

CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusions

Based on the results of data analyzed during both Phases of water quality monitoring (2001-02 and 2002-03) and presented earlier, the following conclusions are drawn:

- The results of water samples collected during Phase-I and Phase-II provided in general same findings however, some variations in percentage samples exceeding permissible limits for certain analysed parameters have been observed in some cities.
- Most of the drinking water samples in the surveyed cities are found fit for consumption with respect to physicochemical and aesthetic water quality parameters;
- Analysis of data indicates that the situation of drinking water quality due to bacterial contamination in the country is generally poor. In none of the cities all samples were safe from bacterial contamination. In some cities all the samples were found contaminated with coliform and E.Coli bacteria during Phase-I of water quality monitoring during 2001-2002. These cities are: Gujrat, Khuzdar, Loralai, and Ziarat. Cities with bacteriological contamination in 75-100 percent water samples are (in descending order of percentage samples found contaminated) Bahawalpur, Multan, Rawalpindi, Mardan, Sukkur, Faisalabad, and Hyderabad. Cities in the range of 50-74 percent contaminated samples include Islamabad, Peshawar, Karachi, Mangora, Sheikhpura, and Quetta.
- Similarly, during Phase-II, in none of the cities all samples were found safe in respect of bacterial contamination. However some improvement has been observed for few cities in terms of more safe samples specifically Islamabad, Rawalpindi, Gujrat, Faisalabad, Khuzdar, Sheikhpura and Peshawar in comparison to Phase-I. Whereas in some cases, the situation further deteriorated e.g. Gujranwala, Karachi and Hyderabad. This highlights the seriousness of bacterial contamination in the drinking water sources in the country. This may be due to many reasons including intermittent water supply, leakage of pipes, pollution from sewerage pipes (problem within the distribution system), and contamination of shallow water tables due to human activities. However some relative improvements in second phase of monitoring may mainly be attributed to the dissemination of the report's findings among water supply agencies and users as well.
- Excess of Arsenic and fluoride concentrations beyond safe limits in water are also a cause of major concern in some areas. For Arsenic these include (in descending order of percentage samples found with Arsenic contamination) Lahore, Multan, Bahawalpur, Sheikhpura, Gujranwala, Kasur and Sialkot. Low cost technologies for arsenic treatment have been introduced by the Council with collaborated efforts and which would soon be soon extended to the problem areas.
- For fluoride hazard in water, the cities are (in descending order of percentage sample found with fluoride contamination) Quetta (29%), Kasur (20%), Karachi (14%), Loralai (10%), Faisalabad (8%) and Bahawalpur (4%);
- Iron is another element, which was found in excess of safe limits in samples collected from some of the cities in Phase-I. These cities are (in descending order of percentage sample contaminated) Sukkur (75%), Bahawalpur (60%), Hyderabad (60%), Loralai (36%), Gujrat (33%), Multan (31%), Karachi (21%), Quetta (8%) and Lahore (6%).

However in Phase-II (2002-03), some changes have been observed. The cities exceeding recommended level for iron include Sialkot (30%), Sukkur (17%), Rawalpindi (13%), Khuzdar (13%), Gujrat (11%), Islamabad (11%), Mardan (8%) and Multan (6%);

- Nitrate (N) was not found to be a problem in any of the cities except Karachi where 4 percent samples were detected to have this parameter in excess of safe limits;
- Lead was also not found to be a problem in any of the cities except Rawalpindi and Gujranwala where 7% samples in each city were detected to have this parameter in excess of safe limits. However, presence of lead contents in the air may not be ignored especially for metropolitan cities like Karachi, Rawalpindi, and Lahore etc. needing air pollution investigations.
- Turbidity of water was another parameter, which was exceeding recommended levels in almost all the cities except Faisalabad, Kasur, Lahore, Sheikhupura, Sialkot, and Mangora. However in Phase-II (2002-2003), in some cities turbidity increased whereas in few cities no turbidity was found as compared to analysis of Phase-I. The cities where no turbidity was found include Islamabad, Rawalpindi, Lahore, Faisalabad, Sialkot, Mardan and Mangora whereas in remaining 14 cities turbidity was found with different levels.
- Other problem parameters detected in water samples are: (i) Sodium (exceeding safe limits in Faisalabad, Kasur, Sheikhupura, Sukkur, Gujrat, Bahawalpur, Gujranwala, Karachi, and Quetta); (ii) Sulfates (Faisalabad, Kasur, Bahawalpur, Sheikhupura, Peshawar and Quetta); and (iii) Total Dissolved Solids (Faisalabad, Kasur, Sukkur, Sheikhupura, Bahawalpur, Gujrat, Sialkot, Loralai, Quetta, Karachi, Peshawar, Gujranwala, Rawalpindi).

