

1.1 Background

Arsenic testing of groundwater utilized for the purpose of drinking water is identified, as an important task due to its serious health effects. Two South Asian countries India and Bangladesh are facing arsenic contamination in their drinking water. Arsenic problem in Pakistan has recently surfaced as a result of field testing, firstly from an investigation on arsenic in ground water of Attock and Rawalpindi districts (2000) conducted through a joint study by Pakistan Council of Research in Water Resources (PCRWR) and United Nations Children Fund (UNICEF) and secondly from National Water Quality Monitoring Program (NWQMP) of PCRWR. The data collected from the Phase-I (2001-2002) of this program revealed the presence of arsenic more than 50 ppb in some locations/cities of Punjab particularly in Multan, Sheikhpura, Lahore, Kasur, Gujranwala and Bahawalpur. In some districts of Sindh, the arsenic contamination exceeded 200 ppb (Kahlowan, *et al.*, 2002). The situation became clear in these areas regarding the presence of arsenic in groundwater after the testing carried out by UNICEF.

In order to undertake further detailed testing in areas identified by UNICEF, a memorandum of understanding (MOU) was signed between PCRWR and UNICEF on 1st October, 2002. It was decided that 5 samples per village (at a distance of at least ½ km from each other) would be collected through field staff of Local Govt. from Bahawalpur, Rahim Yar Khan and Multan Districts. Among the aforementioned 5 samples, one sample per village was collected for PCRWR Laboratory at Islamabad to check the accuracy of kits with the help of Atomic Absorption Spectrometer. PCRWR was made responsible to analyze 2500 samples and to prepare a report based on the results of 12500 samples.

1.2 General Occurrence of Arsenic

Arsenic is the twentieth most common element in nature. It is widely distributed throughout the earth's crust and commonly found in the atmosphere, soils, rocks, organisms and in natural waters. Arsenic can combine with other elements to form inorganic and organic arsenic compounds. The inorganic arsenic appears in compounds with oxygen, sodium, potassium, copper, chlorine, iron and sulphur. Arsenic in plants and animals combines with carbon and hydrogen to form organic arsenic. Organic arsenic compounds that are found in foods are quite harmless and pass through the body quickly. Inorganic arsenic is more toxic. It is deposited in the body and gets concentrated overtime and cause long-term damage. Arsenic in general is said to be about four times as poisonous as Mercury (Aapo SaaK, 2001). Arsenic exists in oxidation states of -3, 0, 3 and 5. The trivalent arsenic As (III) is

considered 60 times more toxic than the pentavalent As (V). Arsenic is considered to be the most toxic form, followed by the arsenites (arsenic-III), the arsenate (Arsenic (V) and organic arsenic compounds. Arsenic occurs as a major constituent in more than 200 minerals including arsenic, arsenide, sulfides, oxides, arsenates and arsenites. Arsenic is used in semi-conductor manufacturing, petroleum refining, wood preservatives, animal feed additives and herbicides (Hungerford and Terry, 2003). Arsenic is mobilized in the environment through a combination of natural processes such as weathering reaction, biological activities and volcanic emissions as well as through a range of anthropogenic activities.

1.3 Objectives

General objective of the study was to evaluate the quality of drinking water in Southern Punjab. The specific objectives of the study were:

- i) To identify arsenic contamination in groundwater of Bahawalpur, Rahim Yar Khan and Multan districts.
- ii) To assess the possible health effects of higher concentration of arsenic and develop guidelines for arsenic contamination's threshold values in Pakistan.
- iii) To recommend the remedial measures and formulate a strategy to develop low cost arsenic removal technologies.

1.4 Project Area Description

1.4.1 Bahawalpur District has an altitude of 400 ft. covering an area of 24,830 Sq. Km. The district consists of six tehsils namely Hasilpur, Bahawalpur, Khairpur Tamewali, Ahmedpur East and Yazman with a total population of about 2.5 million. Bahawalpur was formally the capital of the state and now is the district and divisional headquarters of Bahawalpur division. The district is also an important marketing centre for the surrounding areas which is located on the cross road of Peshawar, Lahore, Quetta and Karachi. East of the Bahawalpur is the Cholistan desert, which covers an area of about 16,000 Sq. Km. and extends to the Thar desert of India.

1.4.2 Rahim Yar Khan District is located in the south of Punjab. According to 1998 census, Rahim Yar Khan has a population of about 3.15 million with an area of 11,880 Sq. km. It has four tehsils namely Khanpur, Liaquatpur, Rahim Yar Khan and Sadiqabad. Rahim Yar Khan District lies between 27°-40' to 29°-16' north latitudes and 60°-45' to 70°-01' east longitudes. The climate of the district is hot and dry in the summer and cold and dry in the winter. Canals and the tube wells are the main water sources followed by wells. The average rainfall is about 100 millimeter. The district is divided into three main physical features i.e.

- i) Riverine area
- ii) Canal irrigated area
- iii) Desert area, which is called Cholistan.

1.4.3 Multan District with an area of about 5,630 Sq. Miles lies between north latitude 29°-22' and 30°-45' and east longitude 71°-4' and 72°-4-55'. It is located at 215 meter (740 ft) above sea level. Multan has five tehsils, Multan City, Multan Saddar, Shujaabad and Jalalpur Pirwala. Topographical view indicates the Multan as plain ground dissected by rivers, canals and narrow water channels. Multan Division is located in a bend created by five confluent rivers. The Scuttle separates it from Bahawalpur district and the Chenab from Muzaffargarh district.