastal plain and the foothills in Nellore district.

Recent Alluvium : Recent Alluvium occurs extensively (80 to 100kms in width) in the deltas of the Krishna and the Godavari and as a narrow band (20 to 40kms wide) along the coastal plains elsewhere. The belt of Alluvium is found deep inland along the valleys of the Vamsadhara and the Nagavalli rivers. The recent alluvium consists of sand, gravel, silt and clay.

2.3 Geology and its influence on the ground water regime

Nearly 84 percent of the state is underlain by hard, crystalline and consolidated formations like Archaean rocks, Cuddapah, Kurnool formations and Deccan Traps. The rest of the state is underlain by semi-consolidated formations like Gondwanas and Tertiaries and unconsolidated deposits like Recent Alluvium. By and large, the occurrence of ground water in the state depends on the "geological setting, climate, rainfall, drainage and topography' and the extent of surface water bodies (see Map 5). In order to consider ground water conditions in the State, the rocks of Archaeans, Limestones, Quartzites and Shales of Pre-cambrian and massive Deccan Traps are grouped together as consolidated hard rocks. Semi-consolidated Sedimentary formations of Gondwanas, Rajahmundry Sandstones and the unconsolidated alluvium are termed as soft rocks. An area of about 228,000 sq.km is occupied by hard rocks while the soft rocks occupy an area of 47,000 sq.km in the State.

2.3.1 Hard Rocks

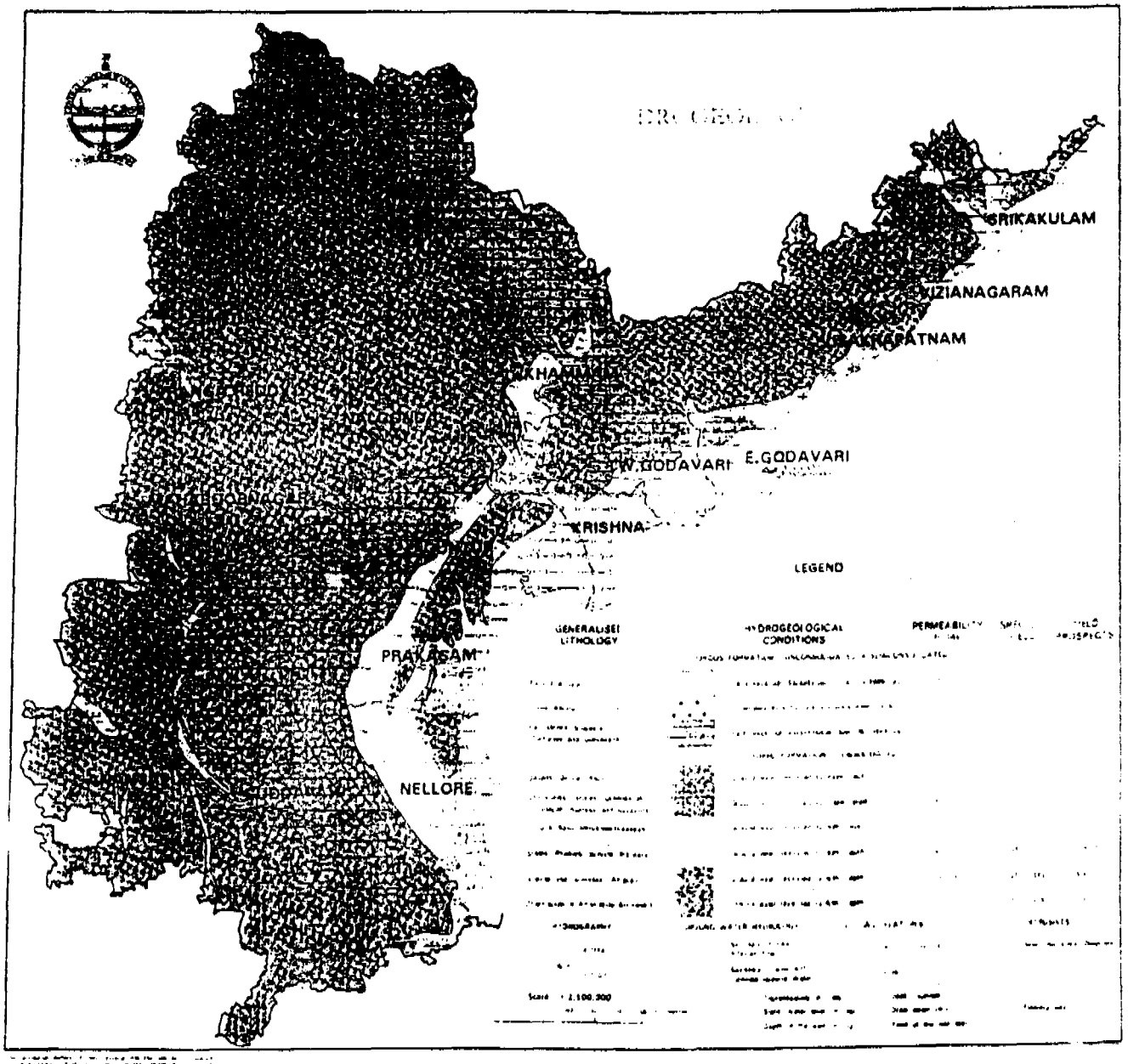
In the hard rock formations, secondary porosity is developed by fracturing, weathering and solution. The fracture porosity is generally not uniform either laterally or with depth. It usually decreases with depth and appears to be negligible below 80 m from ground level except in highly fractured or disturbed areas.

The Dharwar rocks occurring as narrow patches in the state comprise Schists, Phyllites, Amphibolites and Epidiorites. The movement of ground water in Dharwar rocks is mainly through joints, fractures, and fissures. Open wells piercing the weathered zone range in yield from 50 to 100 m^3 /day depending on local topographic setting and degree of weathering and fracturing. The wells in these formations usually sustain pumping for 3 to 4 hours a day. By and large these rocks are not promising for large scale ground water development.

The other prominent crystalline rocks comprise Granites, Gneisses, Khondalites and Charnockites. The dug wells in Granites and Gneisses generally range in depth from 8 to 15 m with yields up to 60-125 m^3/day. The yields from bore wells generally range between 3 and 10 lps. The transmissivity of aquifers in granites is in the order of 10 to 290 m^2/day. The open wells in Khondalites yield 45 to 135 m^3/day. The open wells in Khondalites yield 45 to 135 m^3/day. The Khondalites and Charnockites chiefly occur in parts of Visakhapatnam, Srikakulam, Khammam, West Godavari and East Godavari districts. The bore wells drilled down to 30 to 60m are found to yield 2.5 to 10.0 lps and occasionally 14 lps in highly fractured zones.

The occurrence and movement of ground water in Cuddapah rocks is chiefly controlled by structural features as well as solution channels. Bore wells constructed down to 100m have recorded yields varying from 2 to 15 lps. The average yield from dug wells in Pakhals varies from 30 to 150 m^3/day. In Kurnools ground water movement is controlled by the bedding and cleavage planes in Limestones and Shales, intensity of jointing in Quartzites and Sandstones and solution channels and cavities in Limestones. The open wells in Nandyal Shales yield 10 to 22 m^3/day, in Auk Shales from 12 to 36 m^3/day and in Narji Limestones from 22 to 77 m^3/day. The yields of bore wells in Kurnool group vary from 0.4 to 14 lps. The Deccan Traps are basically fissure flows, hard and compact and possess meagre porosity. Ground water in traps occurs in weathered and fractured zones, vesicular zones and in the inter-trappean and infra-trappean beds. The traps exposed in parts of Adilabad, Mahabubnagar, Medak, Nizamabad and Ranga Reddy districts are vesicular in nature and are promising for ground water development to a limited extent. The bore holes drilled down to 40 to 120 m in these areas

Hydrogeology
Map 5



record yields ranging between 3 and 12 lps. The ground water exploration carried out under Canadian Assisted Ground Water Project of the Central Ground Water Board enabled the estimation of transmissivity of vesicular Basalt which varies from less than 1 m^2/day to about 198 m^2/day.

The Laterites are compact and cemented and occur generally in association with crystalline rocks like Traps and Khondalites. Ground water generally occurs under water table conditions and wells situated in Laterites are usually between 10 and 55 m bgl. The yields of bore wells drilled down to 30 to 54 m. bgl range from 6 to 11 m^3/hr. The yields of open wells situated in the Laterites, capping the traps in Adilabad district vary from 18 to 180 m^3/day.

2.3.2 Soft Rocks

The semi-consolidated formations in the State are represented by the Gondwanas and Tertiaries, which occupy an area of 19,200 sq.km. The Gondwanas mainly occur in the Godavari valley and in isolated patches along the east coast in the districts of Prakasam and Guntur. The lower Gondwanas comprise Talchirs, Barakars, Kamthi and Chinthalpudi Sandstones. The occurrence and movement of ground water is complex in nature, but mainly controlled by structural features. Tube wells constructed in the Barakars have yielded 3.30 to 16.20 lps for drawdowns ranging from 12 to 38 m. The transmissivity of the Barakar aquifers ranges from 18 to 284 m^2/day. The open wells tapping these formations yield between 20 and 30 m^3/day.

The Kamthi Sandstones beyond the depth of 250 m bgl are intercalated with Shales and Clays. The yields of tube wells constructed within the depth of 200 m range from 3 to 48 lps for drawdowns of 9.0 to 30.m. Transmissivity of the aquifers varies between 28 and 950 m^2/day. The yields of tube wells in the Chinthalpudi Sandstones constructed down to a depth range of 50 to 150 m bgl vary from 7 to 16 lps and the transmissivity of the aquifers varies between 150 and 303 m^2/day. At places, flowing conditions are observed in these formations. Exploration carried out down to 600 m in the formations has revealed the presence of potential aquifers between depth of 30 and 310 m bgl and yields vary from 26 to 222 m^3/hour for drawdowns of 7 to 37 m.

The upper Gondwanas consists of Gollapalli Sandstones, Raghavapuram Shales, Tirupathi Sandstones and Kota Sandstones mixed with Shales. Ground water in Gollapally Sandstones occurs under water table conditions in shallow zones and under confined conditions in deeper aquifers. Flowing conditions are also common in these formations, where they are overlain by other younger formations. The yields of tube wells drilled down to about 600 m vary from 7.50 to 62 lps and the transmissivity is of the order of 80 to 900 m^2/day.

The Tirupathi Sandstones are highly porous and permeable constituting promising aquifers. The yields of the tube wells drilled down to 300 m generally range from 9 to 40 lps for varying drawdowns of 15.00 - 35.00 m. The transmissivity of aquifers ranges from 80 to 1900 m^2/day. The Tertiaries are represented by the Rajahmundry Sandstones in East Godavari and West Godavari districts. The yields of tube wells tapping Tertiary aquifers down to depths of 300 m generally vary from 17 to 50 lps for drawdowns of 2 to 30 m and transmissivity of aquifers varies from 86 to 2500 m^2/day indicating higher potentiality of the Tertiary aquifers.

2.3.3 Alluvial Deposits

The alluvium is confined mainly to the deltaic regions of principal rivers. The alluvial aquifers have high porosity and permeability and hence constitute promising aquifers. Filter points are most common in this formation. Bore wells drilled down to a depth range of 15 to 30 m bgl yield copious supplies of water. Even though in Krishna-Godavari delta the alluvium attains a thickness of a few hundred meters, the deeper aquifers are found to contain highly saline water. The filter points and cavity wells in the alluvium have recorded yields ranging from 15 to 60 m^3/hour. The static water level in these formations varies from near ground level to 27.00 m bgl. The specific yields are found to be as high as 25% and the thickness of these alluvial aquifers varies widely from place to place.

Ground water in the coastal alluvium occurs both under water table and confined conditions and is generally developed by means of dug wells, filter points and shallow tube wells. The depth to water

table in dug wells varies from near surface to about 5.0 m.bgl. Usually the quality of water is the main problem in coastal alluvium. Fresh water bodies occur as pockets and lenses within the depth of 20 m.bgl. Hydrogeological surveys carried out in connection with relief operations in the tidal wave inundated and cyclone affected areas in Krishna and Guntur districts revealed that fresh water occurs in pockets and lenses down to depth range of 14 to 16 m.bgl. The exploratory drilling carried out down to a maximum depth of 458 m.bgl. did not show the presence of fresh water pockets at depth.

2.3.4 Chemical quality of ground water

The chemical quality of ground water is found to exhibit considerable variations from place to place and with respect to the geological environment, climate, drainage condition and pollution. The ground water in Khondalites, Quartzites, Gneisses and Granites, in general, is neutral to alkaline and the chloride content ranges from 28 to 525 ppm. The quality of ground water in Cuddapah and Kurnool formations is generally inferior and TDS in many of these places exceed 1000 ppm. The quality of ground water in Gondwana formations is generally good except for local patches. The ground water from Gondwanas in parts of Karimnagar and Warangal is generally alkaline and in places excessively hard. The ground water from Trap rocks is found to contain less TDS ranging from 200 to 300 ppm in upland areas but vary from 400 to 700 ppm in valley portions. Ground water is often brackish to saline in black cotton soils associated with traps.

In the Krishna and Godavari deltas the quality of ground water varies widely. The quality in the shallow zone is generally within potable limits, but deteriorates rapidly with depth.

The main problems associated with ground water quality, when related to drinking water, are those of fluoride and salinity. Fluoride is considered to be the major water quality problem in the state with approximately 25% of habitations affected with unacceptable levels (over 1.5 ppm) in sources. Fluoride increases in concentration in areas of over abstraction where long solution paths are created through drawdown of the water table. Fluoride originates in certain minerals which occur in crystalline rocks, particularly granites and gneiss, which occur over much of Andhra Pradesh. Salinity problems are particularly associated with coastal intrusion of salt water through over abstraction adjacent to the coast.

