IMPACT OF DROUGHT AND WATER POLLUTION ON THE PUBLIC HEALTH MORBIDITY IN BARMER, KORAPUT, NAGPUR AND SIKKIM

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Introduction

As a part of the Hological Approach to Water Mission undertaken by CSIR in the problem districts of Barmer, Sikkim, Koraput and Nagpur, ITRC carried out studies in two broad areas:

(A) Epidemiological Studies for Environmental Impact Assessment.

(B) Water Quality Analysis of Drinking Water Sources.

Section A

The epidemiological studies were aimed at studying the prevalence and types of water borne diseases among the population, and assessing the impact of water problem on the health status of the population.

Section B

The water quality analysis included bacteriological physico-chemical and metal analysis.

Back Ground Information of East District (Sikkim), Koraput (Orissa), Barmer (Rajasthan) and Nagpur (Maharashtra)

Background Information on East Sikkim

Geography of Sikkim

The total area of Sikkim is 7096 sq. km. It has been divided into four districts, viz. North, East, South and West. The altitude of the North district is 1310 meters, of the East district 1777 meters, of the South district 1560 meters and of the West district 1524 meters and the state capital (Gangtok) is situated at an altitude of 1543 meters. The annual rainfall in East district is 2857 mm.

The district headquarter of the East district is Gangtok and of the South district Namchi. East district has got its sub-divisions at Gangtok, Tadong and Pakyong and South district has sub-divisions at Namchi and Jorethans, for the implementation of rural water supply schemes.

Climate and Rainfall

There is high variation in climate and the region is subject to heavy rainfall. The temperature varies with the altitude. The mercury is at its highest during July and August and varies between 22° C to 23° C and lowest during December and January when it varies between 0.48° C to 12.5° C.

The mean annual rainfall, from drizzling to torrential downpour, varies from 2000 to 5000 mm. The greater part of the rainfall occurs between May and September.

Physiography

Sikkim is essentially a mountainous state without a flat piece of land. The mountains rise in elevation northward. The high serrated, snowcapped spurs and peaks, culminating in the Kanchanjunga are attractive features in the scenery of Sikkim. The northern portion of the state is deeply cut into steep escarpments and the southern part is lower, more open and fairly well cultivated.

The mountain ranges, viewed as a whole and from distance are, in general, in the east-west direction. The main ridges in Singalela and Chola, however, run more or less in a north-south direction. The Rungeet and Tiesta which form the main channels of drainage, also run north-south. The valleys, are crossed by these rivers and their main feeders are very deep. The valleys of the Rungeet, the Tiesta and of their main contributaries are about 5000 feet in depth.

Vegetation and Agriculture

About a third of the area of Sikkim is forest. The major parts of the forest are in North and West districts, the majority of the population resides in the East district. All suitable portions of these areas have been cleared for cultivation, and the trees remain only in the rocky ravines and on the steepest slopes where no crop can be grown. The forest consists of tall umbrageous trees with little underwood on the drier slopes but often dense grass jungles,

accompanied with luxuriant undergrowth of shrubs, which renders it almost imperable.

Sikkim's economy is principally agrarian. The main crops are rice, maize, wheat, millet and barley. Only 11-12 per cent land is available for cultivation and there is no scope for expansion. The principal cash crops are cardamom, orange, potato, citrus, apple and pineapple.

Demography

According to 1981 census the male population of North, East, South and West districts was 14784, 77232, 40980, 39444 respectively, whereas the female population was 11671, 61530, 34996 and 35748 respectively. The sex ratio is 835 females per thousand males. The total population of Sikkim at present, is 3,78,858, whereas according to 1981 census the population was 2,14,738. The decennial growth rate (1971-81) of Sikkim as a whole was 50.77, whereas that of East District of Sikkim was 62.07. The percentage of rural population of Sikkim was 83.85.

Background Information on Koraput

Koraput district in Orissa covers an area of 26,961 sq.kms and is situated on the hills of Eastern Ghats. It is irregular in shape and resemble the letter 'Y'. It lies at a longitude of 81-27 and 84-10 and at the latitude 170-50' and 20-30'N. The climate is generally temperate with a maximum temperature of 32.7 C in May and minimum of 17.0 C in

December (1987). Normal rainfall is 152.19 cm, with highest rainfall being recorded during the months of July, August and September.

Demographic Profile

The demographic profile of the population in Koraput is given in Table 1.

Table 1. **Demographic Profile of Koraput** (as per 1981 census)

Population	Number (in '000)	Percentage
Total population	2482	100.0
Sex ratio	993 Females per 1000 males	49.8
Rural population	2203	88.7
Urban population	281	11.3
Schedule Caste	349	14.1
Schedule Tribes	1372	55.2

As per 1981 census the district had 8.42 per cent of total population of Orissa state and ranks fourth in respect of the population in the state. The district occupies the twelfth position in respect of the density of population, with only 92 persons per sq. kms. in comparison to 169 persons per sq. km in the whole of Orissa. 88.7% of rural population reflects the rural nature of the district.

The decennial growth rate of the poulation of the district reveals that the population decreased during 1921 census while it increased in all other censuses. 1971 census shows that the average population per village was 360 and average population per household was 5.

Literacy

The literacy rates among males and females of rural and urban areas of Koraput district are shown in Table 2. These are much below the state (34.23%) and national (36.23%) averages and pointing to the backward nature of the district.

Table 2. **Literacy in Koraput district (Percentage)**

Population	Rural	Urban	Total
Males	29.33	58.83	31.18
Females	6.17	31.58	7.65
Total	17.65	45.65	19.35

Economic Resources

The district is rich in natural and mineral resources. Cultivation is the principal occupation of the inhabitants of the district but in general cultivation practices are primitive. The principal crops in the district are paddy, maize, ragi, alsi and mustard etc. Irrigation facilities are inadequate, only 5.4% of sown area being irrigated (1981).

Two major irrigation projects on the river Kolab and Indrawati are under construction.

45.96 per cent of the district area is forest (1981) and as such forest produces is the means of livelihood to large segments of population. Timber, bamboo, firewood and tendu leaves are major items of forest produce. Its value was estimated to be about Rs.383 lakhs in 1980-81.

Rich mineral deposits of clay, manganese, limestone, iron and bauxite are present. Large quantities of bauxite deposits are found in Damanjodi area. Construction of an alumina project is in progress in this area.

Besides a number of rice mills, saw mills, oil mills etc. a few large scale industries are also functioning here. They are the sugar factory and the ferro manganese plant at Raigadha, the ferro-alloys plant at Theruvally, the paper mill at J.K. Pur, and Hindustan Aeronautical Factory (HAL) at Sunabeda.

Nearly 42 per cent of the population in Orissa state lives below the poverty line. The figure for this particular district may be higher.

Occupation

A majority of the population subsists by exploiting the forest resources or tilling the land. Details of working population as per 1981 census are given in Table 3.

Table 3. Occupation of People

Occupation	Number ('000)	Percentage of total Population
Total working population	965	38.8
Cultivation	521	29.9
Agricultural labour	275	11.1
House-hold/industrial workers	18	0.7
Others	151	6.0

Administrative Set Up

The district is divided into 6 sub-divisions with head quarters at Koraput, Jaypore, Malkangiri, Nowrangpur and Raigadha. There are 17 tehsils, 42 community development blocks, 46 police stations, 515 gram panchayats and 5,683 inhabited villages. There are 10 towns in the district having 3 municipalities and 7 notified area councils.

Problem Villages in Respect of Availability of Water

PHED has identified 5212 problem villages. Of these 2801 have not yet been provided with tube wells. Water quality is a major problem specially because of high iron content which makes it unpalatable. The bacteriological and physico-chemical qualities are yet to be ascertained, and the magnitude of pollution assessed.

Vital Statistics

Birth, death and infant mortality rates constitute the basic information as regards the health of population. District figures of vital statistics are fairly similar to the state figures but vary considerably from the national averages.

Table 4. **Comparison of Vital Statistics**

	Koraput (1985)	Orissa (1983)	India (1985)
Birth Rate	32.5	34.0	32.7
Death Rate	12.4	12.5	11.7
Infant Mortality Rate	134.3	130.0	95

Background Information on Barmer District

Barmer, a border district of Rajasthan, has been under a serious drought for the last 5 years. General information about drought affected areas and population is presented in the tables attached.

These tables attached would show that at least 30 to 50 percent villages of one or the other parts of the district have always remained under the grip of famine since 1980-81. In the year 1985-86, 1986-87 and 1987-88, the whole district was declared famine affected. Thus, this is the third consecutive years of scarcity for the whole district and

the fourth consecutive year for 496 villages. Because of continuous failure of crops, the entire population (rural as well as urban) of the district has lost its only source of livelihood resulting in serious decline of purchasing power.

DISTRICT BARMER - GENERAL INFORMATION

1.	Name of District	:	Barmer
2.	Total area	:	28,387 sq.kms
3.	Total Population	:	11.19 lakhs (Male 5.88, Female 5.31)
	a.Scheduled Caste	:	1.75 lacs
	b.Scheduled tribe	:	0.57 lacs. 11.19 lacs
	c.Others	:	8.87 lacs
4.	Affected population	:	10.35 lacs
5.	Density of population	:	30 persons per sq.km.
6.	Percentage of literacy	:	12.29 (Males 20.04, Female 3.71)
7.	Total villages		
	a. Urban areas	:	4
	b. Rural areas	:	934
	Total		938
8.	Total affected villages		
	a. Urban areas	:	2
	b. Rural areas	:	934
	Total		936
9.	Main occupations	:	Cattle breeding and agriculture
10.	Main crops	:	Bajra, Gowar,Wheat etc.

11.	Administrative units		
	a. Sub divisions	:	2
	b. Tehsils	:	6
	c. Sub-tehsils	:	1
	d. Panchayat Samitis	:	8
12.	Agricultural area of the district	:	23,87,453 Hects.
13.	Irrigated area of the district	:	32,573 Hects.
14.	Area sown during Samvat year 2044	:	3,65,373 Hects.
15.	Crops damaged during Samvat year 2044	:	3,44,853 Hects.
16.	Total cattle population of the district as per 1983 cattle census	:	32.00 lkhs
17.	Affected cattle population	:	32.00 lkhs
18.	Annual average rain fall	:	290 mm
19.	Families selected under integrated rural development programme:	:	
	a. Scheduled caste	:	11,606
	b. Scheduled tribe	:	4,150
	c. Small farmers	:	22,537
	d. Agricultural Labour	:	5,432
	e. Marginal farmers	:	22,774
	f. Rural artisans	:	1,161

Background Information on Nagpur District

History

Nagpur, was founded at the beginning of the 18th century by the Gond Raja, Bakht Buland. The growth and importance of the town was quickened by the advent of the then Great Indian Peninsula Railways (now called the Central Railway). With the attainment of independence in 1947 and the formation of Madhya Pradesh state it became, and continues to be the capital of that state. With the reorganisation of states in 1956, the district was transferred from Madhya Pradesh to Bombay State. The district has formed a part of Maharashtra since 1st May, 1960.

Location

Nagpur district lies between 20 35' and 21 44' north latitude and 78 15' and 79 40' east longitude at the southern base of the Satpuda hills. Chhindwara and Seoni districts of Madhya Pradesh State fall in the north. Bhandara district flanks it on the east and Chandrapur on the south. Wardha and Amravati districts are contiguous with its boundaries in the west. Wardha and Wainganga are two main rivers of the district flowing along a part of the western and the eastern borders respectively and the drainage of the district is divided between them.

Climate

The climate of the district is dry and salubrious. In fact Nagpur is one of the hottest places in India and May its hottest month. The average annual rainfall in the district is 1,161.54 mm (45.73 inches). The rainfall during the period, June to September constitutes about 90% of the annual rainfall, July being the month with the highest rainfall.

Economic Resources

Forest area in the district has considerably dwindled and covers only about 5% of the total area of the district. Forest area is situated on the foothills of the Satpudas on both sides of the Pench river in Ramtek tehsil, while others are scattered in blocks between Katol in the West to Umred in the east.

Minerals are found in abundance in the district. Chief among them being coal, manganese, iron ore, limestone, and clay deposits.

Nagpur city is an important industrial and commercial centre in Maharashtra. The industrial development has remained mostly confined to urban areas. Rural areas are not industrialized and depend mostly on agriculture.

Traditional handy crafts are manufactured with locally available raw material. There are 931 registered factories

employing 475.78 workers per day in Nagpur district. The mining industry is of considerable importance in the district because of its rich manganese ore deposits.

Among the various tehsils, Savner has the largest cultivable area (83.05%) and Ramtek the lowest (76.67%) Rice, Jawar and wheat constitute the staple food of the people. The total cultivable area ia 612,000 hectares of which gross area sown is 607.000 hectares. Oranges constitute an important economic resource.

Organisation of the District

The district comprises five tehsils which encompass fourteen, blocks/taluka. In all there are 1874 inhabited villages in the district Table 5).

Problems Villages

129 villages from Nagpur district have been identified as problem villages. Many of these villages have no source of water at present, as wells etc. have dried up and water is supplied by tanks. The majority of wells which have not dried up are of a shallow type and insanitary. Further more gram panchayats, which are responsible for disinfection of wells do not perform this function satisfactorily.

Table 5. Organisation of Nagpur District

Subdivisions	Villages	Problem Villages
Nagpur	383	27
Katol	343	33
Saoner	236	14
Ramtek	390	1
Umred	518	22
Total	1874	129

Water Resources

The villages in the district have different types of drinking water resources. These are wells, tanks, tube wells, hand pumps, rivers, canals, lakes, springs and nallahs etc. The majority of villages have insanitory wells as sources of water. During the visit of our team to different villages it was found that a number of these wells had dried up and water was being supplied by tankers. Vibrio cholerae were found in a few of these water samples as is evident from Table 6.

Table 6. Examination of Water Samples

Year	Number of Water samples examined	Number of bacte-riologically Unfit	No. of Examined for Vibro	No. of + ve
1984	4595	205	-	-
1985	4925	375	50	4
1986	5664	532	26	1
1987	7693	1303	12	1

The Public Health Laboratory in Nagpur examines the water samples which are routinely sent to them from different areas of the district. The findings are shown in the tables above. Nearly 18 per cent of water samples were found to be bacteriologically unfit for drinking purposes.

Demography

The population of the district accounts for 4.12 per cent of the population of Maharashtra state and is spread over 3.23 percent of the total land area of Maharashtra. Among the five tehsils of the district tehsil. Because of this tehsil being the most thickly populated (1,550,698) the whole district gives the impression of bearly an urban area. Table (7) shows the demographic data of the district.

Table 7. Demographic People of Nagpur District

Total population of Nagpur district (1981)		25,69,000
	- Rural	11,20,000
	- Urban	14,69,000
Total estimated population (1985)		28,69,000
Females per 1000 males		925
Density per Sq. Km.		260
Schedule caste population		1,82,395 (7.05%)
Schedule tribes population		3,53,303 (13.65%)
Decinnial growth rate (71 to 81)		33.26%
Percent of main workers		35.59
Percent of marginal workers		2.58
Percent of non workers		61.83
Literacy: (Percent)	Over all	54.60
	Males	63.74
	Females	44.62

The main workers among the population of the district have been sub-divided into four industrial categories viz. cultivators (20.8%), agricultural labourers (26.24%), workers engaged in household industry (5.42%) and other workers (47.55%).

Vital Statistics

The Table 8 shows the comparative figures in terms of rural and urban differences. Different parameters are also compared with state figures of Maharashtra for the year 1984.



Table 6. Registered Vital Statistical Rates (1984)

Vital Statistics	Nagpur			Maharashtra		
	Rural	Urban	Total	Rural	Urban	Total
Birth Rate	19.1	33.0	27.1	26.4	26.9	29.5
Death Rate	4.0	6.7	5.0	5.4	6.9	6.0
Infant Mortality Rate	47.0	33.0	37.0	31.0	49.0	36.0
Still Birth Rate	17.0	7.5	9.0	13.4	20.3	16.0
Maternal Mortality Rate	3.1	0.0	0.9	1.6	1.4	1.5

Expectation of life at birth is 55.1 years for males and 54.3 for females. The overall figures for Nagpur district, both rural and urban, compare well with those of Maharashtra State and also with all India figures. However, these figures may not be exactly representative because of under-registration.



PUBLIC HEALTH STUDIES OF POPULATION IN EAST DISTRICT (SIKKIM), KORAPUT, BARMER AND NAGPUR DISTRICTS

Repeated droughts, domestic, occupational and industrial activities and geographical situation all influence the quality of the available water resources which are utilised by the local people for their survival and sustain the vegetation and animal life. Water quality plays an important role in the health of the people. Water contaminated with bacteria, pesticides, heavy metals and minerals leads to acute and chronic health problems which are often not detected at an early stage among humans and animals and affect the progeny as well. The chemical contamination affects the plants and renders them unsuitable for use as food material. The population living on polluted water and contaminated food products suffers frequently from a variety of water borne or enteric diseases.

The continued failure of crops leads to malnutrition which reduces work efficiency and the ability of the body to resist infection and renders it vulnerable to infection and toxic chemicals. This strains human resources and results in increasing expenditure on health care programmes. Keeping in view the urgent need to investigate the impact of water quality on the health of the local population and suggest effective intervention programmes, attempts were made to study the morbidity and mortality pattern, specially in respect of diseases related to water quality, in the four districts namely Barmer (Rajasthan), Koraput (Orissa), East

Sikkim and Nagpur (Maharashtra) by contacting the state, district and village health officials and local medical personnel.

Aims and Objectives of the Study

1. To study the prevalence and types of water borne diseases among the population.

2. To assess the impact of polluted water on the health status of the population and identify the diseases and disorders caused directly or indirectly, by the non-availability of safe water.

3. To suggest intervention programmes for immediate and long term implementation.

4. To identify the goals for future studies and ensure the success of the intervention programme.

Methodology

Qualified and experienced medical doctors of Epidemiology Division and Occupational Health Centre, ITRC. along with other members of the teams visited four districts. A series of discussions with government health officials and non-government agencies at state, district and village

levels were held. Enquiries from the villagers were also made. Some individuals were also examined by these doctors. The following agencies were contacted in the four problem districts where the work was undertaken:

1. Secretary, Medical and Health Services, State Government
2. Director, Medical and Health Services, State Government
3. Chief Medical Officer
4. Medical Superintendents of various hospitals
5. District Statistical Officer
6. District Information Officer
7. Sub Divisional Medical Officer
8. P.H.C. Doctors
9. Local Doctors
10. Dy. Director, Desert Medical Research Centre
11. Lions Club Members

Morbidity Pattern in East District (Sikkim), Koraput (Orissa), Barmer (Rajasthan) and Nagpur (Maharashtra) with Special Reference to Water Borne Diseases

East District Sikkim

The water-borne diseases during the last 5 years were: typhoid (166)*, diarrhoea and dysentery (12050), gastro-enteritis (14730), worm infestation (17970), hepatitis (15730), poliomyelitis (2). Cases of scabies (1258) and malaria (102) were also recorded (Table 5).

In Singtam district, situated 25 kms away from Gangtok, the prevalence of diseases during the last five years was as follows: Bacillary dysentery (1983, 2.49%; 1984, 2.67%; 1985, 2.09%; 1986, 1.90%; 1987, 2.17%), amoebiasis (1983, 2.27%; 1984, 2.45% 1985, 2.45%; 1986, 1.72%), 1987, 1.73%) gastroenteritis (1983, 0.36%; 1984 0.54%, 1985, 0.77%; 1986, 0.83%, 1987, 1.08%) infective hepatitis (1983, 0.16%; 1984, 0.22%; 1985, 0.35%; 1986, 0.53%; 1987, 0.71%).

According to a nutrition atlas for 1982 the prevalence of nutritional deficiencies was as follows: Vitamin A deficiency (xerosis conjunctival 7.7%), (bitot's spot 9.4%), niacin deficiency (atrophic papillae 0.8%), Vitamin C deficiency (bleeding gums 21.4%), thyroid enlargement (35.0%) and fluorosis(6.0%).

The Major Problems in Sikkim in Relation to Water

The major problems in Sikkim are (i) non-availability, of water resources within a reasonable distance in most of the vilages (ii) bacteriological and chemical contamination of water, (iii) contamination of water due to agricultural activities in rainy season.

Sources of Water

The main sources of drinking water are streams and springs.

(1) Surface Water

The water available through rain or melted snow is the surface water. Since this water travels a long distance its quality becomes questionable because of contamination with suspended matter, agricultural wastes, heavy metals, faecal matter etc.

Water Quality

The turbidity and contamination is caused of organic pollution, animal faeces etc. There was considerable bacteriological contamination of water in Sikkim.

Water Sources Used for Drinking Purposes

The water borne diseases can be controlled, to a great extent, if the quality of water is improved. It is, therefore, necessary to select the sources of drinking water

supply carefully and to treat the water properly, if contaminated.

The water sources were found to be highly contaminated with mica. The ITRC team observed that the population of Sikkim had become so used to diarrhoea and dysentery that they did not seem to be bothered when they had an attack of these diseases. They did not even consult a doctor most of the time. They either took indigenous medicines or some commonly used allopathic drugs.

Koraput (Orissa)

The overall picture of Koraput is that of a backward, illiterate, tribal population with a high rate of infant mortality. The main occupation of the people is cultivation and a majority of them live below the poverty line. Mortality from communicable diseases is quite high and utilization of existing health services poor. The H-type villages studied by ITRC are located in interior and remote areas normally difficult to approach. They are generally small villages scattered in forest areas with a comparatively low population and a small number of families. The water sources of these villages are rivers, streams, nullahas, open wells, ponds, springs and choas but their availability is limited and usually inadequate. The water sources are unprotected and frequently badly maintained.

Even when safe water sources are available at a short distance, the villagers prefer to use more easily available water, not caring for its quality.

Water-Borne Diseases

Water borne diseases are quite prevalent in this district but the hospital figures for these diseases do not reveal the true magnitude of the problem. The morbidity pattern shown in Table 9, is just the tip of the iceberg, as a majority of the tribal population relies heavily on traditional systems of medicine and seldom utilizes hospital services.

Table 9: Cases of Water Borne Diseases Treated in Hospital

Water Born Diseases	YEARS 1983	1984	1985	1986	1987
Gastroenteritis	N.A.	N.A.	216 (6.5)	182 (6.4)	120 (19.2)
Typhoid	5189 (92.5)	1775 (84.4)	2765 (83.9)	2298 (80.9)	N.A.*
Poliomyelitis	16 (0.3)	10 (0.5)	10 (0.3)	18 (0.6)	19 (3.10)
Infective Hepatitis	402 (7.2)	317 (15.1)	304 (9.32)	341 (12.1)	485 (77.7)
TOTAL	5607	2102	3295	2839	624**

(Figures in parentheses indicate percentage)

*N.A. - Not available

**is low since figures for typhoid cases were not included.

Typhoid is the most common disease and poliomyelitis the least. Since cases of poliomyelitis do not turn up at the hospitals in the acute stage, showing themselves up only when struck with residual paralysis, they are most of the time not labelled as cases of poliomyelitis. These figures, therefore cannot be regarded as representative and give only a vague idea of the situation.

