RAPID ASSESSMENT OF DRINKING-WATER QUALITY IN THE REPUBLIC OF TAJIKISTAN

COUNTRY REPORT

RAPID ASSESSMENT OF DRINKING-WATER QUALITY IN THE REPUBLIC OF TAJIKISTAN

COUNTRY REPORT OF THE PILOT PROJECT IMPLEMENTATION IN 2004-2005

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Foreword

Among the infectious diseases, diarrhoeal diseases are the second major cause of death, killing an estimated 2.2 million people annually, the vast majority children in developing countries. In 2000, heads of state adopted the Millennium Development Declaration at a special session of the United Nations General Assembly, and this led to the universal adoption of eight Millennium Development Goals (MDGs). One of the targets under MDG 7, environmental sustainability, is to halve, by 2015, the proportion of people without sustainable access to safe drinking-water and basic sanitation; this target links to targets under MDGs 4, 5 and 6 (the so-called "health MDGs" –reduction of child mortality, improvement of maternal and child health and reduction of the burden of HIV/AIDS, malaria and tuberculosis-) in that it creates the basis for sustained progress in the overall reduction of the burden childhood illness.

Since 2000, the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation (JMP) is the formal instrument to measure progress towards achieving MDG 7 target C. The JMP builds on monitoring experience gained during the International Drinking Water Supply and Sanitation Decade of the 1980s. In 2000 it took a major methodological departure from its past practice, and started to base its estimates on household surveys and censuses. The definitions of drinking-water and sanitation facilities are categorized as "improved" and "not improved". This refers to the probability that "improved" water sources give access to safe drinking-water and that improved sanitation facilities effectively separate human waste from drinking-water sources.

The JMP statistics on water and sanitation do not, however, provide specific evidence about the quality of water being provided to communities, households and institutions through direct measurements; so far, in these statistics, the safety of the drinking-water can only be inferred. There is, therefore, an urgent need to obtain independently verifiable water-quality data, using reliable, low-cost methods that ideally can be correlated with the datasets on access obtained through the household surveys and censuses. On the basis of such data, governments will be able to make informed decisions to further improve the situation with respect to drinking-water supply in their countries, actions to accelerate progress towards achieving MDG 7 target C can be better targeted and the evidence base on the correlation between lack of access to safe drinking-water and the burden of water-borne disease will be further strengthened. The data are also expected to reveal the extent of major water-quality problems at national, regional and global levels and inform future investment priorities.
A possible method to obtain the data on drinking-water quality could be a rapid, low-cost, field-based technique for assessing water quality. As a result, at a consultative meeting in Bangkok in 2002 organized by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) six countries were selected to implement pilot projects on the Rapid Assessment of Drinking-Water Quality (RADWQ). The countries were China, Ethiopia, Jordan, Nicaragua, Nigeria and Tajikistan.

The project was initiated in Tajikistan in June 2004 with the collection of statistical data needed to develop the survey. To plan and oversee the project, a project steering committee was established, made up of representatives of government institutions (Ministry of Health, Ministry of Melioration and Water Resources, and the State Committee for Environmental Protection), the State Statistics Committee, UNICEF and WHO. The Republican Sanitary Epidemiological Service (SES) was designated by the Ministry of Health as the lead agency for implementing the RADWQ project in Tajikistan. Dr Samaridin Aliev, Chief Doctor of the Republican SES, was appointed national project coordinator and Dr Pirnazar Shodmonov, Head of the Sanitary Department at the Republican SES, as his deputy.

International consultants provided the training on survey methodology, field implementation, use of the field-test equipment and sanitary inspection methods during September 2004. Between October 2004 and April 2005 1780 water samples were taken in the four oblasts (i.e. regions)of Tajikistan that were visited. A final review meeting was organized in Dushanbe during a second consultants' visit in November 2005. At the meeting, the results of the RADWQ survey were shared and recommendations made as to how to improve the RADWQ methodology, these recommendations are included in this current report.

Acknowledgements

The RADWQ project involved years of planning, months of fieldwork, and weeks of data entry and analysis. Successful project implementation would not have been possible without the hard work and dedication of project coordinators, international consultants, statistical experts, field teams, drivers and data-entry clerks, and the support of various individuals. Special thanks are due: to the heads and personnel of the oblast and district SES, as well as to the operators of water supplies visited during the survey, for their collaboration and advice to the field teams on the regional and local level; to all members of the field teams for their continuous and dedicated work under sometimes challenging field conditions; and to Mr Gulom Erdanov for maintaining the accuracy of the SanMan database. Thanks are also due to Ms Yukie Mokuo, Mr Murat Sahin, Mr Ikram Davronov and Ms Nargis Babakhanova, all of UNICEF Tajikistan, for their continuous support throughout project; and to Mr Michael Jackman for conducting the trainings. Finally, the financial support received from the Department for International Development/UKAID of the United Kingdom is gratefully acknowledged.

Acronyms

GBAO	Gorno-Badakhshan Autonomous Oblast
JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation
RADWQ	Rapid Assessment of Drinking-Water Quality
RRS	Rayons under direct Republican Subordination
SES	Sanitary Epidemiological Service
UNICEF	United Nations Children’s Fund
WHO	World Health Organization

Executive summary

During 2004 and 2005 the Republic of Tajikistan and five other countries participated in a World Health Organization/United Nations Children's Fund (WHO/UNICEF) pilot project to test a rapid, low-cost, field-based technique for assessing water quality. The project was named the Rapid Assessment of Drinking-Water Quality (RADWQ), and its purpose was to develop a tool that would help the WHO/UNICEF Joint Monitoring Programme monitor global access to safe drinking-water. The RADWQ methodology is based on the UNICEF Multiple Indicators Cluster Surveys and uses cluster sampling across a country to select individual drinking-water sources for testing. The number and types of parameters used to test the drinking-water sources will depend on the extent of the survey and on local potential health hazards. The output of a RADWQ survey is a snapshot of drinking-water quality for each improved source tested.

In Tajikistan, four field teams visited 1620 sample sites in 53 clusters over a period of six months (from October 2004 to April 2005). The samples were taken from four broad areas (Khatlon; Rayons under direct Republican Subordination (RRS) & Dushanbe; Sughd; and Gorno-Badakhshan Autonomous Oblast), and from two improved water-supply technologies (utility piped supplies and protected springs). Using portable field kits, water samples were analysed for the following parameters: thermotolerant coliforms, faecal streptococci, pH, turbidity, residual chlorine, appearance, conductivity, arsenic, nitrate, fluoride and iron. In addition, samples were taken from 160 households (or ca. 10% of the total sample size), to analyse the deterioration of water quality during distribution and storage.

The results of the RADWQ project in Tajikistan show that the microbiological and chemical quality of water sources is generally high. Of the 1620 sites tested, 87.2% complied with the WHO guideline value and the national standard for thermotolerant coliforms, with utility piped supplies showing slightly better compliance than protected springs (88.6% versus 82.0%). The RADWQ results do not match those coming out of national surveillance statistics for bacteriological parameters in 2003 and 2004, which found that only 69.0% and 66.5% of utility piped systems met the national standard, respectively.

All sample sites in the broad areas visited were in compliance with WHO guideline value and national standards for arsenic and nitrate, regardless of technology type used at the site. The maximum concentrations of nitrate and arsenic measured were 22.8 mg/l and <10 µg/l, respectively, which were consistent with data from the Tajik surveillance system. For fluoride, 99.7% of the sites were in compliance with the WHO guideline value of 1.5 mg/l, but only 73.8% with the national drinking-water standard of 0.7 mg/l. The highest fluoride concentrations were detected in Sughd, which not surprisingly had the lowest compliance level of all the oblasts (51.9%). The maximum fluoride concentration measured was 1.95 mg/l, and the median 0.50 mg/l. If the arsenic, fluoride and nitrate results were included with the microbiological results in the RADWQ analysis, overall compliance for water sources in Tajikistan was 86.9% and 65.9% for WHO guideline values and national standards, respectively.

1 Introduction

1.1 The WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation

In 1990, at the end of the International Drinking Water Supply and Sanitation Decade, WHO and UNICEF decided to combine their experience and resources in a Joint Monitoring Programme for Water Supply and Sanitation (JMP). At its inception, the overall aim of the JMP was to improve planning and management of the water supply and sanitation within countries by assisting countries in the monitoring of their drinking-water supply and sanitation sector. This concept, and the associated objectives, evolved over time. The Millennium Declaration in 2000 and the subsequent formulation of targets under the Millennium Development Goals (MDGs) marked a fundamental change. As the official monitoring instrument for progress towards achieving MDG 7 target C, the JMP prepares biennial global updates of this progress. Prior to 2000, JMP assessments had been undertaken in 1991, 1993, 1996 and 2000. The results for the year 2000 survey are presented in *Global water supply and sanitation assessment 2000 report* (WHO/UNICEF, 2000), which contains data for six global regions: Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania. This report introduced a monitoring approach based on household surveys and censuses which has subsequently been refined. The methods and procedures lead to an estimate of numbers of people with access to improved water sources and improved sanitation. Since the 2000 report, five more JMP reports have been published. The latest, published in March 2010, shows that by the end of 2008 an estimated 884 million people in the world lacked access to improved sources of drinking-water and 2.6 billion people lack access to improved sanitation facilities. If the current trend continues, the MDG drinking-water target will be exceeded by 2015, but the sanitation target will be missed by about 1 billion people (over and above the 1.7 billion who would not have access even if the target were achieved).

