CHAPTER II
WATER POLLUTION

INTRODUCTION

Water is the main limiting factor of human activities in more than one-third of the land area of earth (Walton, 1970). About 97.3 per cent of global water is stored in ocean and inland sea. The remaining 2.7 per cent of water is present in the form of glaciers, in rivers, lakes and is also stored in the form of ground water. The entire population of earth depends on less than one per cent of total water bodies (Miyalam, Manorama Year Book 1988, p. 112) (Fig. 2.1). Only 0.001 per cent of water is present in the atmosphere in the form of water vapour but most of it comes back on earth due to precipitation. A survey of existing resources of water reveals some startling facts. There is an overall shortage of water and whatever water is available is also getting polluted gradually; adversely affecting the quality of life because man is both polluter and sufferer from pollution (Walton, 1970). After air, the most vital element for the survival of life is water. But this necessary resource is also a refuge for biological pests and nuisances (Jain and others, 1977, p. 200). In the global war against hunger we will have to manage our existing resources of water more efficiently. The existence and well-being of all inhabitants of earth depends greatly on water because of
GLOBAL WATER STORAGE

WORLD OCEAN 72.2%

ICE SHEETS AND GLACIERS 2.15%

GROUND WATER 0.62%

STREAM CHANNELS 0.0001

ATMOSPHERE 0.001

FRESH WATER LAKES 0.009%

SALINE LAKES AND INLAND SEAS 0.008%

SOIL WATER 0.005%

SOURCE: STRAHLER AND STRAHLER (1977), P. 94
its multipurpose use. The basic effect of water is on man's health and thus in turn affects all other human activities. In fact we cannot imagine of a world without water for there is hardly any sphere of human welfare - social and economic which is not dependent on water. There could never be "green revolutions" or "Industrial booms" without water.

But this very vital element i.e. water is also posing a threat to the existence of mankind due to water pollution. It is a common knowledge now that most of the diseases are water-borne. The over-all picture at the movement is very grim. Recent studies conducted by various agencies puts the quantity of pure water available at 0.3 per cent out of the existing resources of fresh water (Madhya Pradesh Paryawaran, June 1983, p. 11). Hence it is very important pollution to study the problem of water pollution, in order to take the causes as well as remedies.

In this study an attempt has been made to study the problem of water-pollution in Sagar district. A general survey of water resources in Sagar district reveals that, rivers, tanks, lake and wells in this area are highly polluted. As a result inhabitants of this district constantly face a lot of health problems due to non-availability of pure drinking water. In the study area water pollution is the main reason behind the spread of many diseases. Other kinds of pollution such as that of air is not so grave.
There are some scientific facts about water which are worthy of consideration. For instance generally water (H₂O) is never unpolluted. Gases like Hydrogen sulphide, Carbon dioxide, Ammonia, Nitrogen (H₂S, CO₂, NH₃, N₂) and minerals like calcium, magnesium, sodium get easily dissolved in it (Agrawal, 1987, p. 105). Safe water contains a minimum amount of salt. It should be free from diseases causing bacteria, protozoa and orthopods. On the other hand water which is considered to be highly contaminated from the public health point of view due to the addition of sewage water may still be regarded as healthy and desirable environment for many kinds of animal life from the biological point of view (Walton, 1970, p. 263).

QUALITY OF WATER

Man's concern about the quality of water differs from place to place and time to time. His main concern has been the availability of drinking water free from bacterial contamination. More recently he has been concerned with contamination resulting from odours, soil trace, and visible pollutants. Man is now beginning to be more concerned about the quality of natural water and also about the suitability available water for municipal, agricultural, industrial and recreational uses (President's Science Advisory Committee, Washington, 1965). According to Singh (1985) the water bodies may be classified as clean water, which is free from bacteria and always safe to use; polluted water, water with
substances, and contaminated water which also carries human or animal wastes. The Indian Standard Institute gives the following parameters for drinking water (Table 2.1)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>ISI Standard (IS: 2296-1963)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.0 - 9.0</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>3.0</td>
</tr>
<tr>
<td>Chloride</td>
<td>600</td>
</tr>
<tr>
<td>Sulphate</td>
<td>1000</td>
</tr>
<tr>
<td>Cyanide</td>
<td>0.01</td>
</tr>
<tr>
<td>Fluoride</td>
<td>3.0</td>
</tr>
<tr>
<td>Arscnic</td>
<td>0.2</td>
</tr>
<tr>
<td>Chromium (VI)</td>
<td>0.05</td>
</tr>
<tr>
<td>Lead</td>
<td>0.1</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.05</td>
</tr>
<tr>
<td>Phenols</td>
<td>0.005</td>
</tr>
<tr>
<td>Bacteriological parameters</td>
<td></td>
</tr>
<tr>
<td>Coliform cells/100 ml</td>
<td>5000</td>
</tr>
</tbody>
</table>


The above parameters are 3-5 times higher for surface water (De, 1986, p. 159). The Central Board's publication ADSOR/ BS/3/78-79 gives water quality criteria for surface water as follows:
### TABLE 2.2
WATER QUALITY CRITERIA FOR SURFACE WATER

<table>
<thead>
<tr>
<th>Classification</th>
<th>Designated Best Use</th>
<th>Major Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Drinking water source without treatment but after disinfection</td>
<td>(i) pH to be in between 6.5 and 8.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) DO to be 6 mg/l or more</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) BOD not to exceed 2 mg/l</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iv) Total coliform MPN not to exceed 50/100 ml.</td>
</tr>
<tr>
<td>B</td>
<td>Outdoor Bathing (Organized)</td>
<td>(i) pH to be in between 6.6 and 8.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) DO to be 5 mg/l or more</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) BOD not to exceed 3 mg/l</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iv) Total coliform MPN not to exceed 500/100 ml.</td>
</tr>
<tr>
<td>C</td>
<td>Drinking water source with conventional treatment followed by disinfection</td>
<td>(i) pH to be in between 6.0 and 9.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) DO to be 4 mg/l or more</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) BOD not to exceed 3 mg/l</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iv) Total coliform MPN not to exceed 500/100 ml.</td>
</tr>
<tr>
<td>D</td>
<td>Propagation of fisheries and wildlife</td>
<td>(i) pH to be between 6 and 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) DO to be 4 mg/l or more</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) Free ammonia N not to exceed 1.2 mg/l</td>
</tr>
<tr>
<td>E</td>
<td>Irrigation/Industrial cooling</td>
<td>(i) pH to be between 6 and 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Electrical conductivity not to exceed 2250 micro-nes/cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) Sodium absorption rate not to exceed 26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iv) Boron not to exceed 2 mg/l</td>
</tr>
</tbody>
</table>