Stool Examination

Table 10: **Stool Examination during 1987**

	Jaypore	Koraput	Morangpur	Mission Hospital	Raigadha
Number of stool specimens examined	1676	3426	5558	2500	1672
Number of samples found normal	903 (53.8)	1236 (36.1)	1022 (18.4)	506 (20.0)	656 (39.2)
Number of samples positive for Ova	529 (31.5)	659 (19.2)	143 (25.7)	146 (58.4)	388 (23.2)
Number of samples positive for cysts	248 (14.7)	1731 (50.5)	2060 (37.1)	1040 (41.6)	678 (40.5)

(Figures in parentheses indicate percentage)

Hospital records of stool examination reveal(Table 10) that the majority have either some sort of worm infestation or amoebiasis. The prevalence ranges from 50 per cent in

Jaypore to more than 80 per cent in Nawrangpur. Among the cysts detected in stool samples were E. histolytica and giardia. The commonest worm infestations were A. doudenale and A. lumbricoides though others like H.nana,Taenia solium,E. vermicularis were also encountered.

Epidemics

In 1988 an epidemic of meningitis occurred in Tentulikhunti block in Nowrangpur sub-division. According to the local health authorities this was meningococcal meningitis from which 143 persons suffered and of whom 17 died. Local practitioners and members of local Lions Club, however, thought that they suffered from enteric meningitis, a water-borne infection. Their argument was that most of the cases suffered from diarrhoea, vomiting and high fever before signs of meningism developed and responded well to chloramphenicol. However, no concrete evidence in favour of enteric origin of meningitis was available.

Fluorosis and Manganism

No case of fluorosis or manganism was observed when the team visited different villages in the district, covering all the sub divisions. There were no reports about either of these diseases from hospitals or local practitioners. Dental caries, which were quite common, may have been due to poor dental hygiene rather than deficiency of fluorides in the water.

Industrial Pollution

Some of the major industrial units in the district are National Aluminium Corporation, Hindustan Aeronautics Ltd., J.K. Paper Mill and a sugar mill. They may be possible sources of pollution of the water bodies since they keep releasing their effluents into them. A proper investigation of the quality of the effluents from these industries is called for to confirm the above observation.

Special Problems of the Population in Koraput District

Malnutrition, hookworm infestation and malarial infection are commonly found among the rural population of this district because of its typical social, cultural and environmental factors. Hookworm infestation is very common their as the tribal population moves about barefooted. Malnutrition, including vitamin A deficiency, is quite common probably as a result of high rate of worm infestation coupled with poverty and illiteracy. Plasmodium infection, which is very common too, also one contributing to malnutrition.

Sickle cell trait has been reported among the tribals in M.P. and Orissa. Agrahi tribals in Sambhalpur district are reported to suffer from this abnormality. As such, tribals of this district should also be examined for this trait.

Barmer (Rajasthan)

Barmer has a population of 11.19 lakhs of which 10.35 lakhs are supposed to be continually affected by drought as a result of the failure of the monsoon for the last five years. Barmer district, particularly the western belt, including Chotan, Gunga, Ramsar, Dhorimma and Gudamalane, is the worst affected area in Rajasthan. The population is very thin over wide areas (30 persons per sq. km). Numerous scattered clusters of small habitations make up one village which has an extensive perimeter. Many of these villages are inaccessible and at great distances from the roads.

The main occupation of the people is cattle rearing and agriculture but the drought has led to repeated failures of the crops of 'Bajra', 'Juwar' and wheat and to loss of cattle. Before the drought the people had an adequate diet of cereals supplemented with milk and milk products. Their calorie intake has now been reduced to 1,200 per day, provided by subsidized wheat and bajra from various agencies. As a result of this protein-calorie malnutrition and night blindness (Vitamin A deficiency) are found. Vitamin C deficiency has also appeared during the last six months.

Repeated crop failures have led to loss of livelihood of so many persons. Small and marginal farmers and agricultural labourers have migrated from the district in search of work leaving behind old people, women and children.

Sources of Drinking Water

Hand pumps: In areas where ground water is not so deep India Mark II hand pumps have been provided.

Deep tube wells: As most of the available water sources, when available, are very deep, tube wells have been installed and water stored in reservoirs. After chlorination water is intermittently distributed through stand posts and sometimes piped over long distances to the villages.

Dug wells: Deep dug wells in the worst affected areas now contain very little and muddy water which is used sparingly by the villagers.

Storage of water in Takas: At present there is hardly any surface water for drinking purposes in western Barmer. Traditionally most villagers store rain water in 'takas'. At present many 'takas' are dry and the rest contain water supplied by the PHED tankers or that collected by the villagers from dug wells. The method of storing the water in 'takas' is, in most cases, very unhygienic. Though the river 'Luni' in the Balotra areas has been dry for some years, water is less scarce there than in the western area.

Water quality: Salinity is a very wide spread problem. Increased levels of fluoride are found in some areas. Water supplied through hand pumps and deep tube wells is bacteriologically satisfactory but gets contaminated during distribution. 'Takas' and dug wells, in general, contain bacteriologically contaminated water.

Water-Borne Diseases

Acute bacterial and viral diseases:

Diarrhoea and gastro-enteritis cases ranging between 149 and 1,064 a year, typhoid cases ranging between 1 and 61 a year and infective hepatitis cases ranging between 4 and 22 a year have been reported by the primary health centres. Cholera was reported from the northern areas of the district in 1987.

The incidence of water-borne diseases in the district of Barmer during 1983-1987 is shown in Table 11 and that of some PHC's in Table 12-17.

The susceptibility to water-borne diseases and the mortality caused by them are influenced by malnutrition and vitamin deficiencies prevalent among the population, though they do not indicate too bad a situation. The hospital data already point to a marked increase in pyogenic and suppurative bacterial infections which are linked with the increasingly debilitated condition of the population.

Fluorosis

In certain villages people have skeletal deformities and dental changes due to consumption of water with high fluoride. It is to be noted that in some villages the disease was not directly related to the water fluoride levels which were not as high as may have been expected from the prevalence of fluorosis. It may, therefore, be suggested that the possibility of dietary fluoride or trace metals intake, apart from fluoride in water, being responsible for fluorosis cannot be ruled out. Among hospital patients sporadic fluorotic bone X-ray changes are not uncommon.

Guinea Worm Infection

Cases of guinea worm infection were sporadically observed in some villages which have since been identified as guinea worm affected villages.

Industrial Pollution

In the Balotra area of eastern Barmer the dyeing industry is a very flourishing one. The dried river is used for discharge of effluents from these small scale industries and has now become what may be called a fair-sized lake. There is considerable concern about the possibility of this effluent contaminating the very precious local ground water sources. The information about the health status of the population of Barmer District is given in Tables 4-9.

Table 11: Water Borne Diseases at Barmer

		1983	1985	1986	1987
1.	Cholera	Nil	Nil	Nil	Nil
2.	Typhoid	3	385	454	28
3.	Paratyphoid	153	Nil	Nil	Nil
4.	Amoebiasis	1,018	1,151	1,344	1,087
5.	Gastroenteritis	1,774	1,612	1,770	2,749
6.	Poliomyelits	6	23	38	9
7.	Guinea-worm Infection	292	89	32	711

Table 12: WATER- BORN DISEASES TREATED AT SIWAN P.H.C.

	Diseases	1984	1986	1987
1.	Cholera	Nil	Nil	Nil
2.	Typhoid	7	1	6
3.	Amoebiasis/Dysentry	157	113	135
4.	Gastroenteritis	353	-	-
5.	Infective hepatitis	15	4	22
6.	Guinea-worm	2	N.A.	Nil
7.	Poliomyelitis	Nil	1	Nil
	Out of total patients	11,810	11,075	14,188

Table 13: WATER BORNE DISEASES AT CUDDALORE P.H.C.

	Diseases	1985	1986	1987
	Diseases	1985	1986	1987
1.	Cholera	Nil	Nil	Nil
2.	Typhoid	9	7	3
3.	Amoebiasis	176	92	87
4.	Gastroenteritis	320	329	377
5.	Viral hepatitis	18	17	17
6.	Guinea-worm	Nil	Nil	Nil
7.	Poliomyelitis	Nil	Nil	Nil
8.	Urinary Calculus	Nil	Nil	Nil
	Out of total patients	N.A.N.	13,506	20,097

Table 14: WATER BORNE DISEASES AT DHORIMANA P.H.C.

Population: 1,34,222

	Diseases	1986	1987
1.	Cholera	Nil	Nil
2.	Typhoid	17	Nil
3.	Amoebiasis	6	15
4.	Gastroenteritis	370	1,064
5.	Viral hepatitis	9	5
6.	Poliomyelitis	Nil	6
7.	Guinea worm	Nil	Nil
	Out of total patients	5,529	13,247

Table 15: WATER BORNE DISEASES AT BAITU P.H.C.

	Diseases	1985	1987
1.	Cholera	Nil	Nil
2.	Typhoid	40	61
3.	Amoebiasis	132	162
4.	Gastroenteritis	149	648
5.	Viral hepatitis	6	Nil
6.	Poliomyelitis	Nil	Nil
7.	Urinary Calculus	14	26
8.	Guinea-worm	Nil	Nil
	Out of total patients	6,375	7,218

Table 16: WATER BORNE DISEASES AT SINDHARI P.H.C.

Population: 1,31,453

	Diseases	1986	1987
1.	Cholera	Nil	Nil
2.	Typhoid	10	36
3.	Amoebiasis	129	372
4.	Gastroenteritis	129	230
5.	Viral hepatitis	Nil	Nil
6.	Poliomyelitis	6	Nil
7.	Guinea-worm	Nil	Nil
8.	Urinary Calculus	278	2
	Out of patients	7,936	N.A.

Table 17: WATER BORNE DISEASES AT CHOHTAN AND SHEO P.H.C.'s IN 1986

Population Chohtan: 22,766
Sheo: 101,198

	Diseases	At Chohtan P.H.C.	At Sheo P.H.C.
1.	Cholera	Nil	Nil
2.	Typhoid	25	26
3.	Amoebiasis	30	136
4.	Gastroenteritis	500	131
5.	Viral hepatitis	Nil	38
6.	Poliomyelitis	Nil	Nil
	Out of total patients	1,174	Not available

Nagpur (Maharashtra)

The overall picture presents a significant tribal population. The main occupation of the people is cultivation and mining. The district presents a paradox in terms of health services and health status. More than adequate number of health facilities are present but rural areas are deprived of these as the services are located in urban areas. The chief causes of morbidity are malnutrition and communicable diseases. 129 problem villages have been identified many of which have no source of water at present as wells have dried up and water is being supplied by tankers. The majority of the wells which have water are very shallow, insanitary and ineffectively chlorinated. Water related diseases are chiefly infective in nature and worm infestation is very common. Cases of polymyositis are also commonly encountered in the district.

Water-Borne Diseases

The majority of water-borne diseases are infective in origin. Table 18 shows the morbidity from water-borne diseases during the last four years.

Table 18 Morbidity Rates of Water-Borne Diseases in Nagpur District (Maharashtra)

	1984	1985	1986	1987
Dysentery	19003	36928	29080	35038
Infective Hepatitis	19	30	21	11
Gastro-enteritis	2	18	-	63
Poliomyelitis	4	-	-	-
Typhoid	100	296	193	200

Dysentery and typhoid are common conditions. Gastro-enteritis and infective hepatitis are comparatively rare. These figures do not give a true picture as the diagnosis of these diseases is not confirmed at the PHCs. Under reporting of these cases can not be ruled out. Nine deaths from poliomyelitis were reported during 1983 and two during 1984. It is quite unlikely that there has been no case of poliomyelitis in recent years. Apparently these figures represent only the tip of the iceberg.

Cases of gastro-enteritis are frequently reported from different PHCs. In 1988 alone 201 cases of gastro enteritis were reported and of these 20 proved fatal (case fatality rate approximately 10 per cent). During the week ending 28.5.88 46 cases and 5 deaths were reported. These cases came from PHCs of Narkhed, Dorli, Gumthi, Kalmeshwar, Gumthala, Jaoli and Badegaon.

The edpidemic section of PHCs maintains attack and death rates for various diseases and are shown in Table 19.

Table 19. Attack and Death Rates of Various Water Borne Diseases in Nagpur District

	1987		1988 (till 31st May)	
	Attacks	Death	Attacks	Death
Cholera	23	1	9	1
Gastroenteritis	983	17	193	18
Typhoid	54	Nil	2	Nil
Infective Hepatitis	12	Nil	1	Nil
Poliomyelitis	Nil	Nil	Nil	Nil

Stool and vomitus samples of suspected cases are routinely sent to the public health laboratory for bacteriological examination. The results of the examination of these samples from 1984 to 1987 are presented in Table 20.

Table 20. Stool and Vomitus Culture from Reports

	1984	1985	1986	1987
Number of samples examined	22	384	462	698
V. Cholerae isolated	4	74	44	50
NAG Vibrio isolated	-	2	-	9
Salmonella isolated	-	-	2	4
Shigella isolated	-	-	3	3
Enteropathogenic E.Coli isolated	-	-	-	3
TOTAL	4	77	49	69

Prevalence of Intestinal Parasites

Records of the examination of stools for ova and cysts were not available from rural hospitals. However, in a study in Nagpur city approximately 50.0 per cent of the examined subjects below 15 years were found to have ova and parasites in stool. This is shown in Table 21.

Table 21. **Breakup of Stool Examination Findings in Nagpur District**

435 Samples

	No. found +ve	Percent
Round worm	94	44.1
Giardia	25	11.7
H. nana	15	7.0
A. duodinale	12	5.6
Trichuris trichuria	2	0.9
Enterobious vermicularis	12	5.6
Entamoeba hystolytica	38	17.8
Total	213	100.0

Guinea Worm Disease

Visits to different villages and personal discussion with health authorities, local practitioners etc. revealed that guinea worm disease is no longer found in rural areas of Nagpur district but is prevalent in the surrounding districts. In 1983 and 1984, a few cases (7 and 20

respectively) of guinea worm disease were admitted to hospitals in Nagpur city.

Fluorosis

This has not been reported from Nagpur district. However, it is prevalent in the adjoining district of Chandrapur, mainly in the villages of Warane, Sindewahi and Rajura, where the fluoride levels were found to be in excess of the permissible limit in most of the water samples examined by Public Health Laboratory. It is also prevalent in other Taluks of the district.

Iodine deficiency

Iodine deficiency goitre is prevalent in the villages of the foothills of Garamsur hills. A survey conducted by PSMGMC in Janapani, Ahmednagar, Bilhargoudi villages reported an overall prevalence of goitre in 21.5 per cent of the inhabitants. This is more prevalent in females than in males. Other thyroid disorders i.e. cretinism, carcinoma of thyroid and thyrotoxicosis were not found. Serum PBI analysis was carried out in 57 subjects and was found to be 3.35 ugm per ml which is within normal limits. It was also observed that values of serum PBI decrease as the size of goitre increases. Iodine content of soil and water in these villages was found to be 2 ugm/Kg of soil and 2.56 ugm/Ltr of water. These values were much less than the values in non-goitrous areas.

Special Problems of the District

Polymyositis

During the period September to December, 1986, 85 cases of polymyositis were admitted to Government Medical College and Indira Gandhi Medical College. The disease is characterized by subacute symmetrical weakness of proximal limb and trunk muscles without dermatitis or other skin lesions.

The age group commonly affected was 16 to 25 years and male, female ratio was 1.7 : 1. The majority of cases were from Nagpur and a few from the surrounding region. The role of pollutants both biological and non-biological and their relation to water, if any, needs to be properly examined in respect of the causation of polymyositis.

Sickle-Cell Trait & Sickel Cell Anaemia

Nagpur district has a significant tribal population. In a tribal Ashram School in the adjoining district, of Chandrapur 16.2 per cent boys and 16.7 per cent girls have been reported to be positive for HbAS. Sickle cell anemia was prevalent among 1.02 per cent students. Approximately 20 per cent of sicklers belonged to the schedule tribes. In the light of these findings the tribals of this district need to be examined for sickle-cell trait and abnormal haemoglobins.

Health Status and Health Services in East District (Sikkim), Koraput (Orisa), Barmer (Rajasthan) and Nagpur (Maharashtra)

East District (Sikkim)

The medical and public health services in Sikkim have been presented in Tables 15-18.

There are 785 doctors, 260 auxiliary nurses and midwives and 35 trained nurses. As shown in Table 18, 11854 patients were treated in indoor and 460239 patients in outdoor in the four districts in Sikkim. Of these the majority of cases treated were from the East district. Doctor population ratio is 1 : 3638.

Nutritional Diseases

According to a nutrition atlas of 1982 the prevalence of nutritional deficiencies was as under- Vitamin A deficiency (conjunctival xerosis 7.7%), (bitot's spot 9.4%), niacin deficiency, (atrophic papillae 0.8%), Vitamin C deficiency (bleeding gums 21.4%). Thyroid enlargement (35.0%) and fluorosis (6.0%) were also noted.

Morbidity/Mortality Data

The crude birth rate was 31.0, 31.6, 34.85 and 31.7 in 1981, 1982, 1983, 1984 respectively. The crude death rate was 8.9, 9.5, 10.9 and 10.2 in 1981, 1982, 1983 and 1984 respectively. The infant mortality rate was 93 per thousand. The total number of primary health centres in Sikkim is 20 of

which the East District accounts for 6. The total expenditure on medical, primary health and social welfare is rupees six crore and eighty lakhs. In Sikkim the total number of hospitals in Sikkim having more than 20 beds is 5, of which the East District has two. The total number of hospital beds, doctors and nurses in Sikkim is 575, 115 and 311 respectively of which 375 doctors, 66 beds and 157 nurses are in the East District.

Table 22. Attendance in Out-Patient Department (OPD) and Water Borne Diseases in Singtam

Number of O.P.D. Attendance per year in East District

1983	1984	1985	1986	1987
58,654	58,642	91,976	1,21,300	1,37,753

Bacillary Dysentery

1983	1984	1985	1986	1987
1488 (2.49%)	1569 (2.67%)	1920 (2.09%)	2306 (1.90%)	2984 (2.17%)

Amoebiasis

1356 (2.27%)	1438 (2.45%)	1836 (2.45%)	2086 (1.72%)	2387 (1.73%)

Gastro-enteritis

216 (0.36%)	315 (0.54%)	712 (0.77%)	1014 (0.83%)	1492 (1.08%)

Infective Hepatitis

96	130 (0.16%)	320 (0.22%)	640 (0.35%)	984 (0.71%)

(Percentage of disease based on OPD attendance)

Table 23. Data on Medical and Public Health in Sikkim

(As on 31.03.1987)

Particulars	Unit	North	East	South	West	State
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hospital	No.	1	2	1	1	5
Primary Health Centres	No.	3	6	5	6	20
Primary Health Sub Centres	No.	17	37	33	33	120
Beds	No.	80	495	100	110	785
Doctors	No.	7	55	17	13	92
Auxillary nurses and mid-wives	No.	27	120	61	52	260
Trained Nurses	No.	2	25	4	4	35
I.C.D.S.	No.	75	130	100	100	405
Patients treated indoor	No.	2248	5544	2079	1983	11854
Patients treated outdoor	No.	59985	234471	57381	108402	460239
Population per doctor	No.	3379	2522	4469	5784	3638

Table 24: Death Rate (per 1000 population)

Area	1983	1984	1985
	Sikkim		
Rural	12.2	11.3	11.7
Urban	4.8	5.0	6.2
Combined	10.9	10.2	10.7
	All India		
Rural	13.1	18.8	22.9
Urban	7.9	8.6	7.6
Combined	11.9	12.6	11.7

Table 25:Data about PHCs, Doctors and Nurses in Singtam during 1983-1987

Number of P.H.C.s in East District (Singtam)

1983	1984	1985	1986	1987
5	5	5	5	6

Number of P.H.S.C. in East District (Singtam)

1983	1984	1985	1986	1987
26	26	29	31	34

Number of Doctors in East District (Singtam)

1983	1984	1985	1986	1987
9	9	10	12	14

Number of Nurses in East District (Singtam)

1983	1984	1985	1986	1987
48	50	52	55	60

Koraput (Orissa)

The existing health services in the district are shown in Table 26. The location of these services are depicted in Figure 1.

Table 26: Health Services in Koraput

Services	Number
Government Hospitals	9
Subdivisional Hospitals	3
Project Hospitals	6
Mission Hospitals	2
Allopathic Dispensaries	10
Primary Health Centres (PHCs)	42
Additional P.H.C.s	152
Family Welfare Subcentres	201
M.T.P. Centres	10
Post Partum Centres	2
T.B. Subcentres	55
S.D.T. Subcentres (Leprosy)	27
S.T.D. Clinics	2
Number of Doctors (Government)	227
Number of Trained Birth Attendants	3053
Village Health Guides	1860

Filaria is a problem in Jaypore subdivision of the district.

Morbidity

Table 27 shows the number of patients treated in out-door and indoor in different hospitals of the district.

Table 27: Number of Persons Treated in Hospitals during 1983-1987

	1983-84	1984-85	1985-86	1986-87
Adults				
Males	298481	232866	249567	201977
Females	128786	101378	114993	96869
Children	138786	99321	107413	97065
Total	5,66,053	4,33,565	4,71,973	3,95,911

Mortality Statistics

Table 28 shows some of the causes of death in the population of the district. Fever has been listed as the major cause of mortality. This, obviously, would include typhoid, infective hepatitis and a number of other water borne infections that manifest as fevers.

Table 26: Common Causes of Death (Koraput)

Causes of death	Number	Percentage of total deaths
Fever	5981	63.8
Dysentery and Diarhhoea	620	6.7
Respiratory Diseases	522	5.5
Accidents	175	1.9
Others	2071	22.1
Total	9369	100.0

National Health Programmes

The following programmes are being run in Koraput and signify the major health problems there:

1. Family Welfare and M.C.H. Programme
2. National Malaria Control Programme
3. National T.B. Control Programme
4. National Leprosy Control Programme
5. National Programme for Prevention of Blindness
6. National Filaria Control Programme

Barmer (Rajasthan)

Health services in Barmer district is shown in Table 29. The health services available in the district are not adequate because of the extremely large size of the district.

Table 29: DATA ABOUT HOSPITALS, BEDS AND PARAMEDICAL STAFF AT BARMER

Hospital/PHC/ Dispensary	Beds	Doctors	Nurses	Paramedical Staff
Govt. Hospital, Barmer	293	91	244	180
Referral Hospital, Balota	50	9	10	2
Upgraded P.H.C., Chohtan	30	9	1	18
P.H.C. (7)*	9	-	-	-
Mini P.H.C. (10)*	6	1	-	8
Dispensary (17)*	-	1	-	6
Adipost (8)*	-	-	-	1

*Number

Health Programmes

1. Expanded Programme of Immunisation
2. National Malarial Eradication Programme
3. National Family Welfare Programme
4. National Tuberculosis Control Programme
5. Prevention of Cholera Programme
6. Leprosy Control Programme
7. Prevention of Night Blindness Programme
8. Prevention of Guinea Worm Disease Programme

Even so the morbidity in Barmer district is on the increase because of continuous drought conditions. The worst affected tehsils/villages are Chohtan, Gunga,Ram Sar, Sundara and Disala. Those affected less are Balotra, Dohoimana, Gudamalani, Samdari, Baitu and Pachpadra.

Barmer district has been declared the worst drought affected area in Rajasthan.