2.4 Ground Water

In many regions of the world, water for potable supplies and for supplementary irrigation is obtained from ground water. Many of these areas, particularly in the African and Indian continents, are underlain by hard rock, volcanic or ancient crystalline rocks where ground water most frequently occurs in aquifers within shallow weathered and fractured layers. Yields from individual wells are usually low, and the quantity of water stored in the aquifers is relatively small, perhaps equivalent to only 2-3 years average annual recharge, or less. Further, the climatic conditions, particularly the low and variable rainfall, can limit the quantity of recharge to these aquifers and makes them susceptible to drought.

Most of the water supply sources in the rural areas of India are based on ground water which occurs in a wide range of rock types and usually requires little or no treatment. Therefore, this is usually the cheapest and simplest water supply option.

Since the 1950s, ground water abstraction has increased substantially to provide irrigation water, both as a consequence of the increase in the number of wells, and of progressive replacement of animal-powered lifting devices by motorised pumps capable of much higher yields.

In the of State Andhra Pradesh ground water abstraction has also followed this national pattern. Concern has been expressed in India as to whether this considerable increase in ground water abstraction is largely responsible for a decline in water levels and failure of both irrigation and community water supply wells.

Ground water abstraction for irrigation is currently the largest component of discharge from the aquifer, and as a result of this pumping the water table at the end of the dry season declines to near the

base of the aquifer. Therefore, further increase in ground water abstraction is not possible as all the available water in the aquifer is utilised. In most years the monsoon rainfall will help to recharge the available storage and ensure ground water levels return almost to their original levels. CGWB hydrographs indicate that some areas show declining water table levels whereas others remain fairly constant over time or occasionally increase.

More than 70% of India's population live in rural areas and ground water is vital to the rural economy. Ground water managers understand that efficient management of ground water resources is essential. Effective ground water management requires, firstly, a good understanding of the aquifer system and secondly, that practical measures to control abstractions can be identified and, thirdly, that any legislation is both equitable and acceptable to the rural community.

It is important to recognise that irrigation and drinking water wells are in competition for the same resource. In Andhra Pradesh, the state government, aware of the need to protect public drinking water wells, has produced legislation designed both to restrict the sinking of the new wells within a critical zone (250 m radius) around a community drinking water well (a protection zone) and to regulate abstraction from existing irrigation wells during times of water scarcity, but this is not implemented.

2.4.1 Water Balance

An understanding of the ground water system requires a quantitative assessment of both the input to (recharge) and the output from (abstraction) the aquifer. During the period from November to May there is little or no rainfall recharge and discharge from the aquifer can be equated with the release of water from aquifer storage.

2.4.2 Assessment of water balance

To assess the water balance in hard rock areas the following data are required.

Annual recharge, which is composed of:

- Monsoon recharge
- Non monsoon recharge
- Recharge from surface sources (rivers and streams)
- Recharge from surface water irrigation (due to drainage and canal seepage)

Annual draft, which is composed of abstraction through:

- Dug wells
- Shallow tube wells
- Deep tube wells
- By other traditional means

To calculate the ground water balance, 85% of the annual recharge is considered as net recharge. Similarly net draft is approximately 70% of the gross annual draft.

Ground water balance (as a hectare metre equivalent) = net annual recharge available for development - net annual draft.

2.4.3 Categorisation of block based on level of Ground Water Development

The level of ground water development in a block is taken as the ratio of net yearly draft to total utilisable ground water recharge. By considering the level of development blocks are categorised as:

Ground water development -	More than 100%	-	Over developed
	More than 85%	-	Dark
	Between 65% -85%	-	Grey
	less than 65%	-	White

In darkblocks, micro-level surveys are required to evaluate the ground water resources more precisely for taking up further ground water development. Under the National Water Policy, ground water development is limited to annual replenishable ground water resource, hence exploitation is not permitted in over-exploited blocks. The ground water levels are the ultimate indicators of the extent of ground water development taking place in a block. Hence, the behaviour of ground water level should be a deciding factor to indicate the possibilities of future ground water development.

CGWB statistics for 1994 indicate the following situation existed in Andhra Pradesh:

Dark Blocks	102	9%
Grey Blocks	36	3%
White Blocks	996	88%

2.4.4 Ground Water Potential of the State

The Central Ground Water Board along with the Ground Water Department of Andhra Pradesh has estimated the Ground Water resource and potential of Andhra Pradesh. Table 2.1 shows the ground water resource estimate, district-wise, up to the year 1993 which indicates an overall low level of ground water resource development. The analysis, however, based on a district, is not indicative of the situation at any one specific location. In general, across Andhra Pradesh, local areas of over development of aquifer resources are very common, even in districts classified overall as white.

2.4.5 Reasons for over abstraction

The problem of local over abstraction of ground water resources is generally acknowledged and is caused primarily by an inability to control abstraction and inappropriate incentive schemes. There is also a lack of detailed knowledge of ground water resources and uncertainty of the precise relationships between rainfall and recharge at specific locations

2.4.6 Abstraction overview

The following statistics for the state indicate the pressures on ground water resources:

- Total number of Habitations as per 1991 census .. 69,732
- Total Dug Wells .. 1,213,040
- Total Bore Wells .. 154,284
- Total Hand Pumps provided .. 218,000
- Total number of Power Pumps .. 1,273,972

TABLE 2.1 GROUND WATER RESOURCE AND IRRIGATION POTENTIAL, ANDHRA PRADESH 1993

Sl.No.	District	Total replenishable ground water resources (m.ha.m/yr)	Provision for domestic, Industrial & other use (m.ha.m/yr)	Available ground water resources for Irrigation in net terms (m.ha.m/yr)	Utilisable ground water resources for Irrigation in net terms (m.ha.m/yr)	Gross draft estimated on prorata basis (m.ha.m/yr)	Net draft (m.ha.m/yr)	Balance ground water resources for future use in net terms (m.ha.m/yr)	Level of ground water development as a %	Utilisable Irrigation potential for development (m.ha.)
1	2	3	4	5	6	7	8	9	10	11
1	Srikakulam	0.12643	0.01896	0.10747	0.09672	0.02756	0.01929	0.08818	17.95	0.11697
2	Vizianagaram	0.11173	0.01676	0.09497	0.08547	0.01784	0.01249	0.08248	13.15	0.11360
3	Visakhapatnam	0.11415	0.01712	0.09703	0.08733	0.02184	0.01529	0.08174	15.76	0.12141
4	East Godavari	0.20915	0.03137	0.17778	0.16000	0.03370	0.02359	0.15419	13.27	0.15645
5	West Godavari	0.23456	0.03518	0.19938	0.17944	0.06754	0.04728	0.15210	23.71	0.17367
6	Krishna	0.12348	0.01852	0.10496	0.09446	0.02377	0.01664	0.08832	15.85	0.12986
7	Guntur	0.28331	0.04249	0.24082	0.21674	0.02251	0.01576	0.22508	6.54	0.16868
8	Prakasam	0.18308	0.02747	0.15561	0.14005	0.03019	0.02113	0.13446	13.58	0.19565
9	Nellore	0.30411	0.04562	0.25849	0.17264	0.12004	0.08403	0.17446	32.51	0.22607
10	Kurnool	0.11535	0.01731	0.09804	0.03824	0.02457	0.01720	0.08084	17.54	0.15087
11	Anantapur	0.12490	0.01874	0.10616	0.09554	0.05589	0.03912	0.06704	38.85	0.19868
12	Cuddapah	0.10572	0.01585	0.08987	0.08088	0.04497	0.03148	0.05839	35.03	0.18837
13	Chittoor	0.15814	0.02372	0.13442	0.12098	0.06478	0.04535	0.08907	33.73	0.25330
14	Ranga Reddy	0.07191	0.01079	0.06112	0.05501	0.03183	0.02228	0.03884	36.45	0.10507
15	Hyderabad									
16	Nizamabad	0.11747	0.01762	0.09985	0.08987	0.05028	0.03520	0.06465	35.25	0.15898
17	Medak	0.12918	0.01937	0.10981	0.09883	0.04824	0.03377	0.07604	30.75	0.21306
18	Mahabubnagar	0.14501	0.02175	0.12326	0.11093	0.05863	0.04104	0.08222	33.30	0.25203
19	Nalgonda	0.19941	0.02991	0.16950	0.15255	0.06590	0.04613	0.12337	27.22	0.21398
20	Warangal	0.16730	0.02509	0.14221	0.12799	0.06883	0.04818	0.09403	33.88	0.24051
21	Khammam	0.18847	0.02827	0.16020	0.14418	0.02300	0.01610	0.14410	10.05	0.19797
22	Karimnagar	0.18078	0.02712	0.15366	0.13829	0.08952	0.06266	0.09100	40.78	0.22296
23	Adilabad	0.13552	0.02033	0.11518	0.10367	0.02173	0.01521	0.09998	13.21	0.16194
	Total	**3.52916**	**0.52936**	**2.99979**	**2.69981**	**1.01316**	**0.70922**	**2.29058**	**23.64**	**3.96008**

3. Current Water Usage

3.1 Allocation of Water

The estimate of % share of water resources by demand level for the whole of India are as follows and reflect the changing emphasis anticipated over the next quarter century:

	Annual demands (billion M^3)			
Type of use	**1990**	**(actual)**	**2025**	**(projection)**
	Demand	% Share	Demand	% Share
Domestic	25	4.5	52	5
Agriculture	460	83.3	770	73.3
Hydropower	19	3.5	71	6.8
Industrial	15	2.7	120	11.4
Other	33	6	37	3.5
Total	**552**	**100**	**1050**	**100**

3.2 Domestic Water Usage - Design Norm

3.2.1 AP Rural Piped Water Supply

AP rural Piped Water Supply (PWS) scheme designs are based on 40 lpcd of water supply rate and **exclude any allowance for system losses or animals.**

3.2.2 AP Comprehensive Piped Water Supply Schemes

AP Comprehensive Piped Water supply rate is worked out as shown below:

Stand-post supply of 40 lpcd for 70% of the village population	= 28 lpcd
Private connections of 70 lpcd for 30% of the village population	= 21 lpcd
Allowance for animals	= 06 lpcd
Supply norm for system design	= 55 lpcd

No allowance is made for transmission or distribution losses which could range between 15 and 50%.

3.3 Domestic Water Usage - Actual Figures

From the discussions with villagers in 14 villages of the Andhra Pradesh Rural Water Supply Project visited during the Water Resources Scoping Study, the following examples illustrate the wide variability of **actual household demand**, which depends so much on the status of the members of a household.

Example 1:

A family of 6 members expressed need for the following quantities of water to satisfy their demands:

- Cooking 50 Litres
- Washing 60 Litres
- Bathing 60 Litres

Total 170 Litres

Rate of supply 30 lpcd

The water requirement for 2 Cows was stated as 30 litres for each, twice a day = 120 litres in addition to the above, raising the rate to 48 lpcd.

Example 2:

Another family, having 15 members, expressed the following need:

• Cooking	100 Litres
• Washing	100 Litres
• Bathing	200 Litres
• Latrines	60 Litres
Total	460 Litres
Rate of supply	**30 lpcd**

3.4 Efficiency of Use

3.4.1 Domestic

Domestic efficiency and losses do depend on the source of supply made available, as the following illustrates:

Handpump supply

A villager will generally take only what is needed in vessels that can be hand carried and are used to fill a household storage pot or pots. Vessels will be cleaned at the handpump, hands and feet may be washed whilst fetching the water and a drink will be taken. These activities will be carried out while the handpump is running full bore and a high proportion of waste will occur. Children will often come to the handpump to wash and then drink the water, running many more times the quantity they drink to waste.

Washing of clothes may take place at the handpump which obviously saves carrying of water and disposal, but the amount used will probably be little more than is necessary.

Stand-post supply

The characteristics of use that apply to a handpump also apply to a stand-post but losses can be mitigated by the use of valved outlets that require lifting. Unfortunately, the pressure of water in a stand-post is much higher than in a handpump and use for washing and drinking on the spot will produce more losses. Moreover, taps are usually found to be broken or stolen, which results in considerable loss of water during the supply period and may result in the complete pipe network draining out through low points. At a majority of the villages, the stand-post was found to be a protruding pipe assembly, without any tap.

House Connections

The responsibility of providing house connections is left to the house owner. The workmanship is usually poor, no taps are provided, and considerable waste of water could be observed during the field visits. PVC pipes are often used for the house connections and inadequate cover is provided resulting in pipes being exposed on the surface. The pipes are not only prone to considerable leakage, but also to contamination entering the system. House connections were also observed in the roadside terminating in open pipes below ground level, again providing a prime source for contamination and health risk.

Tube-well supply

Tube-well discharges that are linked to ground level or overhead storage and tap distribution either directly or through stand-posts will have the losses described above together with leakage losses on pipelines and from the storage, depending on the quality of construction, as well as material.

Moreover, the biggest problem connected with the tube-well supply is derogation of the drinking water sources due to interference created by the neighbouring irrigation tube-wells, which eventually results in abandonment of the drinking water source. The derogation effect also shows itself in the frequency of pump motor burn-out, which is imposing an unnecessary financial burden on the village.

Example 2:

Another family, having 15 members, expressed the following need:

• Cooking	100 Litres
• Washing	100 Litres
• Bathing	200 Litres
• Latrines	60 Litres
Total	460 Litres
Rate of supply	**30 lpcd**

3.4 Efficiency of Use

3.4.1 Domestic

Domestic efficiency and losses do depend on the source of supply made available, as the following illustrates:

Handpump supply

A villager will generally take only what is needed in vessels that can be hand carried and are used to fill a household storage pot or pots. Vessels will be cleaned at the handpump, hands and feet may be washed whilst fetching the water and a drink will be taken. These activities will be carried out while the handpump is running full bore and a high proportion of waste will occur. Children will often come to the handpump to wash and then drink the water, running many more times the quantity they drink to waste.

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Piped water supply from remote source

In PWS and CPWS in Andhra Pradesh no provision is made in the design for losses, although the design standard for Urban schemes does include some provision for losses in both distribution and transmission and for treatment backwash. General loss provision in piped water supplies should be treated with more realism at design stage.