CONCEPT OF POLLUTED WATER

According to the Public Health Service of the U.S. Department of Health Education and Welfare, water pollution means "the adding to water of any substance, or the changing of water's physical and chemical properties in any way, which interferes with its use for legitimate purpose". In other words, any change in the quality of water which renders itself unsuitable for its intended use is called as polluted water. Moreover such contamination of water or such alteration of the physical, chemical or biological properties of water or such discharge of any sewage or any other liquid, gaseous or solid substance into water that is likely to create a nuisance by way of physical appearance, odour, taste or render such water harmful and injurious to human health, for the purpose of domestic commercial, industrial, agricultural or other legitimate uses or to health of animal and aquatic life (Singh, 1985, p. 33). Generally, pollution is a state of dication from the pure conditions, whereby its normal function and properties are affected. Water pollution can be best considered in the perspective of possible pollutant cycles throughout the environment. Figure 2.2 indicates the major routes of pollutant inter-change among the biotic, terrestrial, atmospheric and aquatic environment (De, 1986, p. 136). Present levels of water pollution are for the most part below the levels that cause disease or death in people. The documented cases of pollution - caused injuries to plants, fish, birds and
FIG. 2-2

ATMOSPHERIC

DEPOSITION

VOLATILIZATION

SPRAY MISTS

SOLID

PARTICLES

MISTS

AIR

VOLATILIZATION

DUST

DEPOSITION

RELEASE

UP TAKE

BIOACCUMULATION

TERRESTRIAL

PLANTS

ANIMALS

ORGANISMS

MICRO

ORGANISMS

AQUATIC

SOIL

SOLIDS

SORPTION

RELEASE

SOIL

WATER

WATER

RELEASE

SORPTION

SEDIMENTS

DEPOSITION

VOLATILIZATION

SPRAY MISTS

E EROSION AND RUNOFF

IRRIGATION

ENVIRONMENTAL CYCLES OF POLLUTANT
mammals are extensive and the economic less from these injuries has been considerable. Consequently, the signs of polluted water are bad taste of drinking water; offensive odours from lakes, rivers and unchecked growth of aquatic weeds in water bodies; decrease in number of fish in fresh water, and river water; oil and grease floating on water surface. The disturbed the normal uses of water for public water supply: recreation and aesthetics; fish, other aquatic life and wild life.

MAIN WATER POLLUTANTS

Contaminated water mainly contains organic and inorganic pollutants (Gloyna 1970). Water pollutants may be classified under following eight categories: (1) Infectious agents, (2) Oxygen-demanding wastes, (3) Plant imtrients, (4) Organic chemicals, (5) Inorganic chemicals and mineral substances, (6) Sediments and other solids, (7) Radioactive material and (8) Heat.

Jain, Stacay and Urban (1977) classify contaminated water under three categories such as physical, chemical, and biological.


B. Chemical: (1) Acid and alkali, (2) Biochemical oxygen demand (BOD), (3) Dissolved oxygen (DO), (4) Dissolved solid (5) Nutrient, (6) Toxic
compounds.

C. Biological: (1) Aquatic life, and (2) Fecal coliforms.

Moreover, the pollutants, occurring in water bodies from various sources, may be grouped under following categories: (1) Organic pollutants, (2) Inorganic pollutants, (3) Sediments, (4) Radioactive material, and (5) Heat.

1. ORGANIC POLLUTANTS

Dissolved oxygen (D.O.) is important for aquatic life. The optimum D.O. in natural water is 4-6 ppm. Decreasing D.O. is the sign of polluted water, which is mostly due to organic matter. Anaerobic organism, which is from sulphate, nitrate and phosphate, are used chemical bound oxygen. In the surface water D.O. measured frequently to maintain conditions favourable for the growth and reproduction of fish and other aquatic life (Jain & Others, 1977, p. 218). D.O. successively kills sensitive fish and aerobic bacteria, and also water go to black and bubbly and stinks (Singh, 1985, p. 34). The quantity and quality of D.O. in water bodies may vary according is that amount and quality of waste from various industries and domestic uses such as wastes from food processing, industry, and paper mills, from slaughter house, hospitals, laundaries, sanitary sewage, etc. (Kneese & Others, 1975, pp. 12-16). Biochemical oxygen demand (BOD) is another organic pollutant, which depends on D.O. that is depleted from water during the natural biological assimilation of organic pollutants (Agarwal, 1985, p. 250). Normal
operation, construction, repairing, sanitary sewage, floor washing contributed to BOD wastes. High degree of BOD responsible for production of sulphides and amines (Higgins and Burns, 1975, p. 65). The above mentioned human activities are also responsible for focal coliforms in water bodies (Jain & others, 1977, p. 227). Moreover synthetic organic chemical pollutants such as fuel, plastics, plasticizers, fibres, elastomers, solvents, detergents, paints gravely effect fish and other aquatic plants, even if they are present in a small quantity (De, 1986, p. 140). Detergents are responsible for high degree of phosphate in water bodies. Even detergent phosphate produces 16-35 per cent of total phosphate in natural water (Higgins and Burns, 1975, p. 167). The presence of detergent renders life impossible for some microorganism which affects the natural biological purification of water (WHO, 1971, p. 135).

Oil is another important water pollutent which is growing rapidly due to industrialization (Oil-based technology). Various industries and automobile wastes such as, oil, grease, fats and wastes from cleaning scooters, trucks, tractors etc. at rivers, tanks and lakes sides contribute notable amount of such pollutants in water bodies.

Similarly, ground water is also contaminated by synthetic organic compounds. Concentration of these organic contaminants in the water of well is much higher than surface water (U.S. Environmental Protection Agency, 1980,

Consequently, when the people drink this organic contaminated water, causing many endemic diseases, such as cholera, dysentery, leptospirosis, typhoid, paratyphoid fever, tularemia, helminthiasis, protozoal diseases (amoebiasis), viral diseases (WHO, 1971, p. 135). Polio is another important disease which may be caused by organic pollutants of water. In addition, the various organisms occur in infected human urine, which finally mixed in various water bodies and caused diseases (De, 1980, p. 139).

Nine other organic contaminants are trichloroethylene, carbon tetrachloride, tetrachloroethylene, trichloroethane, dechloroethane, 1-1 dichloroethene, dichloroethylenes, methylene chloride, and vinyl chloride (U.S. Environmental Protection Agency, 1980, p. 170) which may be occur in different water bodies. The carbon tetrachloride mostly found in chlorinated well waters, and used as a drinking water. Carbon tetrachlorised generally used in cleaning agents, fire extinguishers and solvent, which is absorbed

Tetrachloroethylene (TCE) present in different amount in various well water sources. TCE is soluble in water and is generally formed during chlorination of well water, which is generally from dry cleaning operations, organic synthesis (National Academy of Science, 1977, p. 939) TCL rapidly absorbed in the gastrointestinal tract, since it is a small, uncharged lipophilic molecule (Stewart and Dred, 1964). TCE also effects nervous system and may cause unconsciousness (National Research Council, 1980, p. 415). Tetrachloroethylene is widely used in dry cleaning and greasing operations, and is absorbed through the lungs and skin and is also absorbed in gastrointestinal tract and generally accumulates in adipose tissue. It is responsible for depression in central nervous system (National Research Council, 1980, p. 415).