Though the entire Barmer district was hit by drought its western belt was the worst affected. The following are some of the conditions which may largely or partially be attributed to scarcity of potable water because of continuous drought and malnutrition:

Eye :

Vitamin A deficiency causing xerophthalmia and Bitot's spots resulting initially in night blindness and then in complete blindness has been very common for the last 9 months. It is

most commonly found among children and old persons. Both the sexes are equally affected.

Scurvy:

This is common because of vitamin C deficiency children of either sex are affected.

Bones:

Calcium and phosphorus deficiencies in the form of rickets among children and osteoporosis among adults is common among the population.

Anaemia:

This ailment is quite common and is found among people of either sex and all of age groups.

Protein Calorie Malnutrition:

This is prevalent mainly among children and more among the females than among males. There has been a two to three fold increase in the prevalence of protein calorie malnutrition than in the previous years.

Fluorosis:

People do not bother to seek advice in respect of their ailments and it has been observed that they visit the PEC's for treatment of other diseases. It is common among adults. The disease is encountered most commonly among the people living in Chohtan and Gunga Tehsils.

Gastro-intestinal Tract:

The most common ailments are gastroenteritis, amoebiasis and worm infestations. In this respect Chohtan and Cunga Tehsils are the worst affected.

Genito- urinary:

Renal and gall-bladder stones are common among the inhabitants of Chohtan Tehsil. Even children (2-3 years of age) have urolithiasis.

Skin:

Eczema and other chronic diseases are common because of unhygienic conditions.

Ear:

Otitis media and upper respiratory tract infections are very common because of unhygienic conditions.

Chest:

The most common diseases are tuberculosis chronic bronchitis (due to heavy bidi smoking) and empyema (mainly tubercular).

Pyrexia of unknown origin (P.U.O.):

P.U.O. is very common perhaps because of high ambient temperature and small intake of water.

Nagpur (Maharashtra)

[illegible] district has achieved the target of the I.C.D.S. for every 30,000 people. The health services available in the district are presented in Table 30.

Table 30. Health Services in Nagpur Districts

	Services	Total	Tribal	Non-tribal
1.	Rural Hospitals	4	1	3
2.	Primary Health Centres	30	3	30
3.	Primary Health Units	1	-	1
4.	Allopathic Dispensaries	30	1	29
5.	Ayurvedic Dispensaries	33	-	33
6.	Sub-centres	250	22	228
7.	Maternity Homes	5	-	5
8.	C.H.C. Units	20	3	23
9.	Cottage Hospital (Ramtek)	1	-	1
10.	Health Unit (Kachar)	1	-	1
11.	Municipal Dispensaries	5	-	5
12.	Leprosy Control Units	2	-	2
13.	Supervisory Urban Leprosy Unit	1	-	1
14.	Filaria Control Unit	1	-	- 1
15.	Malaria Eradication Unit	1	-	- 1

There are 147 doctors, 117 aids and 1034 nurses in Nagpur district. The majority of these are clustered in Nagpur city. The services in rural areas are manned by 84 doctors in different PHC's and 63 doctors in different sub-centres. There are 435 nurses and 408 other paramedical staff. Besides these there are 1173 health guides. The per capita expenditure on medical and health is approximately 95 paise per year.

Diet and Nutrition

The staple food in rural areas is jowar and rice (hand Wheat and bajra are also used occasionally. Cereal consumption during summers is 425 gm/capita/day and 399.65 gm/capita/day during the rainy season. The average daily intake of food by an adult is shown in Table 24.

The average daily intake by an adult in terms of food and nutrient is given in Table 31 and 32.

Table 31. Average Daily Intake of Food by Adults

Food	Actual Intake (gms)		Recommended
	Summer	Rains	
Total Cereals	425.00	399.65	475.00
Jowar	25.00	215.04	
Pulses	15.00	15.00	65.00
Leafy vegetables	8.00	38.66	125.00
Other vegetables	40.00	40.00	75.00
Roots and Tubes	45.00	10.64	100.00
Fruit	-	-	30.00
Milk	15.00	15.00	100.00
Fats and Oils	9.00	9.00	40.00
Meat, Fish, Eggs	9.78	9.78	60.00
Sugar and Jaggery	10.00	10.00	40.00

Table 32. Average Nutrient Intake by Adults

Nutrients	Intake		Recommended
	Summer	Rains	
Calories (K.Cals)	1703.64	1613.67	2000.00
Proteins (gms)	40.30	44.33	55.00
Vitamin A (ugm)	95.54	152.80	3000.00
Thiamine (mg)	1.13	1.37	1.4
Riboflavin (mg)	0.70	0.67	1.50
Ascorbic Acid (mg)	17.89	2.63	50.00
Calcium (mg)	160.82	132.25	400-500
Iron	17.90	12.08	20

The tribal and rural population, specially the children, pregnant women and lactating mothers, suffer from dietary deficiency of calories, proteins, phosphorus, calcium and iron. The protein calorie malnutrition among children is responsible for the high prevalence of Kwashiorkor and Marasmus. Calcium and phosphorus deficiencies result in rickets and osteomalacia.

Morbidity

The number of indoor and outdoor patients attending village P.H.C.'s are given in Table 33.

Table 33. O.P.D. and I.P.D. Attendance in Different P.H.C.'s (1985)

(Figures are in thousands)

Talukas	Indoor Patients			Outdoor Patients		
	Male	Female	Children	Male	Female	Children
Nagpur	345	312	36	1358	1320	519
Hingana	-	x	-	17	14	7
Kamthee	1	2	x	40	45	17
Katol	x	1	1	35	37	28
Narkhed	-	1	-	28	29	19
Saoner	3	6	3	61	68	51
Kalmeshwar	x	1	-	19	18	16
Ramtek	x	1	x	31	32	34
Parshivni	x	x	-	18	17	16
Naudha	x	x	-	21	19	17
Umred	x	1	-	26	38	22
Bhivapur	x	x	-	16	17	15
Kuhi	-	1	-	22	19	17
Total for the distt.	349	326	40	1692	1673	778

x- Indicates less than 1000

The common causes of morbidity are infective diseases of gastrointestinal tract and respiratory system. Malnutrition and other diseases also form a substantial component.

Mortality

The number of deaths from various causes during 1985 is shown in Table 34.

Table 34. Common Causes of Mortality (1985)

Malaria	-
Cholera	7
Measles	-
Pulmonary Tuberculosis	694
Pneumonia	330
Dysentery, Gastroenteritis	267
Cardiac diseases	606
Typhoid	67
Cancer	376
Respiratory diseases	576
Suicides	59
Accidents	973
Others	12,938
Total	16,892

Concluding Remarks and Recommendations

Records of various health agencies in Sikkim Koraput, Barmer and Nagpur districts were carefully studied to investigate the incidence of water borne diseases. In Nagpur confirmed cases of cholera ranged between 44 and 74 cases during 1985 in 1987. There were 983 cases of gastroenteritis, 54 cases of typhoid, 12 cases of hepatitis in 1987.

In Koraput the hospital records (1983-1987) showed that gastroenteritis accounted for 6.4 to 19.2% of the admissions, infective hepatitis 7.2 to 15.1% and poliomyleitis for 0.3 to 3.1% of the admissions.

The prevalence of the following diseases in East district of Sikkim during 1983-1987 was 1.9% to 2.67% for bacillary dysentery, 0.36% to 1.05% for gastroentertis, 0.16% to 0.71% for infective hepatitis and 1.7% to 2.4% for amoebiasis. In Barmer district 1986 and 1987 40 and 60 cases of typhoid, 149 and 648 cases of gastro-entertitis, 6 cases of viral hepatitis and 6 cases of poliomyelitis were attended to. On the basis of this information the districts have been classified as endemic, low endemic or highly prevalent for particular disease.

The study concluded that poverty, illiteracy, ignorance and lack of adequate and safe water for the local inhabitants have resulted in high morbidity rates. Bacteriological

contamination of water is responsible for high incidence water of borne diseases among the population. Typhoid, infective hepatitis, Dysentery, gastro-enteritis, poliomelitis and cholera were the chief causes of morbidity and mortality. The infant mortality rate was found to be quite high in some of the districts indicating lack of adequate health services and poor health status of the local populations.

RECOMMENDATIONS

1. The availability of adequate amounts of safe drinking water be ensured.

2. Intensive health education compaigns involving the media of television, and educational institutions may be undertaken to increase awareness of the hazards of contaminated water.

3. Measures for prompt treatment of gastro-enteritis by fluid replacement be taken and improvement in nutritional status be made.

4. In Barmer it is necessary to carry out some form of screening of the lead levels in water sources as has already been done for the fluoride problem. Since this water is consumed by a significant number of the child populations need to ensured that lead levels are below the permissible limit.

Long term action suggested:

A detailed epidemiological health survey of the population in problem villages with special reference to water borne diseases should be conducted. This will help in assessing improvements made by the intervention programme instituted by Water Technology Mission, Government of India, under the hological approach programme.

SUMMARY OF WATER QUALITY IN SIKKIM, KORAPUT, BARMER AND NAGPUR

In Sikkim even though the water was untreated approximately half the water from streams is potable when evaluated by the coliform MPN test only. However, chlorination of all surface sources is highly desirable as previous studies have shown faecal coliforms are very prevalent. In Koraput a very backwardi tribal area where hygiene is of a very low standard almost all the surface drinking water sources are faecal contaminated with coliform MPN > 10/100 ml and very rigorous steps have to be taken to supply safe drinking water. In Barmer half the ground water sources appeared to be contaminated this may be the result of poor conditions of sampling or inadequate chlorination of these sources before distribution. Intensive local testing of the water in Barmer is required to elucidate the cause of appeared satisfactory with a level of contamination which can easily be overcome.

In general the physico-chemical quality of the water was satisfactory in Sikkim, Koraput and Nagpur and unsatisfactory in Barmer.

CADMIUM contamination of 4 water sources was detected in KORAPUT which requires imediate confirmation (Table 8A Fig. 4,5). Elevation of IRON levels above 5 mg/L was seen in 18.1% of samples and manganese marginally raised in 11.9% samples (Table 8C Fig. 4 and 6) and chromium in twelve samples (> 100 mg/L in 4 samples Table 8E).

In BARMER the water has very high total dissolved solids, with a hgh levels of salinity and hardness corroborated by the widespread elevation of magnesium and calcium levels. High fluoride levels were found in 31.4% of samples, hwoever, alternative sources of water have been made available. Nitrate levels were marginally above permissible limits in 67% of samples. A feature which has not been previously highlighted is the significantly raised lead levels found in 28.6% (19) of samples (Table 9A Fig. 7,8). Chromium was also elevated above 100ug/l in 11.34% of samples (Table 9B Fig. 7,9).

In NAGPUR no serious problem of metal contamination was found. Previous studies in East and South Districts of SIKKIM by ITRC just prior to the Hological studies revealed 20% of the samples had IRON levels above the maximum permissible limits 1.0 mg/L of which 5% were a little above 5 mg/L.

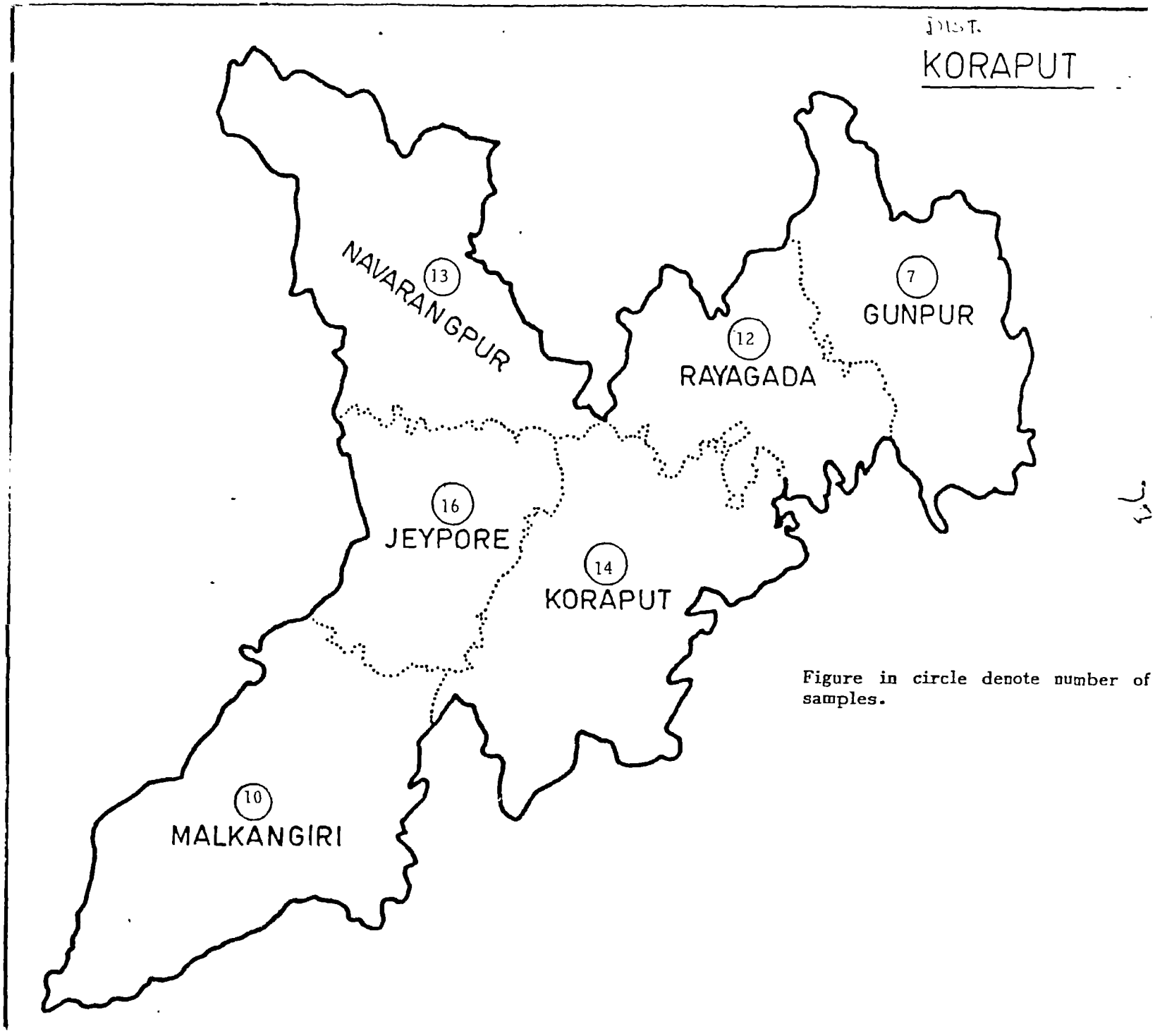
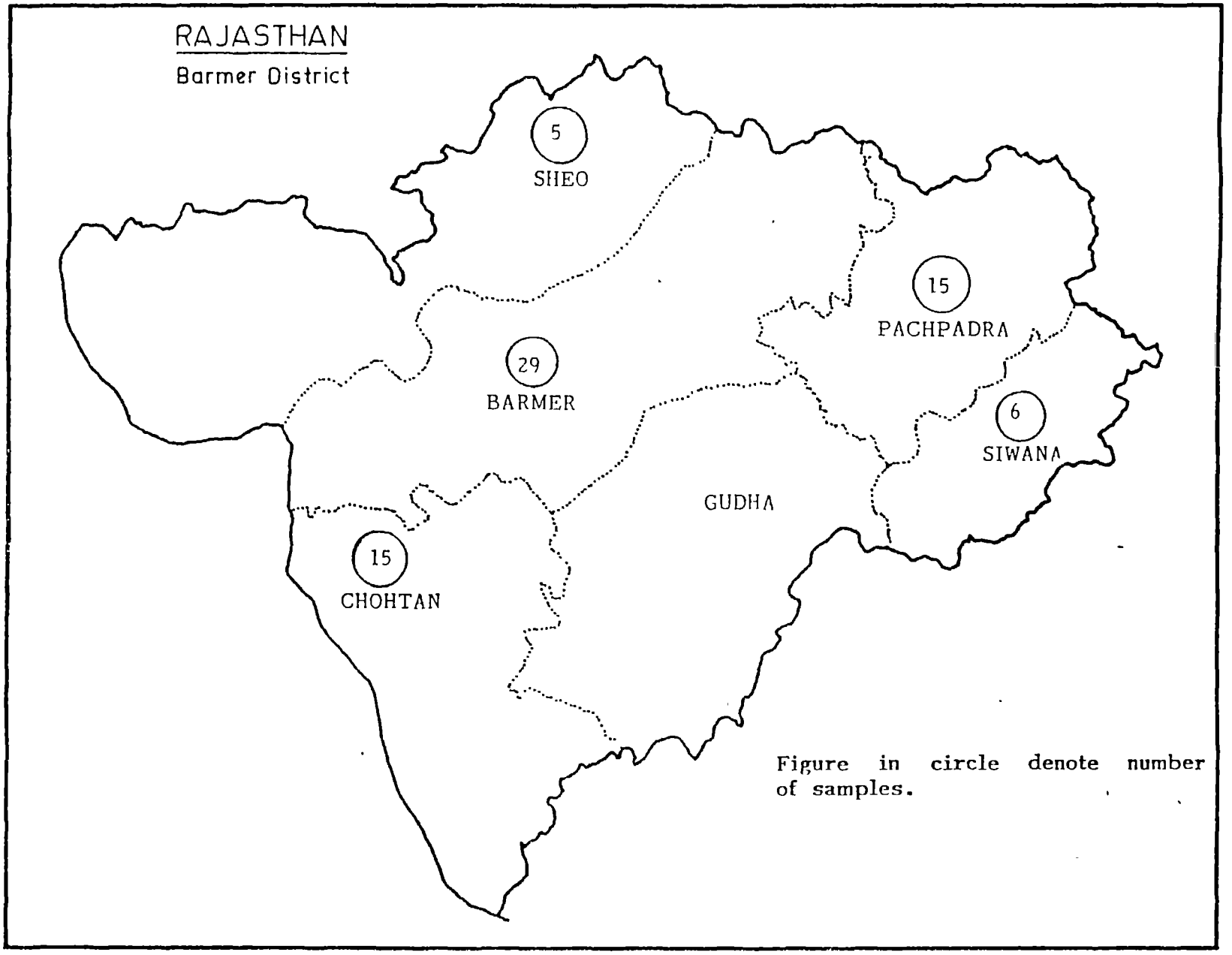


Figure in circle denote number of samples.


RAJASTHAN
Barmer District
5
SHEO
15
PACHPADRA
29
BARMER
6
SIWANA
GUDHA
15
CHOHTAN
Figure in circle denote number of samples.

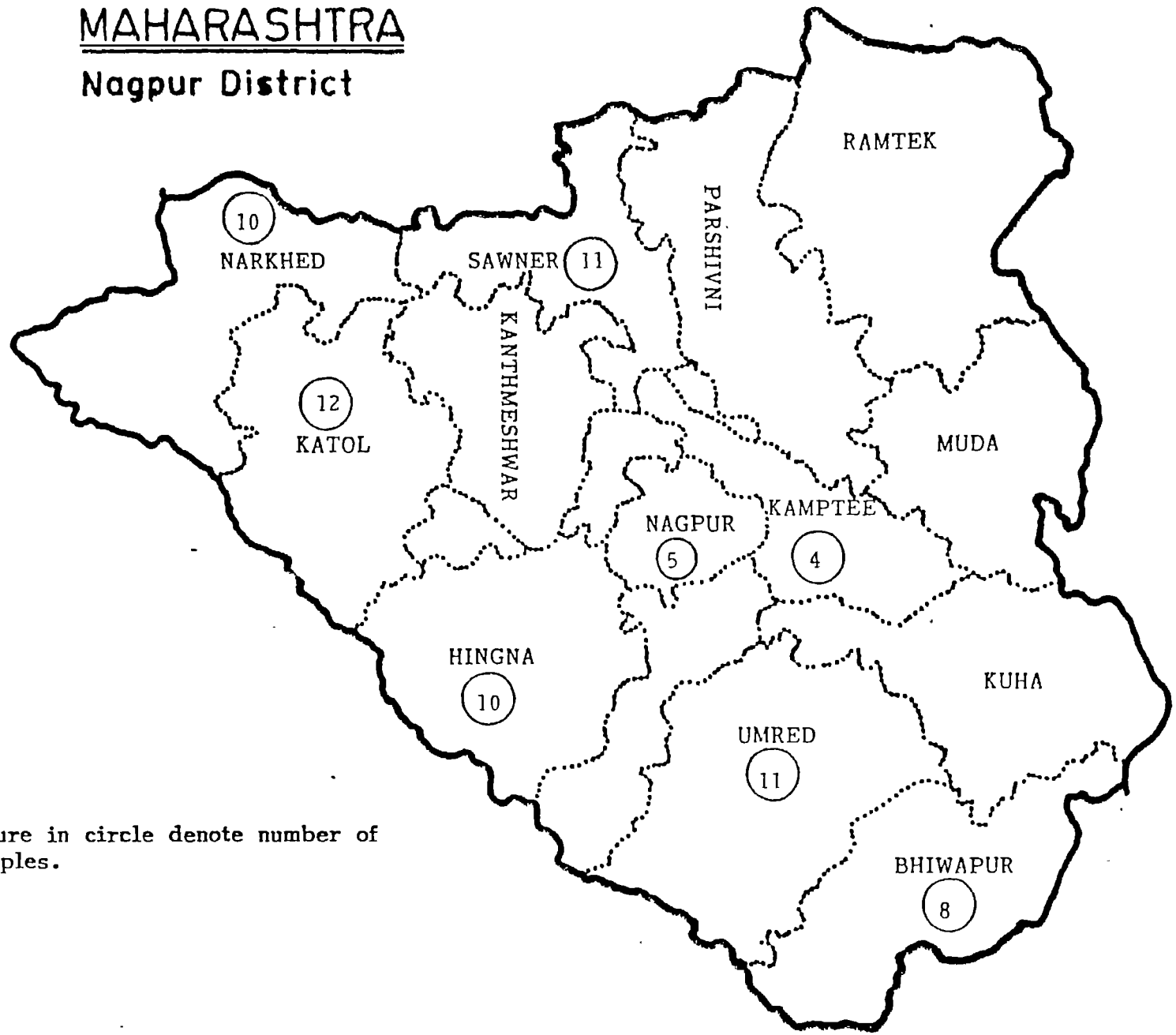
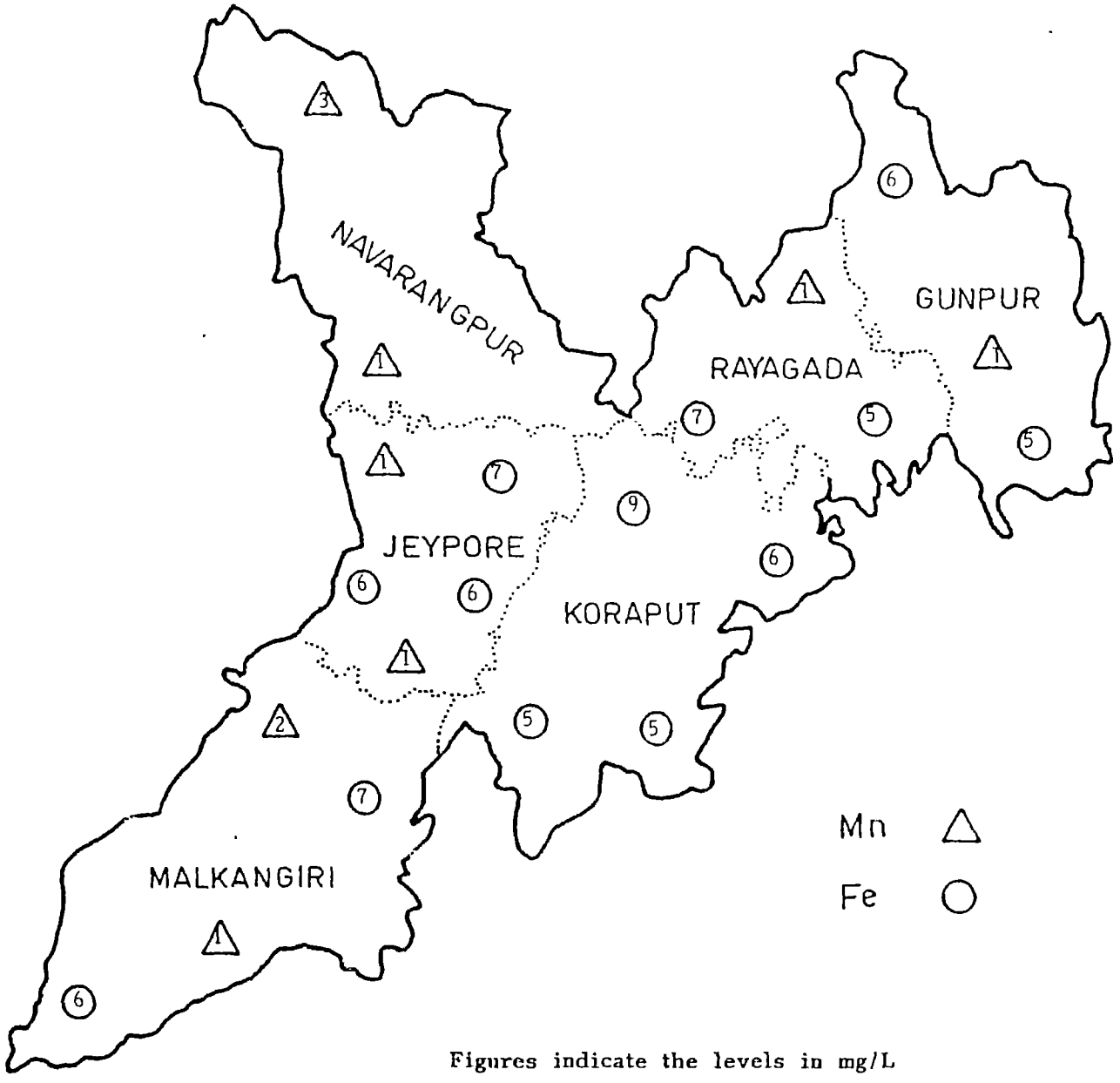


Figure in circle denote number of samples.