Fluoride Treated Water

The Nalgonda Technique is used in Andhra Pradesh for defluoridation of water. The technique consists of sequential addition of lime, alum and bleaching powder, and subsequent contaminant removal through the process of coagulation and flocculation. The process requires slow as well as fast mixing. The stirring mechanism was seen in villages to be connected to a speed reduction gear and stirred only at one speed of about 45 rpm, with the result that the reaction was never complete. Consequently, people get water having more fluoride than the permissible limit, along with some associated chemical taste, and therefore are not happy with the treated water. Moreover, sludge disposal is unscientific, and the slurry was usually seen to be let out freely onto the open land, causing pollution.

The following additional points also impact on water usage at village level:

- Absence of storage at village level
- Power fluctuations and unreliability
- Practice of throwing-away "one-night" old water
- Water used for spraying over the streets for settling dust
- Panchayat's inability to replace the existing old and dilapidated distribution network
- Constructional inadequacies in terms of wrong choice of material
- Poor workmanship
- Poor O and M
- Poor monitoring system
- Poor project formulation
- Recruitment of non-qualified and untrained field staff
- De-motivated Village Water Persons due to irregular or inadequate salary disbursement.
- No realistic provision for drinking water requirement of cattle
- Insanitary practices of house-hold storage among the villagers
- Preference of the villagers for the village tank water, till it lasts, irrespective of quality.
- Poor hygienic practices of the villagers, in general, leading to infrequent baths; no washing of the hands before eating food etc.
- Poor upkeep of the household water pots, followed by their unhygienic use.
- Adoption of standardised 5 HP pumps, irrespective of the demand or the availability.
- Heavily silted village tanks, having limited storage capacity left.
- Practice of siting manure pits nearby the water sources, thereby making the quality of water unfit for consumption.
- Supply of treated water as well as the raw water through the same distribution system.
- Construction of the hand pumps at sites other than the sites suggested by the departmental geo-hydrologist, due to the vested interests as well as political interference.
- Practice of locating water sources in the GOAP land, to avoid the problems of private land acquirement.

3.4.2 Information Available

Unaccounted-for losses are notoriously difficult to quantify, even on simple installations such as handpumps. Representative samples of all schemes should be fully monitored with metering and manual recording of supplies taken to provide more accurate basic data than currently exists.

3.4.3 Willingness to Pay

In all the villages that were visited, people were generally prepared to pay for water supply providing:

- the supply met the actual needs in summer

- the supply was regular and planned
- people were warned of breaks in supply in order that they could conserve their storage
- quality was maintained at a high level
- system repairs were advised of so that resulting poor quality water could be kept away from potable use
- reinstatement of supply was notified to every village on the scheme after breakdown.

Villagers were actually found to be paying Rs.10-20 per household per month for a house connection to the village Panchayats as the water charges, over and above the one time connection charge of Rs. 500 to Rs. 2000. With proper awareness, it is very likely that a sizeable section of the rural habitations may agree to pay an equitable share of the O and M charges.

There was, however, a general scepticism about the long term sustainability of all Government installed water supply systems, whether from groundwater or surface sources, because groundwater sources were not protected from derogation, as well as the fact that they were prone to ever increasing up-take of fluorides and salinity, and the alternatives proposed by PRED using remote surface sources involved major installations of pipelines, treatment and pumping plant and face the ever present problem of poor maintenance.

3.4.4 Factors affecting Cost Recovery

The issue of cost recovery in the Project Schemes has brought out the following factors which have a direct bearing on the effectiveness of cost recovery:

- the present subsidised electricity supply
- the present low and non- volumetric water charges for surface irrigation
- minimal capital cost sharing by the local communities
- absence of the concept of annual contribution towards replacement fund
- low or minimal cost recovery against the desirable full recovery for O and M
- absence of demand-driven approach while deciding investments
- "non-sustainable system" transfer to communities
- absence of the concept of considering water as an economic good - to enable its distribution/re-allocation between users, especially from agriculture to rural domestic uses
- absence of the concept of the "social good" nature of water and its importance as a basic need for all segments of the population and in particular the poor
- absence of multi-tiered pricing structure based on income
- large subsidies on the water used for irrigation
- resentment among the community sections/habitations not receiving water regularly
- absence of the sense of ownership among villagers.
- farmers are already paying some water tax, being the members of the Water Users Association.

All the above issues require careful consideration with related modifications in the approach, in order to motivate the people themselves to come forward without coercion, to willingly pay towards the cost of the services provided to them.

4. Policy, Legislation and Institutional Responsibilities

4.1 Policy

4.1.1 Planning and Management

Type and Size of Projects

PRED is responsible for conceiving, planning, preparing and executing water supply and sanitation projects in the entire State through PWS and CPWS schemes in rural areas and through urban schemes for towns up to 20,000 population.

At field level Chief Engineers are responsible for project formulation and execution, in the three Regions of the State. At the District level, Executive Engineers look after the these activities, supported by sub-divisional officers and associated field staff.

Policy Guidelines issued by AP State Government and PRED

The salient features of a selection of planning and management guidelines issued by the AP Government and PRED recently are given below:

Circular instructions- regarding Epidemics due to pollution of drinking water in rural areas Dated: 1.06.98

The following is the summary of the measures that have been directed to be adopted immediately, through this circular:

- Environment around the water sources to be kept clean;
- Water quality to be tested periodically and measures taken, if found bad;
- The Storage sites be cleaned frequently;
- Chlorination be done regularly;
- Pipeline leakage be found and immediately plugged, to prevent entry of external water;
- Alternative supply of safe water, in case source water is found to be contaminated;
- Co-ordination with the gram panchayat and health department during Epidemics;
- The Executive Engineer (RWS) to be held responsible for any outbreak of water-borne diseases.

Order dated 21.01.81 - Protected Water Supply - Provision of drinking water to the protected water supply schemes in rural areas from Irrigation canals free of cost.

The Order directs that wherever water supply is considered from the major and medium irrigation canals to meet with the drinking water requirements of the habitations situated along the water course, the water from such canals should be supplied free of cost.

Order dated 3.1.84 - PWS - Provision of drinking water to the protected water supply schemes in rural areas from Irrigation canals free of cost -

extension to include Minor Irrigation sources.

Order dated 27.1.90 - RWS - Material's management - Procurement of different materials

This memo authorises the SEs , PR, NAP and Technology Mission to place indent for materials required for PWS Scheme, on requisition from the Executive Engineers, and after approval of Circle level Purchase Committee. It further directs that:

- The indent for the Pumping main pipes be placed after establishing the Source, and after entrusting the work for Storage for execution.

Order dated 4.10.90 - Works - PWS Schemes Execution - Entrustment to Gram Panchayats.

This memo streamlines the procedure for entrustment of execution works to the Gram Panchayat / Village Development Committees / Contractors or to the Department. It spells out the financial powers for award of works on nomination basis.

Order dated 21.10.93 - Natural Calamities -Cyclone and Floods - Preventive measures for DW facilities.

The Memo calls for the action taken by the field engineers in respect of the instructions issued through earlier Memos. The issues involved were:

- Keeping Overhead Tanks full on receipt of Drought/Flood warning;
- Keeping Water Tankers full;
- Strengthening of the weak bunds of all the MI sources and strict vigil and patrolling of the bunds by villagers to avert any breaches.

Order dated 19.12.96 - Guidelines for design of Centrally sponsored RWS programmes and Externally aided projects.

This Memo circulated the following:

- Criteria for coverage of problem habitations;
- Revised design guidelines for implementation of the Centrally sponsored Rural Water Supply programme, under the Rajiv Gandhi National Drinking Water Mission;
- Guidelines for the Externally aided projects (Bilateral Assistance)

Order dated 8.7.97 - RWS - Maintenance of PWs/ PWS Schemes - Control of water-borne diseases in the ensuing monsoon.

The memo issued instructions regarding preventive measures to be taken on a war footing to check any out-break of water borne diseases. The measures directed referred to action on regular water testing; clean surroundings; proper drainage facility around standposts and HPs; ensuring good quality water from treatment plants; proper disinfection of all water supplies; leakage detection and control, and regular cleaning of all storage.

Order dated 21.2.98 - Laying and Jointing of AC and PVC Pipes.

This Memo issued the guidelines regarding precautions to be taken while laying and jointing AC and PVC pipes.

Order dated 10.7.98 - RWS - SMP Projects - Execution of pipelines - Laying, jointing and testing of pipelines.

This Memo issued instructions on the need for proper testing of pipelines as per orders issued earlier.

Dated 1993 Works - PWS Schemes - laying and jointing of pipelines -

This memo issued instructions regarding proper laying and jointing of AC and PVC pipelines, as per the IS Code 6530-1972 and IS Code 7634-1975; also keeping in view the CPHEEO Manual.

Special Programmes

The GOAP has promoted a people's movement for reconstruction and revitalisation of society, through what is known as the "Janmabhoomi" programme. This programme is aimed at fostering the core values of Spirit of sacrifice; Diligence; Honesty; Self-help; Self-respect; Quest for excellence and sense of fulfilment, through the following principles: People's participation; Transparency and accountability; Equity and equality; Innovation and sustainability, by adopting the interventions of environment building; Promotion of grassroots people's institutions; Strengthening of local bodies; Training and orientation and administrative reforms. The core work

areas identified by the GOAP are Community Works, Primary Education, Primary Health and Family Welfare and Environmental Concern, through a responsive Government.

4.1.2 Protection

The following measures are specified by PRED for protection of rural water supply schemes:

Ensuring water quality

- Testing facilities should be provided at each water works
- Residual chlorine to be monitored regularly
- Bacteriological tests are also to be carried out periodically

Training and IIRD

PRED has established a "Research, Development and Training Centre" at Hyderabad. This centre conducts regular training programmes for sector professionals as well as Grass root level trainees. PRED has a well established Geological Wing at Hyderabad, known as CARD, which also arranges short term training programmes (2 to 3 days) related to Scientific Source Finding and Source Development. In addition it has GIS a facility installed and in use.

4.2 Legislation

A review of the important legislation relevant to Water Supply, presently in force in Andhra Pradesh State is given below:

4.2.1 The Environment (Protection) Act, 1986

This is a central act. The following issues are, as an indication, covered under this Act:

- Rules to regulate environmental pollution
- Prevention, Control and Abatement of Environmental Pollution.
- Persons carrying on Industry, operation, etc., not to allow emission or discharge of environmental pollutants in excess of the standards.
- Persons handling hazardous substances to comply with procedural safeguards.
- Powers of entry and inspection.
- Power to take sample and procedure to be followed in connection therewith.
- Penalty for contravention of the provisions of the Act and the rules, orders and directions.

4.2.2 The Andhra Pradesh Farmer's Management of Irrigation Systems Act, 1997

The Act covers the following main issues:

- Delineation of water users area and constitution of an association
- Election of president and members of the Managing Committee of Water Users Association
- Delineation of Project area and constitution of project committee
- Constitution of sub-committees in farmers organisation
- Farmer's organisation to be a body corporate
- Functions of Water User's Association
- Power to levy and collect fee

Andhra Pradesh Water Tax Act 1988

This ordinance contains the following issues:

- Power of the Govt. to levy and collect water tax.
- Notification of Govt. sources of irrigation.

- Determination of water tax.
- Mode of payment of water tax

Andhra Pradesh Ground Water (Regulation for Drinking Water Purposes) Act, 1996

This Act is meant to regulate the exploitation of ground water for the protection of public drinking water sources. It covers the following issues:

- Licences to dig wells
- Distance criteria for source protection
- Power to declare water scarcity area
- Declaration of watershed as over exploitation
- Prohibition of exploitation of water
- Closure and disconnection
- Payment of compensation

4.3 Institutional Responsibilities

4.3.1 Planning and Management

Panchayati Raj Engineering Department(PRED)

Introduction

PRED is a technical department involved in implementation, operation and maintenance of developmental works like roads, buildings, bridges, MI tanks and water supply systems in rural areas of the Andhra Pradesh State. The department's objective is to improve the living conditions of the rural communities, by providing basic infrastructure facilities. In the field of rural water supply, the department's priority is to provide reliable and sustainable protected water supply systems to the problem habitations, which are affected by water quality problems like excess fluoride and salinity and by inadequate supply of water.

PRED functions under the State Ministry of Panchayati Raj and Rural Development, Government of Andhra Pradesh with Principal Secretary as the Administrative Head of PR and RD Department in the Secretariat. Within the PRED, the Department has two separate wings for Rural Water Supply and the other PR works under the control of an Engineer-in-Chief. At the Mandal and the District level, PRED is administratively responsible to the Mandal Development Officer and the Chief Executive Officer, respectively. Technical accountability follows the lines of hierarchy within the PRED.

Members from CGWB and NGRI are included in Technical Appraisal teams raised under the Rajiv Gandhi National Drinking Water Mission programme with a remit to appraise the projects proposed by PRED, for coverage of quality problem habitations in the State.

HRD Activities of PRED

In order to develop Departmental Human Resources, the Department has established its own Training Wing, known as "Research, Development and Training Center" to conduct in-house training programmes for Geologists, Engineers, Water Analysts in the Department, with the help of external resource persons, whenever required. With the advent of the Technology Mission for water supply, the HRD activities have been intensified. At present, the Department has an Executive Director(Chief Engineer cadre) for HRD in the rural water supply sector in the State. Presently, the HRD wing is conducting the following programmes:

- Grass root level training for motivators in villages for easy maintenance of Hand Pumps
- Training of trainers for Departmental Engineers who conduct Grass root level training programmes.
- Sectoral Professional training to middle level and first level Departmental Engineers under the RWS Sector.
- Induction training programme for newly recruited Assistant Executive Engineers.

- Training to Pump Mechanics in the field of Hand Pump Maintenance.
- UNICEF Sponsored training programmes on Hand Pumps to Departmental Engineers at all levels and Geologists.

Central Ground Water Board (CGWB)

Being the apex body, CGWB has been functioning as the custodian of Ground Water in all matters related to exploration, assessment and guidance in development and planning. The department maintains rainfall data and water level fluctuation data, by drilling exploratory bore wells and estimates ground water potential. It assists the PRED department in source finalisation in problematic areas.