Trichloroethane or methyl chloroform, mainly used as an industrial cleaner and degreaser of metal, generally effects central nervous system (Craun, 1985, p. 172). Dichloroethane (ethylene dioxide) is another organic pollutant of water, which is generally used in tobacco flavoring, in soap, paint, varnish, and finish removers (U.S. Environmental Protection Agency, 1980, p. 170). The presence of ethylene-dioxide in water causes, nausea,
vomiting etc. Dichloroetheane is broadly used and its presence in water causes kidney and liver diseases (U.S. Environmental Protection Agency, 1980, p. 170). Methylene chloride pollutant generally used in manufacturing of paint and varnish removers, also effects the central nervous system. Vinyl chloride is generally responsible as a human carcinogen, lesions of skin, bones, liver and even lungs diseases may be attributed to vinyl chloride organic compound (National Research Council, 1977, p. 939).

2. INORGANIC POLLUTANTS

This group of pollutants consists of metals and metal compounds, trace elements, such as lead, calcium, mercury, arsenic, selenium, and antimony (Craun, 1984, p. 137); ether elements of this group are copper, nickel, cobalt and chromium and some other toxic compounds, such as, pesticides, which effect aquatic life (Kenneth, 1970). DDT is another inorganic pollutant of water which occurs in human body fat, and may affect human health (Waddington, 1978, p. 275). Most of the above pollutants enter water bodies due to some human activities, such as, maintenance and repairing shops, industrial operation, electroplating, galvanizing and metal finishing works (Jain & Others, 1977, p. 137). These pollutants may come together or individually create serious health problems (Friberg & Others, 1979). Nitrate, a harmful water contaminant is also present in large quantity in ground water (wells, tubewells, hand pumps) than surface water. A major section of population specially in the rural areas
depends on ground water. The contaminants as such are more harmful to infants, causing methemoglobinemia disease (Treatment, International Water Supply Association, Aqua 1, 5, 1974). The main source of nitrate is contaminated water in human body (National Institute of Environment, 1970, p. 43).

Flouride is usually present in fresh water bodies (WHO, 1970, p. 364). Flouride containing rocks are the natural sources of this contaminant. Besides some types of human activities are also responsible for this kind of contamination (Agrawal, 1987, p. 267 and U.S. Department of Health, Education and Welfare, 1969). The presence of flourine in drinking water is harmful to human health in various ways. Flourine found in water bodies is the cause for endemic fluorosis in human beings (Kanwar and Mehta, 1968, p. 881-886). Medical investigations confirm that as a result of flouride contamination blood cells do not get absorbed in the normal system but gets accumulated in the bones due to its affinity for calcium, causing rotting of teeth, pain in bone joints and bending of legs from the knee joint (Agrawal, 1987, p. 269). In drinking water fluoride concentration below 0.5 ppm, causes dental caries and rotting of teeth, more then 0.5 ppm concentration of fluoride in water, results in fluobosis rendering a person crippled or paralised fluoride contaminants are also known to have decreased milk production capacity in dairy cattle (Little, 1970).
Arsenic

Arsenic is geochemical contaminant of water, and is mainly found in natural sources. Addition of arsenic in water bodies is due to surface water runoff, because this water contaminant is also a constituent of pesticides used. Surface rock erosion also contributes a notable amount of arsenic in water (National Academy of Science, 1977, p. 939). Human activities as well as many other natural source are responsible for arsenic contamination. The consumption of arsenic contaminated water leads to health related problems because arsenic is known to accumulate in muscles and is also distributed to all tissues although a maximum part of it is eliminated with urine. Arsenic and its compounds are poisonous in nature. Its gradual accumulation in human system results in general weakness and other related chronic diseases such as gastrointestinal infection and cardiac abnormalities (Newland, 1982, p. 35). Consumption of arsenic contaminated water is more detrimental to health than inhaling this contaminant or its compounds. Medical findings reveal that arsenic as a contaminant of water causes serious damages to kidneys, liver and the epidermis. A concentration of more than 0.8 mg/litre in drinking water causes bronchial and pulmonary diseases, cardiovascular pathology, hyper-pigmentation of skin, leucoderma, malanoderma etc. (Borgono and Greiber, 1972).

Other inorganic pollutants of water such as mercury,
lead, cadmium; metalloids such as Arsenic, Selinium, etc.,
come from natural sources and human activities. These
pollutants are also harmful to human health. Lead pollution
results in limbs and kidney damage, mental disturbance,
decreased energy production (Goyer & others, 1972, p. 57),
and this contaminated in water also affected cardiovascular
system. Mercury is also found in lake and river water, which
is on account of industrial waste discharges (Agrawal, 1987,
p. 200). In water bodies it is generally found in form of
methyl mercury compound (De, 1986, p. 149). Selinium used
by many industries is also a constituent of pesticides (Smith,
1961, p. 41-45). In atmosphere too it is present as unsoluble
element and due to oxidisation it converts in to soluble
element (Allaway, 1968, p. 131-206). Selenium reaches water
bodies by leadening of rocks and soil (NRC, 1980, p. 415).
Selenium pollution causes loss of hair, especially in
children (Beath, 1962).

Pesticides

Pesticides are biologically active chemicals used for
killing disease causing bacteria which is generally abrasing
herbicides, fungicides, insecticides, reducticides, nematicides,
melluseicides, bacteriosides, etc., which is inhabit
or kill to fungi, insect, green plant, nematedes, melluses,
bacteria and redents. Pesticides generally contain organic
compounds (antibiotics, pyrethrins), synthetic organics
(chlorinated, hydrocarbons, thiocarbonates), and inorganics
(copper sulphate, mercuric chloride) (Strahler & others, 1977, p. 121). Pesticides contain large number of chemicals compounds, such as copper sulphate, zinc oxide, mercuric chloride, mercuric cyanide, inorganic compounds like, arsenic trioxide, sodium arsenite, calcium arsenate, sodium chlorate, boron compounds, sodium tetraborax, calcium cyanamide, sodium cyanate, potassium cyanate, ammonium sulphamate and magnesium chlorate, simple inorganic compounds like carbon bisulphide, carbon tetrachloride, hydrogen cyanide and sulphur dioxide. Other chemical compounds, such as chlorophenol mercury, hydroxymercury chlorophenol, phenylmercuric acetate, ethylmercuric chloride, generally used for fungi control, tributyl-tin hydroxide, triphenyl-tin acetate, and triphenyl-tin disulphide, which is generally a low toxic to plant (Higgins & others, 1975, p. 9-11). At present pesticides used in agriculture are responsible for these toxic material in surface and ground water. DDT (dichloro diphenyl trichloroethene) also occurs in water bodies, even thousand kilometers away from the place of its application because particulate material is generally not so easily biodegradable. Even concentration of these toxic substances continuously increases due to biological magnification (Agrawal, 1985, p. 254).