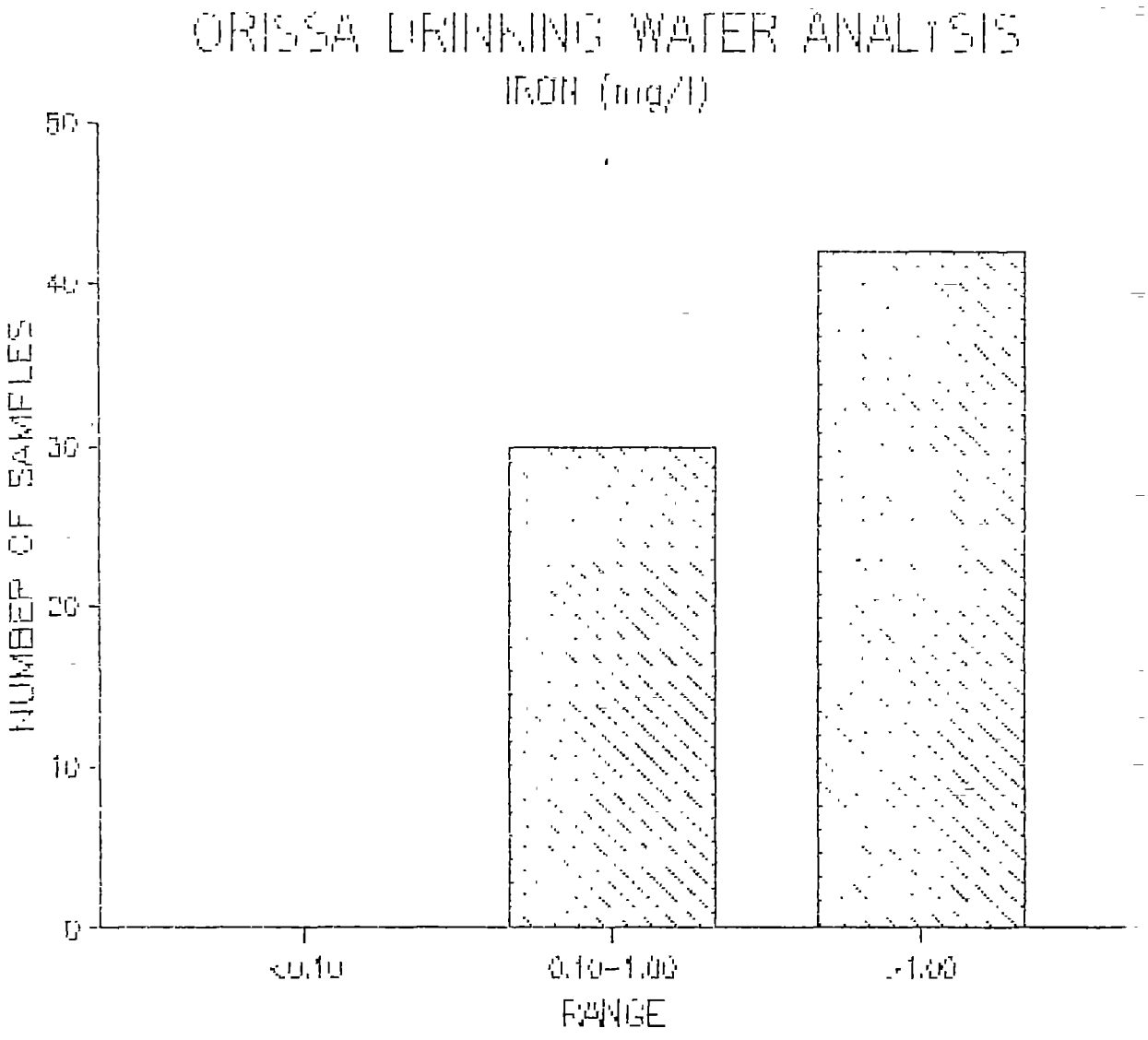
MANGANESE AND IRON LEVELS IN DRINKING WATER IN KORAPUT

Fig. 1



Figures indicate the levels in mg/L

Fig. 2

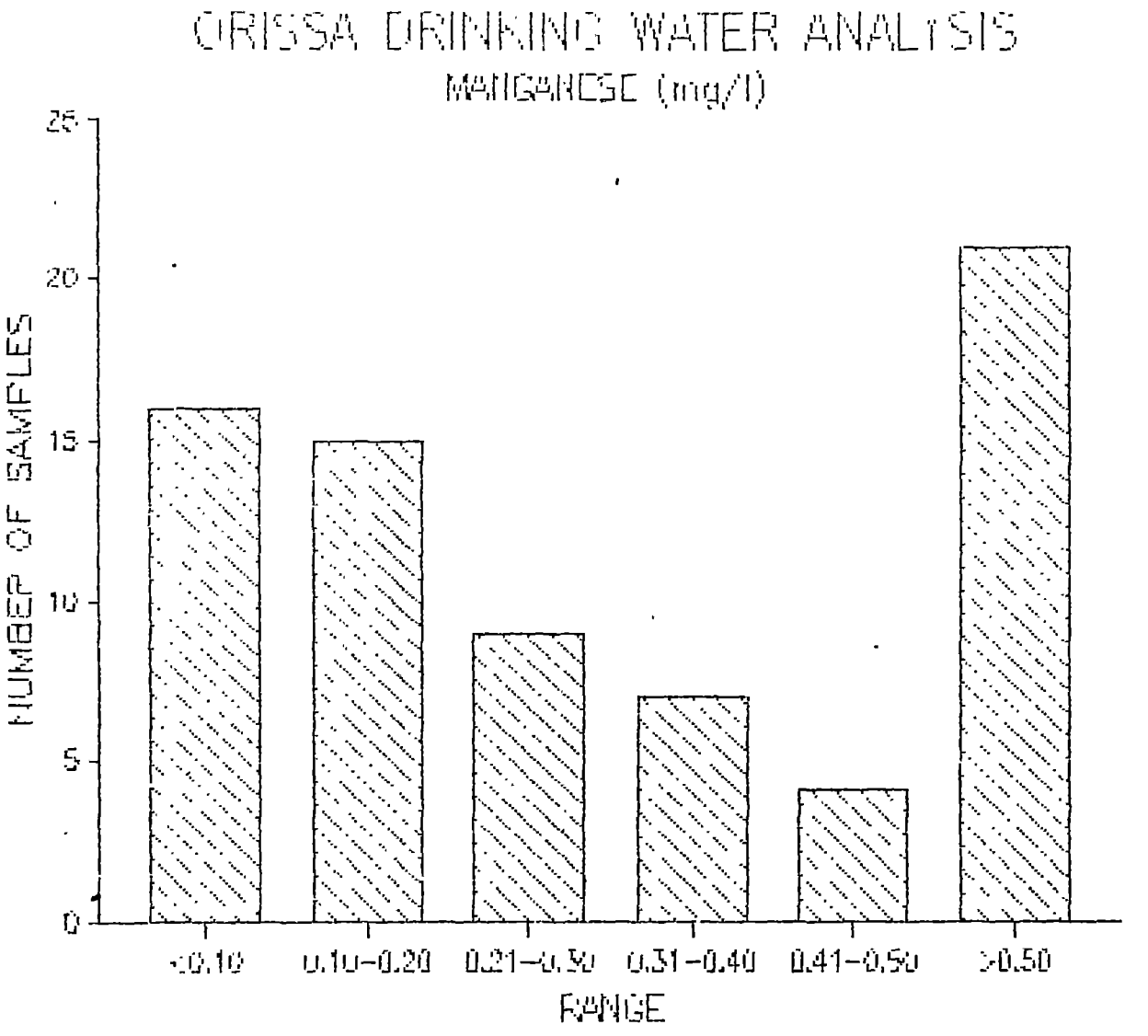


HIGHEST DESIRABLE LEVEL = 0.100 mg/L

MAXIMUM PERMISSIBLE LEVEL = 1.00 mg/L

42 (58.37%) samples are above Maximum Permissible Level (1.0 mg/L)

Fig. 3



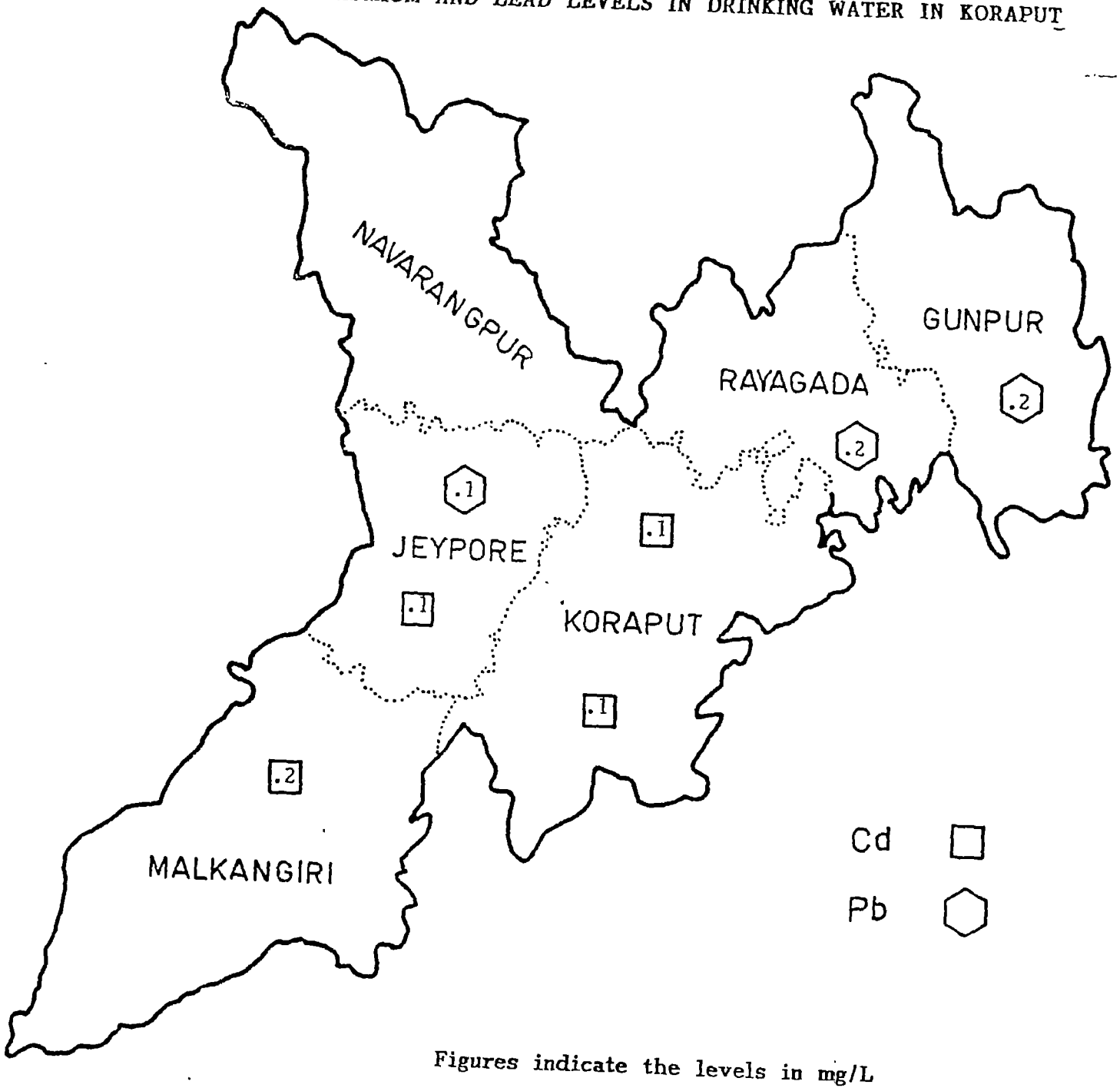
MAXIMUM PERMISSIBLE LEVEL = 0.5 mg/L

21 (29.2%) samples are above Maximum Permissible Level (0.5 mg/L)



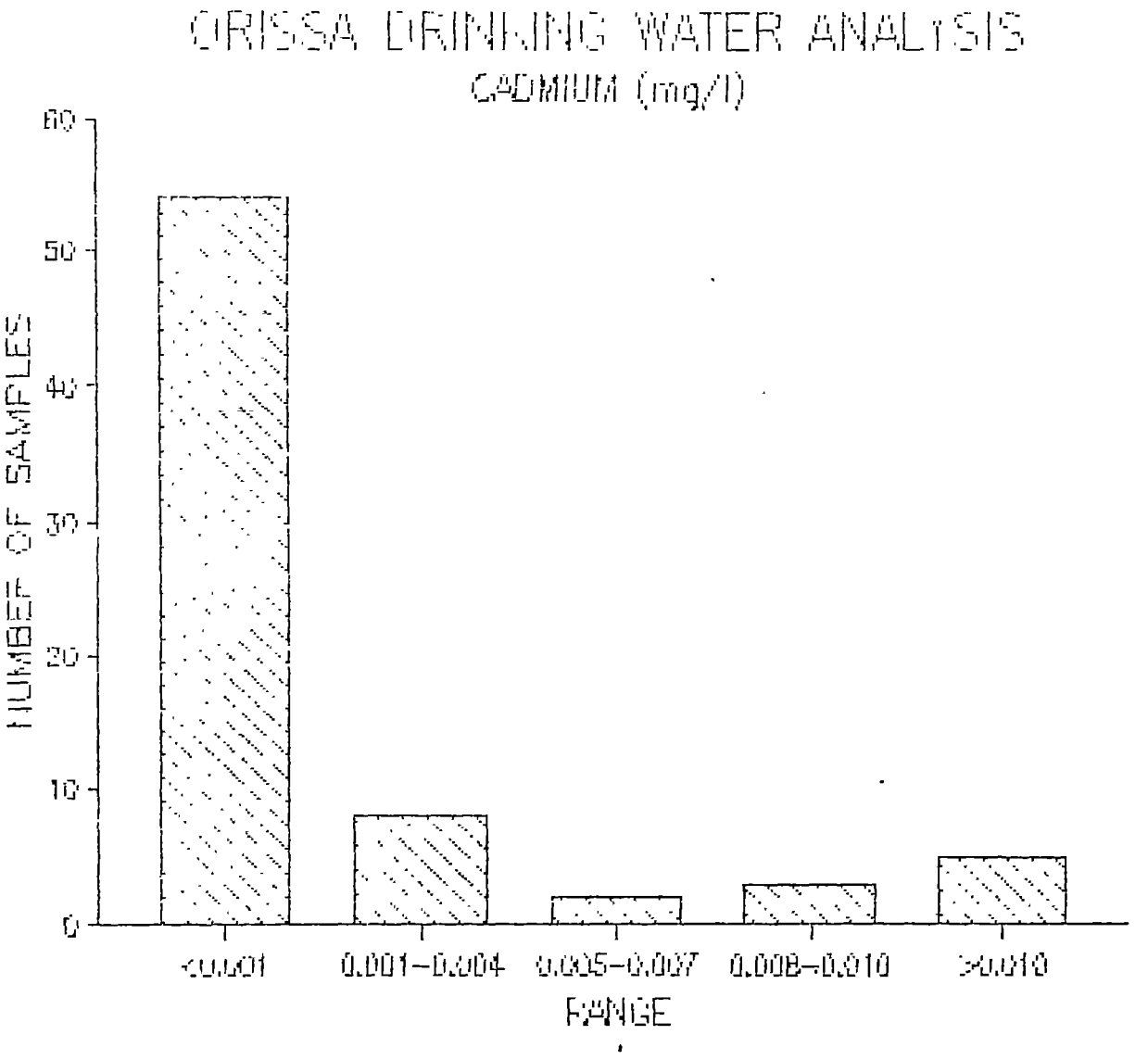
CADMIUM AND LEAD LEVELS IN DRINKING WATER IN KORAPUT

Fig.- 4



Figures indicate the levels in mg/L

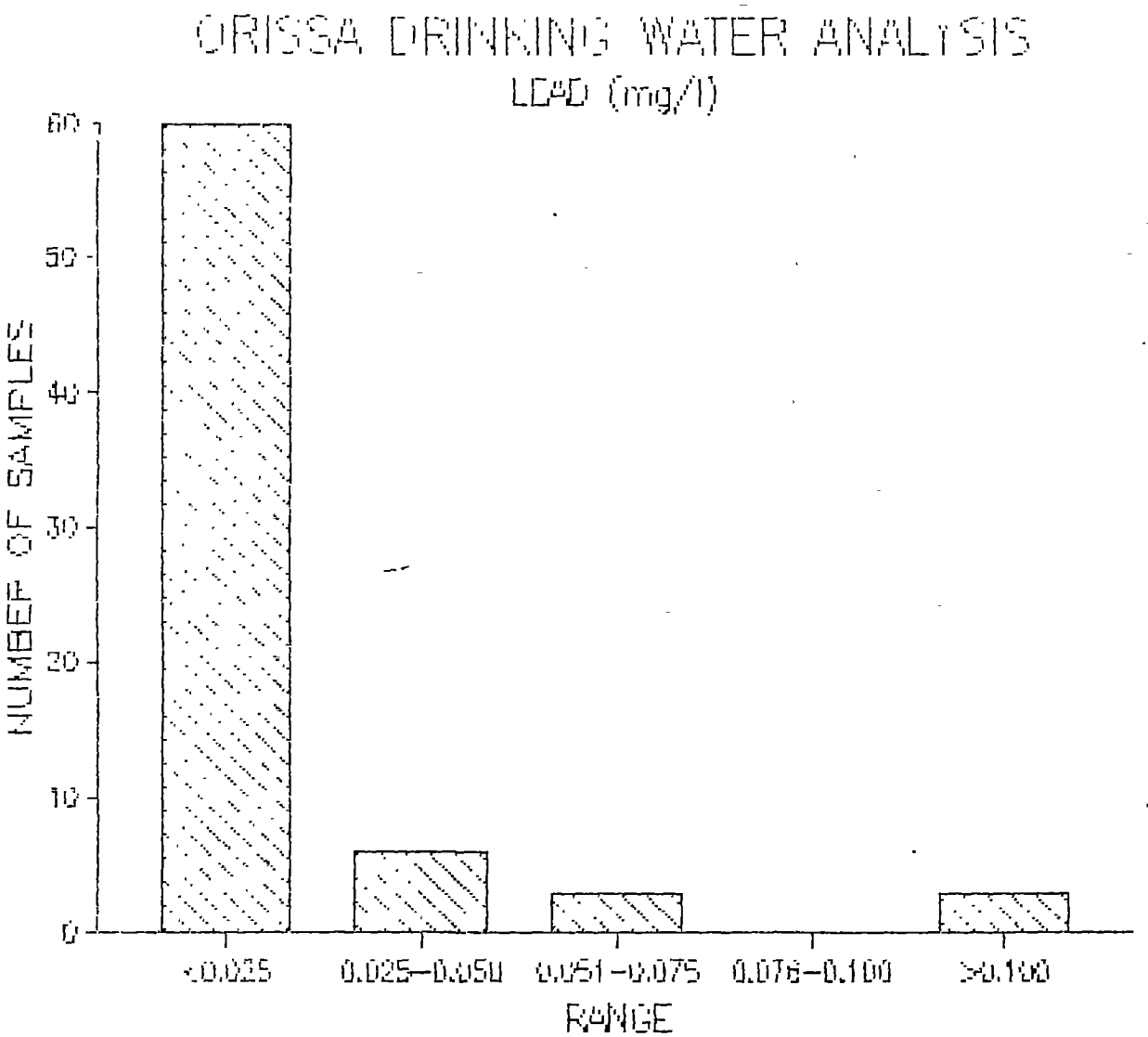
Fig. 5



MAXIMUM PERMISSIBLE LEVEL = 0.010 mg/L

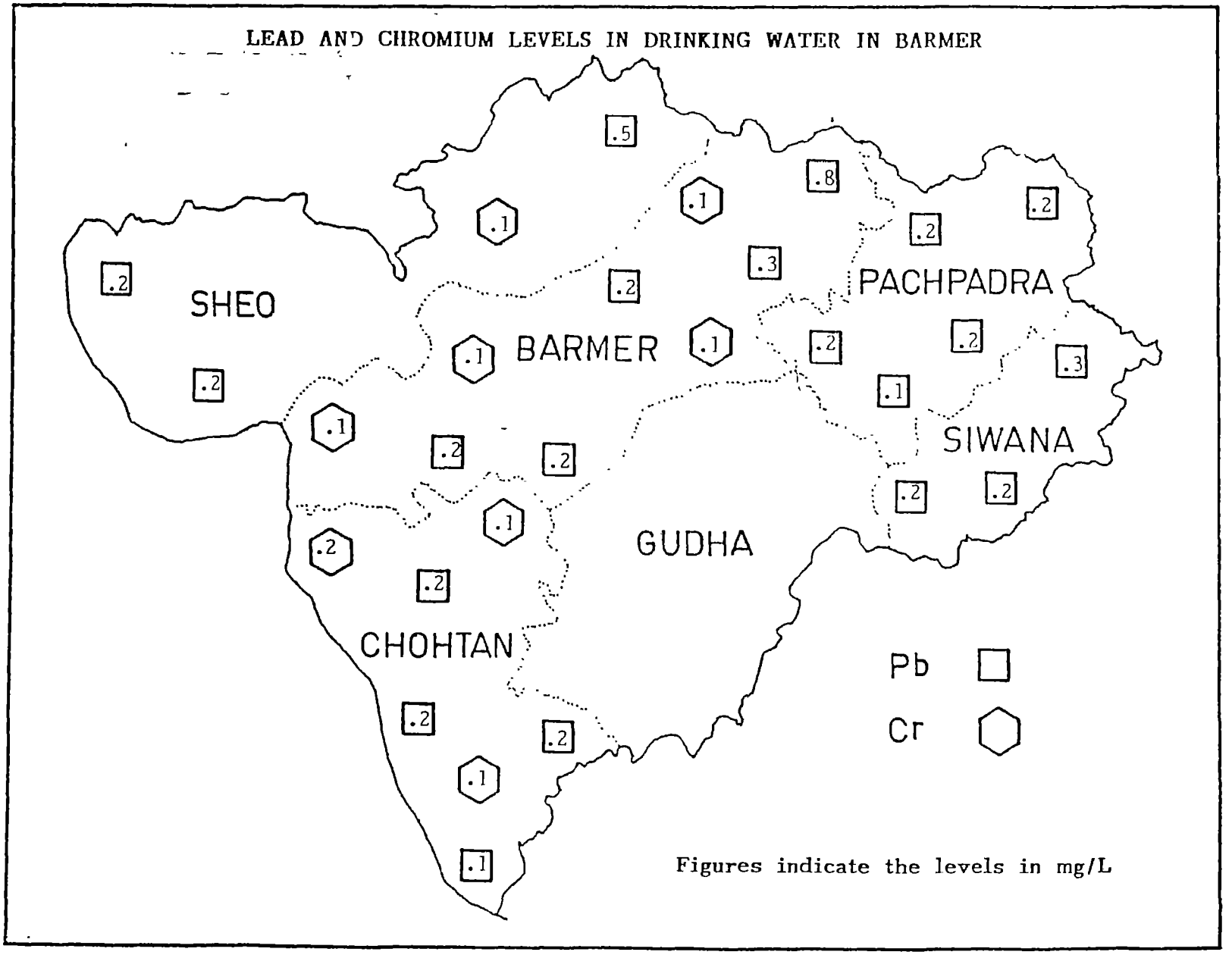
5 (6.94%) samples are above Maximum Permissible Level (0.01 mg/L)