In the past, the JMP drew guidance from a technical advisory group of leading experts in water supply, sanitation and hygiene, and from institutions involved in data collection and sector monitoring. With the formulation and adoption of the JMP Strategy for 2010-2015, this technical support structure will be further strengthened. The JMP strategy further states the vision and mission of the JMP as, respectively: *To accelerate progress towards universal, sustainable, access to safe water and basic sanitation by 2025*[1]*, including the achievement of the MDG targets by 2015 as a key milestone* and *to be the trusted source of global, regional and national data on sustainable access to safe drinking-water and basic sanitation, for use by governments, donors, international organizations and civil society.*

To fulfil its mission, the JMP has three strategic objectives:

- to compile, analyse and disseminate high quality, up-to-date, consistent and statistically sound global, regional and country estimates of progress towards internationally established drinking-water and sanitation targets in support of informed policy and decision making by national governments, development partners and civil society;
- to serve as a platform for the development of indicators, procedures and methods aimed at strengthening monitoring mechanisms to measure sustainable access to safe drinking-water and basic sanitation at global, regional and national levels;
- to promote, in collaboration with other agencies, the building of capacity within government and international organizations to monitor access to safe drinking-water and basic sanitation.

These priorities translate into four strategic priorities for the JMP over the next five years:

- maintaining the integrity of the JMP data base and ensuring accurate global estimates:
- dissemination of data to sector stakeholders;
- fulfilling JMP's normative role in developing and validating target indicators;
- interaction between countries and the JMP

The JMP defines access to drinking-water and sanitation in terms of the types of technology and levels of service afforded. The JMP definitions used at the time of this study are shown in Table 1.1, while current definitions can be found on www.wssinfo.org .

Table 1.1 **JMP definitions of water supply and sanitation (2004)**

Category	**Water supply**	**Sanitation**
Improved	• Household connection • Public standpipe • Borehole • Protected dug well • Protected spring • Rainwater collection	• Connection to a public sewer • Connection to septic system • Pour-flush latrine • Simple pit latrine • Ventilated improved pit latrine
Unimproved	• Unprotected well • Unprotected spring • Vendor-provided water • Bottled water[a] • Tanker truck-provided water[b]	• Service or bucket latrines (where excreta are manually removed) • Public latrines • Latrines with an open pit

[a] Normally considered to be "unimproved" because of concerns about the quantity of supplied water.
[b] Considered to be "unimproved" because of concerns about access to adequate volumes, and concerns regarding inadequate treatment or transportation in inappropriate containers.

The JMP database is the source for WHO and UNICEF estimates on access to and use of drinking-water and sanitation facilities. At the time of the RADWQ pilot studies the database drew upon some 350 nationally representative household surveys, but the database has rapidly expanded and by the beginning of 2010 contained over 1200 such datasets. The data come from household surveys and censuses, including the Demographic Health Survey, the UNICEF Multiple Indicators Cluster Surveys, the World Bank Living Standard Measurement Survey and the World Health Survey (by WHO). These are national cluster sample surveys, covering several thousand households in each country. The samples are stratified to ensure that they are representative of urban and rural areas of each country.

Prior to 2000, coverage data were based on information from service providers, such as utilities, ministries and water authorities, rather than on household surveys. The quality of the information thus obtained varied considerably. Provider-based data, for example, often did not include facilities built by householders themselves, such as private wells or pit latrines, or even systems installed by local communities. For this reason, in 2000, JMP adopted the use of household surveys, which provide a more accurate picture by monitoring the types of services and facilities that people actually use.

Information collected by the JMP is analysed and presented for dissemination in the form of maps and graphs, which can be found, together with other information, on the JMP web site www.wssinfo.org.

Although the use of household surveys and the presentation of data by drinking-water and sanitation ladders and wealth quintiles have significantly increased the quality and comparability of information on improved drinking-water sources and sanitation, there continues to be room for further improvements in the JMP database so it will be even more useful to policy-makers by:

- *Harmonizing indicators and survey questions*. Surveys use different indicators and methodologies, making it difficult to compare information. A guide that harmonizes questions and response categories for drinking-water supply and sanitation, *Core questions on drinking-water, sanitation and hygiene for household surveys* (WHO/UNICEF, 2007), has been prepared and is regularly updated. On-going discussions aim to incorporate updated and new questions into major household survey programmes and population censuses. Currently, the Demographic Health Survey, the Multiple Indicators Cluster Surveys, and the World Health Survey have all adopted the harmonized set of questions for their surveys.

- *Measuring gender disparities*. Data on water and sanitation are collected at the household level and therefore gender-specific data cannot be calculated. However, questions can be designed to determine who bears the main responsibility for collecting water and how much time is spent collecting it. Questions along these lines are being incorporated into the design of new surveys.
- *Measuring water quality*. Existing surveys do not provide reliable information on the quality of water, either at the source or at the household level.

In response to the third challenge, WHO and UNICEF, with the support of the Department for International Development of the Government of the United Kingdom, developed a method for the rapid assessment of drinking-water quality. Pilot studies using the method, referred to as RADWQ (rapid assessment of drinking-water quality), have been carried out in China, Ethiopia, Jordan, Nicaragua, Nigeria and Tajikistan. The six pilot countries represent different regions of the world with a range of environmental and socio-economic conditions, presenting different water quality issues and at various stages of development.

At the conception of the RADWQ pilot studies it was foreseen that the methodology, if proved feasible and successful, could be of value to many countries as a vehicle for building capacity in water quality monitoring at policy, institutional and technical levels. The direct involvement of water authorities and national experts in the studies was also expected to enhance a sense of ownership. Countries could benefit from RADWQ surveys by using the data to create a baseline for future monitoring programmes (e.g. post-2015); for external evaluations; to assess the drinking-water quality in specific geographical areas; or to assess a specific drinking-water supply technology. The RADWQ approach would also provide the international community with the tools to measure improvements in access to safe drinking-water worldwide.

1.2 Historical water-quality data, the current water-quality surveillance/monitoring system and national standards in Tajikistan

The Republican Sanitary Epidemiological Service (Republican SES), the central public-health surveillance agency under the Ministry of Health of Tajikistan, provided the information on water supply coverage and drinking-water quality for the RADWQ project. The Republican SES collects all information from the regional (or oblast) SESs in the oblasts of Khatlon, Sughd and Gorno-Badakhshan Autonomous Oblast (GBAO), as well as directly from the district (or rayon) SESs in those rayons that are under direct republican subordination (known as RRSs).

Types of water-supply technologies and coverage

A summary of the types of water supply technologies used in the different oblasts and the population coverage rates is given in Table 1.2. According to Republican SES statistics, at the time of the study approximately 58% of the total population was served by utility piped water supplies, but coverage for urban populations (99%) was much higher than for rural ones (30%). People without utility piped supplies rely on water from more-or-less protected point sources, such as boreholes, shallow wells, and springs (ca. 13%), or from open sources (25.8%) such as small canals (“ariks”), irrigation channels, rivers, lakes and transported water (2.4%), without any treatment prior to consumption.

In addition to the information shown in Table 1.2, a rayon database of springs and utility piped supplies was compiled for the RADWQ project, which detailed the number of supplies in a rayon as well as the population served by technology (see Annex 1). A detailed inventory of utility piped supplies was also available that included information on the maximum serving capacity (expressed as the number of people served) and the current working condition of an individual supply (see Annex 2).

Table 1.2 **Water-supply coverage for Tajikistan, by technology and oblast**[a]

Region (oblast) [b]	Total population (*N*)	Utility piped supplies (%)	Boreholes (%)	Shallow wells (%)	Springs (%)	Transported water (%)	Open sources (%)
Dushanbe	641 075	98.0	0.0	0.0	0.2	0.8	1.0
RRS	1 467 524	47.7	0.3	1.1	21.2	1.1	28.4
Khatlon	2 308 675	50.3	0.0	5.0	6.5	4.6	33.6
Sughd	1 973 890	67.1	3.8	1.0	6.0	0.9	21.0
GBAO	205 302	17.1	0.4	1.6	25.3	8.2	47.3
National	6 596 466	58.4	1.2	2.3	9.6	2.4	25.8

[a] Source: Republican Sanitary Epidemiological Service records for 2003 and 2004.
[b] GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = Rayons under direct republican subordination.

On the basis of the inventory, it is estimated that at the time of this study approximately 22% of the 650 utility supplies were currently not working (i.e. they are not supplying the population with drinking-water), mainly as a result of the civil war during the 1990s and the lack of maintenance. When the working condition of individual supplies is taken into account, Republican SES estimates indicate that only 42% of the population is served by utility supplies, in contrast to the official figure of 58.4%(Table 1.2). Experience suggests that, of the population without access to utility supplies (officially 42% of the total population of Tajikistan) most use open, non-protected sources for their water supply.

Water-treatment works of urban piped supplies are generally better equipped, maintained and operated than rural supplies. This is particularly true with respect to the availability of functioning disinfection units Financially constrained rural supplies frequently do not have sufficient stocks of disinfectant (i.e. chlorine or hypochlorite). Water disinfection therefore is a rare practice and often applied only during and after outbreaks of intestinal infectious diseases. In most utilities, disinfection is carried out by dosing the water with dry chlorine, which is a low-cost method. It is estimated that more than 70% of the water distribution network in Tajikistan is in poor condition due to the lack of regular maintenance, low water pressure and frequent pipe breaks.

Surveillance and monitoring of water quality

The main responsibility for independent surveillance and monitoring of drinking-water quality rests with the SES at different administrative levels, according to the Tajik *Water code (2000)*. Rayon and municipal SESs are responsible for surveying the supplies in their areas, while oblast SESs also monitor water quality to provide a backup source of data to the SES measurements. The operators of utility piped supplies (e.g. “Vodocanal” agencies, rural water works, municipalities, government departments) have the responsibility to inspect the water production process and monitor its impact on water quality. The State Committee for Environmental Protection is responsible for monitoring open water sources such as rivers, canals, *ariks* and lakes.