DDT is also used for killing mosquito, and in agriculture it is a major source of pesticide. But it pollutes in water bodies causing serious effects on fish, The presence of DDT in cattle milk is dangerous to human health especially
infants. Even breast milk in certain cases contain more DDT than cow milk (Agrawal, 1985, p. 258). Mercury compounds of pesticides are absorbed by skin, mouth and respiratory tract resulting in chronic diseases (Higgins & others, 1975, p. 11).

3. RADIOACTIVE POLLUTANTS

Ionoizing radiation from any material is called radioactivity. When these radiation are absorbed by human being above normal level it causes serious health hazard. There are many human activities responsible for increase in amount of radioactive material. Radio-active material also come from natural sources (Agrawal, 1987, p. 281). Uranium is main radio active material, which generally contains 2-5 lbs of U₂O₃ proton. During ore processing "Uranium Tailing" produces a high level of radioactivity which creates serious pollution problem. In atomic bomb explosions 50 per cent of the energy released is used as explosive, 33 per cent is converted in to heat and remaining 17 per cent produces radioactivity.

4. TEMPERATURE

Temperature is a primary factor, which regulates natural processes in water bodies such as physiological functions in organism, spawning and matching. There are some organisms which are killed when water becomes cold or heated suddenly. Increased water temperature causes nomiclosse in industries, loss of water from evaporation
(Krenkel, 1968, p. 16-17). Increasing temperature may be on account of heavy machine operations and other kinds of industrial operation, and cold water is generally from large flow and deep reservoirs (Jain & others, 1977, p. 214). Thermal pollution in water causes many problem such as (i) Increased heat responsible for lowering the assimilative capacity of stream and increased BOD level, (ii) More DO level require to oxygen, (iii) Change temperature of water bodies causing change in reproduction rate of organism and other activities, (iv) Due to rise in temperature, some compounds become more toxic, and (v) Increase in temperature causes decrease in species diversification (Gloyana, 1970).

Nearly 1 gallon of water is lost due to evaporation every year for 8800 BTU dissipated in cooling towers or 0.61 gallons is evaporated for each kWh produced. Rise in temperature of water bodies causes more water loss by evaporation, and thus increases suspended solid content, which causes problem in biological activities and in other recreational activities (Reid, 1961, p. 267).

SOURCES OF WATER

Rainfall is the main indirect source of water in Sagar district. The rivers, lakes, tanks and ponds, open wells and tube-wells are the direct sources of water for the purpose of drinking, cloth washing, cleaning of various goods and material, industrial and agricultural uses. Among the various water resources some big rivers (Betwa, Bina, Dhasan,
Sonar, Bewas, Kopra and Bamner), and 2700 tube wells are important water sources of Sagar district. Generally, the amount of ground and surface water level is determined by the monsoon rain. During the failure of rains the availability of water both surface and underground is effected negatively. That is why, the availability of water is very uncertain and the drinking water supply becomes a serious problem of the district. Tap water is available in ten urban centers only. The main centers where tap water is available are Sagar, Bina, Khurai, Rahatgarh, Deori, Rehli, Garhakota, Banda, Sanodha, Malthone, Khimlasa etc. but it is not sufficient (Table 2.3 & Map 2.1). About more than 95 per cent water is polluted. About 80 per cent population of the district residing in rural and urban areas is drinking polluted water (Agrawal, 1987, p. 21).

Due to low rainfall year during a drought year sufficient water is not available to the population, causing serious drinking water problem both in rural and urban areas. This problem becomes acute in those rural settlements where there is only one well. About 74 per cent villages (1379 villages) of the district have drinking water problem. Out of this figure 69 per cent have partial water facilities and 5 per cent villages (95 villages) are facing serious water supply problem. Similarly, in urban areas where the entire population depends upon tap water supply only a small quantity of water is supplied during summers and drought season.

The population of the district especially of rural areas mainly uses drinking water from open wells, rivers,
Sagar District

Availability of Piped Drinking Water

1988

Per Caput Pur Day
400 Liters

100
50
25

4  2  0  4  8  12  16 Kms.
### TABLE 2.3

**AVAILABILITY OF DRINKING WATER IN URBAN CENTRES, SAGAR DISTRICT**

(Per caput per day liters)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of urban centre</th>
<th>Water availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Banda</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>Bina</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>Deori</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>Garhakota</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>Khurai</td>
<td>40</td>
</tr>
<tr>
<td>6</td>
<td>Rahatgarh</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>Rehli</td>
<td>45</td>
</tr>
<tr>
<td>8</td>
<td>Sagar</td>
<td>50</td>
</tr>
<tr>
<td>9</td>
<td>Shahgarh</td>
<td>40</td>
</tr>
<tr>
<td>10</td>
<td>Shampur</td>
<td>50</td>
</tr>
</tbody>
</table>


Ponds, tube wells which are usually not free from contamination and so is the case in urban centres where population uses tap water. Since the sources of tap water are the rivers, tanks and open wells, the water from these water bodies is polluted. Moreover, the method of purification is sedimentation which is very defective and people have to drink muddy water especially during the rainy season. Therefore the entire population of the district is drinking impure water.
SOURCES OF WATER POLLUTION