National Geophysical Research Institute (NGRI)

NGRI is a CSIR unit with Headquarters at Hyderabad. It is a centre for advanced, basic and applied research in Physics, related to the Earth and its interior. The Institute is taking up an artificial recharge and retrieval project for decreasing fluoride levels in the ground waters, on an experimental basis, in co-ordination with PRED with joint support from the Rajiv Gandhi National Drinking Water Mission.

National Remote Sensing Agency (NRSA)

NRSA is an organisation in the Department of Space, Government of India, with headquarters at Hyderabad. It deals with reception, processing and production of satellite data. It is the nodal agency for implementation of the Natural Resources Management System. It has branch offices to impart training to help foster satellite data usage. It provides data to PRED for proper study of the geology, watersheds and water resources.

National Institute for Rural Development (NIRD)

NIRD is a National Institute for Rural Development and the only one of its kind in India, located in Hyderabad. It is mainly working for upgradation of information, development, interaction and training of officials associated with rural development. NIRD imparts training to departmental engineers in the field of Community Participation in rural development.

Water and Land Management Training and Research Institute (WALAMTARI)

This is a State Government Institute to cater to the training needs of newly recruited and in-service officials from the Irrigation Department.

Andhra Pradesh State Remote Sensing Application Center (APSRAC)

APSRAC is a State Government organisation under the Department of Science and Technology. It disseminates the satellite data usage and prepares maps for various departments in the State. PRED co-ordinates with this organisation for identifying the ground water potential in the rural areas.

State Ground Water Department (SGWD)

The State Ground Water Department is part of the Ministry for Minor Irrigation and is closely associated with Scientific Source Finding for Water Supply Schemes, being the nodal agency for all matters related to exploration, assessment and management of ground water. All the problematic habitations, which are devoid of sources, being in the drought-prone districts, are being referred to the State Ground Water Department by PRED. The department also drills exploratory wells and monitors the ground water level fluctuations in the State.

Water Testing Laboratories, other than those in PRED

Institute of Preventive Medicine (IPM)

Under IPM, there are four Regional Laboratories at Guntur, Kurnool, Vizag and Warangal. At Eluru and Tirupathi also, IPM has water testing facilities. IPM is a Health Institution, which externally monitors the

following:

- Food Analysis
- Water Analysis (Chemical and Bacteriological)
- Blood Investigations
- Pathological Investigations
- Blood Banking
- Anti-rabies vaccination

National Environmental Engineering Institute (NEERI)

NEERI is a National Institute, which carries out research in water treatment, waste water management, air pollution control, industrial pollution control, solid waste management and other activities, related to environmental preservation and. The expertise of NEERI, relevant to PRED, is utilised for better running of the rural water supply systems. NEERI has a full-fledged Laboratory facility for water analysis.

Zilla Parishad

Under the AP Panchayati Raj Act, 1994 , the following local bodies were re-formed:

- Zilla Parishad at the District level
- Mandal Parishad to cover group of villages (having total population of 30,000 approx.)
- Gram Panchayat, covering a revenue village or a hamlet

The Zilla Parishad has overall administrative control over the Mandal Parishads. The ZP has Standing Committees of a functional nature, delegated with powers, as well as a General Body. Zilla Parishad's Standing Committees are empowered to sanction works, under the State Plan, up to Rs. 5 lakhs and works up to Rs 10 lakhs are cleared by the General Body. Beyond this amount, GOAP has to issue administrative sanctions. All the Executive Engineers of PRED, working in the districts, function under the administrative control of Zilla Parishads.

Zilla Parishads review all the developmental works in the District, covering the rural areas. The administrative structure of the Zilla Parishad has a CEO under the ZP Chairman and Executive Engineer (Works) and Mandal Development Officers under the CEO.

Health Department

In rural areas where there are no public water supply systems, the Health Department has been entrusted with the responsibility of chlorinating all the water sources, ensuring that at least 0.2 to 0.5 ppm of residual chlorine is available, after a contact period of 8 hours. The department has also taken up a massive programme on health and hygiene related issues, throughout the State, to minimise water-borne diseases. The health department has also established water testing laboratories at the following places:

- Ongole
- Cuddapah
- Nizamabad
- Khammam

Ministry of Water Resources

Planning, development and management of water resources and hence of the river basins come under the purview of the Central as well as State Governments. Thus there is a two-tier Organisational set up; one functioning under the State Government and the other functioning under the Central Government. At the Center, the Union Ministry of Water Resources' role and activities include the overall planning, policy formulation, co-ordination and guidance in respect of the sector as a whole. This supports the activities of the State level Water Resources Ministries which carry out the similar activities of overall planning, management and development of water resources on the river basins within their state.

5. Availability of Water Resources

5.1 Reliability and Availability of Data

The data utilised during this study were provided readily and freely by all organisations involved in development of the water resources of Andhra Pradesh. In relation to surface water resources the State Irrigation Department has recently started to produce excellent internal summary reports for each district of the state covering the stage of development of surface resources and the future plans. In addition the Central Water Commission in Delhi has an overview document for the country as a whole which contains excellent information up to 1996. The underground resources of Andhra Pradesh are also well covered in recent documentation provided for the study by Central Groundwater Board and the State Groundwater Department. There is, however, no one body with authority for planning and management of all the water resources of the state and as a result the whole picture may not be accurately presented by the separate data sets. Reliability of data relates to the frequency of capture and the reliability of the capture mechanisms. Improvements in state wide resource data management will result from current World Bank interventions through the National Hydrology Project but there is a more fundamental requirement for water resource data management on a microwatershed basis, which is currently lacking.

5.2 Sources of Information

The following listing is a guide to the availability of information which is comprehensive, condensed into a limited number of sources and provides an up-to-date picture of water resources in the State of Andhra Pradesh. PRED also produces much recent information in-house which was also utilised for the study and was freely available.

- *Union Ministry of Water Resources - Statistics Directorate, Performance Overview and Management Improvement Organisation* - Water and Related Statistics - **February 1995**

  This publication covers Water and Related Resources, Resources Utilisation, Production Related Performance and Related Efficiency, Financial Performance, Social and Environmental Performance and Organisational and Human Resources.

- *AP State Ministry of Major Irrigation - Irrigation and Command Area Development Department* - Irrigation Profiles of all State Districts - **July, August 1998**

  This publication covers a general description of each district, summary details of major surface sources, on going major, medium and minor irrigation projects, water users associations, future plans and drainage works.

- *Central Ground Water Board* - Ground Water Year Book for the Years 1994 to 1997 - **August 1997**

  This report covers physiography, hydrometeorology, hydrogeology, ground water scenario and ground water quality for the whole state.

- Full topographical information is available for the state at 1:250,000, 1:50,000 and 1:25,000, although the 1:25,000 maps cover only about 20% of the state. Substantial remote sensing and hydrogeomorphological maps and interpretations exist, covering all districts, provided by the National Remote Sensing Agency in Hyderabad. Watershed maps covering the entire state at 1:250,000 are currently being procured from Andhra Pradesh State Remote Sensing Applications Centre, Hyderabad.

- The Andhra Pradesh State Directorate of Economics and Statistics produces an Annual Handbook of Statistics for the State about two years after the events and also 6 monthly Economic and Statistical Bulletins (current edition is **December 1997**).

5.3 Water Supply Problem Habitations

5.3.1 Fluoride affected habitations

Map 6 illustrates the fluoride affected habitations across all districts of the state. From this it can be seen that out of 12,068 affected habitations, the highest concentrations were found in the districts of **Prakasam, Anantapur, Nalgonda and Warangal.**

5.3.2 Brackish and Salinity affected habitations

Map 6 also illustrates the brackish affected habitations across all districts of the state. From this it can be seen that out of 4148 affected habitations, the highest concentrations were found in the districts of **Srikakulam, Visakhapatnam, East Godavari, Nellore and Chittor.**

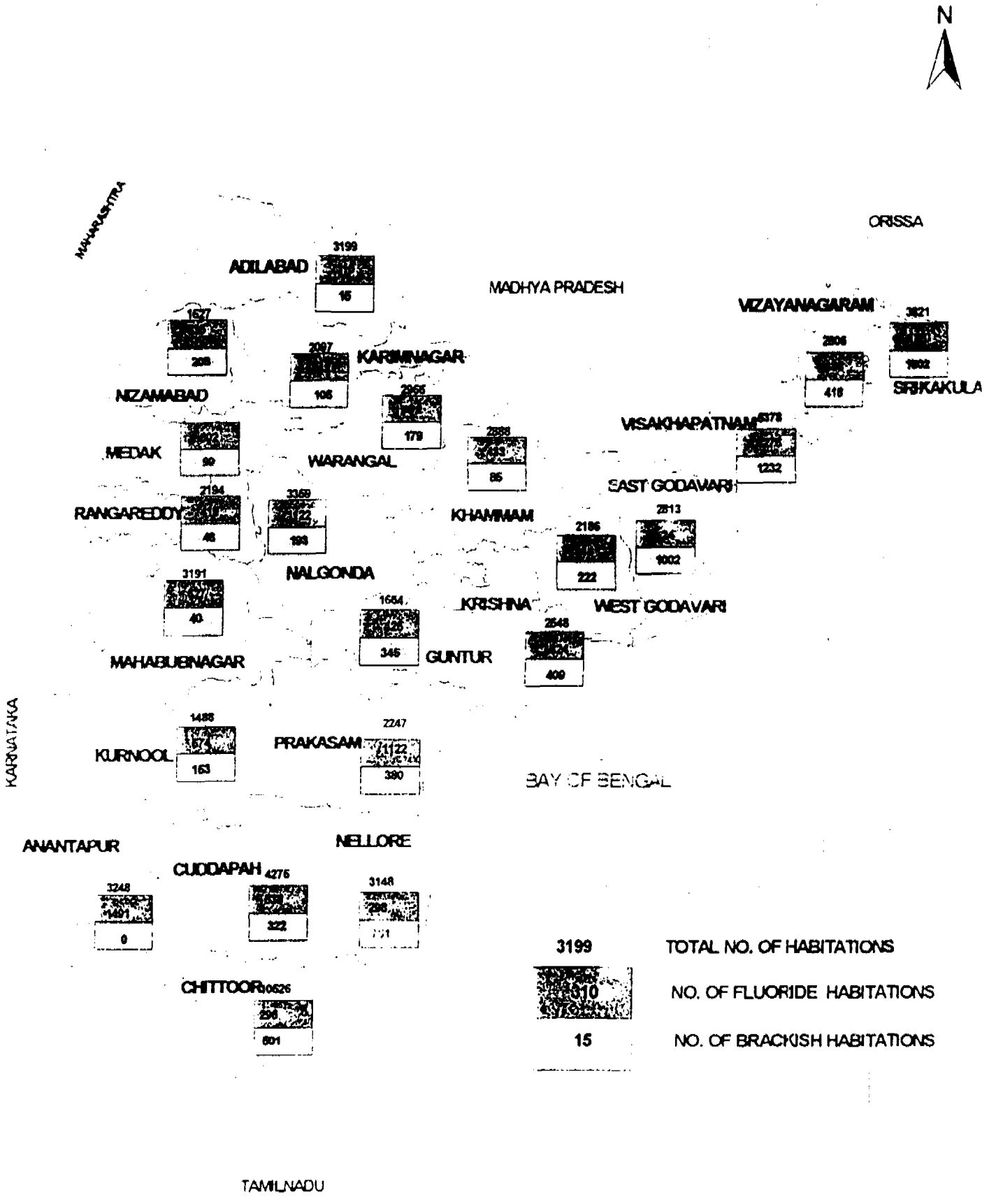
5.3.3 Partially Covered Habitations

Table 5.1 summarises the current state of affairs with respect to problem habitations across the whole of Andhra Pradesh and highlights the partially covered habitations. From this it can be seen that out of 69,732 habitations. 26,976 are partially covered and the total balance problem habitations stands at 38,180, with the highest concentrations in the districts of Nizamabad, Warangal and Medak.

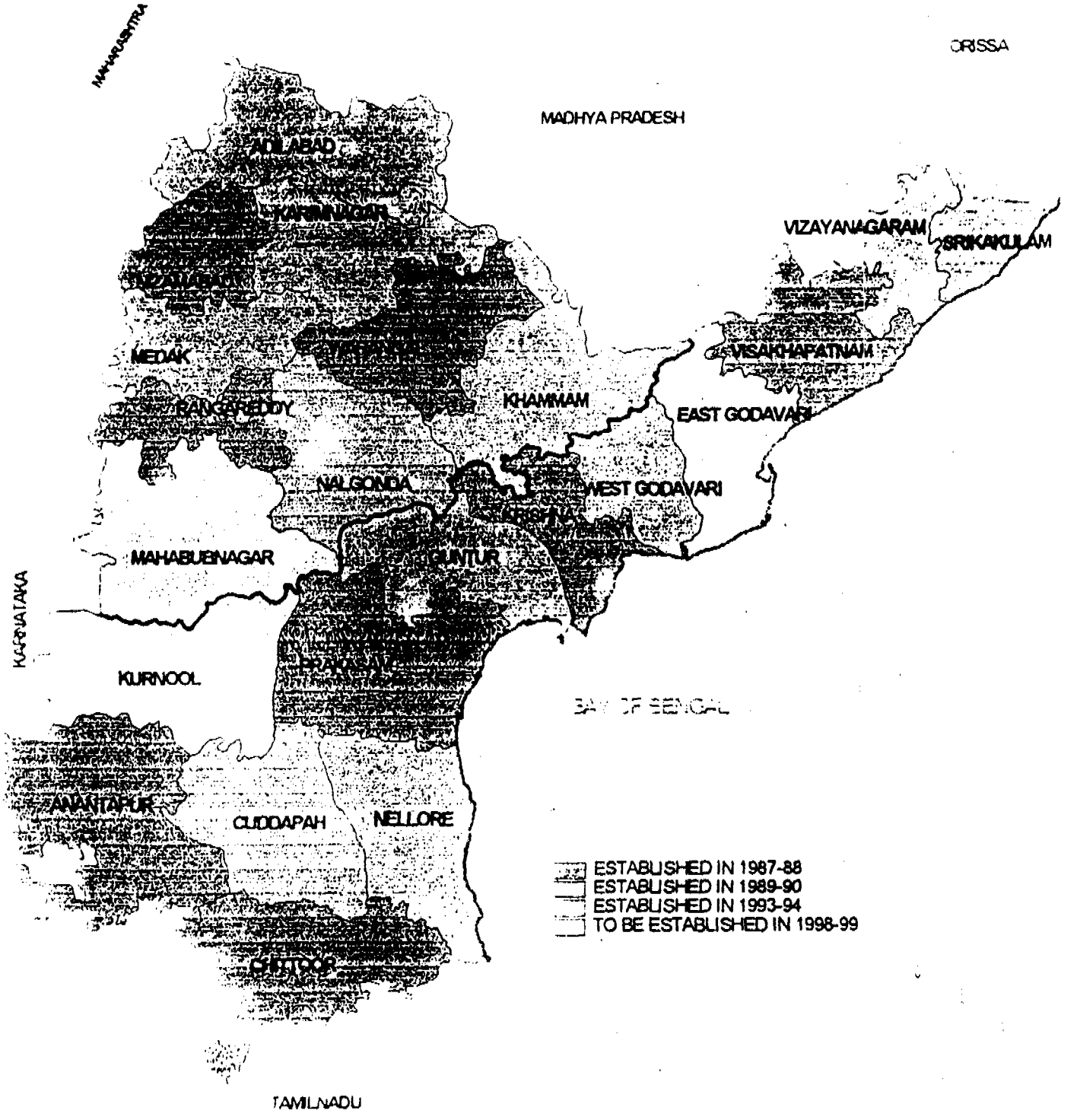
5.3.4 Water Quality Monitoring

Map 7 illustrates the district level coverage of water quality monitoring laboratories across the state.