The parameters and frequencies of water-quality monitoring for the operators and rayon SESs are defined by the Soviet Standard GOST 2874-82 *Drinking water* (see below) and the sanitary norm *Provision of sanitary epidemiological safety to the population (2003)*. The monitoring frequencies can differ, depending on the parameter being measured, the type of water source, the population served, and whether disinfection is applied. The list of legally defined parameters in the GOST standard is even longer than, for example, that provided by the European Union Drinking-water Directive, but as a practical matter regular water quality monitoring in Tajikistan currently focuses on the following basic set of parameters:

- *Microbial parameters.* This involves taking heterotrophic plate counts, as well testing for indicator organisms such as *Escherichia coli* ("coli index") and faecal streptococci. Further investigations of specific pathogenic organisms are carried out as necessary.
- *Physical and chemical parameters*. This involves measuring basic water quality and organoleptic parameters (e.g. taste, odour, colour, turbidity, pH, temperature, residual chlorine), as well as levels of selected potentially toxic chemicals such as nitrates, various metals, chlorides, sulfates, iron, copper and fluoride.

At the time of this study, many laboratories were unable to follow standard procedures for water quality sampling and analysis, owing to a lack of financial, technical and trained human resources. Although the laboratories of the Republican and oblast SESs had basic equipment for water quality analysis, most of the equipment in the rayon SESs was outdated or did not work. Most of the rayon laboratories lacked adequate transportation, communication equipment and staff trained in water quality sampling and analysis. For these reasons, the ability and capacity of the rayon labs to carry out water quality analysis in rural areas was generally limited, and thus most of the current water quality data for Tajikistan focused on utility piped supplies in urban centres. The overall situation made it difficult to survey and monitor drinking-water quality independently, to prevent infectious disease outbreaks and to improve sanitary conditions.

The responsibility for sanitary inspections belongs, by law, *Provision of sanitary epidemiological safety to the population (2004),* to the rayon SESs. Surveillance is to be carried out by "preventive" and "scheduled" sanitary inspections. During the design, construction and commissioning of a water supply, for example, regular inspections are carried out to prevent the development of conditions that would lead to poor sanitary conditions. Regularly scheduled sanitary inspections are to be undertaken quarterly to assess the sanitary condition of a water supply during operation. Currently, most rayon SESs are not in a position to carry out any sanitary inspections, mainly owing to a lack of staff (i.e. sanitary doctors) and transportation.

The main responsibility for data collection, storage and analysis belongs to the SESs at the different administrative levels (i.e. oblast SESs collect information from rayon SES, and the Republican SES collects data from oblast SESs). All records are generally handwritten and stored as paper files, which are often lost owing to improper storage. The lack of electronic equipment, particularly at the rayon and oblast level, makes data analysis difficult and time consuming. It is impossible to establish an electronic database, for example, which means that the paper information can only be accessed by personnel in the government agency dealing with water quality issues. Currently, there are no plans to share the information with the general public through the mass media (such as the internet) because the technical facilities do not exist.

Historical water-quality data

In recent years, drinking-water quality in Tajikistan has been deteriorating. Many of the utility piped supplies break down frequently and service can be intermittent; both phenomena adversely affect the microbial content of the drinking-water. The extent of the problem can be seen from the data in Table 1.3 for utility piped water supplies during the years 2001–2004. In 2004, for example, 33.5% of the water quality samples tested did not meet the national standard for *E. coli*.

The deterioration in the chemical quality of water has been mainly attributed to a decline in source protection measures and sanitary conditions. In 2004, for example, 46% of water samples tested did not comply with national standards for one or more of: residual chlorine, nitrate, sulfate, ammonia, hardness and metals (Table 1.4).

In 2001, the Republican SES, with support of the WHO and the Federal Environmental Agency, Germany, carried out a countrywide survey to assess the level of organochlorine insecticides in Tajik drinking-water sources (Schmoll, 2002). Historically, the country witnessed an intense use of pesticides, particularly in cotton growing areas, but in the 1990s there was a sudden drop in pesticide use. However, no current data were available on pesticide levels in Tajik groundwater and surface waters used for drinking-water. The Republican SES study showed that insecticide contamination was widespread, with 86% of the 110 sites investigated having concentrations of one or more substances above the detection limit. However, insecticide levels were generally below the WHO guideline values, except at one site where one parameter exceeded the WHO guideline value.

Table 1.3 Noncompliance of water samples in Tajikistan with national standards for *E. coli*, 2001–2004[a]

Region (oblast) [b]	2001		2002		2003		2004	
	No. of tests	Non-compliance (%)	No. of tests	Non-compliance (%)	No. of tests	Non-compliance. (%)	No. of tests	Non-compliance (%)
Dushanbe	n/a	n/a	3 249	22.0	3 305	19.7	3 517	23.8
RRS	563	16.7	227	34.4	253	24.9	3 655	23.2
Khatlon	n/a	n/a	5 827	64.0	5 789	46.8	8 000	46.8
Sughd	1 843	18.7	2 682	19.6	2 702	12.7	2 459	19.6
GBAO	n/a	n/a	n/a	n/a	243	16.9	33	27.3
National	2 406	18.2	11 985	42.5	12 295	31.0	17 664	33.5

[a] Source: Republican Sanitary Epidemiological Service records.
[b] GBAO = Gorno-Badakhshan Autonomous Oblast. n/a = data not available. RRS = rayons under direct republican subordination.

Table 1.4 Noncompliance of water samples in Tajikistan with physical and chemical national standards, 2004[a]

Region (oblast) [b]	No. of samples	Noncompliance (%)
Dushanbe	2 878	58.0
RRS	378	18.0
Khatlon	996	69.7
Sughd	1 155	6.8
GBAO	66	28.8
National	5 473	46.2

[a] Source: Republican Sanitary Epidemiological Service records. Noncompliance is for one or more of residual chlorine, nitrate, sulfate, ammonia, hardness and metals.
[b] GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = Rayons under direct republican subordination.

National drinking-water standards

At the time of the RADWQ study, national sanitary norms and regulations for drinking-water quality were being developed. Examples include defining norms for water quality monitoring in centralized and non-centralized water supply systems, and setting up administrative zones to protect water sources. A draft of a national law on drinking-water had been developed, and it was under government review. Generally, the development of legal and normative documents on drinking-water supply and quality is the responsibility of the Republican SES, operating under the Ministry of Health. In the absence of a national drinking-water law, the 1982 Soviet Standard GOST 2874-82 *Drinking-water* is still the valid legal reference in the Republic of Tajikistan (see Annex 3 for standard values of parameters included in the RADWQ project).

It worth mentioning that this is only the beginning of the process to develop and harmonize the national water sector and substantial work continues to be anticipated, requiring financial, technical and consultative support, both from national institutions and international organizations.

2 Methods

2.1 Survey design

The methodology for the RADWQ pilot project is detailed in the handbook, *Rapid assessment of drinking-water quality: a handbook for implementation* (Howard et al., 2003). In essence, the method involves selecting representative sampling points using a statistically-based survey; analysing the water quality for a suite of parameters; carrying out sanitary inspections at the selected sampling points; analysing the data and its relation to historical data; and making conclusions and recommendations. There are six countries in the pilot study and data from each will be presented in individual country reports (of which this is one) and in an overall summary report.

The survey design selected for the RADWQ project uses a cluster sampling approach to identify the number, type and location of water supplies to be included in the assessment. Cluster sampling means that the water supplies selected for inclusion in the assessment are geographically close to one another (in "clusters"), but are representative of all water-supply technologies. This approach was selected for RADWQ as it is used in other international surveys addressing water, sanitation and health (such as the Multiple Indicator Cluster Survey) that contribute to the WHO/UNICEF JMP. In addition, cluster sampling improves the efficiency of the assessment by making access to the water supplies easier and by reducing costs.

The key element of the survey design is to ensure that the selection of the water supplies to be included reflects their importance; therefore only improved technologies supplying more than 5% of the population are included. The basic sampling unit is the water supply, rather than the households that use them. The rapid assessments are primarily designed to assess the quality and sanitary condition of the water supplies and hence the risk to water safety. A limited analysis of water stored in households, matched to water sources, is included in the assessment.

The number of water samples to be taken was calculated using Equation 2.1:

$$n = \frac{4P(1-P)D}{e^2} = \frac{4*0.5(1-0.5)*4}{0.05^2} = 1600 \qquad \text{(Equation 2.1)}$$

n = required number of samples;
P = assumed proportion of water supplies with a water quality exceeding the water-quality target(s) established;
D = design effect;
e = acceptable precision expressed as a proportion.

For the RADWQ pilot project, the proportion was assumed to be 0.5, with a precision of ±0.05 and a design effect of 4. This gave the number of water supplies to be included within each country assessment as 1600 (Equation 2.1). The steps of the rapid assessment are summarized in Figure 2.1 and the steps in survey design are summarized in Figure 2.2. The range of parameters tested and the inspections undertaken are shown in Table 2.1.

2.2 Country-specific survey design

A training workshop on the survey methodology was conducted on the 15−16 September 2004, followed by several meetings of a core technical working group for in-depth discussions about the data and the design of the survey for specific countries. A Russian translation of all training materials and the RADWQ methodology was available at the time of training.

A summary of the country-specific survey design is shown in Table 2.2 and Figure 2.3, and the frequency of testing for individual parameters is shown in Table 2.3. The individual steps used to design the survey are documented in Annex 4. A more detailed explanation of the survey design in Tajikistan follows.