The well being of communities both in urban and rural is highly dependent on the water available for their daily needs. Therefore, water requirement for human consumption, and sanitation is one of great social and economic importance. As regards pollution problem caused by contaminated water there are two types of channels through which contaminants enter the human system (i) the direct pollution when people drink or use the contaminated water; (ii) indirect pollution through ingestion of contaminated food, vegetable, fruits, etc. Out of these two channels drinking water is the major source of contaminant in Sagar district because more than 90 per cent population is drinking polluted water which is dangerous to human health. This water problem is mainly due to the lower development of water resources and water facilities. More than 80-90 per cent villages of Sagar district depend on open wells, 15 per cent on rivers, lakes and other water storage sources and about five per cent of ground water like tube wells, hand pumps for their drinking water needs and for other uses. The problem becomes more serious during summer season when water level of entire wells, tube wells go down. Moreover 80 per cent wells are dry (Photograph 2.1 & 2.2) and remaining serve water for only one hour alternatively after an interval of more than 3 hours. Therefore, rural population have to drink polluted water obtained mostly from local rivers or nalas. In summer season the flow of water in rivers becomes lean and assumed
the form of ponds or tank (Photograph 2.3). In rural areas the people due to lack of knowledge do not know about water pollution, hence very little attention is paid towards the maintenance and cleaning of wells. Nearly 95 per cent male and 50 per cent female population of villages take bath or wash clothes by the side of wells and river banks. As a result contaminated water containing organic pollutants and other sediments such as ash and mud flows back into the well and rivers thereby polluting the water (Photograph 2.4 & 2.5). Besides, the cattle is also responsible for polluting water sources. In the villages it is a common scene to see cattle sitting around wells, in ponds or in shallow streams of river, resulting in pollution of water. Birds are also known to build their nests inside the cracks in the walls of well, adding wastes and organic food to the water in the well. Children usually are very fond of throwing odd things in to the water and if the well is not deep enough they even play in the waters of well. There is virtually no proper drainage system around wells and tube wells, causing a lot of slush. The polluted water gets absorbed in to the soil strata and gradually seeps down into the water resource polluting it (Photographs 2.6 & 2.7). In rural areas dust is also swept by winds into the well and in rains both dust and leaves and grass is washed down into the wells. Besides, wells which are located in agricultural land contain a lot of toxic pollutants due to the use of pesticides and its constant absorption in the soil around the well. Surface water carries these
pollutants mixed in soil into the well. The worst form of polluted water is the village pond. Villages which depend on water from ponds are the worst affected due to high percentage of pollutants present in the water. Animals drink water directly from the ponds and also float around in it during summers. Clothes are also washed on stones around the pond and even rinsed in the same water. People take bath standing in the water of pond. Vehicles such as tractors are also washed at the same site. And worst of all the same water is carried in pots to the homes for drinking and cooking purposes.

In urban areas of Sagar district the sources of pollutants are not different from rural areas. In these centres the pressure of population in terms of demand is greater because of limited water resources. Tap water is supplied in ten urban centres for one to two hours only. The entire pipeline in the water distribution network is not only unplanned but also is responsible for contamination of supplied water due to leakages. At the points of leakage in pipe lines for which human activities are greatly responsible, water during the supply hours starts collecting in craters which have developed around these points. And when the flow of water in these pipe lines is stopped muddy contaminated water flows back in to the pipe lines. Thus what the consumer receives is polluted water during the supply hours. The sewage and water pipes not only run parallel at certain places but also run across each other.
Hence there is not only a constant risk but also actual contamination at certain points on account of leakages in the lines or faulty joints.

Although this district does not have a large industrial base yet the existing industries do not manage the disposal of toxic industrial wastes resulting in pollution of water resources such as surface and groundwater. The Municipal Corporations virtually pays very little attention towards these sources of contamination. It is only when diseases assume epidemic proportions that something is done only to patch up the affair or cool down public tempers but once the matter subsides things move along in the same old fashion.

Even in the urban centres 40 per cent of population depends on drinking water from wells and tube wells. During the summers the tap water is supplied on alternating days. Hence the population has to fetch water from wells and tube wells in tankers or small trolley kind of tanks. Often even these tankers are rusty and not properly cleaned and the result is that what they drink and use is polluted water again (Photograph 2.8). The sewage system is largely responsible for water pollution in the district (Photograph 2.9). Pollution rate from this particular source is four times more serious than that from the industrial wastes.

In Sagar city scarcity of drinking water is an annual problem. Water from Bewas river is supplied as tap water.
But in summer season the river becomes almost dry and in its place what flows is a small stream of the size of a nullah (Photograph 2.26) creating an acute water problem. Recently in Sagar the tap water is supplied for one hour only on alternative days (Naiduniya, 1989). The result is long queues at the well and tube wells (Photographs 2.12 & 2.13). The water supplied from Bewas river is muddy especially during the rainy season. Since the only form of purification existing at the moment is the sedimentation which usually takes much time for purification. Hence in order to meet the immediate demand, semipurified water is supplied to the city population, which may be called as contaminated water. The entire city population uses this contaminated water for drinking purposes. The tap water is also not free from bacteria and other kinds of contaminants. Besides due to poor maintenance of pipe line, water also get polluted through leakages. Since water pressure is low during supply hours in order to collect more water people construct low level and even underground tanks keeping the pipeline as low as possible. In the absence at proper covering or cleaning dust and other kinds of pollutants fall into the water thereby contaminating it (Photograph 2.14). In order to meet this scarcity the local administration has with the help of agencies such as P.H.E. provided 500 bore wells. Because of the unplanned borings, a maximum tube wells have been bored near Sagar lake, which is a highly polluted (Photograph 2.14 & 2.15). Nearly 3000 persons of the
surrounding areas due to their recreational activities constantly add more and more pollutants to it (Photograph 2.16). Washermen and residents of the areas wash their clothes regularly in lake water (Photograph 2.17 & 2.18). Animals especially buffaloes float in the water of the lake (Photograph 2.19). Most of the sewage lines open into the lake is discharging tons of wastes in the lake water. There are five large sewerage lines besides many small sewerage openings from the surrounding areas (map 2.2). Chemical wastes from a pharmaceutical company (Photograph 2.20) and regular domestic waste falls at Chakraghat (Photograph 2.21). The sewerage pipeline from Shanichari toury at Mandir ghat and sewerage carrying hospital waste (Duffrin nullah) near local bus stand causes serious problems of chemical, organic and other kinds of contamination. The Gopalganj area nullah also joins the Sagar lake at Dhobighat.

The location of a number of tube wells near polluted water sources such as Sagar lake - city waste disposal areas and even public toilets are potential contamination threat to the fresh water supply. The water from these tube wells is contaminated and is also responsible for many water borne diseases (Photographs 2.23). Many wells of Sagar city are also not free from contamination for instance the well located in Katra bazar by the road side. This well is also used for storing water from Bewas river and other sources. Since the well is uncovered and located in high air pollution the stored water gets contaminated due to heavy traffic and
SAGAR CITY

SOURCES OF POLLUTION IN SAGAR LAKE

1. SEWERAGE FROM GOPAL GANJ
2. SEWERAGE FROM KAKA GANJ
3. SEWERAGE FROM PURVYAU
4. SEWERAGE FROM SHANICHARI
5. SEWERAGE FROM BADI HOSPITAL

INDEX

○ SEWERAGE

### WASHING AND BATHING GHAT

+++ DHOBI GHAT
movement of people on the road. Carbon particles from smoke and also dust particles fall down into the well. There are many vendors who sell their products near the well. Due to strong winds blowing at times leaves and waste paper also fall in to the well. People sitting at the site do not hesitate in throwing cigarette and bidi ends in to the water. Another such polluted water well is located in the Amar cinema compound. Nearly 150 big and small hotels use water for drinking and other purposes from this source. It is estimated that nearly 10,000 persons drink water from this well everyday. Workers from these hotels and other poor class population have their bath and even wash clothes on this well thereby contaminating the water (Photograph 2.24). Sewerage near the wells play important role in the increase of level of pollution. It has been observed that in the entire district the sewerage system is very poor and is a major source of water pollution. A well near bus stand also presents a suitable example (Photograph 2.6). The pollution of the Keshavganj locality constantly face the problem of drinking water and maximum wells in this area become dry in summer season (Photograph 2.1). Most of the people residing in this area depend on a particular well which is located in swampy area (Photograph 2.25). Main source of water pollution in Sagar city is the poor sewerage system. Waste water from open surface drainage spreads every where, due to choking of sewers by solid wastes dumped from houses. Near Apsara cinema their is a slum area which is surrounded by
MAP 2.3

SAGAR CITY
POOR SEWERAGE

INDEX

■ POOR SEWERAGE

■ MUDY AREAOF LAKE
sewerage water (Photograph 2.28). Generally children of this slum play in this nala (Photograph 2.29). Another important polluted water area is located near Radha Krishna cinema (Photograph 2.30 & 2.31). People use this site as an open latrine, causing environmental hazard.