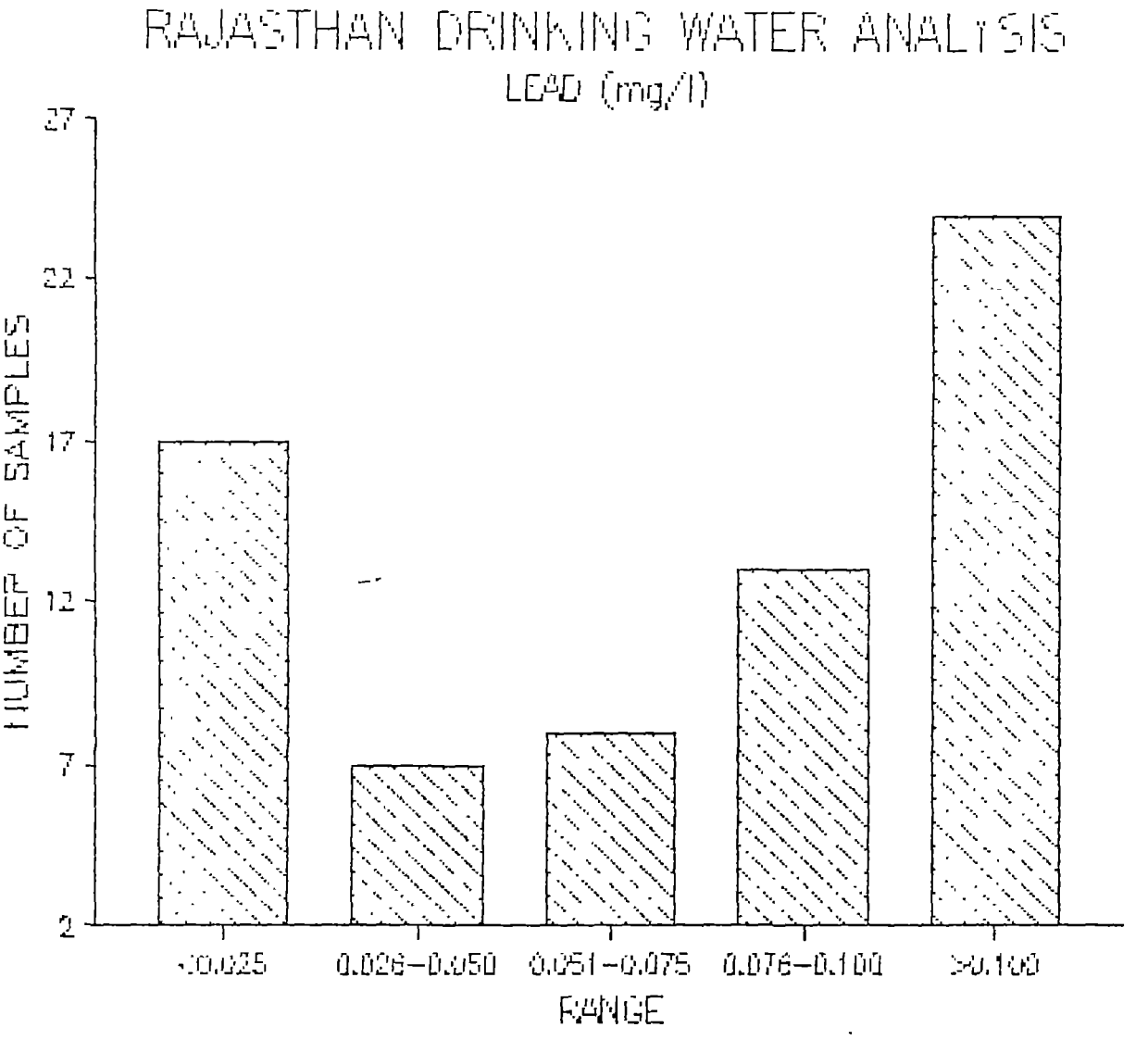
Fig. 6



MAXIMUM PERMISSIBLE LEVEL = 0.100 mg/L

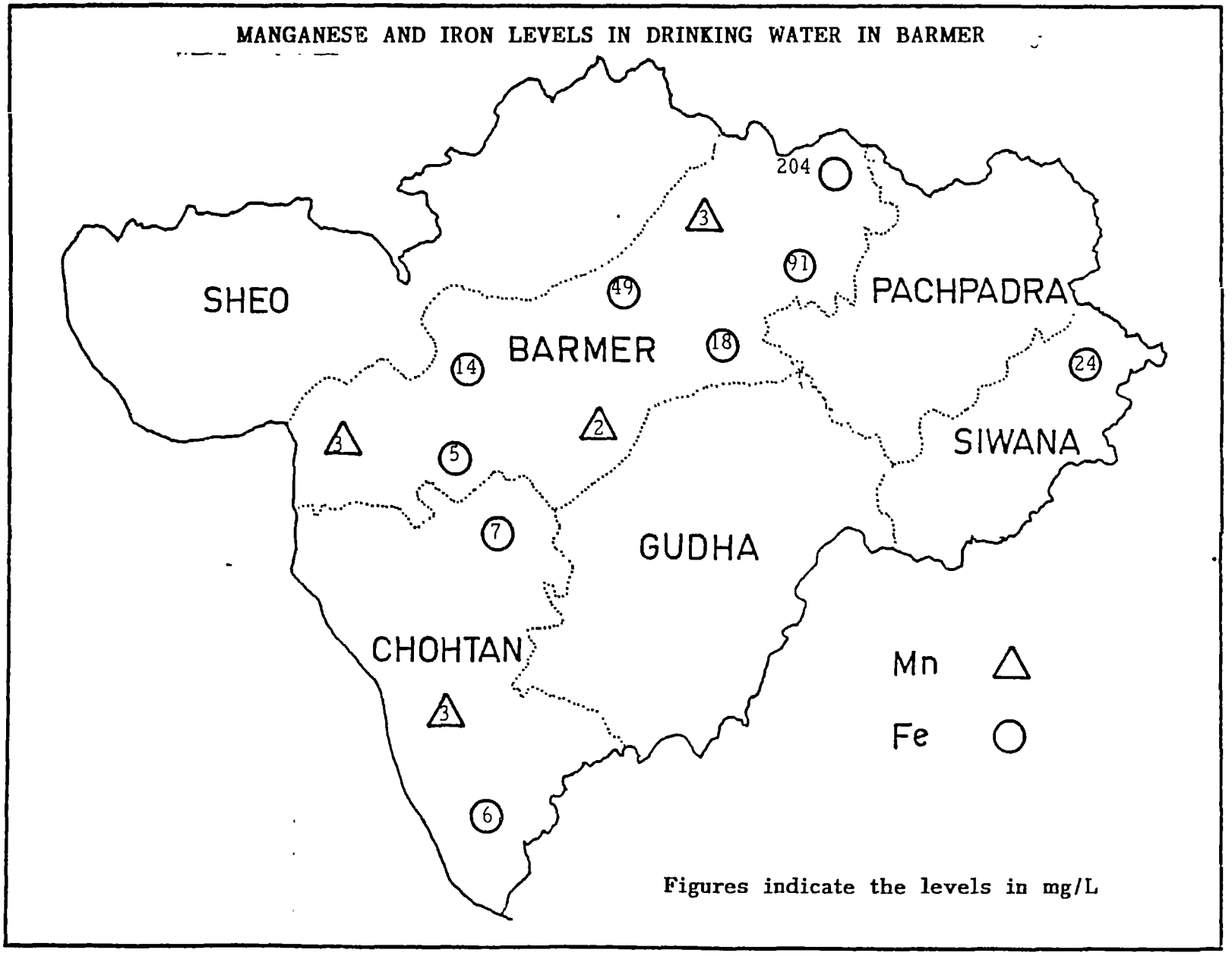
3 (4.2%) samples are above Maximum Permissible Level (0.1 mg/L)

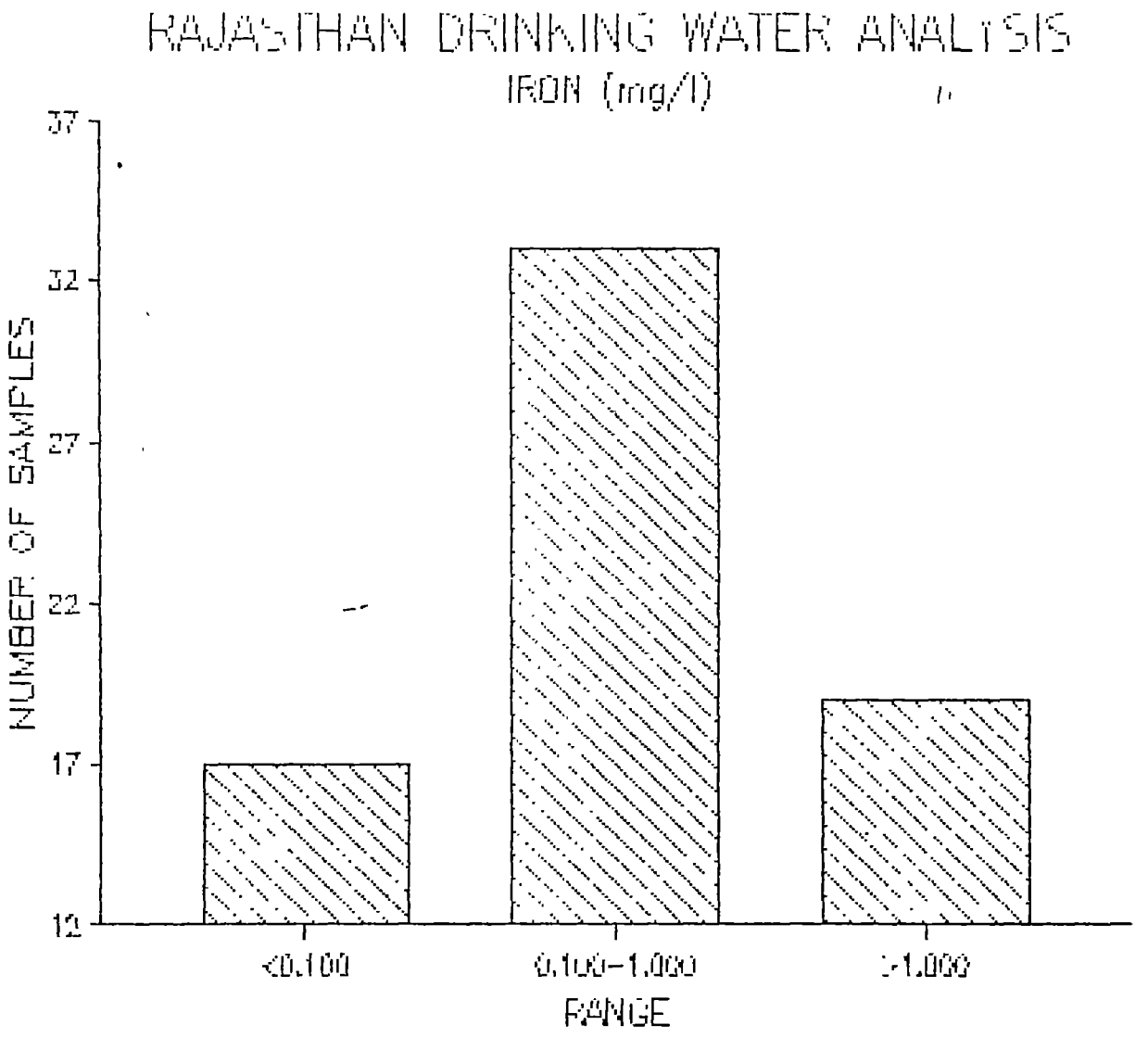

LEAD AND CHROMIUM LEVELS IN DRINKING WATER IN BARMER
SHEO
BARMER
PACHPADRA
SIWANA
GUDHA
CHOHTAN
Pb
Cr
Figures indicate the levels in mg/L



MAXIMUM PERMISSIBLE LEVEL = 0.100 mg/L

24 (34.78%) samples are above Maximum Permissible level (0.1 mg/L)

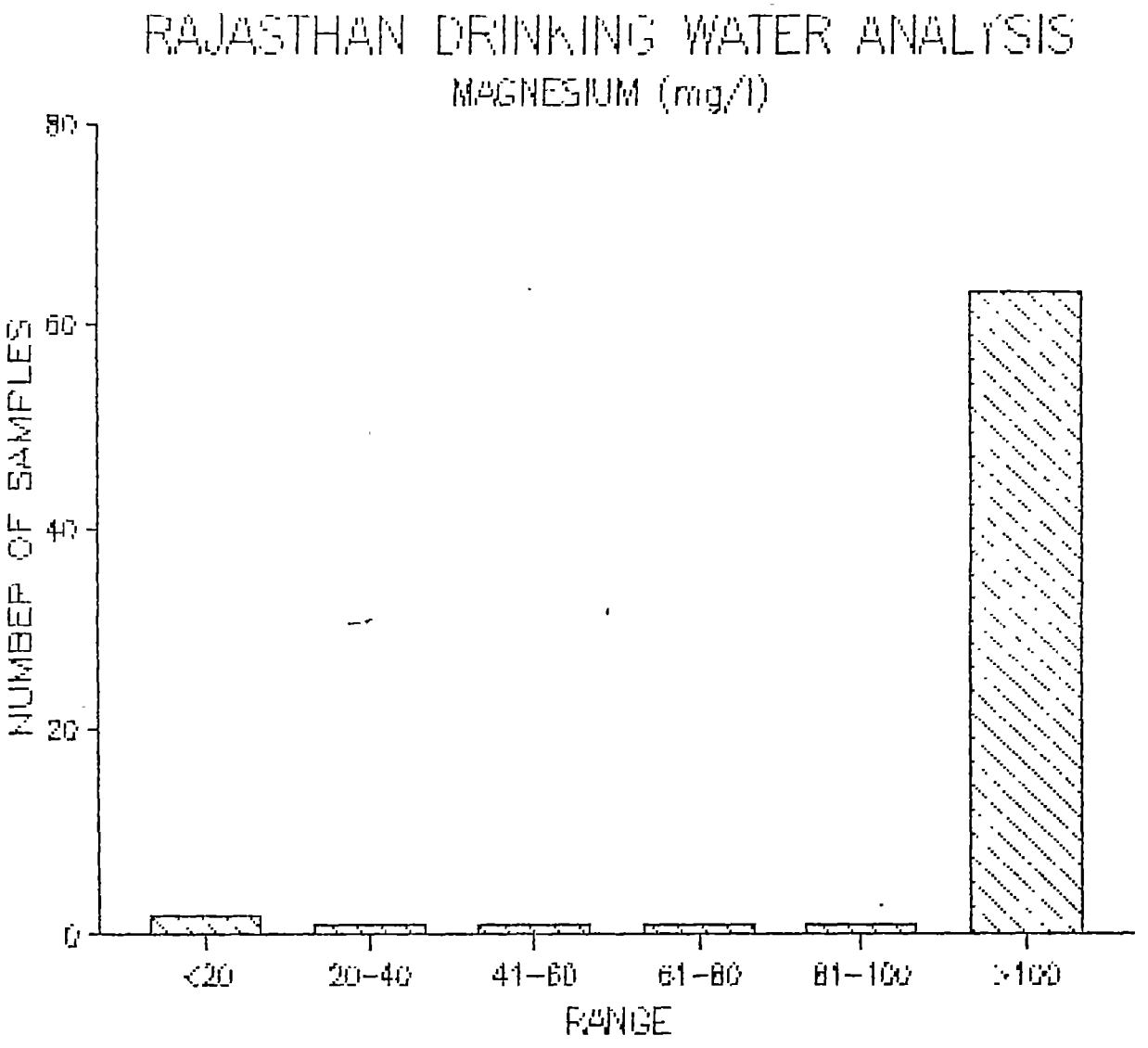

MANGANESE AND IRON LEVELS IN DRINKING WATER IN BARMER
204
3
91
49
SHEO
PACHPADRA
BARMER
18
14
24
2
3
5
SIWANA
7
GUDHA
CHOHTAN
Mn
Fe
3
6
Figures indicate the levels in mg/L



HIGHEST DESIRABLE LEVEL = 0.100 mg/L

MAXIMUM PERMISSIBLE LEVEL = 1.00 mg/L

19 (27.54%) samples are above Maximum Permissible Level (1.00 mg/L)



MAXIMUM PERMISSIBLE LEVEL = 100 mg/L

63 (91.3%) samples are above Maximum Permissible Level (100 mg/L)

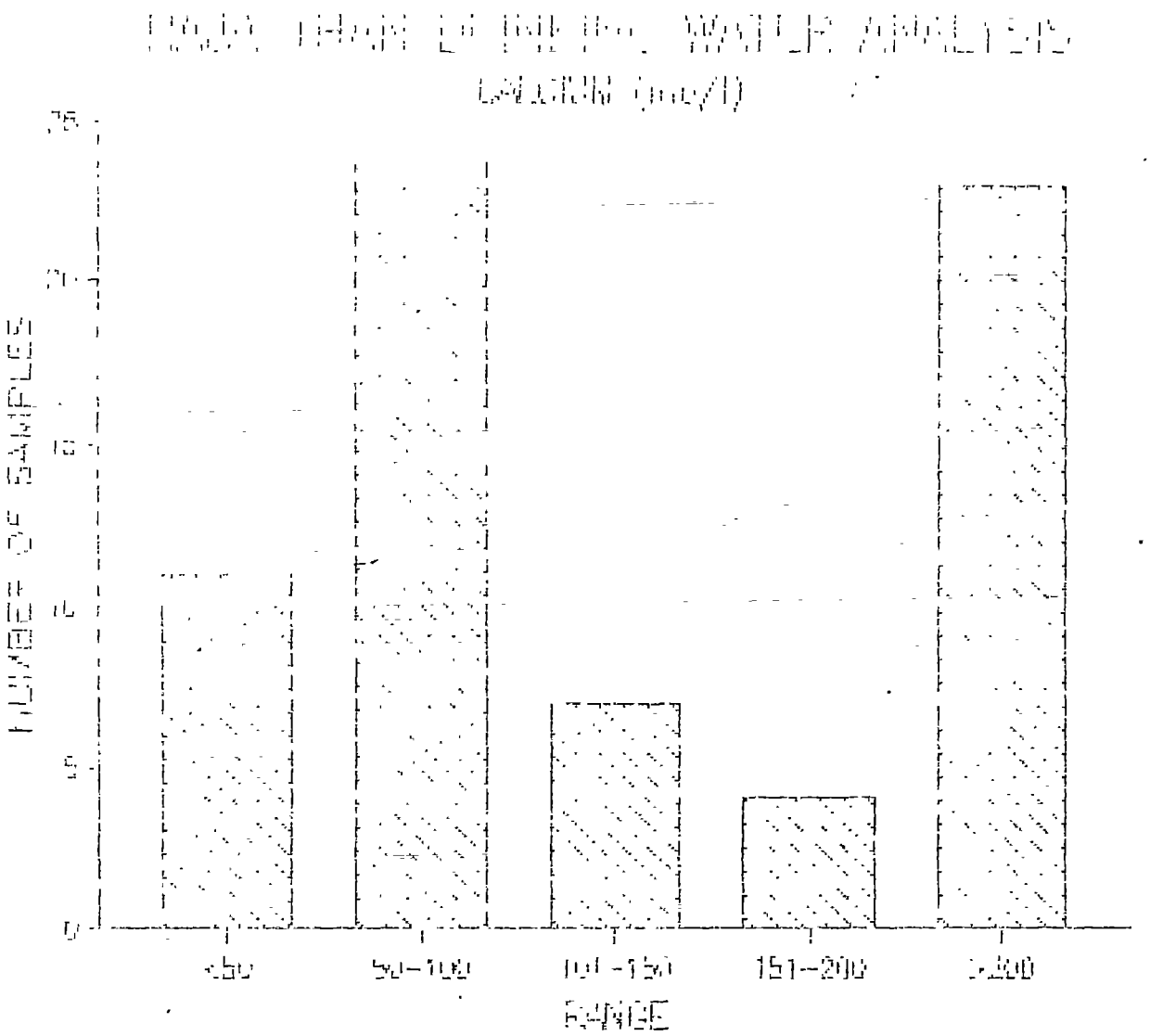
Methods

The ITRC Water analysis Kit was used for carrying out the physico-chemical analyses by micro methods in Koraput, Barmer and Nagpur. PH and electrical conductivity were measured using the Century portable kit. In Gangtok a field laboratory previously established by ITRC was used. Here standard methods for the Water Quality Assessment were followed for both bacteriological and physico-chemical analysis. In Nagpur standard bacteriological tests were also performed utilizing facilities at NEERI. In Barmer and Koraput simplified bacteriological techniques i.e. the coliform presence absence test and simplified membrane filtration technique using a syringe assembly were used. This gave information on potability.