Figure 2.1 **Steps in the rapid assessment of drinking-water quality**

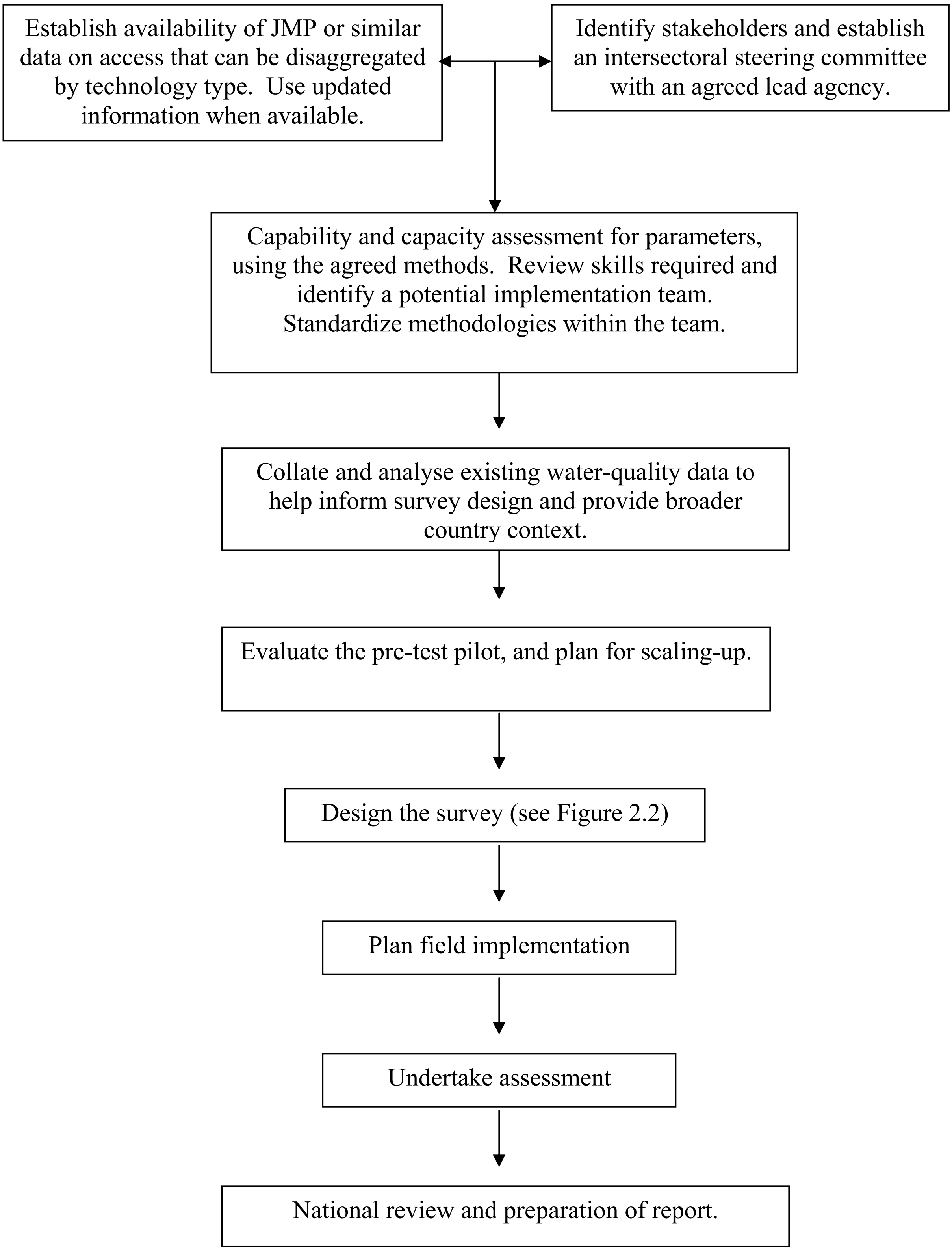


Figure 2.2 **Steps in the design of the RADWQ survey for Tajikistan**

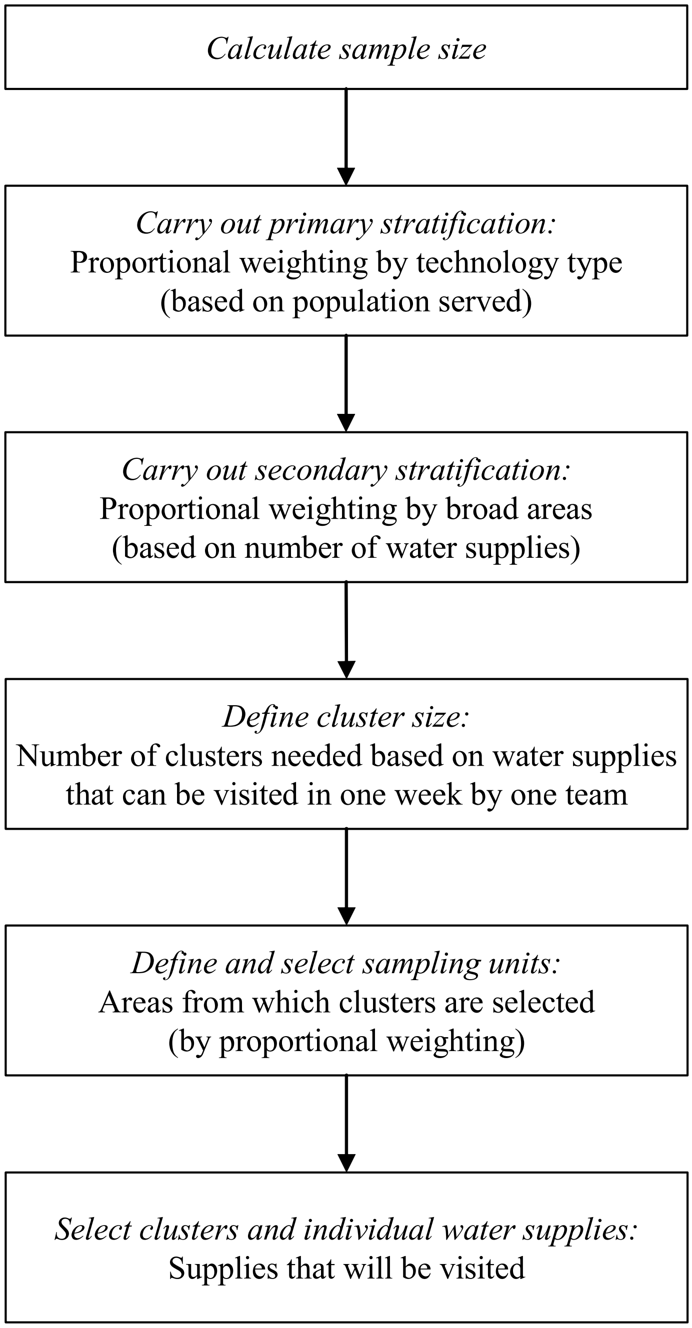


Table 2.1 **RADWQ parameters and inspections**

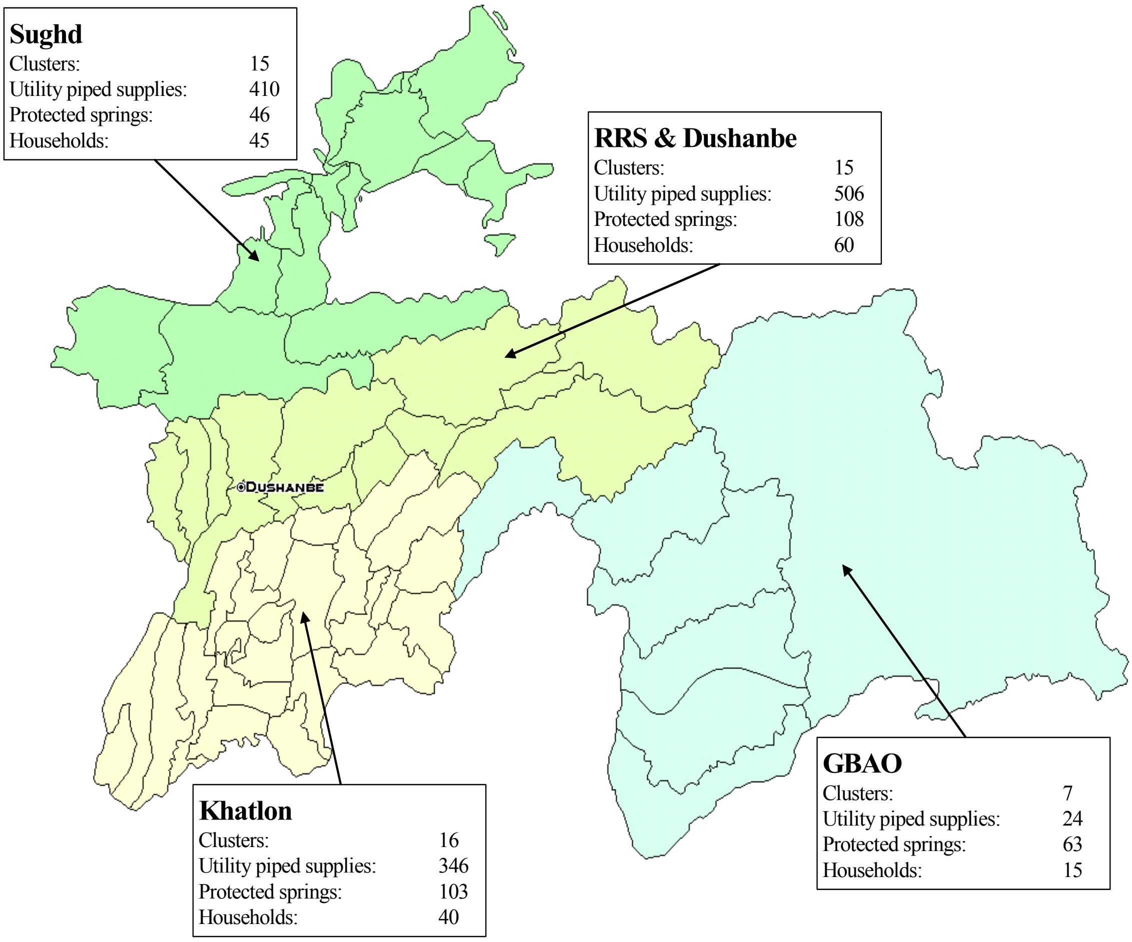
Microbiological and related parameters	Physical and chemical parameters	Inspections
Thermotolerant coliforms	Appearance	Sanitary inspection
Faecal streptococci	Conductivity	
Turbidity	Nitrate	
pH	Iron	
Residual chlorine	Arsenic	
	Fluoride	
	Copper	