Other main significant areas of water pollution in Sagar city are Kakaganj, Tili ward, Kaboola pull, etc. It is observed that the people of the slum slaughter pigs and wash the meat in this sewerage and even washing of clothes is very common in this water. In the absence of proper sewerage system and non-availability of pure drinking water the dependence on the polluted water resources in various parts of the city people suffer from water borne diseases (Naiduniya, 1988).

Bina is an important of the area under study. The city also faces the problem of acute shortage of water as the water resources are very limited. The problem of shortage coupled with that of water pollution makes the situation grave. The total water supply distribution per person in a day is much below the normal needs of a human being. In some areas of the city there is virtually no tap water supply. About 25 per cent population of Bina is supplied drinking water for only 0 or 7 days in a month, according to a Newspaper report (Naiduniya, Bhopal, 22 September 1988). On account of negligence and poor maintenance of pipe lines even the available water is wasted due to leakage of joints.
and virtually no taps at public water points (Photographs 2.32 & 2.33). Small ponds of contaminated water can be seen around or near these water points which is a case of gross negligence and waste of essential element (Photograph 2.34). Surprisingly some public water points are provided over sewers (Photograph 2.35).

Wells are the main sources of drinking water in Bina. In the Eatawa area of this town 80 per cent wells are located in agricultural land or near the nullah which carries the town’s waste. There is only one well in north Chamrola area and the entire population residing here depends on this water source only. This well is located on the side of a wide nullah which is permanently choked due to domestic refuse being dumped into it by the residents and absence of cleaning facility by the civic authorities. Even in the south Chamrola there is a similar problem. Both these sources of water are highly polluted on account of their nearness to nullahs. In areas such as Galla Mandi and Achawal ward, wells are the only source of drinking water and these wells are located near places which are covered with stagnant highly polluted water (Photograph 2.34). As such the water of the wells gets polluted. Most of the wells are located in agricultural lands and these are polluted on account of the use of pesticides for crop protection. At times the farmers mix the pesticide containing many poisonous elements on the site of water. As a result at times some part of it gets spilled into the well thereby polluting the water which
FIG. 2.3
POLLUTED WATER LEACHATE FROM A WASTE DISPOSAL SITE MOVING TOWARD A SUPPLY WELL

SOURCE: STRAHLER, A.N. (1972): PLANET EARTH, HORPER & ROW, NEW YORK
is consumed by a large section of the population washing
and bathing is common around all wells.

A small river which is named after a temple located
on the bank known as 'Bada Mandir' is another source of
water supply. Organic wastes from the temple in the form
of fruits, vegetables and floral offerings is thrown in to
this river. Besides about 1000 families living in its
vicinity wash clothes in this river (Photograph 2.36). As a
result the water gets contaminated and in the absence of
adequate filtration facilities the same water is pumped to
the city to meet the needs of the people.

Like Sagar city even in Bina the main source of water
pollution is the existing poor sewerage system. There is
cess pool method and open drainage system in Bina. Satawa
region of Bina is the worst affected on account of water
pollution.

Whether it is Achawal ward, Raj Kumar cinema area
well or other wells located in Bilgaiyan, Purana Galla Mandi,
Katwali or Railway colony the sources and process of water
pollution are the same. Cesspools and open sewerages around
water points or near wells contaminate the water. Its not
surprising that most of the people suffers from a number of
diseases mainly waterborne. The culprits in all these cases
of water contamination are the people as well as authorities
entrusted with respective tasks.
Khurai a township near Bina is an urban centre which depends on lakes and wells for water supply. All the three lakes in the Khurai contain water with a relatively very high percentage of water pollution. Once again the story of pollution is the same as elsewhere. Washing, bathing, dumping of solid wastes in waters. Most of the sewerage lines find their ultimate openings in the lake or near water sources such as wells. They are Syll Drains (SD) and open surface drains sewerage system in Khurai.

In the entire study area besides the cities, towns and rural areas already mentioned; nearly 273 villages in Banda and Shahgarh alone have limited water resources. Even whatever amount of water the people receive is polluted and not fit for human consumption as per the normal standard of pure water. In villages people wash their utensils and clothes at the site of well and as a result only pollute the water source (Photograph 2.37). In Moodhri village the population use the water of a nearby nullah for bathing and other purposes. Dogs can be seen swimming in the same nullah (Photograph 2.38). Yet again in Bhangarh area the entire population depends on wells which contain contaminated water. In fact this is an overall picture of the entire district water is always in scarce supply, the existing water sources, whether rivers, wells or lakes are highly polluted. Purification facilities virtually do not exist in some place. The existing water resources get polluted from various sources the sewerage system being the most common
ractor, (Photograph 2.39, 2.40, 2.41). Besides it has also been observed in general that pesticides used by farmers for protecting the crops find their way ultimately to the water sources such as well.

Effects of Water Pollution in Sagar District.

Water pollution problem is more significant than any other kind of pollution, in Sagar district. It is evident from the fact that about two-third diseases of Sagar district, are caused by drinking polluted water. The situation is not too different in all the places of study area. The data on water borne diseases is incomplete because only poor class families of the study area visit government health centres for treatment. Most of the chronic cases are not registered by the health centre officials in order keep best health records. During survey it was observed that only 30 per cent population of rural areas and nearly 20 per cent population of urban areas visited government health centres. The present study of water pollution effects in study area mainly depends on field observation or help provided by both private and government doctors as well as news papers reports.