The methods utilized for the chemical tests are given below:

Chemical analysis

- Chloride was estimated by the argentometric method.
- Sulphate was estimated by the turbidity method.
- Hardness was estimated by the EDTA titrimetric method.
- Nitrate was estimated by the phenoldisulphonic acid method.
- Fluoride was estimated bythe SPADNS method.
- Alkalinity was estimated by the methyl orange method.



MAXIMUM PERMISSIBLE LEVEL = 200 mg/L

23 (33.3%) samples are above Maximum Permissible Level (200 mg/L)

Metal analysis

Cadmium, copper, total chromnium, cobalt, manganese, total iron, lead, nickel, calcium, zinc and manganesium were quantified by direct current plasma spectrophotometry (DCP).

Microbiological analysis

The most probable number of coliforms/100 ml (MPN) was estimated by the conventional multiple tube method followed by the Ejkman test to obtain the faecal coliform count, in Sikkim and Nagpur. In the Barmer the presence absence test was utilized. In this test, a bottle containing 50 ml of media was innoculated with 50 ml of water sample at the site. A 50 ml metal measure was sterilized by immersion in alcohol followed by flamming before collecting the sample and pouring it into the culture bottle. This inocculated bottle of media was returned to the laboratory and incubated at 35 C for 1-5 days. If no acid and gas formation is observed in the culture bottle, the water is unlikely to contain pathogens and is regarded as safe for drinking. When acid and gas formation occurs coliforms bacteria are present. In Koraput membrane filtration with a syringe assemble fabricated in the laboratory was used. Varying quantities of water were passed through a membrane filter which was then incubated on selective agar. Colonies forming after overnight incubation at 37 C were counted. Positive coliform tests were confirmed faecal type by sub culturing on Eosin Methylene Blue (BMB).

RESULTS

In Sikkim using the Most Porable Number (MPN) of coliforms/100 ml, 44.6% of the 65 samples analysed were classed as satisfactory *(with <10 coliforms per 100 ml) while 23.08% were of excellent quality i.e. <1 coliform per 100 ml. Non-potable water i.e. >10 coliforms/100 ml formed 55.39% of the samples tested (Table 2). There is far less contamination of the water sources in this cold hilly area. than is seen in the hilly and hot tribal area of Koraput Only 5 samples analysed in Koraput had <10 coliforms per 100 ml and only 5 had no faecal coliforms two of which came from tube well sources. The remaining samples were non-potable with >10 coliforms/100 ml and faecal coliforms present. The poor quality of the drinking water sources is very obvious (Table 3).

In Barmer twenty three ground water sources of drinking water were sampled, sometimes before treatment other times from the distribution system. Ten i.e. almost half were satisfactory, two were suspicious and eleven did not appear satisfactory. However, as normal standards for collection and transmission of samples to the laboratory could not be

met resampling is necessary. Two village 'Taka's' and one PHED 'Taka' sampled were found unsatisfactory. Out of the 39 dug wells and ring wells all had unsatisfactory coliform counts >10/100 ml of which 35 were faecal type (Table 4).

In Nagpur the ground water samples from hand pumps were fairly satisfactory, one out of nineteen showed faecal contamination and four exhibited coliform counts >10 /100 ml i.e. unsatisfactory. Three out of the seven piped supplies tested were satisfactory probably the other samples were contaminated in the distribution system. As expected dug wells were unsatisfactory. Details are givein in Table 5A,B).

Physico-chemical Analysis

The ranges for the physico-chemical characteristics of the drinking water are presented in the Table 6. The physico-chemical quality of the water in Sikkim was satisfgactory and within permissible limits. In Koraput also the routine physico-chemical properties were satisfactory.

In Barmer 62 (88.6%) samples had total dissolved solids above permissible limits. 25 samples (35.7%) had hardness above permissible limits, 33 (47.1%) samples had excess chlorides and 21 (30.0%) samples had excess sulphates. Nitrates were a little above permissible limits in 47(67%) samples.

In 22 (31.4%) samples fluorides were raised above 1.5 mg/L and in 8 samples (11.4%) the levels were > 5 mg/L.

Alternative sources of water with satisfactory fluoride levels have been made available to the villagers.

In Nagpur district overall physico-chemical quality of drinking water was satisfactory only 4 (1.4%) samples have hardness above permissible limits and 1 sample (1.4%) with excess of sulphate. In 5 (7%) smaples fluorides were > 1.5 mg/L.

Metals Analysis

Table 7 summarises the range of various metals in water samples from Koraput, Barmer and Nagpur districts. In Koraput CADMIUM was found to be above permissible limits in 5 (6.94%) samples, IRON above permissible of limits 1.0 mg/L in 42 (58.41%) samples >5 mg/L in 12 samples. Manganese was above permissible limits 0.5 mg/L in 21 (29.2%) samples. Lead was above permissible level in 3 (4.2%) samples only.

Barmer recorded maximum levels of MAGNESIUM which are above permissible limtis in 63 (91.3%) samples, CALCIUM in 23 (33.3%) samples, these findings account for the high TDS and hardness.

LEAD levels were elevated in 24 (34%) samples an important finding which requires more investigation.
CHROMIUM was elevated in 8 (12% of samples).
IRON levels were elevated in 19 (27.54%) samples and
MANGANESE in only 4 (5.8%) samples.

In Nagpur district the overall levels of all metals were within permissible limits, except for iron which was slightly high in 8 (11.42%) samples. Magensium was above permissible levels in 7 (10%) samples and calcium levels exceeding permissible levels in only 2 (2.85%) samples.

Table 1: Summary of Drinking Water Sources Sampled in East Sikkim, Koraput, Barmer and Nagpur.

Districts/ Source	Sikkim	Koraput	Barmer	Nagpur
Spring	92	5	-	-
Surface Water (stream,River Water, Pond)	-	21	3	-
Dug Wells (Ring Wells) Open Wells	-	20	42	36
Tube Wells	-	5	14	9
Hand Pumps	-	-	5	19
Piped Supply	-	-	-	7
Tanker	-	-	1	-
Tanka	-	-	3	-
Reservoir	-	-	1	-
Choa	-	12	-	-
Nullah	-	8	-	-
Dam	-	1	-	-
Total	92	72	69	71

Table 2: Summary of Bacteriological data for Drinking Water Samples* Analysed from Sikkim

Class	Range of coliform MPN/100 ml	Number of Samples	Percentage
Excellent	1	15	23.08
Good	1-3	3	4.62
Satisfactory	3-9	11	16.92
Potable	10	29	44.62
Non-potable	10	36	55.39

Table 3: Summary of Bacteriological Data for Drinking Water Samples Analysed from Koraput

Source	Number of Samples	MPN <10/ 100 ml	Faecal coliform negative
Ground Water			
Tube Well	2	1(100%)	2(100%)
Dug Well	13	Nil	Nil
Surface Water			
River, spring, pond, Nullah, 'Choa'	26	3(11.5%)	3(11.5%)
Total	41	5	5

Table 4: Summary of Bacteriological Data for Drinking Water Samples Analysed from Barmer

Source	Number of Samples	MPN <10/ 100 ml	Faecal coliform negative
Ground Water			
Tube wells, hand pumps, reservoirs distribution points	23	10(43.4%)	10(43.4%)
Dug wells	39	Nil	4(10.25%)
'Tanka'	3	Nil	Nil
Total	65	10	14

Table 5A: Summary of Bacteriological Data for Drinking Water Samples Analysed from Nagpur Dist.

Source	Number of Samples	MPN <10/ 100 ml	Faecal coliform negative
Ground Water			
Dug Well	39	2(1.5%)	8(20.5%)
Hand pump	19	15(78.9%)	18(94.7%)
Tube well	6	3(50.0%)	5(83.3%)
Pipe supply	7	3(42.9%)	4(57.1%)
Total	71	23	35

Table 5B: Summary of Bacteriological Data for Drinking Water Samples Analysed from Nagpur Dist.

Source	Number of Samples	Excellent <1	Good 1-3	Satisfactory 4-9	Non-potable >10
Ground Water					
Dug Well	19	9(47.4%)	2(10.6%)	4(21%)	4(21%)
Hand pump	6	-	1(16.7%)	2(33.3%)	3(50%)
Tube well	39	-	2(5.1%)	-	37(94.9%)
Surface Water					
Pipe supply	7	1(14.3%)	-	2(28.6%)	4(57.1%)
Total	71	10		8	48

Figure in parenthesis show the percentage of samples.

Table 6: Range of Physico-chemical Properties of Drinking Water Samples Analysed under the Hological Approach in East (Sikkim), Koraput (Orissa), Barmer (Rajasthan) and Nagpur (Maharashtra)

Characteristics	Sikkim	Number of Samples above max. per.level with %	Koraput	Number of Samples above max. per.level with %	Barmer	Number of Samples above max. per.level with %	Nagpur	Number of Samples above max. per.level with %	High des. Level	Max. per. level
pH	6.9-7.3	-	5.7-8.6	-	7.2-8.7	-	6.98-8.5	-	7.0-8.5	6.5-9.0
Conductivity	51.5-91.5	-	15-770	-	1414-36600	-	256-3890	-	-	-
Total Solid	28.3-47.7	-	58.3-614	-	777.7-20130	62(88.6%)	-	-	500 mg/L	1500
Alkalinity	5.0-20.0	-	ND-240	-	ND-1720	-	30-670	-	-	-
Hardness	6.0-22.0	-	5-230	-	90-1660	25(35.7%)	20-980	1(1.4%)	300	600
Cl	2.5-17.5	-	ND-114.3	-	45-8500	33(47.1%)	10-480	-	200	1000
SO	ND-18.5	-	3.2-108.8	-	30-1500	21(30%)	2.5-562.5	1(1.4%)	200	400
NO	ND-1.64	-	0.02-5.8	-	0.02-11.7	47(67.1%)	ND-3.5	-	20	-
F	ND-0.83	-	0.03-0.12	-	0.34-10.6	22(31.4%)	0.54-2.5	5(7%)	1.0	1.5
Si	4.8-29.0	-	0.12-7.8	-	-	-	-	-	-	-
Fe	-	-	0.05-8.0	-	-	-	-	-	0.1	1.0

Table 7: Range of Metal Values of Drinking Water Samples Analysed underthe Hololological Approach in District Koraput (Orissa), District Barmer (Rajasthan) and District Nagpur (Maharashtra)

Metal	Koraput	Number of Samples above max per.level with %	Barmer	Number of Samples above max. per.level with %	Nagpur	Number of Samples above max. per.level with %	Highest desirable level mg/L	Maximum Permissible Level mg/L
Cd	ND-0.16	5(6.94%)	ND-0.009	-	ND-0.01	-	-	0.01
Cr	ND-0.53	4(5.6%)	ND-0.157	8(11.6%)	ND-0.063	-	-	-
Cu	ND-0.08	-	ND-0.082	-	ND-0.029	-	0.05	1.5
Co	ND-0.05	-	ND-0.03	-	ND-0.005	-	-	-
Fe	0.16-9.15	42(58%)	ND-203.79	19(27.5%)	ND-6.893	8(11.42%)	0.1	1.0
Mn	0.02-2.6	21(29.2%)	ND-3.22	4(5.8%)	ND-0.364	-	0.1	0.5
Ni	ND-0.11	-	ND-0.0336	-	ND-0.036	-	-	-
Pb	ND-0.22	3(4.2%)	ND-0.76	24(34%)	ND-0.047	-	-	0.1
Zn	ND-1.2	-	ND-0.762	-	ND-2.919	-	-	5
Mg	0.21-29.2	-	4.4-1186	63(91.3%)	1.35-322	7(10%)	-	100
Ca	1.0-58.1	-	3.4-1654	23(33.3%)	8.4-345.5	2(2.85%)	-	200

Koraput (Orissa)

Table 8A: Water Sources with Cadmium above 0.050 mg/L

Block	Location	Source	Metal Level
Khairaput	Oringi	Nullaha	0.160
Boipariguda	Barangpali	River	0.103
Laxmipur	Kiskapadi	Choa	0.090
Laxmipur	Musupalli	River	0.080

Table 8B: Water Sources with Lead above 0.1 mg/L

Block	Location	Source	Metal Level
Kolnora	Chitikapanga	DW	0.220
B. Cuttack	Hikira	DW	0.170
Boipariguda	Umuriguda	River	0.120

Koraput (Orissa)

Table 8C: Water Sources With Iron above 5.0 mg/L

Block	Location	Source	Metal Level
Koraput	Gunjiguda	Spring	9.150
Korkonda	Chirupalli	Choa	7.350
Boipariguda	Umuriguda	River	6.960
Kolnora	Chitikapanga	DW	6.830
Kotpad	Ghhatrela	River	6.450
Kotpad	Ghhatrela	DW	6.020
Koraput	Kondoputraghat	Choa	5.940
Korkonda	Bandiki	Choa	5.850
Chanderpur	Hemburu	Choa	5.810
Laxmipur	Kiskapadi	DW	5.300
K. Singpur	Naringtola	Pond	5.260
Gudari	Shivalingpur	Choa	5.200
Koraput	Malichellar	DW	5.150

Table 8D: Water Sources With Manganese Above 1.0 mg/L (Permissible limit 0.5 mg/L)

Block	Location	Source	Metal Level
Norangpur	Majea	Pond	2.600
Korkonda	Bandiki	Choa	1.830
K.Singpur	Naringtola	Pond	1.330
Boipariguda	Barangpali	DW	1.200
Korkonda	Chirupalli	Choa	1.200
Kundura	Chosarala	OW	1.200
Tentulikunti	Amuliguma	TW	1.200
Gunpur	Narsingamunda	OW	1.030

Table 8E: Water Sources with Chromium Above Maximum Permissible level of 0.05 mg/L

Block	Location	Source	Metal Level mg/L
Boipariguda	Barangpali	OW	0.530
Chanderpur	Hemburu	Choa	0.100
K. Singpur	Naringtola	Pond	0.070
Kasipur	Kutni	Nullaha	0.190
Khairaput	Korpundiguda	Nullaha	0.460
Korkonda	Bandiki	Choa	0.088
Korkonda	Chirupalli	Choa	0.090
Kotpad	Ghatrela	River	0.075
Kotpad	Ghatrela	OW	0.160
Kundura	Ghosarala	OW	0.090
Norangpur	Majea	Pond	0.065
Tentulikunti	Amuliguma	TW	0.90

OW = Open well
TW = Tube well

Barmer Rajasthan

Table 9A: Water Sources With Lead above 0.130 mg/L

Village	Source	Metal Level mg/L
Visala	RW	0.759
Harsani	DW	0.503
Balasar	TW	0.309
Arbi Ki Gafan	DW	0.239
Surajagir	RW	0.221
Visala	RW	0.201
Bamsin	Ditch	0.197
Ramzan Ki Gafan	Tanka	0.196
Choch Mandir	DW	0.189
Balotra	TW	0.188
Balotra	TW	0.188
Nanad	RW	0.182
Sandiya Nadi	Pond	0.181
Balotra	River	0.176
Tirmaniar	HP	0.172
Balewa	HP	0.157
Harsani	TW	0.154
Unkha	HP	0.148
Balotra	DW	0.131

RW - Ring Well

Barmer Rajasthan

Table 9B: Water Sources with Chromium above 0.100 mg/L

Village	Source	Metal Level mg/L
Vindayania	Tanker	0.129
Visala	RW	0.119
Santra	DW	0.118
Arbi Ki Gafan	DW	0.109
Harsani	Well	0.109
Baitoo	R No. 1	0.102
Santra	DW	0.091

Table 9C: Water Sources with Manganese above 1.5 mg/L

Village	Source	Metal Level mg/L
Visala	RW	3.220
Sadiya Nadi	Pond	2.680
Visala	RW	2.600
Surajagir	RW	1.610

Table 9D: Water Sources with Iron above 5.0 mg/L (Unfiltered Water)

Village	Source	Metal Level mg/L
Visala	RW	203.790
Surajagir	RW	90.900
Nanad	RW	48.996
Dediyar	RW	24.196
Bagdaan	RW	17.476
Nanad	TW	14.436
Arbi Ki Gafan	Well	6.376
Visala	RW	5.376

Table 9E: Water Sources with Calcium above 300 mg/L

Village	Source	Metal Level mg/L
Nareva School	Well	1140.0
Santra	DW	1120.0
Mathasar Ka Thala	RW	768.0
Utarni	DW	746.0
Kharapar	DW	702.0
Choch Mandir	DW	654.0
Utarni	DW	626.0
Balotra	River	580.0
Rajan Ki Gafan	Well	538.0
Balotra	DW	498.0
Balotra	DW	402.0
Nareva School	DW	384.0
Chainpeera	DW	370.0
Padmaram	DW	330.0

Nagpur (Maharashtra)

Table 10A: Water Sources with Iron Above 5.0 mg/L

Tahsil	Village	Source	Metal Level mg/L
Hingna	Monde	Dug Well	6.893

Table 10B: Water Sources with Iron Above 150.0 mg/L

Tahsil	Village	Source	Metal Level mg/L
Bhivapur	Mallarpur	Hand pump	322.00
Saoner	Dahegaon	Dug well	300.40
Hingna	Raipur	Dug well	160.30

BACKGROUND INFORMATION

BASIC ESSENTIAL TESTS FOR WATER QUALITY

Safe Drinking Water must be free of Thermotolerant Coliforms (Faecal Coliforms)

1 Microbial Analysis

To determine the immediate suitability of water for drinking a test of microbial quality is imperative before acceptance of a water as safe. Also subsequently the water must be tested at regular intervals to detect any signs of developing faecal pollution.

2. Fluoride Level

Initially a fluoride level is desirable to ensure no danger of fluorosis exists on long term consumption of the water.

3. Total Solids - chlorides - sulphates

These give a general indication whether the quality of the water is within acceptable limits. If the levels are high there is usually no health risk but the water can be aesthetically unacceptable. The conductivity meter readings reflect these parameters.

4. Nitrate Level

Water with high nitrate levels are better avoided if possible for long term consumption dur to a possible cancer risk.

SIGNIFICANCE OF PARAMETERS USED IN WATER ANALYSIS

PHYSICAL PARAMETERS

Odour

In some areas consumers accept quite highly coloured waters which are otherwise safe. Contamination of drinking water supplies with iron or manganese is often indicated by discoloration of the water on standing exposed to air. Recently it has been appreciated, however, that high colour may be related to the presence of substances which on chlorination react to from tri-halomethanes, so high colour may be undesirable from the health point of view if water is to be chlorinated.

Turbidity

Absence of turbidity is very important to the consumer with regard to ensuring complete acceptance and particularly when the choice lies between crystal clear sparkling well water and opaque ground water. Turbidity may be due to harmless constituents or precipitation of iron oxide, manganese or aluminium.

pH

The importance of pH is in relation to the application of treatment technologies and prevention of corrosion of metal pipes and fittings.

Conductivity

The guidelines is 400 micro siemens for drinking water based on criteria for prevention of corrosion of pipes. From the health angle it is of little importance provided the parameters with more relevant application to public health considerations are satisfactorily estimated. It is, however, related to the salinity of the water supply and may be an indicator or industrial pollution.

PARAMETERS FOR DETECTION OF CONTAMINANTS WITH A HEALTH RISK

Microbial Contamination

The absence of faecal type coliforms is an absolut requirement for safe drinking water. The effects of thes harmful organisms could be due to the presence of one o the other types of pathogenic bacteria such as Salmonell typhi, organisms causing cholera, diarrhoea and gastr enteritis or hepatitis virus. It is undesirable to hav coliform organisms in drinking water, but non-faeca coliforms in low numbers may be tolerated under certai circumstances. Contamination with these organisms can b overcome by chlorination of the water source.

Fluoride

Enemic fluorosis is a very serious problem in parts o India ultimately causing severe crippling skeletal deformities. It is imperative that water for drinking has levels below 1.5 mg/litre. If no alternative source is available water must be treated to reduce the fluoride level.

Nitrate

Attention is paid to the nitrate content following the reported cancer risk and rarely observed (particularly where breast feeding is common) association with infantile methaemoglobinaemia. Carcinogenic nitrosoamines are formed by the gut bacteria from nitrate in water and amines present

in food. But at levels below 100 mg/litre as NO this event is unlikely. No definite evidence of cancer induction in man is avilable but there is no reason to supposed man is not susceptible. With increasing use of fertilizers, improved land drainage, changing trends in the weather pattern, a continuous upward trend in nitrate levels is anticipated. However, treatment is a problem with no cheap technology presently available.

Cadmium

Without industrial pollution detection of significant levels in drinking water is unlikely but recently the presence of cadmium in superphosphate fertilizers has been reported and, therefore, surveillance is necessary. Elevated cadmium levels in food and water caused Itai Disease reported in Japan following industrial pollution.

Chromium

Trivalent chromium is believed to be non toxic when taken orally but hexavalent chromium is known to be carcinogenic when inhaled which has led some countries to formulate standards for chromium levels in drinking water. However, it is not known in what state chromium exists in water. No Indian standards have been formulated.

Lead

Increasing environmental exposure to lead which can cause serious haematological and neurological effects has led to concern about lead levels in drinking water. The lead is derived from the effect of soft water on the pipes or industrial pollution. Lead levels inw ater are unlikely to pose a problem in rural India.

Mercury

Elevated mercury levels are solely the result of industrial pollution and a concern has developed following the discovery that mercury is methylated by bacteria in the environment, then taken up by fish which later provide a source of food for man. Minamata disease was reported from Japan following environmental mercury pollution. Mercury in drinking water, however, is present in organic form.

Arsenic, cyanide and selenium are recognised hazardous substances to health but are unlikely to be encountered in a rural environment.

CONTAMINANTS ASSOCIATED WITH RELATIVELY INSIGNIFICANT HEALTH HAZARDS

Total Solids

This is an indicator of the brackishness or salinity of water which is a problem in many areas of India. In India the upper permissible limit is 1500 ppm for drinking water. The problem is dealt with by reverse osmosis, electrodialysis or solar desalination. However, even at 5000 ug/litre no adverse toxic effects are experienced by man apart from the brackish taste. Chloride and sulphate contribute to the salinity or brackishness of water.

Iron

This causes astringent taste, discoloration, deposits of rust and can promote the growth of iron bacteria but poses no danger to health. Concentrations of 0.05 mg/litre are considered satisfactory. India, 0.1 mg/litre is the highest desirable level and 1 mg/litre the maximum permissible level.

Manganese

When manganese precipitates out in water the blackened discoloration gives great concern to consumers.

Copper

No health effects are observed at recommended guideline levels.

Zinc

There is no danger to health except at very high levels.

Nickel

It is thought prodent to have a limit in view of the adverse effect of industrial exposure, however, without industrial discharge of nickel its presnece is unlikely. There are no WHO guidelines.