- *Database.* Data on water supply coverage and technology were available at three administrative levels (i.e. national, regional and district level), as required by the methodology (see alsoTable 1.2). Additionally, a detailed rayon inventory of individual utility piped supplies was available, which included information about the serving capacity and working condition of individual water supplies (Annex 2). The database allowed an exact calculation of supply zones.
- *Criteria for including a water supply in the survey.* The cut-off size for supplies to be included in the survey was set at a serving capacity of 500 people. Also, even though the utility piped supplies in Tajikistan are subdivided into four categories, only three of the categories were included in the survey. The fourth supply category was judged not to be a primary source of drinking-water and therefore was not relevant for the RADWQ project. The included categories of water supply were: municipal/communal supplies; kolkhoz supplies, which serve the rural population; and supplies serving individual hospitals, kindergartens or schools. The fourth category, supplies serving workers at individual combines or industries, was not included.
- *Primary stratification.* At the national level, utility piped supplies and springs serve more than 5% of the population[1] (Table 1.2). Other improved technologies (according to JMP definitions) serve less than 5% of the population. In contrast, it is estimated that ca. 42% of the total population uses water from open sources (i.e. rivers, channels, irrigation canals) for domestic purposes (see also Section 1.2). It was decided to include in the survey only water supplies that served more than 5% of the national population. The option of applying the 5% criterion to the oblast, rather than national, level was discussed but rejected. Following that option would have meant that transported water would have be included in the oblast of GBAO, and dug wells included in the oblast of Khatlon. The data would therefore have better represented the primary source of drinking-water of the rural population in these regions.
- *Secondary stratification.* The oblast administrative level was selected as the broad area category. It is the most accepted broad division within the country, and the oblasts divide the country into geographical categories (e.g. mountainous and flatland areas). An overview of the broad areas selected is given in Figure 2.3.
- *Sampling units*. Rayons were chosen as the sampling unit category from which the clusters were to be selected, because rayon data on the served population were available. Towns that represented an independent administrative unit were annexed to the overlying rayons, with the exception of the city of Dushanbe, which was treated as an independent sampling unit. The selection of sampling units or rayons to be included in the survey used proportional weighting tables, as suggested by the RADWQ methodology (see Annex 4 for a list of selected rayons).

[1] Even though national figures for springs do not differentiate between protected and non-protected sources, all springs were included in this study as a way to verify their level of protection.

- *Cluster size*. Cluster sizes ranged from 12 to 30. They were selected individually for each technology and broad area, so as to adequately reflect local conditions (such as the accessibility of rayons, and the road and weather conditions).
- *Selection of clusters and individual water supplies*. Individual water supplies to be visited were selected during a week in the field, after seeking advice from local authorities (particularly the rayon SES and/or water-supply operators) or from the local population. Where official sampling taps were not available, a nearby household tap was chosen as the sampling point, and the results recorded as if they were from an official sampling tap.
- *Repeat sampling approach*. According to the primary stratification, 1286 sampling points in the utility piped system needed to be included in the survey. However, the 5000 people per zone criterion suggested in the handbook meant that only ca. 800 sampling points could have been achieved for the whole of Tajikistan. Three options were discussed by the technical group. First, reduce the size of the supply zone from 5000 to 2500 people, which would mean a size of 1336 sampling points could be achieved. Second, take a repeat sampling approach. Visiting each sampling point twice would give an idea of water-quality changes over time, and only 1286/2 sampling points would be needed. The third option was a combination of the first two, and this was seen as the most suitable option as it maintains the advantages of a cluster-based approach. In contrast, the first two options practically change the survey from a cluster to a cross-sectional study, in which 95% or 80%, respectively, of all theoretically possible sampling points in utility piped systems would have been included.

Figure 2.3 **RADWQ sampling distribution in Tajikistan, by broad area**[a]



[a] Source: RADWQ Team, Tajikistan. The designations do not imply any opinion whatsoever on the part of the World Health Organization or the United Nations concerning the legal status of any country, territory, city or area; or of their authorities; or concerning the delimitation of their frontiers or boundaries. GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Table 2.2 **Country-specific survey design for Tajikistan**[a]

Step	Method described in project handbook	Survey design in Tajikistan	Justification for variation from handbook method
1	**Calculate sample size.** (= 1600).	In total, 1780 sampling points were included in the survey: 1620 from source waters and 160 from households.	Because of rounding during secondary stratification, the sample size for source waters is 1606. This number increased to 1620, owing to a mistake in the sampling plan.
2	**Primary stratification.** Proportional weighting by technology type, based on % of population served. (Note: only technologies serving >5% of the population were included in the survey).	The study area covered the whole of the Republic of Tajikistan. Two technologies served more than 5% of the population, which were therefore selected in the primary stratification: • utility piped supplies (1286 sample points); • protected springs (320 sample points).	To achieve the required number of sample points in utility piped supplies: • the zone size was reduced from 5000 to 2500 people per zone; • a repeat sampling approach was adopted (i.e. 643 sampling points were selected, but each point was tested/inspected twice).
3	**Secondary stratification.** Proportional weighting by broad areas (based on the number of water supplies across the country).	Broad areas correspond to oblast administrative areas. Four broad areas were selected (see also): • RRS & Dushanbe : 253 utility piped supplies and 108 protected springs; • Khatlon: 173 utility piped supplies and 103 protected springs; • Sughd: 205 utility piped supplies and 46 protected springs; • GBAO: 12 utility piped supplies and 63 protected springs.	
4	**Define clusters (size and number).** Based on supplies that can be visited in one week by one team (cluster size).	In total, 53 clusters were identified. As the 30 clusters for utility piped supplies were visited twice, this resulted in 83 team-weeks or 21 project-weeks with 4 teams. The clusters in the broad areas were defined as follows (cluster size, number of clusters): • Dushanbe and RRS: utility piped supplies (30, 9); protected spring (20, 6). • Khatlon: utility piped supplies (20, 9); protected spring (15, 7). • Sughd: utility piped supplies (20, 11); protected springs (15, 4); • GBAO: utility piped supplies (12, 1); protected springs (12, 6).	Cluster sizes were selected for each technology and broad area, to adequately reflect local conditions (such as accessibility, road and weather conditions).
5	**Define and select sampling units.** These are the areas from which clusters are selected by proportional weighting.	Rayons were used as the sampling units for the third administrative level. The results of proportional weighting are given in Annex 4.	
6	**Select clusters and individual water supplies.** These are the supplies that will be assessed for water quality.	Sampling plans were prepared for the field teams (e.g. Annex 6). They provided details on the rayons from which clusters or supplies were to be selected, and on the water supply scheme numbers to be assigned. Selection of individual supplies/sample points was undertaken by the field teams, after seeking advice from the local authorities or population.	

[a] GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Table 2.3 **RADWQ parameters and frequency of testing in Tajikistan**

Parameter	Water supplies tested (%)	Households tested (%)
Thermotolerant coliforms, turbidity, pH, free residual chlorine, appearance, conductivity, arsenic, fluoride and iron	100	100
Faecal streptococci	10	0
Total residual chlorine[a]	15	0
Nitrate	35	100
Copper[b]	0	100

[a] Total residual chlorine was tested in only ca. 15% of samples, owing to the limited number of DPD3 tablets available.
[b] Testing for copper is only necessary if it is used in the household plumbing.

2.3 Field implementation and data recording

Field implementation

The fieldwork was carried out immediately after finalization of the survey design. It lasted exactly six months, starting on 18 October 2004 and ending on 18 April 2005.

The survey design was planned for four field teams. Teams were formed by staff members of the Republican SES and the oblast SESs of Sughd, Khatlon and GBAO (see Annex 5 for a list of field team members). Each field team consisted of one microbiologist and one chemist, both with experience in water quality analysis and water sampling procedures. At the first consultants' visit in September 2004 all team members were trained in the correct use of the Wagtech field testing equipment that was provided and in the correct procedures of sanitary inspections. In addition to the training provided by the international consultants, the Republican SES organized a separate meeting of field team members for an in-depth follow-up training in sanitary inspection, including practical exercises in water works.

On the basis of the survey design, each field team was provided with detailed sampling plans (an example is presented in Annex 6). For each of the broad areas, the plans provided detailed information on the rayons from which the clusters or individual supplies were to be selected; on the water supply scheme numbers to be used both for water sources and household samples; and, on the water quality parameters to be tested at individual sampling points. As mentioned (Section 2.2), individual water supplies to be visited were selected during the week in the field, after seeking advice from local authorities, particularly from the rayon SES and/or water-supply operators. For this purpose, the Republican SES provided field teams with supporting letters that outlined the purpose of the study and asked local authorities for their collaboration and support.

An initial workplan was prepared after finalizing the survey design. It specified project weeks and assigned clusters to the four field teams (Annex 7). Since GBAO was considered to be the most difficult region, in terms of accessibility during the winter, the fieldwork started in mid-October in GBAO with three teams in the region. After fieldwork was finished in GBAO, the Republican SES and UNICEF organized a one-day meeting in Dushanbe, where field teams reviewed their first experiences in GBAO and planned the work in other regions.

The initial workplan was modified several times, mainly in response to suggestions by the field teams. Unforseen delays played a large role and resulted from a variety of factors, such as the deployment of field team members in collective cotton-picking works in Sughd; the severe road and weather conditions during winter, which limited the accessibility of some areas; power cuts; family problems; and national holidays. The delays led to an extension of the initial workplan by four weeks and all field teams frequently worked weekends to compensate for the delays, otherwise it would not have been possible to implement the field studies in the allotted six-month period.

Throughout the field visits, field teams faced transportation problems, especially when travelling to mountain villages. Most of the time, field teams rented appropriate vehicles in the survey area. Only in broad area 1 (i.e. RRS & Dushanbe) were the vehicles provided by the Republican SES appropriate for undertaking the assessment.