In Sagar district the year 1987 is known as "year of Meningitis", because out of 8 district of Madhya Pradesh Sagar is the main district which is effected seriously by this epidemic. In Sagar district 1,889 cases of meningitic have been recorded in 1986 (Table 2.4), out of
## Table 2.4

**WATER POLLUTION'S DISEASES IN SAGAR DISTRICT, 1986**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Diseases</th>
<th>Number of cases recorded in various Government health centres</th>
<th>Per cent of total water pollution diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diarrhoea</td>
<td>39,682</td>
<td>22.33</td>
</tr>
<tr>
<td>2</td>
<td>Cholera</td>
<td>208</td>
<td>0.11</td>
</tr>
<tr>
<td>3</td>
<td>Typhoid fever</td>
<td>2,308</td>
<td>1.29</td>
</tr>
<tr>
<td>4</td>
<td>Paratyphoid and other salmonella infections</td>
<td>5,950</td>
<td>3.34</td>
</tr>
<tr>
<td>5</td>
<td>Dysentery and Amoebiasis</td>
<td>26,046</td>
<td>14.66</td>
</tr>
<tr>
<td>6</td>
<td>Tuberculosis of central nervous system</td>
<td>34</td>
<td>0.019</td>
</tr>
<tr>
<td>7</td>
<td>Bacterial diseases</td>
<td>4,141</td>
<td>2.33</td>
</tr>
<tr>
<td>8</td>
<td>Viral diseases</td>
<td>2,205</td>
<td>1.24</td>
</tr>
<tr>
<td>9</td>
<td>Infective hepatitis</td>
<td>999</td>
<td>0.56</td>
</tr>
<tr>
<td>10</td>
<td>Malaria</td>
<td>15,550</td>
<td>8.75</td>
</tr>
<tr>
<td>11</td>
<td>Helminthiases</td>
<td>2,839</td>
<td>1.59</td>
</tr>
<tr>
<td>12</td>
<td>Avitaminosis and other Nutritional deficiencies</td>
<td>2,032</td>
<td>1.14</td>
</tr>
<tr>
<td>13</td>
<td>Meningitis</td>
<td>1,889</td>
<td>1.06</td>
</tr>
<tr>
<td>14</td>
<td>Influenza</td>
<td>2,014</td>
<td>1.13</td>
</tr>
<tr>
<td>15</td>
<td>Vasal pneumonia</td>
<td>5,201</td>
<td>2.92</td>
</tr>
<tr>
<td>16</td>
<td>Diseases of teeth</td>
<td>6,641</td>
<td>3.73</td>
</tr>
<tr>
<td>17</td>
<td>Gastritis and duodeoitis</td>
<td>12,104</td>
<td>6.81</td>
</tr>
<tr>
<td>18</td>
<td>Diseases of digestive system</td>
<td>20,907</td>
<td>11.76</td>
</tr>
<tr>
<td>19</td>
<td>Infection of kidney</td>
<td>4,532</td>
<td>2.55</td>
</tr>
<tr>
<td>20</td>
<td>Infection of skin</td>
<td>18,514</td>
<td>10.42</td>
</tr>
<tr>
<td>21</td>
<td>Ankylosis and acquired musculoskeletal deformities</td>
<td>1,431</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Source: Chief Medical Officer, Sagar District, 1986.
them some person have been died. During last 3 months of 1989 (January-March), there are 56 cases registered, out of them 8 persons has died due to meningitis (Naiduniya, 4.4.89).

Cholera, typhoid and paratyphoid, and dysentery are common diseases caused by water pollution in Sagar district. There are 34,512 cases of above diseases recorded in study area, out of them 75.46 per cent cases of dysentery and embolisis and 23.46 per cent cases of typhoid and para-
typhoid.

Dysentery is common water borne disease in study area due to protozual contaminants : water bodies. Dysentery disease highly occur in Sagar district due to greater protozual concentration in drinking water bodies and even some time rural areas population use water from ponds for drinking purposes. There are 26,046 cases of dysentery reported in Sagar district which are nearly 14.66 per cent of total water borne diseases. Actually this disease is common and it is observed that percentage of dysentery disease not less than 30 or more, because generally population of the district take it too easy and they avoid going to hospital for treatment, and in urban areas most of the population have started self medication or visit private doctors. In Bina centre there are 970 cases of this disease recorded in only one private clinic during 1988. It is also observed this disease is more common in monsoon season. Dysentery is common in rural areas there are 85.05 per cent
cases of this disease reported in only 10 Primary Health
Centres (PHC) and mini primary health centres such as Deori,
Rahatgarh, Gourjhamar, Sanodha, Bunnad, Surkhi, Dhana,
Garhakota, Malthone and Rehli. Out of them more than 30 per
cent cases of district have been registered in Deori PHC
during the year 1986. In Malthone PHC 1,600 cases were
reported in the year 1986. The problem became serious in
August 1988, when 60 persons of Barodiyakala and Madkhera
villages of Malthone PHC seriously suffered from dysentry
due to consumption of polluted water from various sources, and
out of them four persons were reported to have died (Naiduniya,
August 30, 1988). At Teela village of Sagar tahsil and some
other villages such as Bandri, Pithoriya, Rajvans, Vidvasan,
Bannora suffered from serious water shortage and population
used much polluted water for drinking purpose and therefore
many persons got sick, out of them 14.28 per cent were
reported to have died (Naiduniya, April 21, 1988). It also
observed that dysentry is much common disease in University
hostels especially in rainy season. In the study area there
are nearly 21,000 cases of infective digestive system are
registered which is second important effect of water pollution
because it is nearly 15.22 per cent of the total water borne
diseases in Sagar district. Deori has highest number of
dysentry patients with 15.21 per cent cases registered.
Moreover, 10.9 per cent similar cases have been registered
in the District Hospital Sagar.

Contaminated water infects kidney seriously. Actually
due to use of pesticides for agriculture arsenic contaminated received in both surface and ground water bodies, which is major cause of kidney infections (National Research Council, 1979, p. 84), which is also carcinogenesis (IARC, 1976). In Sagar district nearly 4,532 cases of kidney infections were reported in various health centres, out of them highest 29.67 per cent cases recorded in Banda Primary health centres and 18.02 per cent recorded in Sagar city dispensary. Arsenic contaminated water also effects liver organ (National Research Council, 1979, p. 415). There are 130 cases of liver diseases reported in the Sagar district.