Table : Standard of quality for drinking water supply ICMR 1975

Substances	Substances with undesirable health effec Upper limit of concentration
Arsenic	0.05 mg As/I
Cadmium	0.01 mg Cd/1
Lead	0.1 mg Pb/1
Mercury	0.001 mg Hg/1
Selenium	0.01 mg Se/1
Cyanide	0.05 mg Cn/1

Substances and Characteristics affecting the acceptability of water for domestic use

Substances of characteristics	Undesirable effect that may be produced	Highest desirable level	Maximum permissible level
Substances effecting the colour, TCU(1)	Discolouration	5 units	25 units
Substances causing odours	Odours	Unobjectionable	Unobjectionable
Substances altering the taste	Taste	Unobjectionable	Unobjectionable
Turbidity JTU(2)	Gastrointestinal irritation	5 units	25 units
Dissolved solids	Gastrointestinal irritation	500 mg/L	1500 mg/L
pH range	Taste, corrosion, scale formation	7.0 to 8.5	6.5 to 9.0
Total hardness	Taste, scale formation	300 mg $CaCO_3$ /L	600 mg $CaCO_3$ /L
Calcium	Taste, scale formation	75 mg Ca/L	200 mg Ca/L
Magnesium	Taste, scale formation gastrointestinal irritation in presence of sulphate	Not more than 50 mg /L if there is less sulphate magnesium upto 100 mg/L Mg may be allowed at the rate of 1 mg	100 mg/L 200 mg/L sulphate
Copper	Astringent taste, discolouration, corrosion of pipes fittings, utensils	0.05 mg Cu/L	1.5 mg Cu/L

Iron	Astringent taste, discolouration, turbidity, deposits growth of iron bacteria in pipes	0.1 mg Fe/L	1.0 mg Fe/L
Chloride	Taste, corrosion in hot water systems	200 mg Cl/L	1000 mg Cl/L
Sulphate	Gastrointestinal irritation when combined with manganese or sodium	200 mg SO_4/L	400 mg SO_4/L
Nitrate	Danger of infantile methaemoglobinaemia, if the water is combined by infants	20 mg NO_3/L	-
Fluoride	Fluorosis	1.0 mg F/L	1.5 mg F/L
Phenolic compounds	Taste, particularly	0.001 mg phenol/L	0.002 mg phenol/L
Manganese	Astringent taste, discolouration, turbidity, deposits in pipes	0.1 mg Mn/L	0.5 mg Mn/L

ABBREVIATIONS USED

Physico-chemical Analysis

Temp = Temperature C; Turb = Turbidity ppm; Cond = Conductivity u mhos TS = Total Solids; Alk = Alkalinity as $CaCO_3$; Hard = Total hardness as $CaCO_3$; Cl = Chloride; SO = Sulphate; F = Fluoride; NO = Nitrite as Nitrogen; NO = Nitrate as Nitrogen; DO = Dissolved oxygen.

All values as mg/litre.

Metals Levels All values and permissible limits given in mg/litre.

Cd = Cadmium; Cr = Total chromium; Cu = Copper; Pb = Lead; Mn = Manganese; Ni = Nickel; Zn = Zinc; Fe = Total iron; Co = Cobalt; Ca = Calcium; Mg = Magnesium; ND = Not detected - Not done.

Microbiological Analysis:

P-A = Presence or Absence Coliforms + Present - Absent

MPN = Most probable number of coliform organisms per 100 ml of water

FC = Most probable number of faecal coliform organisms per 100 ml of water

DW = dug well; RW = ring well; HP = hand pump; PS = piped supply

SIKKIM: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGICAL MISSION)

BACTERIOLOGICAL AND PHYSICAL ANALYSIS

LOCATION	SOURCE	MPN	pH	COND	TS
				mhos	mg/l
AHO-YANGEAM	SPRING	21	7.29	63.66	35.01
ARITAR	SPRING	-	7.08	56.63	31.15
ASSAM-LINGZEY	SPRING	0	7.02	64.75	35.61
BARBING	SPRING	5	6.96	54.05	29.73
BHOSMEY	SPRING	8	7.09	66.92	36.81
BHUSUK	SPRING	>180	6.92	55.84	30.71
BIRING (ALT.)	SPRING	-	7.14	67.22	36.97
BIRING (MAIN)	SPRING	43	7.00	54.85	30.16
BUDANG THANGI	SPRING	18	7.11	65.34	35.94
BURTUK (ALT.)	SPRING	161	6.89	71.48	39.31
BURTUK (MAIN)	SPRING	2	7.25	67.72	37.24
CHAJACHEN	SPRING	-	7.02	80.98	44.54
CHALAMTHANG	SPRING	18	7.31	65.54	36.05
CHANDEY	SPRING	54	7.17	57.42	31.58
CHANG CLAKHA	SPRING	-	6.88	59.80	32.89
CHANGESANTI	SPRING	7	7.22	63.36	34.85
CHHALAMPHAMG	SPRING	-	6.96	55.44	30.49
CHOCHENPHERY	SPRING	28	7.04	53.26	29.29
CHUBBA	SPRING	11	7.10	55.64	30.60
DIKLING	SPRING	0	7.06	54.45	29.95
EAST PENDAM	SPRING	0	7.13	66.53	36.59
KAMBAL	SPRING	5	7.20	62.57	34.41
KAMEREY	SPRING	22	7.02	70.09	38.55

SIKKIM: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGICAL MISSION)

CHEMICAL ANALYSIS

LOCATION	SOURCE	ALK	HARD	Cl^-	SO_4^{--}	No_3^-	F^-	Sio_2
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg\l
AHO-YANGEAM	SPRING	10	14	5.00	ND	0.13	0.42	-
ARITAR	SPRING	10	14	5.00	ND	0.10	0.04	-
ASSAM-LINGZEY	SPRING	10	10	2.50	ND	0.15	0.44	-
BARBING	SPRING	10	14	6.25	2.0	0.15	0.21	-
BHOSMEY	SPRING	5	10	7.50	2.0	0.12	0.62	-
BHUSUK	SPRING	10	6	7.50	ND	0.22	0.04	-
BIRING (ALT.)	SPRING	10	10	7.50	ND	0.25	ND	-
BIRING (MAIN)	SPRING	5	10	7.50	2.0	0.10	ND	-
BUDANG THANGI	SPRING	10	10	7.50	2.0	0.12	ND	-
BURTUK (ALT.)	SPRING	10	14	5.00	4.0	0.17	ND	-
BURTUK (MAIN)	SPRING	5	10	7.50	ND	0.10	ND	-
CHAJACHEN	SPRING	10	14	10.00	ND	0.15	0.21	-
CHALAMTHANG	SPRING	10	10	7.50	6.0	0.03	0.22	-
CHANDEY	SPRING	15	10	5.00	8.8	0.03	0.34	-
CHANG CLAKHA	SPRING	15	18	10.00	4.0	0.09	0.42	-
CHANGESANTI	SPRING	10	15	2.50	2.0	ND	0.04	-
CHHALAMPHAMG	SPRING	5	10	10.00	ND	0.05	ND	-
CHOCHENPHERY	SPRING	10	10	10.00	ND	0.05	0.62	-
CHUBBA	SPRING	10	6	7.50	ND	ND	-	-
DIKLING	SPRING	15	14	2.50	4.0	0.08	-	-
EAST PENDAM	SPRING	10	14	2.50	2.0	0.03	-	-
KAMBAL	SPRING	10	14	10.00	8.0	0.08	-	-
KAMEREY	SPRING	15	14	7.50	8.0	0.08	-	-

SIKKIM: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
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BACTERIOLOGICAL AND PHYSICAL ANALYSIS

LOCATION	SOURCE	MPN	pH	COND	TS
				mhos	mg/l
KARTOK	SPRING	-	6.86	54.55	30.00
KHAMDUMG	SPRING	35	7.00	57.72	31.74
LAMTEN	SPRING	-	7.20	62.87	34.41
LINGDOK	SPRING	-	7.11	65.54	36.05
LINGTAM	SPRING	0	7.10	61.81	37.84
LINKEY (ALT.)	SPRING	-	7.12	61.58	33.87
LINKEY (MAIN)	SPRING	0	7.10	55.54	30.55
LOKDADA	SPRING	-	7.15	82.67	45.47
LUING	SPRING	1	7.10	59.60	32.78
LUNGDUM	SPRING	3	7.21	54.45	29.95
MACHNG	SPRING	>180	6.98	91.18	50.15
MARTAM	SPRING	12	6.89	61.78	33.98
MULUKEY	SPRING	-	6.98	54.05	29.30
NAITAM	SPRING	10	7.10	51.48	28.31
NAMIN (ALT.)	SPRING	>180	7.31	65.54	36.05
NAMIN (MAIN)	SPRING	>180	7.22	58.81	32.34
NANDOK	SPRING	10	7.06	61.58	33.87
NAVEY (ALT.)	SPRING	-	6.93	57.82	31.80
NAVEY (MAIN)	SPRING	-	7.04	55.64	30.60
NAZITAM	SPRING	54	7.04	55.84	30.71
NORTH REGU	SPRING	14	7.11	83.66	46.01
PACHAK	SPRING	0	7.18	71.18	39.15
PACHEY (SAMSING)	SPRING	0	6.92	82.96	45.63

SIKKIM: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGICAL MISSION)

CHEMICAL ANALYSIS

LOCATION	SOURCE	ALK	HARD	Cl^-	SO_4^{--}	No_3^-	F^-	Sio_2
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg\l
KARTOK	SPRING	10	14	7.50	ND	0.07	-	-
KHAMDUMG	SPRING	5	10	7.50	2.0	0.05	-	-
LAMTEN	SPRING	10	14	7.50	ND	0.12	-	-
LINGDOK	SPRING	15	10	5.00	ND	ND	-	-
LINGTAM	SPRING	10	10	7.50	4.0	0.05	-	-
LINKEY (ALT.)	SPRING	10	18	2.50	2.0	0.12	-	-
LINKEY (MAIN)	SPRING	10	14	7.50	ND	0.15	-	-
LOKDADA	SPRING	15	10	7.50	ND	ND	-	-
LUING	SPRING	10	14	5.00	ND	0.09	-	-
LUNGDUM	SPRING	10	14	2.50	2.0	0.07	-	-
MACHNG	SPRING	20	14	5.00	4.0	0.07	-	-
MARTAM	SPRING	15	18	3.75	2.0	0.10	-	-
MULUKEY	SPRING	10	14	8.75	4.0	0.15	-	-
NAITAM	SPRING	15	14	5.00	ND	0.12	-	-
NAMIN (ALT.)	SPRING	10	14	7.50	ND	0.15	-	-
NAMIN (MAIN)	SPRING	10	6	10.00	ND	0.15	-	-
NANDOK	SPRING	15	10	7.50	ND	0.08	-	-
NAVEY (ALT.)	SPRING	10	14	5.00	8.0	0.15	-	-
NAVEY (MAIN)	SPRING	15	14	5.00	ND	0.04	-	-
NAZITAM	SPRING	15	18	5.00	2.0	0.10	-	-
NORTH REGU	SPRING	10	14	2.50	2.0	0.12	-	-
PACHAK	SPRING	10	14	7.50	2.0	0.09	-	-
PACHEY (SAMSING)	SPRING	5	10	10.00	4.0	0.12	-	-

SIKKIM: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
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BACTERIOLOGICAL AND PHYSICAL ANALYSIS

LOCATION	SOURCE	MPN	pH	COND	TS
				mhos	mg/l
PACHEYKHANI (ALT.)	SPRING	12	7.10	62.57	34.41
PACHEYKHANI (MAIN)	SPRING	35	7.02	66.73	36.69
PADHAMCHEN	SPRING	0	7.10	74.05	40.73
PAKYONG	SPRING	28	7.11	55.74	30.66
PARBING	SPRING	0	6.95	52.67	28.97
PARKHA	SPRING	0	7.21	86.72	47.70
PATUK	SPRING	5	7.10	55.44	30.49
PENLONG	SPRING	-	7.21	55.64	30.60
PHENGYONG	SPRING	3	6.88	54.45	29.95
PREMLAKHA	SPRING	0	7.12	73.46	40.40
RAADONG	SPRING	8	6.96	66.53	36.59
RALEYKHESI	SPRING	35	7.13	59.50	32.73
RANGPO-KHALA	SPRING	-	6.98	73.46	40.40
RANKN	SPRING	161	6.99	56.63	31.15
RAWATE (ALT.)	SPRING	-	7.18	52.47	28.86
RAWATE (MAIN)	SPRING	-	7.21	55.44	30.49
REY BLOCK (ALT.)	SPRING	-	7.02	54.65	30.06
REY BLOCK (MAIN)	SPRING	-	7.10	52.47	28.86
RIWA-RIKYAP	SPRING	14	6.92	52.97	29.13
ROLEP	SPRING	35	7.14	53.76	29.57
RONGYEK	SPRING	5	6.90	58.41	32.13
SAMBUI	SPRING	>180	6.56	58.81	32.34
SAMDONG	SPRING	8	7.04	61.78	33.98

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CHEMICAL ANALYSIS

LOCATION	SOURCE	ALK	HARD	Cl^-	SO_4^{--}	No_3^-	F^-	Sio_2
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg\l
PACHEYKHANI (ALT.)	SPRING	15	14	2.50	ND	0.22	-	132.0
PACHEYKHANI (MAIN)	SPRING	15	18	5.00	ND	0.10	-	24.0
PADHAMCHEN	SPRING	15	14	7.50	ND	ND	-	29.0
PAKYONG	SPRING	10	18	7.50	ND	0.03	-	12.8
PARBING	SPRING	10	14	7.50	2.0	0.15	-	8.6
PARKHA	SPRING	10	14	7.50	2.0	0.06	-	20.8
PATUK	SPRING	10	18	2.50	ND	0.15	-	4.8
PENLONG	SPRING	10	14	5.00	4.0	0.08	-	4.8
PHENGYONG	SPRING	10	14	7.50	2.0	0.10	-	24.0
PREMLAKHA	SPRING	10	10	7.50	4.0	0.10	-	21.0
RAADONG	SPRING	15	10	7.50	ND	0.08	0.31	12.8
RALEYKHESI	SPRING	15	14	5.00	2.0	0.10	0.42	5.2
RANGPO-KHALA	SPRING	10	10	5.00	2.0	0.08	0.04	7.2
RANKN	SPRING	10	10	5.00	8.0	0.09	0.51	13.0
RAWATE (ALT.)	SPRING	15	15	5.00	2.0	0.10	0.62	8.6
RAWATE (MAIN)	SPRING	5	5	12.50	ND	0.10	0.62	11.8
REY BLOCK (ALT.)	SPRING	10	10	5.00	ND	0.05	ND	7.6
REY BLOCK (MAIN)	SPRING	10	10	3.75	2.0	0.10	0.51	10.2
RIWA-RIKYAP	SPRING	10	10	7.50	2.0	0.08	0.83	7.6
ROLEP	SPRING	5	5	7.50	2.0	0.08	0.22	10.8
RONGYEK	SPRING	15	15	5.00	2.0	0.09	0.42	13.4
SAMBUI	SPRING	10	10	5.00	2.0	0.10	0.62	10.0
SAMDONG	SPRING	5	5	7.50	4.0	0.18	0.83	8.0

SIKKIM: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGICAL MISSION)

BACTERIOLOGICAL AND PHYSICAL ANALYSIS

LOCATION	SOURCE	MPN	pH	COND	TS
				mhos	mg/l
SAMLIKMARCHAK	SPRING	11	7.06	63.56	34.96
SARAMSA	SPRING	0	6.98	58.51	32.18
SHERWANI	SPRING	>180	6.99	81.18	44.65
SHOTAK	SPRING	-	6.98	63.36	34.85
SHYOG-YONG	SPRING	-	7.16	60.39	33.22
SICHEY (ALT.)	SPRING	-	7.15	61.38	33.76
SICHEY (MAIN)	SPRING	18	7.04	55.84	30.71
SIMIK	SPRING	92	7.18	62.70	34.20
SINGBEL	SPRING	>180	6.82	52.67	28.97
SISMI	SPRING	0	7.16	74.45	40.95
SOUTH REGU	SPRING	14	7.12	86.72	47.70
SUDUNGLAKHA	SPRING	-	6.92	54.95	30.22
SYARAI	SPRING	-	6.63	65.74	36.16
TADONG	SPRING	10	7.27	56.63	31.15
TATHENGCHLY	SPRING	1	7.12	56.83	31.25
TEPHYAKMARDY (ALT.)	SPRING	-	6.90	53.46	29.40
TEPHYAKMARDY (MAIN)	SPRING	-	6.98	53.66	29.51
THEKABUNG	SPRING	0	7.20	64.05	35.23
TINTEK	SPRING	5	7.16	71.28	39.20
TRIKUTIM	SPRING	12	6.88	54.65	30.06
TUMIM	SPRING	>180	7.20	71.28	39.20
UPPER RONGYEK	SPRING	-	7.12	51.58	28.37
ZOLUK	SPRING	0	7.12	72.47	39.86

SIKKIM: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGICAL MISSION)

CHEMICAL ANALYSIS

LOCATION	SOURCE	ALK	HARD	Cl^-	SO_4^{--}	No_3^-	F^-	Sio_2
		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg\l
SAMLIKMARCHAK	SPRING	5	5	5.00	4.0	0.08	0.83	11.6
SARAMSA	SPRING	10	10	2.50	2.0	0.36	0.62	13.8
SHERWANI	SPRING	5	5	5.00	4.0	0.08	0.51	12.8
SHOTAK	SPRING	15	15	7.50	4.0	0.22	0.66	10.2
SHYOG-YONG	SPRING	15	15	7.50	2.0	0.26	ND	13.2
SICHEY (ALT.)	SPRING	15	15	5.00	ND	0.22	0.04	12.4
SICHEY (MAIN)	SPRING	10	10	5.00	6.0	0.22	0.06	18.6
SIMIK	SPRING	15	15	5.00	2.0	0.25	0.21	23.2
SINGBEL	SPRING	15	15	5.00	4.0	0.08	0.42	19.4
SISMI	SPRING	15	15	10.00	ND	0.34	0.42	9.6
SOUTH REGU	SPRING	20	20	5.00	ND	0.72	0.56	12.2
SUDUNGLAKHA	SPRING	10	10	5.00	18.0	0.32	0.08	6.8
SYARAI	SPRING	10	10	7.50	ND	0.25	0.66	14.0
TADONG	SPRING	15	15	5.00	ND	0.34	0.83	15.0
TATHENGCHLY	SPRING	10	10	7.50	ND	0.34	0.44	14.6
TEPHYAKMARDY (ALT.)	SPRING	5	5	5.00	16.0	0.03	ND	12.4
TEPHYAKMARDY (MAIN)	SPRING	15	15	7.50	2.0	0.57	ND	20.0
THEKABUNG	SPRING	15	5	7.50	12.0	0.36	0.16	7.2
TINTEK	SPRING	15	14	7.50	2.0	0.25	ND	14.0
TRIKUTIM	SPRING	15	18	5.00	ND	0.36	ND	11.2
TUMIM	SPRING	10	14	10.00	2.0	0.74	0.62	11.6
UPPER RONGYEK	SPRING	15	14	7.50	4.0	0.74	0.52	9.6
ZOLUK	SPRING	10	18	12.50	ND	0.06	ND	10.0

RAJASTHAN: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGY MISSION)

BACTERIOLOGICAL AND PHYSICAL ANALYSIS

BLOCK	LOCATION	SOURCE	MPN/ 100 ml	P-A TEST	FC	pH	COND mhos/ cm	TS mg/l
BARMER	KHARAPAR	DW	>10	P	P	7.80	36600	19398.00
BARMER	UTARNI	DW	>10	P	P	7.63	17060	9041.80
BARMER	UTARNI	DW	>10	N	N	7.41	27500	14575.00
BARMER	NAND	HP	<10	N	N	7.58	6830	3619.90
BARMER	SANTRA	DW	>10	P	P	8.18	4350	2305.50
BARMER	NAND	RW	>10	P	P	7.81	6300	3339.00
BARMER	SANTRA	DW	>10	P	P	8.16	5030	2665.90
BARMER	SURAJAGIR	RW	>10	P	P	7.47	9080	4812.40
BARMER	SANTRA	DW	>10	P	P	8.12	5630	2983.90
BARMER	VISALA	RW	>10	P	P	8.07	3450	1828.50
BARMER	SANTRA	DW	>10	P	P	8.14	7640	4049.20
BARMER	VISALA	RW	>10	P	P	7.88	8470	4489.10
BARMER	SANTRA	DW	>10	P	P	8.16	8610	4563.30
BARMER	PAU	RW	>10	P	N	8.06	1697	899.40
BARMER	SANTRA	DW	>10	P	N	8.00	1996	1057.80
BARMER	CHAINPEERA	DW	>10	P	N	7.69	25700	13621.00
BARMER	SANTRA	DW	>10	P	P	7.97	6150	3259.50
BARMER	NAND	TW	<10	P	N	7.64	13920	7377.60
BARMER	JHUND	DW	>10	P	P	8.27	13030	6905.90
BARMER	VISALA	RW	>10	P	P	7.70	1414	749.42
BARMER	NIMBANIAN KI DHANI	TW	-	-	-	8.09	3900	2067.00
BARMER	KANKI	RW	>10	P	N	8.32	1570	832.10
BARMER	NIMBANIAN KI DHANI	TW	-	-	-	8.03	3900	2067.00

RAJASTHAN: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGY MISSION)

CHEMICAL ANALYSIS

BLOCK	LOCATION	SOURCE	ALK	TOTAL HARD	Ca HARD	Cl^-	SO_4^{--}	NO_3^-	F^-
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
BARMER	KHARAPAR	DW	290	1550	575	8500.0	750.0	11.3	3.00
BARMER	UTARNI	DW	190	1500	650	4000.0	570.0	11.1	0.72
BARMER	UTARNI	DW	330	1660	650	6000.0	940.0	11.3	1.37
BARMER	NAND	HP	620	300	70	875.0	131.0	10.9	2.89
BARMER	SANTRA	DW	370	200	70	437.5	100.0	11.1	2.25
BARMER	NAND	RW	420	580	280	700.0	212.0	11.3	1.44
BARMER	SANTRA	DW	310	200	70	625.0	125.0	11.1	3.35
BARMER	SURAJAGIR	RW	560	750	190	850.0	386.0	11.5	1.15
BARMER	SANTRA	DW	400	260	120	750.0	156.0	11.1	3.50
BARMER	VISALA	RW	750	210	80	200.0	88.0	4.1	4.50
BARMER	SANTRA	DW	400	240	90	968.8	271.0	11.1	3.00
BARMER	VISALA	RW	660	310	100	1050.0	462.0	10.9	4.50
BARMER	SANTRA	DW	380	350	80	3500.0	271.0	11.3	3.50
BARMER	PAU	RW	290	210	80	175.0	15.0	10.6	0.56
BARMER	SANTRA	DW	240	270	165	375.0	69.0	11.3	3.35
BARMER	CHAINPEERA	DW	340	1080	250	7000.0	73.0	11.5	3.00
BARMER	SANTRA	DW	300	400	75	781.3	175.0	11.3	3.50
BARMER	NAND	TW	470	880	320	1650.0	500.0	11.5	1.44
BARMER	JHUND	DW	520	340	65	4000.0	362.0	11.1	7.60
BARMER	VISALA	RW	1720	560	280	1200.0	1000.0	1.9	1.44
BARMER	NIMBANIAN KI DHANI	TW	320	270	60	700.0	125.0	0.0	3.00
BARMER	KANKI	RW	250	220	110	185.0	37.6	10.9	0.50
BARMER	NIMBANIAN KI DHANI	TW	360	250	50	650.0	143.0	0.2	12.50