A further challenge during fieldwork was the lack of methanol. This was initially supplied by the international consultant before the start of the project, because there was no methanol locally available. However, some teams ran out of methanol during fieldwork and had to rely on methanol stocks from the rayon SES, if available. Items such as gloves, lighters, markers, etc., were also in short supply in remote areas.

The national coordinator or his deputy, together with the responsible project assistant at UNICEF, undertook regular supervision visits to the field (at least one visit a month to each of the four broad areas). Field teams sent biweekly progress reports to the project coordinator, which also included the results of water-quality analyses and sanitary inspections. The status of project implementation was summarized in monthly reports prepared by UNICEF, which were forwarded to the international consultant (see Annex 8 for an example report).

The total budget for project implementation was approximately US$ 32 000, mostly for transportation costs and daily subsistence allowances (Annex 9). It had to be revised during fieldwork to cover the additional costs of car hire in the regions.

Data recording

Each day the sampling results were recorded in daily report forms, together with the cluster number, date, name of analyst, community and sample sites visited (see Annex 10 for a sample form). Completed sanitary inspection forms for each day's activity were attached to the daily report sheets, and all forms were kept in a folder. On a weekly or bi-weekly basis, report forms were sent to the project coordinator and later to the data clerk for entry into the SanMan database. The data clerk was trained to use the SanMan software during the first consultants' visit in September 2004.

The format of the daily report forms proved to be useful and thoroughly developed. They could be considered for any future water quality survey conducted by the SES at different administrative levels. Nevertheless, as field practice has shown, in some situations it was more convenient for the field teams to record the data in their notebooks first and to copy them onto the record forms after one day's work, particularly during bad weather periods and in mountainous regions.

In SanMan, each sample site was identified by a unique water supply scheme number, an eight digit code. In the case of Tajikistan, the following coding system was used:

- *Digits 1-3*: country code (= TJK);
- *Digit 4*: broad area code (RRS & Dushanbe = 1; Khatlon = 2; Sughd = 3; GBAO = 4);
- *Digits 5-6*: cluster code (consecutive numbering within one broad area);
- *Digits 7-8*: sample code (consecutive numbering within one cluster).

2.4 Data analysis

Data analysis is one of the most important parts of the project, because it is the principle mechanism by which raw data are transferred into usable information for project managers, communities and other decision-makers. Raw data itself is of little use – most people will not understand what it means and few will have sufficient time or interest to analyse the data. What is required is simple, direct and comprehensible information that can be used without further manipulation and is meaningful to the target audience.

All water quality and sanitary inspection results were stored in the SanMan database, and later exported to Excel for analysis. Data were analysed following the guidelines provided by the international consultant. This included an analysis of compliance for microbial, physical and chemical parameters by broad areas (oblasts) and supply technology, and for compliance to WHO guideline values and national standards (i.e. the Soviet Standard GOST 2874-82 *Drinking water*).

Household samples were also analysed for microbiological and chemical parameters, with a focus on how drinking-water quality deteriorated between the distribution system and household taps.

In line with the *WHO guidelines for drinking-water quality* (WHO, 2004), all samples were assessed for sanitary risks by inspections that used a standard set of questionnaires developed for the RADWQ pilot project. Individual water supplies were assigned to risk categories using a "risk-to-health matrix", which cross-checks a sanitary risk score with the count for thermotolerant coliforms, to give a measure of the potential health risk.

The value of proxy parameters for assessing water quality (i.e. turbidity for bacteria, conductivity for chemicals) was also examined. The output of the analysis was Pearson's *r*, a linear correlation coefficient that can easily be calculated within MS Excel. A drawback is that the derivation of Pearson's *r* assumes the data are distributed normally, and the analysis uses means and standard deviations, so that outlier values[2] can disproportionately influence the results. More rigorous analyses exist, such Spearman's *rho*, which does not assume the data are normally distributed, and uses a rank transform method that makes it resistant to outliers, but which cannot be calculated within MS Excel.

[2] An outlier is a value far from most others in a set of data.

3 Results

3.1 Microbiological parameters

A variety of microorganisms may be found in water, including pathogenic and non-pathogenic species. Non-pathogenic microorganisms may cause taste and odour problems with water supplies, which can influence whether people use the water for consumption, but the principle concern for microbiological quality is contamination by pathogenic species. Most water-borne pathogens derive from faeces, and to analyse the microbiological quality of drinking-water the usual practice is to test for the presence of indicator organisms, normally bacteria such as *E. coli* and thermotolerant coliforms.

The following microbial parameters were included in the RADWQ project:

- *Thermotolerant coliforms.* The ease of use and rapidity of tests for thermotolerant coliforms justify their use, but it is recommended that confirmation tests for *E. coli* be undertaken for each type of water source whenever possible.
- *Faecal streptococci.* Some 10% of all water-source samples were tested for faecal streptococci. This was designed to provide a small-scale within-study investigation to evaluate the usefulness of these bacteria.

Thermotolerant coliforms

The thermotolerant coliforms are a group of coliform bacteria that grow at 44°C and include *E. coli* as well as other species that may have an environmental source. In temperate climates, it has been estimated that approximately 95% of thermotolerant coliforms are *E. coli*, but in tropical climates this proportion may be significant lower. This shows that the results of analyses should be interpreted cautiously, and highlights the need for other data collection methods. Thermotolerant coliforms analysis can be performed using a variety of different techniques and results can be obtained within 14–24 hours using relatively inexpensive methods.

E. coli derives almost exclusively from human and animal faeces and some strains are pathogenic (e.g. *E. coli* O157:H7). There is some evidence that *E. coli* is able to multiply in nutrient-rich tropical soils, although it is generally recognized that this ability is limited and in most case the indigenous bacteria would out-compete the *E. coli.* The identification of *E. coli* is simple but time consuming, as it typically requires a two-stage process of presumptive and confirmative testing.

In the RADWQ project, a total of 1620 sites from utility piped supplies and protected springs were selected to be tested for thermotolerant coliforms. As shown in Table 3.1, 87.2% of all samples tested in Tajikistan met the requirements of both the national standard and the WHO guideline value. Compliance was generally higher for utility piped supplies (88.6%) than for protected springs (82.0%). The difference in compliance likely derived from the fact that water from springs was not disinfected. The cumulative frequency of thermotolerant coliform counts is shown in Table 3.2. Most of the test results ranged between 1–10 cfu/100 ml. Fewer than 14 samples (less than 1% of the sampling points) showed counts or more than 10 cfu/100 ml, most from protected springs.

For utility piped supplies, compliance varied between broad areas and ranged from 66.7% in GBAO to 93.3% in RRS and Dushanbe. The variation between broad areas was largely due to differences in the quality of the supply infrastructure and in regular maintenance activities, particularly in Dushanbe. It was also assumed that the supply of chlorine (or hypochlorite) for disinfection was better in Dushanbe and RRS than in other regions of the Republic.

As mentioned in Section 2.2, we used a repeat sampling approach for utility piped supplies (i.e. each site was visited twice). The time between the two sampling rounds varied between rayons, from one week to four months. The results in Table 3.1 and Table 3.2 include all sampling points, regardless of when they were taken (in the first or second sampling round), whereas the data in Table 3.3 provide a comparison of the results between the two sampling rounds.

Table 3.1 Compliance with the Tajikistan national standard and WHO guideline value for thermotolerant coliforms

Broad area[a]	Utility piped supplies		Protected springs		Total	
	No. of samples	Compliance (%)	No. of samples	Compliance (%)	No. of samples	Compliance (%)
RRS & Dushanbe	506	93.3	108	86.1	614	92.0
Khatlon	346	85.5	103	94.2	449	87.5
Sughd	410	86.6	60	58.3	470	83.0
GBAO	24	66.7	63	77.8	87	74.7
National	1 286	88.6	334	82.0	1 620	87.2

[a] GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Table 3.2 Cumulative frequencies for thermotolerant coliforms

Count category (cfu/100 ml)[a]	Utility piped supplies		Protected springs		Total	
	Proportion (%)	Cumulative frequency (%)	Proportion (%)	Cumulative frequency (%)	Proportion (%)	Cumulative frequency (%)
<1	88.6	88.6	82.0	82.0	87.2	87.2
1-10	11.4	99.9	14.1	96.1	11.9	99.1
11-100	0.1	100.0	3.0	99.1	0.7	99.8
>100	0.0	100.0	0.9	100.0	0.2	100.0
Total no. of samples	1 286		334		1 620	

[a] cfu = colony forming unit.

Table 3.3 Comparison of sampling rounds for utility piped supplies

Compliance	Proportion (%)
Compliance with WHO guideline value and national standard in 1st sampling round	89.5
Compliance with WHO guideline value and national standard in 2nd sampling round	88.1
Compliance with WHO guideline value and national standard in 1st and 2nd sampling round	84.2
Thermotolerant coliform counts	**Proportion (%)**
Thermotolerant coliform count higher in 1st sampling round	6.2
Thermotolerant coliform count equal in 1st and 2nd sampling rounds	89.0
Thermotolerant coliform count lower in 1st sampling round	4.8

For protected springs, compliance was lowest in Sughd (58.3%) and highest in Khatlon (94.2%). It is suspected that source protection measures are not adequately maintained, particularly in Sughd, but this would need to be confirmed by an in-depth analysis of the sanitary risk factors identified by individual site inspections. The results of the RADWQ survey suggest that approximately 44.3% of the springs included in the survey were not adequately protected and could not be described as "protected" (Table 3.13).

Faecal streptococci

Faecal streptococci may also be used as indicators of the microbiological quality of water. Compared to *E. coli*, these bacteria have a stronger relationship to diarrhoeal disease and to bacterial indicators of known human faecal origin. They are generally more environmentally resistant than *E. coli* or thermotolerant coliforms and it has therefore been recommended that the levels of these bacteria be tested in groundwater receiving contaminated recharge water and in chlorinated distribution systems. A variety of techniques can be used for analysis and although some are simple, they are time-consuming and results cannot be obtained within 48 hours. This may limit their usefulness in routine monitoring, but would have limited impact on their value in assessments.