Andhra Pradesh
Habitation wise details of Quality problems
Map 6



Location of Water Quality Monitoring Laboratories in Andhra Pradesh
Map 7



6. Allocation of Water Resources

6.1 Summary of Current Situation

6.1.1 Problem Habitations

Out of a total of 69732 habitations in the state, 38,180 habitations are currently considered not to be provided with safe drinking water throughout the year. The worst affected districts, based on the statistics provided, appear to be Nizamabad (92% affected), Warangal (88% affected), Nalgonda (83% affected), Kurnool (79% affected) and Karimnagar (77% affected) (see Table 5.1).

6.1.2 Approach Adopted

Allocation from irrigation storage and canals

With discussion and agreement from Irrigation Department, allocations are made from irrigation storage, via canals, for rural water supplies. To overcome the close down of canals for routine summer maintenance, summer storage tanks are constructed by PRED to hold 60-90 days supply in reserve. The water retained in these tanks does, however, suffer from the levels of pollution present in the canal water and there is much evidence of algal growth. This impacts on the slow sand filtration units which are attached to the summer storage tanks and used before the water goes into supply. New irrigation schemes constructed by Irrigation Department include a theoretical 10% for water supply.

Across the state many thousands of MI Tanks exist, which are basically designed to irrigate small village level command areas. In the three most northern districts of Coastal Andhra Pradesh, 20,000 MI Tanks exist. These tanks should also act as percolation tanks which would recharge groundwater reserves, but because of silt build-up and sealing of the bottom of the tanks, recharge is very limited. The silting process also reduces storage depth and encourages the storage over a progressively widening area, thereby enhancing the losses due to evaporation. Little desilting work is carried out either by GOAP or the GP. Techniques do exist to encourage more effective recharge from these tanks, but there is little evidence that they are used for this purpose in the state.

Demand levels

Demand levels are not generally discussed with the village population. PRED use design norms of 40 lpcd in single habitation piped water supply schemes, 55 lpcd in CPWS schemes which cover a number of habitations and have private connections as well as stand-posts and 75 lpcd in Urban Piped Water Supply Schemes where treatment and distribution losses are accounted for in a limited way and where a higher proportion of house connections is assumed.

Control of private wells

Private wells exist throughout most village areas, mainly to supply supplementary water to the Kharif crop and full water to a Rabi crop together with water needs of animals. Drinking water will be taken from irrigation wells if the drinking water source in the village fails even when distances are great. Although legislation exists in Andhra Pradesh to control well construction within a radius of influence of a drinking water source, the control is not being used. The majority of drinking water sources go dry in summer due to derogation by irrigation wells and the consequent lowering of the water table.

Rural water pricing levels

The greatest price influences on rural water supply are the very low, horsepower based charges for electricity used for agricultural pumping equipment and the uneconomically low and non-volumetric charges for canal supplied surface irrigation water. Water use efficiency is not encouraged by this pricing scenario and directly impacts on resource availability for drinking water. The willingness to pay for drinking water at sensible economic levels is undermined by these distorted pricing policies. Similarly, the National Water Policy, which gives drinking water first priority, is also undermined by these agricultural pricing policies.

District	Total Habs.	Problem habitations						Balance P.C Habs	Total Balance Habs	
		Fluoride		Brackish		Balance habitations				
		Total	Covered	Total	Covered	Fluoride	Brackish			
Srikakulam	3821	128	3	1802	865	125	937	1406	2468	0.645904
Vizianagaram	2806	185	48	41[illegible]	68	137	350	948	1435	0.511404
Visakhapatnam	5378	276	74	1232	372	202	860	2093	3155	0.586649
East Godavari	2813	24		1002	627	24	375	1366	1765	0.627444
West Godavari	2186	14	14	222	209		13	780	793	0.362763
Krishna	2548	624	333	409	161	291	248	1138	1677	0.658163
Guntur	1654	425	168	345	154	257	191	809	1257	0.759976
Prakasam	2247	1122	490	380	207	632	173	729	1534	0.682688
Nellore	3148	298	176	761	375	122	386	1405	1913	0.607687
Chittoor	10526	296	140	501	391	156	110	2459	2725	0.258883
Cuddapah	4275	538	172	322	191	366	131	660	1157	0.270643
Anantapur	3248	1491	1047			444		975	1419	0.436884
Kurnool	1488	574	534	153	153	40		1145	1185	0.796371
Mahabubnagar	3191	627	157	40	10	470	30	1407	1907	0.597618
Ranga Reddy	2194	419	164	48	23	255	25	991	1271	0.579307
Nalgonda	3359	1122	337	193	79	785	114	1911	2810	0.836558
Medak	2173	602	255	99	5	347	94	949	1390	0.639669
Nizamabad	1527	535	194	208	65	341	143	932	1416	0.927308
Warangal	2966	1382	401	179	106	981	73	1576	2630	0.886716
Khammam	2888	433	227	85	55	206	30	1239	1475	0.510734
Karimnagar	2097	643	231	105	20	412	85	1119	1616	0.770625
Adilabad	3199	310	70	15	12	240	3	939	1182	0.36949
Total	69732	12068	5235	8519	4148	6833	4371	26976	38180	

Table 5.1

Rural piped water supply schemes are designed on the basis of no private connections and no charge is made for stand-post supplies. Where private connections are subsequently added to PWS schemes, or included in the design of CPWS schemes, charges of between Rs 300 to 2000 are made for the connection, with materials used charged extra at cost and a monthly charge of between Rs5 and 20 per household is made and generally collected by the GP.

PRED close to Gram Panchayats

There has been, in the past, a tendency to adopt a subsidised approach to rural water supply linked to limited community participation in investment in assets, operation and maintenance and future rehabilitation or replacement. PRED was established with a much closer link to the Gram Panchayats and the responsibility for operation and maintenance for PWS and CPWS schemes is theoretically with the GP. In fact the GP's rarely accept allocating funds for O&M, pay unskilled operators very low wages, allow private connections beyond those provided for in the scheme design and it is often left to PRED to provide support. The result in many cases has been poor service, lack of timely maintenance and schemes becoming inactive. The communities have, as a result, developed little faith in the government bodies involved, and revert often to unhygienic traditional sources or are involved in carrying water over long distances.

Land

PRED is limited to constructing water supply sources on government land within each village area and does not have access to private land. This limits hydrogeological and geophysical exploration and causes physical problems with the technique necessary for geophysics due to a lack of open area to carry out the work within a tightly packed housing area in the village.

6.1.3 Watershed and Catchment Degradation

Poor land management is a root cause of many of the water resource management problems that exist across India. Increases in rural population have resulted in the deforestation and over-grazing of watershed upland areas, resulting in erosion, siltation and land degradation. The ability of upland areas to slow run-off and develop percolation and thereby increase groundwater resources is restricted as vegetative cover is removed to meet the energy needs of the rural populatio . This impacts directly on cropping potential and accelerates groundwater depletion, reflecting in the early drying up of traditional village water source wells. Much work has been done throughout India to understand, implement and document the local level catchment management techniques that can dramatically improve water resource utilisation in rural watersheds. The widespread adoption of these techniques is not yet happening in Andhra Pradesh.

6.1.4 Traditional Sources

Most Indian villages retain their traditional sources of drinking water although many are in disrepair and are the repositories of household waste. In some villages, when the newly installed government system for water supply fails, the traditional source is reverted to with consequent problems of water borne diseases.

The traditional source may have been replaced by a better hand-dug well and then by a hand-pump and later by a tubewell. More recently a local piped water supply system will have appeared and now a comprehensive piped water supply system elevated storage reservoir is found on the edge of the village. Tremendous assets have been poured into rural water supply in India - over 2.6 million hand-pumps as an example. But few systems are sustained through summer. Only on very rare occasions are any of these systems rehabilitated before a new system is considered. Nevertheless, village water sources are being replaced by more expensive imported water from remote sources and the village still retains the potential to provide a proportion, if not all, of the actual demand, at a lower overall cost.

6.2 Data Gaps

6.2.1 Hydrological Data

Significant gaps exist in measurement stations for groundwater level monitoring, water quality monitoring, river flow at sub-catchment level and for general meteorological data, particularly rainfall. Current data quality also needs improvement as much data collection is manual and with limited frequency. Much repetition of data collection occurs with variable spatial bases - on the one hand a district will be the unit area and on the other hand a geographical sub-basin will be the data related area. Little co-ordination between data collecting agencies occurs and a commonality of reason for data collection does not exist. Access to data can be very restricted, particularly where inter-state disputes exist in relation to allocation of major river basin resources. **An integrated approach to hydrological data collection is required on a highly professional basis by one authority, with unrestricted access to all the concerned authorities.**

6.2.2 River Basin Modelling

River basin modelling is a very limited activity and fully integrated basin development models are not produced. In the longer term **fully integrated basin development models, which cross state boundaries, are essential for sustainable water resources development planning.**

6.2.3 Monitoring

Performance monitoring of rural water supply systems is rarely carried out over a long term period and the sustainability of water supply assets is only revealed during infrequent surveys (such as the Rajiv Gandhi Drinking Water Mission Survey of Rural Habitations). Monitoring of irrigation water use and efficiency is also inadequate.

Monitoring is invariably carried out manually and little or no use is made of automatic data logger monitoring systems which would give much better information about rainfall distribution over time and the spatially linked responses in groundwater storage and run-off. **Better performance monitoring of installed water supply schemes should therefore be implemented to provide planners and designers with appropriate feedback.**

The problems of fluoride, salinity and brackishness in Andhra Pradesh point to the need for a comprehensive integrated quality monitoring system. Surface waters also contain high fluoride levels and industrial pollution is having a major impact on surface and groundwater in certain districts (Medak for instance). Most foods produced in Andhra Pradesh, because they are irrigated with fluoride containing water, also contain high levels of fluoride. This is passed to the population in the food chain who receive cumulative doses through both food and water. Many papers and research projects have high-lighted the problem but because of poorly managed data collection the interpretation of the data produces widely varying conclusions.

6.2.4 Needs Assessment

No attempt is made to assess the actual water supply needs of a village, the state of existing sources or the development potential of a village. Designs are carried out on the basis of norms related to the village population, the projected population 20 years beyond the anticipated completion date of a new supply scheme. Although this simplifies the activities of the designers of schemes within PRED it totally ignores the fact that small amounts of money not spent at the planning and design stage to determine actual needs can have tremendous implications at a later stage of construction when "cost to change" is so great. A full needs assessment should therefore be carried out before any scheme is designed.

6.2.5 Local Sources

Detailed information concerning local village sources is not maintained. Sustainability of a source through the summer period is not monitored, the data presented on "seasonal sources" is highly confused and the change in quality with time is similarly not known with any degree of accuracy. Yield of a source, the impact of adjacent irrigation abstractions and the seasonal movement of groundwater is also poorly understood. Although techniques of remote sensing and geophysical investigation are available in Andhra Pradesh, insufficient use is made of them and the data they provide, to optimise location of new groundwater sources. Too often the

influence of the village sarpanch is allowed to over-rule the indications from data interpretation, with the resulting high rates of failure and poor sustainability. **Better information should therefore be maintained on source sustainability.**

6.2.6 Use

Data is not collected to identify actual use at village level for drinking, washing, bathing and cooking and the quality necessary and acceptable for these activities. Many widely different figures are quoted from international publications but little grass-roots verification is carried out. The Chief Minister, when recently asking for the amount of pure drinking water needed by an average person each day in the state, could not readily be told what the accepted figure was.

The actual animal water requirements are also not well understood but are probably more important to an owner than his own water requirement. Animal demands for drinking continue at a high level through the summer period when irrigation is discontinued following drying up of sources. Cattle populations frequently match or exceed human populations, yet, adequate provision is never made in system designs.

There is therefore an urgent requirement to understand village water needs and priorities through adequate data collection.

6.3 Problems Identified

6.3.1 Study Workshops

During the study 1 day workshops were held in each of the three regions of Andhra Pradesh at Hyderabad, Tirupati and Visakhapatnam to consider the water resource problems in the state. Over 150 representatives of PRED, State Groundwater Board, Irrigation Department and Zilla Parishads attended the workshops. UNICEF and DFID were also represented. The basic programme and list of attendees is attached in Appendix 2.