RAJASTHAN: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGY MISSION)

METAL ANALYSIS

BLOCK	LOCATION	SOURCE	Ca	Cd	Cr	Cu	Co	Fe	Mg	Mn	Ni	Pb	Zn
BARMER	KHARAPAR	DW	702.0	ND	0.049	0.029	0.002	0.686	1186.0	0.058	0.336	0.089	0.062
BARMER	UTARNI	DW	626.0	ND	0.032	0.013	0.006	2.136	820.0	0.460	0.046	0.064	0.031
BARMER	UTARNI	DW	746.0	ND	0.025	0.016	0.006	0.408	974.0	0.222	0.058	0.076	0.018
BARMER	NAND	HP	34.0	ND	ND	ND	ND	ND	64.6	ND	ND	0.017	ND
BARMER	SANTRA	DW	60.8	ND	0.091	0.010	0.004	0.110	168.4	0.023	0.020	0.007	0.030
BARMER	NAND	RW	163.6	0.006	0.038	0.011	0.003	48.996	299.0	0.428	0.008	0.182	0.063
BARMER	SANTRA	DW	48.4	ND	0.118	0.010	0.004	0.062	134.2	0.018	0.041	0.007	0.070
BARMER	SURAJAGIR	RW	195.0	0.004	0.054	0.017	0.006	90.990	358.0	1.610	0.035	0.221	0.124
BARMER	SANTRA	DW	129.2	ND	0.059	0.015	0.004	ND	222.0	0.012	0.175	0.035	0.113
BARMER	VISALA	RW	45.8	ND	0.020	0.017	0.007	5.376	82.6	3.220	0.038	0.201	0.198
BARMER	SANTRA	DW	64.0	ND	0.054	0.025	0.025	0.318	230.0	0.054	0.298	0.026	0.328
BARMER	VISALA	RW	193.6	0.007	0.009	0.008	0.004	0.178	310.0	0.018	0.024	0.108	0.125
BARMER	SANTRA	DW	88.2	ND	0.038	0.008	0.005	0.578	300.0	0.054	0.025	0.016	0.090
BARMER	PAU	RW	30.6	ND	0.013	ND	ND	0.114	113.6	0.037	0.012	0.006	0.010
BARMER	SANTRA	DW	1120.0	ND	0.067	0.009	ND	0.620	151.4	0.057	0.035	0.010	0.171
BARMER	CHAINPEERA	DW	370.0	ND	0.038	0.037	0.003	0.148	952.0	0.239	0.136	0.067	0.114
BARMER	SANTRA	DW	107.8	ND	0.070	0.016	ND	0.462	306.0	0.030	0.082	0.034	0.148
BARMER	NAND	TW	35.6	ND	0.006	0.002	ND	14.436	38.4	0.141	0.004	0.094	0.017
BARMER	JHUND	DW	76.6	ND	0.059	0.016	ND	0.334	360.0	0.029	0.096	0.023	0.112
BARMER	VISALA	RW	77.2	0.008	0.025	ND	ND	ND	157.0	0.312	ND	0.087	ND
BARMER	NIMBANIAN KI DHANI	TW	62.4	ND	0.021	ND	ND	0.474	153.0	0.007	ND	0.011	ND
BARMER	KANKI	RW	-	-	-	-	-	-	-	-	-	-	-
BARMER	NIMBANIAN KI DHANI	TW	84.4	ND	0.025	0.006	ND	1.400	143.2	0.063	ND	0.012	0.068

RAJASTHAN: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGY MISSION)

BACTERIOLOGICAL AND PHYSICAL ANALYSIS

BLOCK	LOCATION	SOURCE	MPN/ 100 ml	P-A TEST	FC	pH	COND mhos/ cm	TS mg/l
BARMER	BHIMRA	TW	-	-	-	8.12	5100	2703.00
BARMER	BAITOO	R NO.2	<1	N	-	7.79	5300	2809.00
BARMER	VISALA	RW	>10	P	P	8.07	6820	3614.60
BARMER	BAGDAAN	RW	>10	P	P	7.94	9340	4950.20
BARMER	MITHODA	TW	-	-	-	8.28	3280	1738.40
BARMER	BAITOO	R NO.1	<10	P	-	7.82	5400	2862.00
CHOHTAN	UNKHA	HP	<10	P	-	8.72	11330	6004.90
CHOHTAN	BACHCH KI DHANI	WELL	>10	P	P	8.39	3920	2077.63
CHOHTAN	RAMZAN KI GAFAN	TANKA	>10	P	P	8.19	9570	5072.10
CHOHTAN	MATHASAR KA THALA	RW	>10	P	P	7.68	23100	12243.00
CHOHTAN	DEDUSAR	WELL	>10	P	P	8.38	5540	2936.20
CHOHTAN	ARBI KI GAFAN	DW	>10	P	P	7.85	15730	8336.90
CHOHTAN	BAWARY	TW	-	-	-	8.47	4650	2464.50
CHOHTAN	UNKHA	HP	<10	P	-	8.80	1474	781.22
CHOHTAN	SADIYA NADI	POND	>10	P	P	8.46	3581	1897.93
CHOHTAN	RAMZAN KI GAFAN	WELL	>10	P	P	7.89	24200	12826.00
CHOHTAN	SANWA	TW	-	-	-	8.35	4070	2157.10
CHOHTAN	ARBI KI GAFAN	TANKA	>10	P	P	8.55	3850	2040.50
CHOHTAN	VINDAYANIA	TANKER	-	P	N	8.28	4890	2591.70
CHOHTAN	ARBI KI GAFAN	WELL	>10	P	P	8.42	4840	2565.20
CHOHTAN	CHOHTAN	TW	<1	N	N	8.40	2900	1537.00
PACHPADRA	NAREVA SCHOOL	WELL	>10	P	P	7.24	9700	5141.00
PACHPADRA	PACHPADRA	DW	<10	P	P	8.02	2700	1431.00

RAJASTHAN: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGY MISSION)

BLOCK	LOCATION	SOURCE	CHEMICAL ANALYSIS						
			ALK	TOTAL HARD	Ca HARD	Cl^-	SO_4^{--}	NO_3^-	F^-
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
BARMER	BHIMRA	TW	310	410	100	650.0	274.0	1.2	1.37
BARMER	BAITOO	R NO.2	310	430	90	1000.0	250.0	0.3	1.06
BARMER	VISALA	RW	1030	210	70	550.0	188.0	10.4	10.60
BARMER	BAGDAAN	RW	840	320	60	1150.0	300.0	10.9	1.15
BARMER	MITHODA	TW	390	130	45	325.0	63.0	10.9	0.85
BARMER	BAITOO	R NO.1	300	440	80	1300.0	286.0	3.5	1.37
CHOHTAN	UNKHA	HP	810	200	50	1650.0	436.0	11.3	3.35
CHOHTAN	BACHCH KI DHANI	WELL	220	280	100	675.0	108.0	10.9	0.64
CHOHTAN	RAMZAN KI GAFAN	TANKA	280	1200	300	1975.0	218.0	11.1	0.85
CHOHTAN	MATHASAR KA THALA	RW	210	1420	725	6500.0	560.0	10.9	0.75
CHOHTAN	DEDUSAR	WELL	150	310	120	845.0	165.0	10.9	0.90
CHOHTAN	ARBI KI GAFAN	DW	200	1110	240	2675.0	625.0	11.3	1.06
CHOHTAN	BAWARY	TW	180	300	150	750.0	106.0	11.3	0.66
CHOHTAN	UNKHA	HP	360	90	15	47.5	40.0	8.4	1.50
CHOHTAN	SADIYA NADI	POND	190	150	140	125.0	30.0	4.7	0.34
CHOHTAN	RAMZAN KI GAFAN	WELL	310	1680	650	5700.0	812.5	10.9	0.85
CHOHTAN	SANWA	TW	240	230	80	485.0	175.0	11.3	0.66
CHOHTAN	ARBI KI GAFAN	TANKA	200	150	90	600.0	112.0	10.9	0.57
CHOHTAN	VINDAYANIA	TANKER	340	620	300	575.0	126.0	11.3	0.57
CHOHTAN	ARBI KI GAFAN	WELL	320	650	210	725.0	156.0	11.1	0.45
CHOHTAN	CHOHTAN	TW	220	500	290	210.0	175.0	11.3	0.44
PACHPADRA	NAREVA SCHOOL	WELL	370	1560	500	4150.0	424.0	11.3	0.72
PACHPADRA	PACHPADRA	DW	160	280	120	575.0	156.0	1.3	0.53

RAJASTHAN: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGY MISSION)

METAL ANALYSIS

BLOCK	LOCATION	SOURCE	Ca	Cd	Cr	Cu	Co	Fe	Mg	Mn	Ni	Pb	Zn
BARMER	BHIMRA	TW	131.0	ND	0.041	0.004	ND	0.156	250.0	0.004	0.094	0.015	0.033
BARMER	BAITOO	R NO.2	127.6	ND	0.051	0.002	ND	1.028	266.0	0.027	ND	0.020	0.010
BARMER	VISALA	RW	67.4	0.003	0.119	0.049	0.006	203.790	104.8	2.600	0.050	0.759	0.188
BARMER	BAGDAAN	RW	34.4	0.007	0.012	ND	ND	17.476	130.2	0.198	ND	0.060	ND
BARMER	MITHODA	TW	43.6	ND	0.056	0.002	0.002	0.006	113.8	0.003	0.011	0.021	0.045
BARMER	BAITOO	R NO.1	78.4	ND	0.102	0.002	ND	0.186	15.2	0.013	0.005	0.013	0.010
CHOHTAN	UNKHA	HP	23.2	ND	0.009	0.007	0.004	ND	286.0	0.006	0.007	0.148	0.044
CHOHTAN	BACHCH KI DHANI	WELL	69.8	ND	0.022	0.019	ND	2.030	242.0	0.184	0.029	0.088	0.032
CHOHTAN	RAMZAN KI GAFAN	TANKA	13.8	0.002	ND	0.008	0.003	0.086	300.0	0.014	0.013	0.196	0.017
CHOHTAN	MATHASAR KA THALA	RW	768.0	ND	0.038	0.027	0.006	0.536	756.0	0.054	0.173	0.089	0.127
CHOHTAN	DEDUSAR	WELL	86.4	ND	0.109	0.008	ND	0.420	314.0	0.042	0.042	0.095	0.103
CHOHTAN	ARBI KI GAFAN	DW	296.0	ND	0.109	0.017	0.005	0.232	780.0	0.062	0.065	0.239	0.094
CHOHTAN	BAWARY	TW	79.2	ND	0.037	0.004	ND	0.040	270.0	0.011	0.007	0.116	ND
CHOHTAN	UNKHA	HP	3.4	ND	0.009	0.011	0.003	0.236	4.4	0.018	0.030	ND	0.103
CHOHTAN	SADIYA NADI	POND	88.2	0.009	0.157	0.082	ND	6.616	224.0	2.680	0.204	0.181	0.290
CHOHTAN	RAMZAN KI GAFAN	WELL	538.0	ND	0.030	0.010	0.005	0.348	1044.0	0.084	0.038	0.062	ND
CHOHTAN	SANWA	TW	43.2	ND	0.045	0.024	ND	0.324	254.0	0.018	0.056	0.026	0.136
CHOHTAN	ARBI KI GAFAN	TANKA	57.8	ND	0.051	0.008	0.003	ND	244.0	0.032	0.020	ND	0.064
CHOHTAN	VINDAYANIA	TANKER	200.0	ND	0.129	0.014	0.005	0.212	312.0	0.048	0.028	0.083	0.052
CHOHTAN	ARBI KI GAFAN	WELL	63.0	ND	0.081	0.023	0.005	6.376	258.0	0.480	0.056	0.040	0.130
CHOHTAN	CHOHTAN	TW	133.6	ND	ND	0.012	ND	ND	234.0	0.010	0.020	0.078	0.762
PACHPADRA	NAREVA SCHOOL	WELL	1140.0	ND	0.038	0.020	0.005	0.252	432.0	0.022	0.101	0.112	0.022
PACHPADRA	PACHPADRA	DW	75.6	ND	0.010	0.025	ND	0.132	140.8	0.020	0.056	0.062	0.290

RAJASTHAN: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGY MISSION)

BACTERIOLOGICAL AND PHYSICAL ANALYSIS

BLOCK	LOCATION	SOURCE	MPN/ 100 ml	P-A TEST	FC	pH	COND mhos/ cm	TS mg/l
PACHPADRA	BAGUNDI	PTW	<1	N	N	8.08	2800	1484.00
PACHPADRA	ASOTRA	TW	-	-	-	8.07	5300	2809.00
PACHPADRA	BALOTRA	DW	>10	P	P	7.30	12200	6466.00
PACHPADRA	BALOTRA	TW	<10	N	P	7.79	10090	5347.70
PACHPADRA	PADMARAM	OW	>10	P	P	7.36	13200	6996.00
PACHPADRA	NAREVA SCHOOL	TANKA	>10	P	P	7.80	2600	1378.00
PACHPADRA	NAREVA SCHOOL	DW	>10	P	P	7.69	8100	4293.00
PACHPADRA	BALOTRA	TW	<10	P	P	7.16	22100	11713.00
PACHPADRA	BALOTRA	R	-	-	-	8.18	5430	2877.90
PACHPADRA	BALOTRA	RIVER	>10	P	N	7.77	31900	16907.00
PACHPADRA	CHOCH MANDIR	DW	>10	P	-	7.92	28400	15052.00
PACHPADRA	BALOTRA	DE	>10	P	P	7.86	32200	17066.00
PACHPADRA	BALOTRA	OW	>10	P	-	7.80	13060	6921.80
SHEO	MUNGERIA	DW	>10	P	P	7.93	9920	5257.60
SHEO	BALEWA	HP	-	-	-	7.34	13440	7123.20
SHEO	HARSANI	DW	<10	P	N	7.92	9578	5076.34
SHEO	HARSANI	TW	-	-	-	7.95	8900	4717.00
SHEO	BALEWA DHANI	RW	>10	P	P	7.36	11350	6015.50
SHIVANA	JUNEJON KI BASTI	RW	>10	P	P	7.90	6140	3254.20
SHIVANA	TIRMANIAR	HP	-	-	-	7.60	13250	7022.50
SHIVANA	DEDIYAR	RW	>10	P	P	7.65	7040	3731.20
SHIVANA	TANU RAJOI	DW	>10	P	P	8.12	8910	4722.30
SHIVANA	BAMSIN	DITCH	>10	P	P	7.55	8900	4717.00
SHIVANA	BALASAR	TW	-	P	N	8.12	5010	2655.30

RAJASTHAN: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGY MISSION)

CHEMICAL ANALYSIS

BLOCK	LOCATION	SOURCE	ALK	TOTAL HARD	Ca HARD	Cl^-	SO_4^{--}	NO_3^-	F^-
			mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
PACHPADRA	BAGUNDI	PTW	160	310	140	575.0	137.0	1.5	0.56
PACHPADRA	ASOTRA	TW	ND	380	130	925.0	300.0	2.3	0.53
PACHPADRA	BALOTRA	DW	280	890	580	2350.0	880.0	2.8	0.62
PACHPADRA	BALOTRA	TW	140	550	240	1825.0	474.0	4.9	0.68
PACHPADRA	PADMARAM	OW	210	760	300	2875.0	750.0	4.2	1.37
PACHPADRA	NAREVA SCHOOL	TANKA	130	270	90	500.0	131.0	1.2	0.90
PACHPADRA	NAREVA SCHOOL	DW	570	770	250	1450.0	181.0	10.4	0.49
PACHPADRA	BALOTRA	TW	500	1250	300	6125.0	1370.0	11.3	0.57
PACHPADRA	BALOTRA	R	ND	380	145	950.0	250.0	2.9	0.55
PACHPADRA	BALOTRA	RIVER	220	1560	500	7125.0	1250.0	1.9	0.60
PACHPADRA	CHOCH MANDIR	DW	230	1600	1500	6250.0	1500.0	11.7	0.53
PACHPADRA	BALOTRA	DE	600	1170	575	7000.0	1180.0	10.9	0.51
PACHPADRA	BALOTRA	OW	600	860	600	2100.0	500.0	4.9	0.62
SHEO	MUNGERIA	DW	440	790	90	950.0	300.0	11.5	0.90
SHEO	BALEWA	HP	590	740	280	1950.0	412.0	11.3	1.50
SHEO	HARSANI	DW	400	670	60	1400.0	188.0	10.9	1.44
SHEO	HARSANI	TW	570	250	25	1325.0	212.0	1.9	10.60
SHEO	BALEWA DHANI	RW	570	560	125	1375.0	436.0	11.3	1.50
SHIVANA	JUNEJON KI BASTI	RW	650	220	40	700.0	125.0	10.9	4.50
SHIVANA	TIRMANIAR	HP	1180	510	35	1800.0	350.0	11.1	5.30
SHIVANA	DEDIYAR	RW	530	640	160	950.0	125.0	10.9	0.55
SHIVANA	TANU RAJOI	DW	450	330	35	1225.0	175.0	11.3	2.89
SHIVANA	BAMSIN	DITCH	230	580	105	1825.0	300.0	1.1	0.62
SHIVANA	BALASAR	TW	430	260	75	600.0	94.0	8.8	5.50

RAJASTHAN: HOLOLOGICAL APPROACH TO ENVIRONMENTAL MANAGEMENT
(WATER TECHNOLOGY MISSION)

METAL ANALYSIS

BLOCK	LOCATION	SOURCE	Ca	Cd	Cr	Cu	Co	Fe	Mg	Mn	Ni	Pb	Zn
PACHPADRA	BAGUNDI	PIW	63.2	ND	0.010	0.014	ND	0.252	119.0	0.011	0.079	0.052	0.104
PACHPADRA	ASOTRA	TW	57.8	ND	0.002	0.025	ND	0.028	274.0	0.012	0.096	0.068	0.171
PACHPADRA	BALOTRA	DW	498.0	ND	ND	0.031	0.016	0.086	628.0	0.029	0.050	0.131	0.115
PACHPADRA	BALOTRA	TW	208.0	ND	ND	0.006	0.003	0.120	514.0	0.026	0.007	0.188	0.014
PACHPADRA	PADMARAM	OW	330.0	ND	ND	0.020	0.005	ND	546.0	0.012	0.074	0.081	0.099
PACHPADRA	NAREVA SCHOOL	TANKA	110.4	ND	0.020	0.078	ND	0.488	135.6	0.050	0.075	0.027	0.115
PACHPADRA	NAREVA SCHOOL	DW	384.0	ND	0.037	0.036	ND	2.516	322.0	0.286	0.122	0.037	0.306
PACHPADRA	BALOTRA	TW	308.0	ND	ND	0.012	0.020	ND	896.0	0.048	0.058	0.188	ND
PACHPADRA	BALOTRA	R	95.0	ND	ND	0.008	ND	1.412	300.0	0.015	0.030	0.020	0.014
PACHPADRA	BALOTRA	RIVER	580.0	ND	ND	0.025	0.006	0.166	1066.0	0.081	0.012	0.176	0.044
PACHPADRA	CHOCH MANDIR	DW	1654.0	ND	ND	0.011	0.030	0.004	1130.0	0.021	0.048	0.189	ND
PACHPADRA	BALOTRA	DE	1312.0	ND	0.020	0.022	0.020	0.440	1056.0	0.152	0.056	0.249	ND
PACHPADRA	BALOTRA	OW	402.0	ND	0.005	0.013	0.005	0.004	596.0	0.193	0.036	0.024	0.055
SHEO	MUNGERIA	DW	86.8	ND	ND	ND	ND	0.202	376.0	0.005	ND	0.083	0.088
SHEO	BALEWA	HP	214.0	ND	0.023	0.018	0.002	1.836	430.0	0.024	0.004	0.157	0.032
SHEO	HARSANI	DW	123.4	0.005	ND	0.010	ND	0.164	412.0	0.014	0.016	0.503	0.232
SHEO	HARSANI	TW	63.6	ND	0.005	0.004	ND	1.224	204.0	0.030	ND	0.154	0.438
SHEO	BALEWA DHANI	RW	250.0	ND	ND	0.003	ND	0.024	338.0	0.010	0.003	0.084	0.018
SHIVANA	JUNEJON KI BASTI	RW	234.0	ND	0.004	0.008	ND	1.140	478.0	0.214	ND	0.066	ND
SHIVANA	TIRMANIAR	HP	226.0	ND	ND	0.004	ND	0.632	376.0	0.027	ND	0.172	0.024
SHIVANA	DEDIYAR	RW	82.4	ND	0.012	0.004	ND	24.196	176.4	0.280	ND	0.118	ND
SHIVANA	TANU RAJOI	DW	80.6	ND	0.005	0.005	ND	0.330	282.0	0.006	ND	0.085	0.056
SHIVANA	BAMSIN	DITCH	212.0	ND	0.018	0.019	0.021	2.136	420.0	0.286	0.055	0.197	0.134
SHIVANA	BALASAR	TW	78.6	ND	ND	0.003	ND	0.918	49.0	0.016	ND	0.309	0.316

RECOMMENDATIONS

1. An intensive drive must be immediately initiated to ensure adequate chlorination of all surface water sources. Also nationwide network for the manufacture and adequate supply of chloride preparations for disinfection of water supplies be assured. Top priority must be given to train village level personel in the procedures required to effectively chlorinate water supplies. Chloroscopes for testing for residual chlorine in the disinfected water must be freely available.

2. Small district level laboratories must be established to perform a small number of essential water quality analyses with particular reference to simple bacteriological analysis and residual chlorine. Attention must be directed:

(a) Towards ensuring that rural piped supplies are distributing bacteriologically safe water, otherwise Mini epidemics may occur in future due to supply of contaminated water.

(b) All hand pumps must be periodically for the presence of thermotolerant coliforms. Positive waters must be checked and immediate steps should be taken to remove contamination from sources found consisitently positive.

3. Where possible dug wells may be replaced by safe spot sources. In many areas these wells often provide a sustained water supply when other soures disappear. It may be worthwhile to convert the dug wells to sanitary wells to supplement the available sources.

4. Where ever levels of iron contamination have been found aesthetically unacceptable iron removal units, domestic or community based, may be installed.

5. Areas with epidemic fluorosis should be provided with alternative water sources. In case this is not possible defluoridation technologies may be instituted.

6. When water is unacceptable, brackish or saline, alternative water sources may be sought. If they are not available, local feasibility of utilizing desalination technologies be explored.

7. Lead levels were found to be above 0.100 mg/L in 34% of the water samples from Barmer. High lead levels in drinking water attributable to lead containing naturally occurring minerals were found by ITRC in Pilani, Rajasthan in an earlier study.

In view of the reports that lead is injurious to children and leads to mental retardation and other disorders, it is desirable that some surveillance of the blood lead levels in school children in affected areas of Barmer is undertaken by the local health authorities.