There were 18,514 persons suffering from skin infection in 1986. It is also observed that children in rural areas bathe in ponds or any small storage tanks of rainy water mainly suffered from skin disease. During the survey of Khurai urban centre it has been observed that nearly 1000 children of poor families used to take their bath in Khurai lake and into "Dohela" every day, out of them nearly 40 per cent well suffering from eczema and other skin diseases. In Mandi Bamora nearly 15 per cent children suffered with eczema, who use to take bath in a small tank of the village. Cholera, malaria, typhiod and paratyphoid are other important water borne diseases. In the study area contaminated shallow well water is main source of transmission of cholera. Drinking polluted water also causes typhoid, which give fever, headache and abdominal pains (Benenson, 1975, p. 413). Paratyphoid is another contaminated water disease.
In the study area, these diseases are common, there are 8,466 cases registered in various health centres, out of them 36.14 per cent cases of typhoid and paratyphoid recorded in Deori primary health centre and 25.04 per cent in Dhana mini primary health centre. The maximum (72.11 per cent) cholera cases registered in Bannad Mini Primary health centre. Recently problem on account of these diseases related to water pollution has become serious in Banda and Shahgarh area of district. Nearly 25-35 patients daily suffered from typhoid, due to polluted drinking water (Naiduniya, 1988). Recently cholera disease had spread in the study area. In Sagar city, due to polluted water from small tank near bus stand, some settlement such as Krishnaganj, Lajpatpura, Brandavan Bag, Shukrawari and Shanichari cholera assumed epidemic proportion and many people were affected (Naiduniya, 1988). In Malthone Block, population of 8 villages viz. Barodiya Kalala, Ratanpur, Khoida, Gahmiriya, Palethni, and Beekore Dabdera suffered from this epidemic due to water pollution and nearly 10 per cent patient of this disease have died. It is also observed that cholera mainly occur in slums (Naiduniya, 1988). In some villages such as, Gugra, Shahgarh, Kandva, Jagthas, Dalpatpur, Tatkhara, Khejra, Manda, Todi, Baraytha, Padwar, Vijari, Nayakhera of Banda tahsil also suffered from Cholera and other infectious diseases due to water pollution, and many persons died (Naiduniya, 1988). Infectious diseases due to polluted water also spread in Bandri, Bidvasan, Ranjwans, and Bamnora
area and few persons died due to drinking polluted water (Naiduniya, 1988).

Diarrhoea is the main bacterial disease of district which is the result of water pollution. It is evident from the fact that highest number of cases of water borne diseases reported as diarrhoea disease. During the year 1986 about 40 thousand cases of diarrhoea have been reported which was 22.39 per cent of total water borne diseases of Sagar district, out of them Bina urban centre consists a higher proportion of this disease (27.34 per cent). In the rural area high percentage of diarrhoea cases are reported in Shahpur where it was 7.63 per cent of total district.

Malaria is another common water pollution's diseases of the study area. About 15,550 cases was reported in 1986, out of them 52.09 per cent recorded in the district hospital and city dispensary. Due to absence of sewerage system mosquito problem seriously occurs in Sagar city causing problem of Malaria in city as well as other study areas. In the year 1988 the problem became serious in some areas of the city such as Krishnaganj, Lajpatpura and Shanichari due to absence of sewerage (Naiduniya, 1988). In railway colony area of Bina mosquito problem also occurs seriously due to poor sewerage and accumulated polluted water near residential areas. In Banda and its nearby areas malarial problem also occur seriously due to contaminated water and mosquito in rough sewerages (Naiduniya, 1988). In the year 1987-88 District Malaria Department reported 4,657 cases,
out of them some patients died. It is also observed that problem becomes serious during moderate temperature prevalence (October–December), where 75.41 per cent cases of malarial were reported (Table 2.5).

Yet another water-borne disease is Gastroenteritis which is common in study areas. Vomiting, diarrhoea and fever are the symptoms of gastroenteritis. In the study area, the problem is becoming serious in Sagar city due to choking of sewerages (Naiduniya, 1988). In Banda tahsil's villages such as Gagra, Shahgarh, Kandwa, Baraytha, Naya-khera, Talkhera, Dalpatpur, Jagthar, Mamka, Todi, Padwar and some other villages suffering from gastroenteritis disease seriously, and nearly 50 patients died due to gastroenteritis and cholera (Naiduniya, 1988). During field survey of these villages, it has been observed that nearly 15 per cent patients go to other places of the district (mostly Damoh) for treatment therefore the actual data is not available in the district hospital records. Besides, the actual number of patient is much higher then hospital record, because tendency of doctors to keep best record, only serious cases of filariasis or its death are not registered in hospitals. Filariasis was only recorded in Shahpur primary health centre, where it was only 27 in year of 1986, but at present nearly 30 villages of Banda tahsil suffered from filariasis problem. Nearly 273 villages of this tahsil suffered from drinking water problem and water pollution problem (Naiduniya, 1988). About 4,141 cases were also reported of other
### TABLE 2.5
NUMBER OF CASES OF MALARIA DISEASE IN SAGAR DISTRICT 1987-88

<table>
<thead>
<tr>
<th>Month/Year</th>
<th>Number of cases</th>
<th>Per cent of the total diseases</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>62</td>
<td>1.33</td>
</tr>
<tr>
<td>May</td>
<td>136</td>
<td>2.92</td>
</tr>
<tr>
<td>June</td>
<td>189</td>
<td>4.05</td>
</tr>
<tr>
<td>July</td>
<td>257</td>
<td>5.51</td>
</tr>
<tr>
<td>August</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>September</td>
<td>622</td>
<td>13.34</td>
</tr>
<tr>
<td>October</td>
<td>365</td>
<td>7.83</td>
</tr>
<tr>
<td>November</td>
<td>1550</td>
<td>38.27</td>
</tr>
<tr>
<td>December</td>
<td>976</td>
<td>20.95</td>
</tr>
<tr>
<td>January</td>
<td>205</td>
<td>4.40</td>
</tr>
<tr>
<td>February</td>
<td>131</td>
<td>2.80</td>
</tr>
<tr>
<td>March</td>
<td>164</td>
<td>3.50</td>
</tr>
<tr>
<td></td>
<td>4657</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Source: District Malaria Department.

Bacterial water borne diseases out of them highest was in Sanodha (22.45 per cent), Shahpur (20.42 per cent), Rehli (18.35 per cent) and Chhulla (16.90 per cent).

Viral diseases especially viral hepatitis are significant water borne diseases, which developed in human body due to drink contaminated water. That is why number
of pneumonia and bronchities diseases is higher than influenza. There are 5,201 cases of pneumonia were recorded in 1986, out of this figure 30.83 per cent cases of influenza and pneumonia are recorded in Bannad rural area and 5.51 per cent cases of pneumonia recorded in Rahatgarh primary health centre. The particular number of bronchities are not available, but with Emphysema and asthma 20,509 cases are recorded in various health centres.

Fluoride from natural sources, an important ground water pollutable (National Research Council, 1974, p. 113), and human activities also contribute in its amounts in drinking water bodies, causing teeth diseases (The Times of India, 1987). There are 6,646 cases are reported in the study area, out of them 25.63 per cent cases are reported in Surkhi and in Gourjhamar mini primary health centres.

REFERENCES


National Research Council (1979) Geochemistry of water in Relation to Cardiovascular Disease, National Academy of Science, Washington, D.C.


President Science Advisory Committee (1965) Restoring the Quality of our Environment, Report of the Environmental Penel, Washington, D.C.


Singh, Pramod (1985) Environmental Pollution and Management, Allahabad, Chough Publications.