The assessment results showed that 151 of 154 (98.1%) water samples tested for faecal streptococci from utility piped supplies and protected springs met both the national standard and the WHO guideline value (Table 3.4). For utility piped supplies, only 2 of 34 samples (5.9%) in Sughd did not meet the requirements. Both came from the same supply scheme and also tested positive for thermotolerant coliforms (the positive findings were not confirmed in the second sampling round, 3.5 months later). For springs, only one sample of 11 tested (9.1%) in RRS and Dushanbe was not in compliance with the national standard, and again the sample had a high thermotolerant coliform count.

Table 3.4 Compliance with the Tajikistan national standard and WHO guideline value for faecal streptococci

Broad area[a]	Utility piped supplies		Protected springs		Total	
	No. of samples	Compliance (%)	No. of samples	Compliance (%)	No. of samples	Compliance (%)
RRS & Dushanbe	49	100.0	11	90.9	60	98.3
Khatlon	35	100.0	11	100.0	46	100.0
Sughd	34	94.1	7	100.0	41	95.1
GBAO	2	100.0	5	100.0	7	100.0
National	120	98.3	34	97.1	154	98.1

[a] GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Table 3.5 Cumulative frequencies for faecal streptococci

Count category (cfu/100 ml)[a]	Utility piped supplies		Protected springs		Total	
	Proportion (%)	Cumulative frequency (%)	Proportion (%)	Cumulative frequency (%)	Proportion (%)	Cumulative frequency (%)
<1	98.3	98.3	97.1	97.1	98.1	98.1
1-10	1.7	100.0	2.9	100.0	1.9	100.0
11-100	0.0	100.0	0.0	100.0	0.0	100.0
>100	0.0	100.0	0.0	100.0	0.0	100.0
Total no. of samples	120		34		154	

[a] cfu = colony forming unit.

3.2 Chemical parameters

Many chemical substances that are found in water affect public health, the acceptability of the water (aesthetics), and the operational performance of supplies. In the third edition of the WHO *Guidelines for drinking-water quality*, for example, guidelines values are given for 98 such substances (WHO, 2004). However, it is expensive, difficult and largely unnecessary to test for all these parameters, even within an assessment, and priorities have to be set as to which chemical parameters will be tested. Certain physical characteristics of the water should also be included in assessments of water quality, as they are useful indicators of change in quality and are often cited by consumers as reasons for rejecting a source. Physical and chemical parameters may have natural or anthropogenic sources, and their occurrence and concentration can vary over time and by location. The temporal variation is greater in surface waters and shallow groundwater, compared with deep groundwater, and the microbiological quality of such water sources is often poor. The poor chemical quality is primarily related to human activity, but this also means that prevention measures are usually possible and that the contamination may be relatively short-lived if the chemical clears quickly from the water supply.

In deeper groundwater, microbiological quality is often very good and therefore chemical quality is a higher priority. Chemical contaminations of deeper groundwater are also more likely to be natural and therefore removal, rather than prevention, may be required. Generally, the quality of deep groundwater is stable and monitoring is required less frequently than for shallow groundwater and surface water sources, both of which are prone to natural (e.g. erosion, run-off) and anthropogenic pollution/contamination. However, a slow flow rate in deep groundwater may lead to long-term contamination problems.

Many chemicals affect the palatability and thus acceptability of water sources (e.g. salinity, turbidity and iron; Section 3.3). However, some chemicals constitute a health hazard because of their toxicity (e.g. fluorides, arsenic and nitrates), and others can indirectly lead to adverse health effects because they render the water objectionable and consumers may reject the water in favour of microbiologically contaminated water sources. Commonly, naturally occurring chemicals in water pose a chronic, rather than acute, risk to health and exposures of several years are required to have a health impact.

Nitrate

Nitrate is one of the most ubiquitous chemical contaminants of water bodies worldwide as it is derived from human activities, particularly from the disposal of human wastes and the use of inorganic fertilizers in agriculture. Nitrate is of concern because of its link to methaemoglobinaemia of “blue-baby” syndrome. Although the actual health burden from nitrate is often considered relatively insignificant (because of breast-feeding practices), it is likely that the health burden is underreported.

Nitrate is also of concern because of its properties in water. If it enters a water body in which oxidation is occurring, only dilution and hydrodynamic dispersion are likely to significantly reduce its concentration, until the input load is reduced. Long-term resource problems and costly investments can therefore result if nitrate is allowed to build up in source waters. As nitrate is expensive and difficult to remove from water, blending nitrate-rich waters with low-nitrate waters may be the only viable option. In reducing or non-oxidizing waters, by contrast, nitrate may not be formed, as organic nitrogen would be converted to ammonia by denitrifying bacteria.

Water samples at approximately one third (or 642) of all sites visited were tested for nitrate. All complied with the WHO guideline value (50 mg/l) and the national standard (45 mg/l) (Table 3.6). The highest concentrations (up to 22.8 mg NO_3/l) were in the broad area of Sughd. These findings are in line with current data that indicate that nitrate is not a water quality problem in Tajikistan.

Fluoride

Excess fluoride is associated with dental and skeletal fluorosis, which may cause severe deformation and disability in susceptible individuals. Excess fluoride in the water should always be suspected if people have mottled teeth or skeletal deformities, even if there are no data. In contrast, a lack of fluoride is associated with dental caries and in some countries fluoride is added to drinking-water to improve dental health. This remains a controversial issue and fluorination may not be the most effective way to reduce the incidence of dental caries. When fluoride levels in drinking-water supplies are high enough to be a health concern, the fluoride usually derives from natural sources, although some may also come from industrial pollution. Fluoride should always be analysed during source development, particularly when developing groundwater sources.

Water sources were tested for fluoride at all 1620 sites visited. Of these, 99.7% of the samples met the WHO guideline value of 1.5 mg/l, although only 73.8% met the current national standard of 0.7 mg/l (Table 3.7). Noncompliance was particularly high in Khatlon and Sughd. The maximum fluoride concentration found was 1.95 mg/l, and the median was 0.50 mg/l. These figures are likely to improve in the future, because it has been suggested in the current revision of sanitary norms and water-supply rules (see Section 1.2) that a lower national standard for fluoride be used (of 1.2 mg/l).

Arsenic

Arsenic accumulates in humans and is concentrated in the food chain. It is associated with skin disease and cancers. Exposure to drinking-water that contains low concentrations of arsenic (<50 µg/l) over a number of years can result in toxic concentrations in humans and be carcinogenic. Most arsenic in water is naturally occurring, from arsenic-bearing minerals associated with volcanic activity, but it may also come from anthropogenic sources (e.g. mining and other industries). It became one of the principal water quality issues in the late 1990s because of its increasing presence in groundwater in Bangladesh and neighbouring countries. Prior to this, there were few data on arsenic levels in water, mainly because sophisticated laboratory equipment was needed to measure such low arsenic concentrations. Recently, new laboratory and field methods were developed and these are helping to document arsenic levels in water worldwide. In Asia and Latin America, in particular, water sources can be extensively contaminated by arsenic.

All 1620 water sources visited were tested for arsenic (Table 3.8). All sources complied both with the WHO guideline value (10 µg/l) and the national standard (50 µg/l), which is consistent with other national data indicating that arsenic is not present in Tajik source waters.

3.3 Aesthetic parameters

Iron

Iron is mainly of aesthetic importance, but its presence may cause consumers to reject water because of the colour. Iron from natural sources usually occurs with manganese and both elements can colour clothes and sanitary ware. Iron is a particular problem with groundwater supplies and is usually formed from the oxidation of ferrous iron in the water itself, but it may also be caused by corrosion of galvanized iron riser pipes and, in some cases, by the action of iron bacteria. Some surface waters also have iron problems, particularly those related to colloidal iron.

As iron and manganese from natural sources normally occur together, a high indicator for one could signal possible problems with the other. Iron is the primary parameter for the assessment because of its impact on aesthetic quality, and because of its presence (and potential problems) in some rising mains and pipes. Water-treatment processes that remove iron also remove manganese.

All water samples taken from utility piped supplies and protected springs were tested for iron. Of the 1620 water samples analysed, 8.5% met neither the value suggested by WHO for the acceptability of drinking-water (0.3 mg/l), nor the national standard (Table 3.9). Total noncompliance was greatest in the broad area of Sughd (19.1%), and was slightly greater for utility piped supplies than for springs, which may be due to corrosion of iron pipes in the distribution system or in household plumbing.

Turbidity

Turbidity is a critical parameter for describing the microbiological quality of drinking-water, and is the most basic parameter to measure when monitoring water quality. It is recommended that turbidity measurements be included in water quality surveys, together with pH and residual chlorine, as they either directly influence microbiological quality (in the case of chlorine) or may influence disinfection efficiency and microbial survival (in the case of pH and turbidity). Very high turbidity, even in the absence of faecal indicator bacteria, is cause for concern as it could indicate that sanitary integrity is compromised.

Of the 1620 water samples tested for turbidity, 90.4% met the WHO value of 5 NTU suggested for the acceptability of drinking-water (Table 3.10). The RADWQ results could not be compared with the national standard, because it uses milligrams per litre as its unit of turbidity (Annex 3).