In the first part of the workshop regional representatives presented the geological setting, the water resource potential and utilisation, water quality and its impact and a summary of some of the main problems felt in water supply. This was followed by group discussions on problems under separate headings of: Source; Quality of water, design, specification and construction; Operation and Maintenance; Sanitation; Management. The groups then carried out a process of prioritisation of problems and presented this to the full workshop through a group leader. The presentations of each of the group leaders were then considered in an integrated way to bring together common threads and highlight the priority problem with a comprehensive definition. An attempt was then made to reverse the problem into a guiding approach solution. The problems are listed in Appendix 2.

7. Recommendations for Future Rural Water Supply

7.1 Basic Principles

7.1.1 Water as the key resource

Water is the key resource in ecosystem management, followed by the complimentary resources of land and people. The importance of water in India is all the more so because of the monsoon related pattern of the rainfall regime and the concentration of supply of the resource into a short period of about four months over the majority of the country. Unfortunately the supply is characterised by a high degree of variability, firstly, over the years and, secondly, for a given year, over time and space.

7.1.2 Judicious use of water

In conditions of scarcity it is evident that judicious use of the resource is essential. Disputes arise when the perceptions of one section of society regarding needs are in conflict with the water demands of other sections which have been satisfied in the past through traditional or "riparian" rights.

There is therefore a requirement to reach a concensus on norms for determination of needs and for allocation to various uses. Fixing priorities amongst a variety of needs is essentially a matter of attitudes and values at village level. Conflicts are difficult to reconcile if there is no common understanding of the needs versus the availability. A participative approach is necessary to evolve an understanding based on a scientific appraisal of resource availability within a village area and any constraints that exist, and the ways and means of overcoming these constraints by optimising use of the resource in an agreed co-operative manner.

7.1.3 Water as a natural resource

Prior to the development of irrigation, and in particular the use of pumping plant and availability of the necessary energy to drive the pump, water availability was the reason why villages developed in a particular location. In a majority of watersheds the needs of the population were satisfied without importing water over long distances. It can be said, therefore, that the naturally occurring water resources of a village would be sufficient to provide basic subsistence needs, apart from irrigation for other than supplementary needs during the Kharif season, for all sections of society in the village. Irrigation has upset this natural state of affairs as the figures for growth of irrigation pumpsets in the state shows:

YEAR	IRRIGATION WELLS WITH PUMPS
1960	17963
1965	57225
1975	283590
1985	724715
1995	1642993

7.2 Project Framework

7.2.1 Project Goal

The Project Goal would be Poverty Alleviation through improved livelihoods and health, contributing to a Super Goal of Poverty Elimination in the State of Andhra Pradesh.

7.2.2 Project Purpose

The Project Purpose would be that Villagers gain access to equitable, appropriate and sustainable water and environmental sanitation services

7.2.3 Project Outputs

Minimum Needs Supplied

The subsistence water requirements of a rural family can be divided into the following main components:

- Domestic needs for drinking, washing and cooking and to support any sanitation system
- Water for livestock, fodder production, biomass production for energy and, if the family is land holding, water to supplement rainfall for the kharif crop; to ensure subsistence for the family throughout the year.

Any scheme should provide all village members with this minimum quantity of water as a right and optimally at no cost until fodder and biomass producing areas in the village are established, protected, and become self generating. Demands for private water connections and much higher per capita supplies should be charged for at true economic rates or not at all.

Resources Evaluated Fully

Given the desire for participative management of water resources, the study of the water balance of a village within a watershed setting is not a matter of academic interest but a practical requirement arising out of planning for livelihood needs. The assessment should determine the quantity of water available for productive use and also the proportion that currently becomes evaporative loss to the watershe · The creation of upland area terraces with grass cover for fodder provision will reduce soil loss, erosion and evaporative losses and convert these into productive transpirational losses and increase groundwater percolation to lower levels. The watershed is an optimum unit for a comparison to be made between actual outflow and estimated recharge. This is not done at present but is essential for good watershed resource management. It will be necessary to monitor carefully the groundwater movement and identify the results of watershed management activities, if introduced.

An important outcome of resource evaluation is the identification of the fact that minimum needs are not being met in a village due to abstraction for irrigation for economic gain. The need to redress this balance has then to be discussed at village level and the necessity for external resources considered.

Village Developed Economically

It is important to give due consideration to the carrying capacity that is expected of a watershed. This depends on the perceptions of the people regarding their needs. It is clear that the subsistence requirements for domestic water, food, fuel and fodder must be provided, but needs should not be limited to subsistence. Today the rural poor and disadvantaged have aspirations to producing surplus resources, giving time to cultural and social activities, upgrading their skills and advancing their education. Whilst accepting that there is a limit at any one time for development, the carrying capacity should be aimed such that the legitimate aspirations of the rural society can be satisfied, especially the rural poor.

This means that village economic development is an essential element of a rural water supply project which utilises water as a social good for minimum needs and as an economic good for developmental activities.

Equity Guaranteed

As well as an objective in its own right, equity is an important precondition for the social sustainability of any production or development system. Social stability is essential for the realisation of ecological sustainability and the ecological balance cannot be maintained when a large deprived section of society is obliged to overexploit biomass resources for survival.

The ecosystem should be capable of generating the surplus needed to provide for infrastructure development and create an environment for cultural development and education, especially for the poor.

A development project should therefore provide recognition that a key factor of growth is the equitable distribution of and access to assets, inputs and benefits not only for humanitarian reasons but for the attainment of high levels of productivity.

Subsidies Re-orientated

The rural poor currently receive subsidies through distribution of subsidised essential commodities and the provision of temporary employment which burden the economy without creating longer term assets. The richer members of rural society receive subsidies which effectively promote the over-exploitation of the natural resources of the village, particularly the groundwater reserves.

There is a clear need to re-orientate subsidies and withdraw those which support degradation of the watershed. Emphasis should be placed on prioritising subsidies to support long-term development of watershed assets and help to generate resources through enhancement of productivity and yield.

Water Resource Management Principles Established

Water is a key to successful watershed management. Good watershed management requires greater retention of rainfall through improved soil management practices and on-farm water conservation, better run-off management with infiltration and erosion control measures and a land use pattern which supports these actions. Furthermore the water system itself has to be well managed including treatment of streams, regulation of groundwater use and the development of water sources and systems based on the sustainably developable water resources of the watershed. The requirement for the importation of expensive outside resources should only be considered when local resources have supplied minimum needs and been developed sustainably for economic gains, and only then on the basis of economic justification. Adverse quality of watershed resources obviously impacts on resource management decisions and may affect the need for importation or the use of appropriate treatment systems.

Careful assessment and management of the locally available water resources of a watershed must be established as a prime element of any rural water supply project which sets out to develop or augment watershed resources in a properly integrated way.

Priorities Established

The location of a project will be made against criteria set down by secondary and tertiary stakeholders. It will therefore be necessary to establish which criteria should be used for the selection process. The following list is an indicative one of some of the most important criteria:

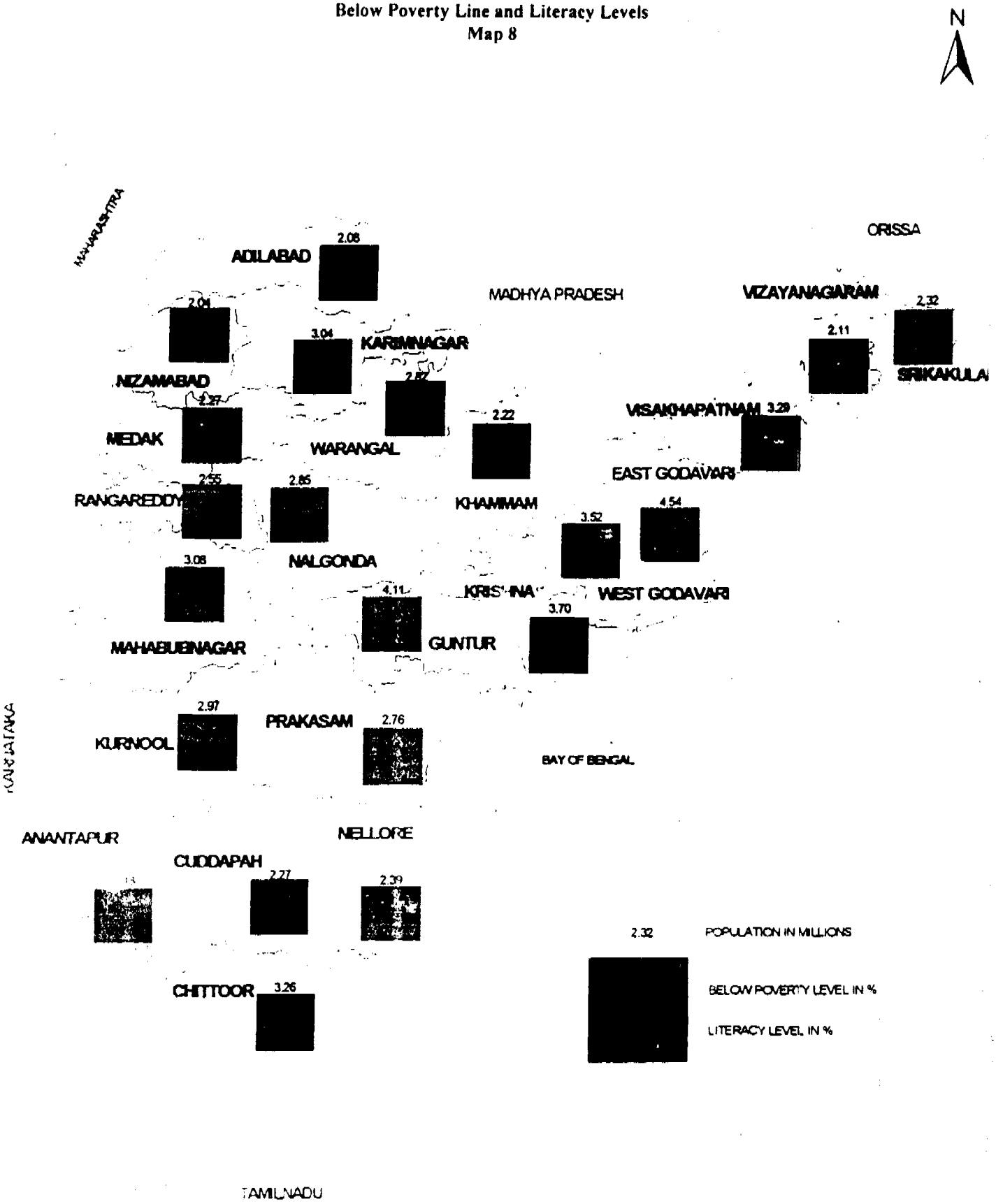
- Villages with the highest percentage of Below the Poverty Line households (see Map 8)
- Villages with the lowest literacy levels (see Map 8)
- Villages with the highest incidence of poor water quality
- Villages with the lowest level of existing water supply service
- Villages willing to contribute to costs and accept sanitation system

Independent Review Carried Out

It is evident from the visit to the villages covered by the current PRED Rural Water schemes and through inspection of existing project proposal documents prepared by PRED that the design and implementation of both groundwater based and the larger comprehensive schemes would have greatly benefited from review of policies, design criteria and methods and the field supervision of construction, prior to the start of planning process.

Reviews of both technical and social criteria appear necessary and monitoring of operation and maintenance is essential. A review of this nature is also best carried out by independent, qualified organisations on behalf of both the funding agencies and the eventual owners, the people of the watersheds.

Andhra Pradesh
Below Poverty Line and Literacy Levels
Map 8



7.3 Options

Two basic options exist for PRED to provide water supply to rural villages in Andhra Pradesh, a PWS based on a local village source with standposts and a CPWS based on a remote source and covering a number of villages with both standposts and house connections.

7.3.1 PWS based on Watershed Development

Scheme Basics

If it is possible to sustain a local source for village water supply by appropriate conservation, recharge and water harvesting methods within a watershed, and using an integrated, watershed based approach to water resource management with the agreement of the village population, then **this is the preferred option.** The scheme should be based only on the specified needs of the village and should be designed for local operation and maintenance.

Benefits

A scheme based on watershed management will have the following benefits:

- maximises water efficiency
- benefits the poor
- targets needs
- develops the village economically
- turns potential evaporative loss into transpirational benefit
- provides water at least unit cost
- centres on local resources
- involves a multi-disciplinary approach
- is in line with latest GOI, World Bank and DFID strategy
- is less capital intensive
- protects the environment and develops the ecosystem
- creates ownership of assets
- is manageable by the village
- produces fodder and biomass for energy needs
- minimises water wastage

Problems

The following problems will need to be addressed:

- requires efforts by all stakeholders
- takes time and patience
- resource assessment must be done accurately
- is open to outside interference
- needs financial and technical advice and support
- is not completely within PRED current experience and capability
- is considered by some as a "pious hope"
- requires a community approach
- schemes are many in number
- poor quality local water makes the option more difficult to sustain in certain areas

7.3.2 Comprehensive Piped Water Supply Scheme based on remote source

Scheme Basics

Where a village or group of villages does not have a local source of water which can, by whatever means, be made sustainable in quality and quantity, a scheme based on a remote source may become necessary. This will be an option of last resort because the cost of water and the impositions regarding maintenance will be difficult

for the village to manage. The scheme should be based only on the specified needs of the village and should be designed for local operation and maintenance.