The details of major problem parameters in the surveyed cities are given in Table 6.1 showing percentage of samples exceeding their permissible guideline values in each city.

Table 6.1: Major Problem Parameters Detected in Water Samples of Surveyed Cities

S. #	City	Problem Parameters with Percentage Samples Exceeding Guidelines	
		Phase-I (2001-02)	Phase-II (2002-03)
1	Islamabad	Bacterial contamination (74) & turbidity (3.7)	Bacterial contamination (37), Iron (11)
2	Bahawalpur	Bacterial contamination (96), arsenic (60), iron (60), sodium (8), fluoride (4), Sulfate (12), turbidity (16), hardness (12) & TDS (16)	Bacterial contamination (68), arsenic (68), iron (4), sodium (8), fluoride (4), Sulfate (12), turbidity (31), hardness (8) & TDS (16)
3	Faisalabad	Bacterial contamination (79), fluoride (7), sodium (43), potassium (36), sulfate (36), hardness (21), taste (29) & TDS (43)	Bacterial contamination (38), fluoride (8), sodium (43), potassium (46), sulfate (46), hardness (23), taste (29) & TDS (50)
4	Gujranwala	Bacterial contamination (29), taste (14), arsenic (7), potassium (7) sodium (7), turbidity (7) & TDS (7)	Bacterial contamination (71), arsenic (43), sodium (7), & TDS (7)
5	Gujrat	Bacterial contamination (100), iron (33), turbidity (33), potassium (11), sodium (11), sulfate (11) & TDS (11)	Bacterial contamination (78), turbidity (33), potassium (11), iron (11), sodium (11), TDS (11)
6	Kasur	Bacterial contamination (40), odour (21), taste (10), arsenic (30), fluoride (30), sodium (30), potassium (20), sulfate (20), & TDS (30)	Bacterial contamination (40), turbidity (10), odour (21), taste (10), arsenic (40), iron (10), fluoride (20), sodium (30), potassium (20), sulfate (20) & TDS (30)
7	Lahore	Bacterial contamination (13), arsenic (31) & iron (6)	Bacterial contamination (37), and arsenic (100)
8	Multan	Bacterial contamination (87), arsenic (75), iron (31) & turbidity (6)	Bacterial contamination (69), arsenic (94), iron (6), turbidity (19)
9	Rawalpindi	Bacterial contamination (87), iron (7), turbidity & TDS (7)	Bacterial contamination (64), iron (13), TDS (7)
10	Sheikhupura	Bacterial contamination (55), arsenic (45), sodium (27),), hardness (9), sulfate (9) & TDS (18)	Bacterial contamination (27), turbidity (9), arsenic (64), sodium (27), hardness (9) sulfate (9), & TDS (18)
11	Sialkot	Bacterial contamination (40), odour, sodium (10), sulfate (10) & TDS (10)	Bacterial contamination (40), arsenic (10%), Iron (30), odour, hardness (10), & TDS (10)
12	Hyderabad	Bacterial contamination (73), turbidity (67), hardness (6), iron (60), odour, taste (25) and arsenic (7)	Bacterial contamination (100), turbidity (93), iron (7), odour, and taste (33)
13	Karachi	Bacterial contamination (61), iron (21), turbidity (11), fluoride (7) sodium (7), nitrate (N) & TDS (4)	Bacterial contamination (85), turbidity (64), fluoride (14), sodium (7), & TDS (8)
14	Sukkur	Bacterial contamination (84), iron (75), turbidity (58), sodium (25) & TDS (25)	Bacterial contamination (83), flouride (8), iron (17), turbidity (58), hardness (8), potassium (8), sodium (17) & TDS (33)
15	Khuzdar	Bacterial contamination (100) & turbidity (12)	Bacterial contamination (62), iron (13), turbidity (25)
16	Loralai	Bacterial contamination (100), fluoride (55), iron (36), turbidity (18), hardness (9) & TDS (9)	Bacterial contamination (80), fluoride (10), turbidity (30), hardness (10), & TDS (10)
17	Quetta	Bacterial contamination (50), fluoride (42), turbidity (16), iron (8), sodium (5), sulfate (8), hardness & TDS (13)	Bacterial contamination (45), fluoride (29), turbidity (8), sulfate (5), hardness (8), & TDS (8)
18	Ziarat	Bacterial contamination (100), turbidity (25), hardness (13), & fluoride (13)	Bacterial contamination (100), turbidity (43), hardness (13)
19	Mangora	Bacterial contamination (60)	Bacterial contamination (56)
20	Mardan	Bacterial contamination (84), turbidity (8) & hardness (8)	Bacterial contamination (75), iron (8),
21	Peshawar	Bacterial contamination (69), turbidity, hardness (8) & TDS (8)	Bacterial contamination (46), sulfate (8), hardness (8), & TDS (8)