Benefits

A scheme based on CPWS with a remote source will have the following benefits:

- water sources are available from irrigation storage
- principles are within PRED experience
- schemes are fewer in number
- larger schemes fit easier into major basin planning
- high quality water is possible
- may be the only option if local resources are polluted irreparably

Problems

The following problems will need to be addressed:

- encourages abandonment of existing assets
- reduces irrigated crop production if sourced from irrigation storage
- ignores water resources potential at village level
- delivered water is much more expensive than locally sourced groundwater (x 5 times)
- schemes are not considered economically viable
- maintenance of delivery system is difficult
- ownership is difficult to engender
- cost recovery is limited to a small proportion of O&M
- difficult to find right quality of staff for O&M
- leakage losses are high
- contamination is more likely with large pumped distribution systems

7.4 Additional Project Outputs

7.4.1 Need for Sub-Projects

During the study it has become clear that there are a number of areas that would benefit the whole subject of ensuring safe, sustainable rural water supplies by additional work being carried out in a very carefully specified and monitored environment in parallel with the main project. The following list is a starting point:

- The effects of annual recharge on groundwater quality determined
- Groundwater movement resulting from natural recharge assessed
- Regional and watershed based hydrographs of groundwater movement produced
- Summer Storage Tank pollution and water quality changes observed
- Minor Irrigation tank recharge systems developed
- Water supply system material and equipment quality monitoring and control methods established
- Water Treatment system design, operation and maintenance improved and rationalised

7.4.2 Integrated Water Management

PRED has responsibility for rural water and sanitation within the Panchayati Raj and Rural Development Ministry. Watershed development is the responsibility of the Commissioner for Rural Development in the same Ministry. To guarantee an integrated approach to water resource management at watershed level, which is essential for sustainable water supply, means that there is the need for a district level authority for water resource management on a watershed basis, including representatives of the above departments and including additional representatives from the Ministry of Minor Irrigation which includes both the AP State Ground Water Department, the AP State Irrigation Development Corporation and AP State Rural Irrigation Corporation.

A new project should therefore set out to develop and create this organisation and apply water resource management techniques in the project area in an integrated way and define a successful methodology for future replication.

7.4.3 Model Approach

An important output of a new project should be a **fully documented model approach** for each of the main options undertaken in order that PRED has a manual that will ensure replicability throughout the state. It is also vital that training needs are evaluated and met by appropriate training programmes as the project develops that support replicability.

7.5 Project Activities

The following core project activities are given as a guide:

7.5.1 Survey Team

A **multi-disciplinary village survey team(s) established** including:

All-Round Team Leader, Hydrogeologist, Irrigation Engineer, Water Supply Engineer, Soil and Water Conservation Specialist, Public Health Expert, Sociologist, Institutional Specialist, Economist, Senior Sarpanch(s) and BDO. Persons having multi-disciplinary skills should obviously be preferred to reduce numbers, but all areas have to be covered.

7.5.2 Survey

In the identified watershed village survey carried out to complete:

- Water resource assessment - including conservation, harvesting potential, natural storage and quality
- Water demand assessment - minimum needs, irrigation (Kharif/Rabi/Summer), livestock,
- Water infrastructure inventory
- Land use assessment, soil survey, village map, topography, ownership .
- Watershed features assessment - forest, wasteland, biomass development areas, resource conservation potential
- Population, livestock, social structure, migration and financial standing of GP
- Health, awareness and sanitation

7.5.3 Water Resource Balance

Establish Water Resource balance and variance by analysis of available data and correlation with on-the-ground verification within the micro-catchment.

7.5.4 Awareness

Round-table meeting of village heads and survey teams to explain the results and summarise:

- Data synthesis and a summary of the findings across the watershed
- Assets and resources of the watershed
- Needs as identified
- Requirement for re-allocation or prioritisation
- Potential for Village Economic Development
- Cost to Provide
- Revenue Sources to sustain during establishment and stabilisation of the watershed
- Outline development plan
- The need for external resources
- Village contribution during construction, operation and maintenance

7.5.5 Project Planning

- Assess Project Outputs, Activities, Risks and Assumptions
- Establish Project Plan
- Discuss/Modify plan at village level within overall watershed framework
- Develop awareness of changes/benefits/potential

7.5.6 Project Implementation

- Set up Project Management Unit as an active field unit only.
- Establish Activities/Responsibilities/Targets/Milestones for all active stakeholders
- Monitor Project - Technically, Financially and programmewise - from outside.
- Re-assess project targets, replan, advise, involve at village level only.
- Assess physical achievements and estimate village economic development benefits in terms of alleviation of poverty levels.
- develop a replicable, documented model.
- develop a district level integrated water resources management authority

APPENDIX 1

VISIT PROGRAMME

1. Visit to Delhi and Andhra Pradesh from 5th to 17th July 1998

Sunday 5th July

Travelled from UK to India

Monday 6th July

Meeting at WSO, DFID, New Delhi with Brian Baxendale to discuss the programme and arrange the initial meetings in Hyderabad with Panchayati Raj Engineering Department.

Meeting with Alison Barrett of the Urban Poverty Office to discuss experience in Andhra Pradesh.

Travel to Hyderabad

Tuesday 7th July

Preliminary meeting with Brian Baxendale and the Scott Wilson team, Jim Baldwin; S N Bhatnagar, Water and Sanitation Engineer; and A V Appa Rao, Chief Engineer (Retired) Andhra Pradesh Irrigation Department.

Meeting with Engineer-in-Chief, Panchayati Raj Engineering Department, Mr Venkateshwarlu together with his Chief Engineer (Water Supply) G Narasimham; Executive Engineer (Design), K Sampath Rao; and M Venkata Swamy, Joint Director. The last two were seconded to join the Scott Wilson team for the field visits and data collection.

Wednesday 8th July

Field visit to Mahabubnagar District. Met local MLA en route and discussed the water supply situation in his area and visited **Pochamma Gadda**, a tribal village of 1000 population, with him. Continued to **Padakal**, population 5000, where a meeting was convened with the Surpanch and villagers. This procedure was adopted in every village visited. Continued to **Talakondapalli**, the Mandal (sub-district) headquarters, population 6500, for a village meeting and tour of the village and a final meeting at Mandal Office.

Thursday 9th July

Field visit to Mahabubnagar District. Visited **Panjugal**, population 2500, followed by **Marchal**, population 4500, a Scheduled Caste village and then to adjacent Tribal Tandas (habitations), **Sarambanda Tanda** and **Duntabgunta Tanda** followed by **Timmayipally**, population 1000, a Scheduled Tribe "model" village.

Friday 10th July

Field visit to Ranga Reddy and Nalgonda Districts. Visited **Ibrahimpatnam**, Mandal headquarters, and met Nasingh Rao, SE and N Goud, EE, who both joined the field visit.

Visited Raipol, population 8000, in Ranga Reddy District and inspected the Fluoride Treatment Plant.

On to Nalgonda District to **Rangapur**, population 1400, followed by the high fluoride village of **Anampet**, population 5600.

Saturday 11th July

Field visit to Medak District. Visited **Ghanapur**, population 4500, followed by **Beeramguda**, population 3000 and **Bojya Tanda**, a tribal habitation of 300 population.

Sunday 12th July

Rest Day

Monday 13th July

Meeting at **National Remote Sensing Agency**, with A K Chakraborti, Head of Water Resources Group.

Meeting at **State Groundwater Directorate**, with Mr Laxmaiah, Deputy Director.

Meeting at **National Geophysical Research Institute**, with Dr R N Athavale, Joint Director.

Tuesday 14th July

Brian Baxendale, DFID WSEG, joined the consultants team for the days visits.

Meeting at **Central Groundwater Board**, with Dr Srisailanath, Regional Director.

Meeting at **Irrigation and Command Area Development**, with P Gopalakrishna Murthy, Engineer-in-Chief, B Anantha Ramloo CE Investigations and S M A A Jinnah CE Minor Irrigation.

Meeting at **APWELL**, the Netherlands funded Groundwater Borewell Irrigation Schemes Project, with Dr J L Plakkoottam and K L Srivastava.

Final Round-up meeting at **PRED** with Engineer-in-Chief Venkateshwarlu.

Wednesday 15th July

Travel to Delhi. Prepare Inception Report.

Thursday 16th July

Prepare Inception Report.

Friday 17th July

Present Inception Report to DFID, Water and Sanitation Office.

Saturday 18th July

Return to UK

2. Visit to Andhra Pradesh from 21st to 29th August 1998

21st August

Travel to India

22nd August

Travel to Hyderabad. Data analysis.

23rd August

Data Analysis

24th August

Workshop on Water Resources of Telangana Region in Hyderabad.

25th August

Travel to Tirupati.

26th August

Workshop on Water Resources of Rayalaseema Region in Tirupati.

27th August

Travel to Visakhapatnam

28th August

Workshop on Water Resources of Coastal Region of Andhra Pradesh.

29th August to 6th September

Return to Hyderabad. Work on Draft Final Report.

1st September

Participated in the RDG Workshop in Hyderabad.

Meeting with S P Tucker, Commissioner, Rural Development.

2nd September

Wrap up meetings with EiC Dr M Venkateshwarlu, and later with Principal Secretary Arjun Rao, together with Brian Baxendale, DFID WESG

7th September

Presentation of Draft Final Report to DFID in Delhi.

APPENDIX 2

Workshops in Hyderabad, Tirupati and Visakhapatnam
Programme and Participants List
Problems Identified

Workshop Programme

The following outline programme was adopted for all three Regional Workshops:

Time From	Time To	Activity	Responsibility
10.00	10.30	Assembly and coffee	PRED
10.30	10.45	Introduction to Workshop and anticipated outputs	Jim Baldwin
10.45	11.00	Regional Presentation - Geological Setting and impacts on water supply	PRED
11.00	11.15	Regional Presentation - Water Resource Potential and utilisation	PRED/Irrigation Dept
11.15	11.30	Regional Presentation - Water Quality and impacts on water supply	PRED
11.30	12.00	Regional Presentation - Summary of problems felt in water supply	PRED/ZP/NGO's
12.00	12.30	Introduction to Problem Analysis and Group Work	Jim Baldwin
12.30	14.00	LUNCH	PRED
14.00	14.45	Problem Identification in Groups	Group Leaders
14.45	15.45	Summary and Prioritisation of Problems	Group Leaders/All
15.45	16.00	TEA	PRED
16.00	17.00	Solution Brainstorming and Analysis of Effectiveness	Jim Baldwin/All
17.00	17.30	Safe, Sustainable Rural Water Supply - The Way Forward	Jim Baldwin/All

List of Officers Attending the Regional work shop on Water Resources Study

Venue : Hotel Central Court, Hyderabad. **Dated: 24-08-98**

S.No.	Name	Designation
1	B.Mohan Rao	Jr. Geologist,O/o. SE(PR), Hyd.
2	R.Mohan Rao	Executive Engineer, RWS
3	Md. Khaja Moinuddin	Jr. Geologist,O/o. EE(RWS), Hyd.
4	B.Rajalingam	Sr. Geologist, Warangal
5	A.Vidya Sagar	Jr. Geologist, SE(RWS), Khammam
6	B.Bhaskaralingam	AEE, O/o. EE, Manchiryal
7	A.Satish	Water analysist, PRED, Hyd.
8	K.Ramuloo	EE, RWS, Medak
9	B.Sreekant	Dy.E.E., O/o. ENC(PR), Hyd
10	D.Kesava Rao	Executive Engineer, RWS, Hanumkonda
11	T.Yadagiri	Executive Engineer, RWS, Kothagudem
12	A.V.Subba Rao	EE, RWS, Manthani
13	N.Damodar Rao	Jr.Geologist, EE(PR), Khammam
14	A.Jeevaratnam	Jr.Geologist, EE(RWS), Kothagudem
15	G.Satyanarayana	Water Analysist, Nalgonda
16	Prabhoji B.	Water Analysist, Warangal
17	C.Sivakameswar	Jr. Geologist, EE(RWS), Warangal
18	J.Mohan Rao	Jr. Analysist, Warangal
19	A.Narayana Rao	Jr. Geologist, SE(RWS), Mahabubnagar
20	E.Narasimha Reddy	Water Analysist, Nizamabad
21	P.Narsing Rao	SE, RWS, Hyderabad
22	G.Srinivasachary	Sr. Geologist, SE(RWS), Hyd.
23	B.Bhoopati reddy	EE, RWS,
24	A.K.Mathur	Jr. geologist, O/o. ENC(PR), Hyd.
25	G.Maheswar Reddy	AEE, O/o. EE, Hyderabad
26	G.Rukkaiah	AEE, O/o. EE, (RWS), Sangareddy
27	G.Reddy	EE, RWS/PR, Khammam
28	C.Gyaneswar	S.E. RWS, Mahabubnagar
29	A.Vijaya Kumar	AEE., O/o. ENC(PR), Hyd.
30	R.Parthasarathi	Jr. Water Analyst
31	G.Ravindranath	Jr. Water Analyst
32	K.Srinivasa Reddy	Jr. Water Analyst
33	M.Laxma Reddy	E.E., RWS, Nagarkurnool
34	P.K.Mathur	Sr. Geologist, O/o. ENC(PR), Hyd
35	V.Krishna Reddy	EE, RWS, Nalgonda - II
36	P.Venkat reddy	EE, RWS, Nalgonda - I
37	G.Ramakrishna	EE, RWS, Banswada
38	D.Bhattacharya	Project Coordinator Manager-DFID
39	B.Shyambabu	EE, RWS, Mahabubnagar
40	K.Venkateswarlu	Jr. Geologist
41	N.V.Ramana	Sr. Geologist
42	T.S.Brahmanandachary	Jr. Geologist
43	A.V.Apparao	Executive Engineer (Retd.)
44	P Jagidiswar	SE, RWS, Karimnagar
45	P.Nandakumar	EE, RWS, Sangareddy
46	S.Rangarao	S.E., I/C, Hyderabad
47	Anilkumar	A.D. (GWD), Hyderabad
48	T.S.Prakasha Rao	Dy E.E., RWS, Khammam

49 N.Ramachandra Rao	S.E., RWS, Nizamabad
50 B.Venkateswarlu	Z.P.Chairman, Warangal
51 A.Yadaiah	E.E., RWS, Manchiryal
52 S.S.Prakash Reddy	AEE, o/o. EE(RWS), Hyd.
53 K.Srinivasa Rao	AEE, O/o.SE(RWS), Hyd.
54 K.Jitendar Rao	AEE, O/o.SE(RWS), Hyd.
55 P.Gopal Rao	
56 Md. Jameeluddin	Jr. Geologist, RWS
57 A.Laxminarayana Goud	EE, RWs, Hyderabad
58 G.Rajesham Gowd	Z.P.Chairman, Karimnagar
59 D.V. Ramaiah	Dy.E.E., RWS, Devarakonda
60 G.Ch. Subbaiah	AEE, o/o. S.E(RWS), Warangal
61 M.Rajesekhar Reddy	Dy.E.E., RWS, Hyderabad
62 Dr M Venkateswarlu	EIC PRED
63 Mr J Baldwin	Consultant DFID

List of Officers Attended to Regional work shop on Water Resources Study

Date: 26/08/1998 **Hotel Bliss - Tirupathi**

S.No.	Name	Designation
1	N.Krishna Reddy	Dy. E.E., RWS, Tirupathi
2	K.Bhaskara Naidu	Water Analysist, Tirupathi
3	S.Azeem Sharif	Water Analysist, Kurnool
4	J.Venkata Siva Reddy	AEE I.D., Tirupathi, (I&CAD)
5	K.Somi Reddy	Jr. Geologist, Tirupathi
6	P.V.Siva Reddy	Jr. Geologist, Cuddapah
7	B.Rammohan	Jr. Geologist, Kurnool
8	K.Damodara Raju	Jr. Geologist,
9	K.Satyanarayana Rao	Dy. E.E., RWS, Kurnool
10	B.Ambarisha Reddy	Jr. Geologist, Kurnool
11	M.s.Narayana Reddy	Jr. Geologist, Anantapur
12	M.Nagaraj	Jr. Geologist, Anantapur
13	Chakrapani	E.E., RWS Chittoor
14	Prakasam	Geologist, RWS., Ongole
15	Prakasam	Jr. Water Analyst, Ongole
16	Gangadhar	Jr. Water Analyst, Anantapur
17	C.Venkatapathi	EE, RWS, Kurnool
18	S.Nagendra	EE, RWS,(Projects), Adoni
19	A.Jagannadham	EE, RWS, Anantapur
20	M. Ramachandra Rao	EE, RWS, Penugonda
21	K.V.S.Sastry	EE, RWS, Ongole
22	D.V.R. Raju	EE, RWS,(Projects),Podili
23	V.Krishnamurthy	EE, RWS, Anantapur
24	K.V.Raghava Redd,	EE, RWS, Nellore
25	N.Subba Reddy	EE, RWS, Gudur
26	G.Rama Naidu	SE, RWS, Ongole
27	K.Kishore Kumar	Dy.E.E., RWS, Anantapur
28	K.Sampathi Rao	Exe.Engineer, (P&D), Hyd.
29	P.S.Sasthry	EE, RWS, Madanapalle
30	N.Easwaraiah	Jr.Geologist, Madanapalle
31	K.Prathapareddy	Jr.Geologist, Chittoor
32	C.Kallangiri	Asst.Director, Chittor(G.W.Dept)
33	B.Ranga Rao	Asst.Engineer, RWS, Chandragiri
34	M.A.Kareem	S.E., RWS, Kurnool
35	S.Seethapathi Pillai	E.E., RWS, Tirupathi
36	A.Narasimha swamy	S.E., RWS, Anantapur
37	B.Krishna Murthy	S.E., RWS, Tirupathi
38	K.Martin	S.E., RWS, Cuddapah
39	A.S.N.Rao	EE, RWS, Rajampet
40	L.C. Reddy	EE, RWs, Pulivendula

List of Officers Attended to Regional Workshop on Water Resources Study

Venue : Hotel Green park, Visakhapatanam. **Dated: 28_08-98**

S.No.	Name	Designation
1	Liaquat Alikha	Jr.Geologist,RWS Division,Kovvvuru, W.g.Dist.
2	N.Sudhir kumar	Jr.Water Analyst,PRIWQM lab Vijayawada.
3	K.V.Bhaskar Sastry	Addl.Water Analyst,PRIWQM lab Vijayawada.
4	K.V.Gangadhara Rao	Jr.Water Analyst,PRIWQM lab Visakhapatnam
5	K.B.R. Prasada Rao	Executive Engineer, RWS Projects, Vijayawada
6	Indrasena Reddy	S.E., RWS, Vizianagaram
7	R.Yerukunaidu	Executive Engineer, RWS Projects, Srikakulam
8	K.Satyanarayana Babu	Sr. Geologist,PRIWQM lab Vijayawada.
9	K.Veeraswamy	Executive Engineer, RWS Projects, Amalapuram
10	M.Arunkumar	Jr. Geologist,Vijayawada
11	B.Madhusudhana Rao	Jr. Geologist,Srikakulam
12	V.S.M.L.Prasad Rao	Jr. Geologist,Guntur
13	D.Subba Rao	Jr. Geologist,Visakhapatnam
14	Y.Narasimhulu Babu	Jr. Geologist,Vizianagaram
15	R.C.Acharya	Executive Engineer, RWS Projects, Vizianagaram
16	M.R.Nagesh	Asst.Executive Engineer, RWS Vizianagaram
17	Mr. Viash	Project Officer, UNICEF
18	S.Hussain	Executive Engineer, RWS Kovvur .
19	M.Innaiah	Executive Engineer, RWS Vijayawada
20	P.Raghavayya	Executive Engineer, RWS Visakhapatnam
21	A.N.S.V.Prasad	Executive Engineer, RWS Palasa
22	R.Adinarayana	A.G.P.Dy. Director Office, Vizianagaram
23	R.Venkateswara Rao	Executive Engineer, RWS Guntur
24	P.Venkataratnam	Executive Engineer, RWS Narasaraopeta
25	A.Satyanarayana	Executive Engineer, RWS Tenali
26	K.Sampathi Rao	Executive Engineer, RWS Hyderabad
27	M.Subba Rao	S.E. RWS, Guntur
28	Y.Bullebbai	Dy. Executive Engineer, RWS, Visakhapatnam
29	N.P. Pillai	Executive Engineer, RWS Projects, Visakhapatnam
30	B.Anajaneya Varama	Executive Engineer, RWS Gudivada
31	A.S.Murthy	Executive Engineer, RWS Guntur
32	A.Srihari	Executive Engineer, RWS Kakinada
33	A.Nageswara Rao	S.E. RWS, Kakinada
34	P.Sunil Babu	Jr. Geologist, Kakinada
35	N.R.K.Chowdary	Executive Engineer, RWS Projects, Eluru
36	T.Ravi Kumar	Asst.Executive Engineer, RWS Visakhapatnam
37	I.S.N.Raju	SE, Vamsadhara Project, Srikakulam
38	A.S.Murthy	S.E. I/C. Vizag
39	N.S.Rao	A.D. GWD, Vizag
40	B.Raja Rao	Executive Engineer, P.R., Vizag
41	V.Panasa Ramana	Jr.Water Analyst,PRIWQM lab, Kakinada
42	Dr. K.Mrunalini	Chairperson, Z.P.,Srikakulam
43	Jim Baldwin	Representative, D.F.I.D.
44	S.S. Naidu	S.E. RWS Vizag
45	N.V.V.R.K.Prasada Babu	Dy.Executive Engineer, RWS Mummidivaram

46	U.Kutumba Rao	Chief Engineer, RWS, Hyderabad
47	P.G.U.Bhaskara Rao	S.E., RWS, Vijayawada
48	K.Venkata Swamy	Joint Director, Hyderabad

List of problems identified by various groups during work shop on 24.8.98 at Hyderabad

I Source

1. Hand pump located for convenience not scientifically
2. Irrigation abstraction causes drinking water source failure
3. Interference between adjacent wells
4. Sabotage of public bore holes
5. Public sources limited to Government lands
6. Infiltration wells polluted by industries
7. Preference to surface sources in ground water quality affected areas
8. Incorrect capacity of pumps
9. Mining is impacting on source
10. Design does not recognise power availability
11. Insanitary conditions near the drinking water source
12. Supply lines broken
13. Inappropriate pipe material used

II. Water Quality

1. Excess fluoride in drinking water (25% of the habitations)
2. Brackish Water (1.5% of total habitations)
3. Industrial Pollution (4% of total habitations)
4. Nitrates pollution (approx. 2% of total habitations)
5. Bacteriological contamination (10%)
6. Iron contamination (2%)
7. Corrosion of rising mains
8. Per capita norm dictates quality
9. AC pipes inappropriate
10. In-situ pipeline testing not done
11. Poor planning of field works
12. VLC not trained for responsibilities

III. Operation & Maintenance

1. Repair done; maintenance not done
2. Operators not trained properly
3. Insufficient funds with gram panchayat
4. Inadequate power supply
5. Depletion of ground water in summer
6. Damage to pipelines and equipment (air valves)
7. Actual HSCs. are more than design number
8. No community ownership
9. Poor environmental sanitation
10. Encrustation on equipment & pipes

Sanitation

1. Insufficient awareness
2. People prefer open area for defecation
3. Flush water not available
4. Inadequate funds for village cleaning
5. Unsafe practices at hand pump

IV. Management

1. People not involved in design/management of systems in organisation
2. Legislation not implemented
3. Poor understanding of needs in design
4. Resources not managed in an integrated way
5. Financial limitations
6. Environmental degradation
7. Data recorded but not utilised in management
8. INTEGRATED APPROACH MISSING

List of Problems identified during the workshop at Tirupathi on 26th August 1998

I. Source

1. Per capita demand criteria
2. Public source is restricted to Govt. site
3. Access in limited to conduct geophysics for hand pumps
4. Proper yield test for the bore well
5. Scheme design is done before the source is determined
6. Insanitary condition around the source
7. Spacing between sources
8. Control legislation for cut off deep bores
9. Bacteriological and polluted inlet channel problems for SS tank
10. Indiscriminate removal of sand from the beds of rivers
11. Sources does not have recharging capacity

II a) Water quality

1. Fluoride
2. Salinity
3. Brackish
4. Nitretic contamination
5. Fertilisers & Pesticides
6. Industrial pollution
7. Environmental conditions

b) Design quality

1. Actual power supply is not as per designed hours of supply
2. Design norms insufficient to meet demand
3. House connections are allowed but not incorporated in design
4. Capacity of OHSRs is not sufficient

c) Specification quality

1. Pumps do not confined manufacturing specifications
2. Frequent breakdowns of AC pipes during Operation & Maintenance
3. Valves, do not function properly
4. Hand pumps spares not confined to specifications

III. Operation & Maintenance

1. Gram panchayats are not spending their funds for operation & repairs
2. Public are not involved in operation & repairs
3. Skilled operators are not being engaged.
4. Quality of materials and responsibility of the suppliers for their maintenance
5. Preventive maintenance
6. Power fluctuations
7. Vandalism and misuse of water
8. Insistence for water tariff
9. Provision for house connections and other requirements like cattle demand and washerman.

Sanitation

1. Open defecation is a health hazard
2. Open defecation is a problem for women
3. People have no interest in sanitary systems
4. No space for construction of latrine in villages
5. Flush water not available
6. Insufficient motivation to the people
7. No proper drainage in villages.
8. Improper hygienic conditions around water sources
9. No regular maintenance of drains.
10. No integrated approach for water supply & drainage

IV Management

1. Water users are not involved in construction & maintenance
2. Poor electricity management
3. Pollution and extraction uncontrolled
4. Responsibilities not defined in Maintenance
5. Difficulty in ensuring quality in construction, materials procured and enforcing specifications
6. Improper planning and implementation
7. Incorrect assessment of water need
8. Insufficiency in HRD in the sector
9. Irrigation distribution of water.

List of problems identified during the workshop at Visakhapatnam on 28 August 1998

I Source

1. Filter points or shallow wells in coastal areas are not dependable and also subject to contamination
2. Sources (bore wells or open wells) near M.I. tanks (rainfed) are getting dried up during summer season
3. Over exploitation of ground water near drinking water bore wells by other agencies for Irrigation purposes.
4. Farmers objected drilling of bore wells to the water potential Government lands which are near to their lands.
5. Acquisition of water potential private lands is becoming difficult. Thus source creation is becoming uneconomical because of canal pumping mains.
6. Potential deep fracture zones identification is difficult with available infrastructure.
7. Designs for 16 hrs. pumping with smaller capacity pumps. Private people are pumpng with higher rate causing failure of source
8. impossible to create sources (Bore wells) in non fluoride zones of the villages because of lack of government land
9. Increased fluoride content in deeper levels due to depletion of ground water
10. Recharge of ground water is not in proportion with the withdrawal of water.
11. Unhygienic practices causing pollution to source within the village.
12. hrs. pumping of raw water to SS Tank could not be maintained due to inadequate water supply
13. Indiscriminate discharge of effluents from industries to streams and rivers which is polluting water sources.

II. a) Water Quality

1. Fluoride
2. Total dissolved solids
3. Chloride
4. Iron
5. Nitrate
6. Turbidity
7. Bacteriological contamination due to sewage & drainage
8. Excess Magnesium & Sulphates
9. Guinea worm
10. Chemical pollution due to industrial effluent and agricultural activity.

b) Quality control matters

1. Per capita requirement in design
2. Poor design of pumping main
3. Quality control of material at factory for all materials not satisfactory
4. Laying, Jointing of pipes not done properly
5. Improper fixing of Air valves & pressure relief valves
6. Asbestos cement pipes preferred over PVC or HDPE
7. Quality of construction of platforms inadequate
8. G.I. Pipes in hand pump poor quality
9. Casing pipe mild steel which corrodes
10. Electrical items - pump sets, panel boards not tested by Dept. Q.C.
11. Inexperienced contractors used on turn key basis

III. Operation & Maintenance

1. Non availability of skilled mechanics for operation
2. Too many private tap connections
3. No feed back about the breakdown
4. Mishandling the system by the villagers
5. Non-payment of tariff by public
6. Non availability of suitable spare parts nearby
7. No ownership feeling by the villagers
8. Non-response to awareness camps on operation
9. political interference in the operation
10. Erratic power supply
11. Insufficient conveyance facility (Mobile vans)

Sanitation

1. Non-response of the public to the awareness camps on hyeginic practices
2. No integrated approach to water supply and sanitation
3. Non availability of trained masons
4. Non flexibility of the designs

IV Management

1. Maintenance of PWS Schemes
2. Role not properly defined
3. Too many stake holders to the water but none to own
4. Incorporation of private not covered by management
5. Effective management system totally ignored for O&M management
6. Mismanagement of source sustainability
7. Inadequate community support- mobilisation through HRD activities
8. Poor documentation management
9. Improper material management and inventory control
10. Personal management to handle PWS schemes to be improved
11. Consignee and material quality management poor.