6.2 Recommendations

There is no doubt that majority of the population of the country is exposed to the hazard of drinking unsafe and polluted water. As is evident from the data presented, the water supplies in all the surveyed cities, some of which are metropolitan and cosmopolitan with expected better delivery of civic amenities and service, are found microbiologically unfit for human consumption. It is therefore no surprise that the inhabitants of these cities frequently suffer from the incidence of waterborne diseases like Typhoid, Gastro-enteritis, Cholera, Hepatitis, *etc.* in the spread of which contaminated water has now been accepted as the main source. It also gives indications of the very serious extent of the problem that could be prevalent in much greater proportions in smaller towns and rural areas of Pakistan. So far as health concerns of citizens are concerned after bacterial contaminations, the other problem parameters, except for Arsenic, Fluoride, and Iron, are of minor significance. It is essential that solution should be found to ameliorate these problem areas by undertaking crash program.

Based on the data presented earlier, the following specific recommendations are made:

1. Water supply agencies not only in the surveyed cities but elsewhere in the country must ensure that the supply of water to the consumers is of safe quality particularly with respect to bacterial contamination. It is their civic duty to ensure that the water is given appropriate dose of chlorine and provided adequate contact time with maintenance of proper pH and reduction the turbidity of water to permissible limits by providing adequate filtration facilities;
2. A very effective and economical way to decontaminate bacterially affected water is ozonation. For this, the civic bodies and concerned agencies should be made to install ozonators on tube wells supplying drinking water to citizens;
3. The departments responsible for water supply in urban areas in particular should replace age-old leaking pipes in their water supply systems. These pipes are not only a source of wastage of scarce water but are also a major cause of bacterial contamination in the distribution system;
4. It should be mandatory on the agencies responsible to regularly monitor quality of water being supplied to the consumers through analysis done at their own laboratories or other accredited laboratories of repute;
5. Regular monitoring of all water resources and water points at the national level should be ensured to help identify problem areas, causes of contamination, and design a framework of corrective plans;
6. The National Drinking Water Quality Standards, promulgated by Pakistan Standards Quality Control Authority should be enforced immediately and made applicable to both private and public bodies and entrepreneurs in the Water Sector;
7. The public should be encouraged to periodically clean all domestic undergrounds and overhead tanks (cistern system) in their house. For this well-planned awareness campaigns should be initiated;
8. Lead absorbed by water bodies from atmosphere can be quite injurious to health. Use of lead free gasoline for vehicles should be encouraged in the country, particularly in those areas where surface water is the main source of drinking water like Karachi, Islamabad, and Rawalpindi to avoid contamination;
9. Most of the industries in the country are indiscriminately discharging harmful toxic elements into water bodies. The Environmental Protection Agency should become more

active and strictly enforce laws and regulations preventing industrial entrepreneurs from discharging their effluents directly into open water bodies and groundwater;

10. It has been observed that sub-standard chemicals containing impurities are used in water treatment plants. Such chemicals can produce different kinds of contaminants, causing health hazards. It is strongly recommended that strict quality control must be ensured in the treatment plants;
11. Alternate sources of water should be identified in areas where the quality of source of existing water supply is questionable. Examples for such cases are wells from which water with high concentrations of Arsenic is pumped for drinking purposes. There are reported cases of Arsenicosis from many areas in central Punjab and Sindh. These wells should be abandoned and new sources identified. Similarly there are other problem parameters as well;
12. Low cost household level water treatment technologies with low technical input to use them should be developed using indigenous material and expertise particularly for controlling and treating water with biological, arsenic, and fluoride contamination.
13. No new water supply scheme should be approved unless detailed investigations of water quality, quantity, possible sources of local contamination, and its sustainability have been carried out;
14. For effective awareness, educational institutions & mosques including mass media should be used for creating awareness about the importance of water quality among the users; and
15. Seminars and workshops should be frequently arranged to disseminate the findings of the water quality monitoring results.

The details regarding problem parameters, health effects and possible solution for the rectification for each city is shown at Annexure-I.