Table 3.6 **Compliance with the Tajikistan national standard and WHO guideline value for nitrate**[a]

Broad area	Utility piped supplies			Protected springs			Total		
	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)
RRS & Dushanbe	197	100.0	100.0	44	100.0	100.0	241	100.0	100.0
Khatlon	147	100.0	100.0	35	100.0	100.0	182	100.0	100.0
Sughd	149	100.0	100.0	40	100.0	100.0	189	100.0	100.0
GBAO	9	100.0	100.0	21	100.0	100.0	30	100.0	100.0
National	502	100.0	100.0	140	100.0	100.0	642	100.0	100.0

[a] GV = guideline value. nat. std. = national standard. GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Table 3.7 **Compliance with the Tajikistan national standard and WHO guideline value for fluoride**[a]

Broad area	Utility piped supplies			Protected springs			Total		
	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)
RRS & Dushanbe	506	100.0	83.0	108	100.0	88.9	614	100.0	84.0
Khatlon	346	99.7	73.7	103	100.0	97.1	449	99.8	79.1
Sughd	410	99.0	50.0	60	100.0	65.0	470	99.1	51.9
GBAO	24	100.0	95.8	63	100.0	92.1	87	100.0	93.1
National	1 286	99.6	70.2	334	100.0	87.7	1 620	99.7	73.8

[a] GV = guideline value. nat. std. = national standard. GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Table 3.8 **Compliance with the Tajikistan national standard and WHO guideline value for arsenic**[a]

Broad area	Utility piped supplies			Protected springs			Total		
	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)
RRS & Dushanbe	506	100.0	100.0	108	100.0	100.0	614	100.0	100.0
Khatlon	346	100.0	100.0	103	100.0	100.0	449	100.0	100.0
Sughd	410	100.0	100.0	60	100.0	100.0	470	100.0	100.0
GBAO	24	100.0	100.0	63	100.0	100.0	87	100.0	100.0
National	1 286	100.0	100.0	334	100.0	100.0	1 620	100.0	100.0

[a] GV = guideline value. nat. std. = national standard. GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Table 3.9 **Compliance with the Tajikistan national standard and WHO suggested value for iron**[a]

Broad area	Utility piped supplies		Protected springs		Total	
	No. of samples	Compliance (%)	No. of samples	Compliance (%)	No. of samples	Compliance (%)
RRS & Dushanbe	506	91.7	108	95.4	614	92.3
Khatlon	346	100.0	103	100.0	449	100.0
Sughd	410	80.7	60	81.7	470	80.9
GBAO	24	100.0	63	100.0	87	100.0
National	1 286	90.6	334	95.2	1 620	91.5

[a] GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Table 3.10 **Compliance with WHO suggested value for turbidity** [a]

Broad area	Utility piped supplies		Protected springs		Total	
	No. of samples	Compliance (%)	No. of samples	Compliance (%)	No. of samples	Compliance (%)
RRS & Dushanbe	506	73.5	108	98.1	614	77.9
Khatlon	346	95.7	103	100.0	449	96.7
Sughd	410	99.8	60	95.0	470	99.1
GBAO	24	100.0	63	100.0	87	100.0
National	1 286	88.3	334	98.5	1 620	90.4

[a] GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Compliance was generally higher for protected springs (98.5%) than for utility piped supplies (88.3%), probably because spring water is generally more protected from matter causing turbidity. Indeed, utility piped supplies in the broad area RRS and Dushanbe had the lowest compliance (73.5%), which may be explained by the fact that most raw waters in this region are surface waters (i.e. rivers). In autumn and spring, runoff caused by heavy rainfall and/or thaw pollutes the water sources with particulate matter, causing turbidity, but the water-treatment works of piped supplies are inefficient at removing turbidity. As the RADWQ survey was mainly conducted between the autumn of 2004 and the spring of 2005, the results for RRS and Dushanbe most likely reflect this situation. In the other broad areas, the level of compliance with turbidity standards was high because the raw waters for utility piped supplies were often groundwaters such as artesian boreholes.

Conductivity

Conductivity, the ability of water to carry an electric charge, is a proxy indicator of dissolved solids and is therefore an indicator of the taste/salinity of the water (a conductivity of 1400 µS/cm is equivalent to 1000 µg/l total dissolved solids). Although there is little direct health risk associated with this parameter, high values are associated with poor taste and hence customer dissatisfaction and complaints. If conductivity changes over time, or if conductivity values are high, this can indicate that the water is contaminated (e.g. from saline intrusion, faecal pollution or nitrate pollution) and can cause corrosion in rising mains and pipes.

Table 3.11 **Compliance with WHO suggested value for conductivity**

Broad area[a]	Utility piped supplies		Protected springs		Total	
	No. of samples	Compliance (%)	No. of samples	Compliance (%)	No. of samples	Compliance (%)
RRS & Dushanbe	506	99.6	108	99.1	614	99.5
Khatlon	346	100.0	103	100.0	449	100.0
Sughd	410	81.5	60	95.0	470	83.2
GBAO	24	100.0	63	100.0	87	100.0
National	1 286	93.9	334	98.8	1 620	94.9

[a] GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Nationally, only 5.1% of all water samples tested were not in compliance with the WHO suggested value for electrical conductivity (1.4 µS/cm) (Table 3.11). Total noncompliance was greatest in the Sughd region (16.8%), which may be explained by the "hard" water in the area (i.e. water with high concentrations of salts, such as calcium and magnesium).

3.4 Overall compliance

The RADWQ project defined overall compliance as the proportion of water samples that met the WHO guideline values and national standards for thermotolerant coliform count, and for chemicals such as arsenic, fluoride and nitrate, which are of public health imporftance. In the case of Tajikistan, however, overall compliance was synonymous with compliance for thermotolerant coliforms and fluoride, as all water supplies in the RADWQ survey were in compliance with the national standards or WHO guideline values for nitrate and arsenic (Table 3.6, Table 3.8).

Of the 1620 water supplies tested, 86.9% and 65.9% were in overall compliance with WHO guideline values and national standards, respectively (Table 3.12). The difference in overall compliance levels is explained by the fact that the national standard for fluoride is less than half of the WHO guideline value. In the broad areas or oblasts, compliance with the WHO guideline values was greatest for water supplies in RRS and Dushanbe (92.0%) and least for those in GBAO (74.7%).

3.5 Sanitary risk factors

In addition to the analysis of microbial, chemical and aesthetic parameters, sanitary inspections were carried out at all supply points visited during the RADWQ study. Sanitary inspections are visual assessments of the infrastructure and environment surrounding a water supply, taking into account the condition, devices and practices in the water-supply system that pose an actual or potential danger to drinking-water quality and thus to the health and well-being of the consumers. The most effective way to undertake sanitary inspections is a semiquantitative standardized approach using logical questions and a simple scoring system. Sanitary inspections are complementary to a water quality analysis and there is an increase in the power of analysis when both types of data are available. Sanitary inspections also provide a longer-term perspective on the risks of microbiological contamination, and thus complements the "snapshot" water quality analysis.

Table 3.12 **Overall compliance with WHO guideline values and Tajikistan national standards for thermotolerant coliforms, fluoride, arsenic and nitrate**[a]

Broad area	Utility piped supplies			Protected springs			Total		
	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)
RRS & Dushanbe	506	93.3	77.7	108	86.1	77.8	614	92.0	77.7
Khatlon	346	85.3	60.7	103	94.2	91.3	449	87.3	67.7
Sughd	410	85.6	44.9	60	58.3	33.3	470	82.1	43.4
GBAO	24	66.7	66.7	63	77.8	73.0	87	74.7	71.3
National	1 286	88.2	62.4	334	82.0	73.1	1 620	86.9	65.9

[a] GV = guideline value. nat. std. = national standard. GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Table 3.13 **Results of sanitary inspections**

	Questions for the sanitary risk inspection	Risk frequency (%)
PIPED WATER-TREATMENT PROCESS: 342 SITES INSPECTED		
1	Are cracks evident in the pre-filters?	14.0
2	Are there leaks in the mixing tank?	21.9
3	Is the mixing tank in an unsanitary condition?	5.3
4	Are there hydraulic surges at the intake?	6.1
5	Is any sedimentation tank unsanitary?	47.4
6	Is the air and water-supply distribution in any sand bed uneven?	12.0
7	Are there mud balls or cracks in any of the filters?	3.2
8	Are there cross connections between backwashed and treated water?	4.1
9	Is there evidence of insufficient coagulant dosing (e.g. alum)?	9.9
10	Are free residual chlorine concentrations (minimum, 0.2 mg/l) not being achieved?	19.0
PIPED WATER-DISTRIBUTION SYSTEM: 944 SITES INSPECTED		
1	Do any taps or pipes leak at the sample site?	7.7
2	Does water collect around the sample site?	16.7
3	Is the area around the tap unsanitary?	3.4
4	Is there a sewer or latrine within 30 m of any tap?	2.4
5	Has there been discontinuity in the last 10 days?	56.4
6	Is the supply main exposed in the sampling area?	6.9
7	Do users report any pipe breaks within the last week?	2.3
8	Is the supply tank cracked or leaking?	1.8
9	Are the vents and covers on the tank damaged or unsanitary?	6.6
10	Is the inspection cover or concrete around the cover damaged or corroded?	14.9
PROTECTED SPRING: 334 SITES INSPECTED		
1	Is the spring unprotected?	44.3
2	Is the masonry protecting the spring faulty?	37.7
3	Is the backfill area behind the retaining wall eroded?	7.8
4	Does spilt water flood the collection area?	12.9
5	Is the fence absent or faulty?	63.2
6	Can animals have access within 10 m of the spring?	52.4
7	Is there a latrine uphill and/or within 30 m of the spring?	1.5
8	Does surface water collect uphill of the spring?	7.2
9	Is the diversion ditch above the spring absent or nonfunctional?	18.6
10	Are there any other sources of pollution uphill of the spring (e.g. solid waste)?	12.3
HOUSEHOLD CONTAINER: 119 SITES INSPECTED		
1	Is the water storage container used for storing any other liquid/material?	6.7
2	Is the water storage container kept at ground level?	21.0
3	Is the water storage container lid/cover absent or not in place?	6.7
4	Is the storage container cracked or leaking or unsanitary?	3.4
5	Is the area around the storage container unsanitary?	23.5
6	Do any animals have access to the area around the storage container?	5.0
7	Is the tap/utensil used to draw water from the container unsanitary?	5.0
8	Is the water from the container also used for washing/bathing?	21.0
9	Has there been discontinuity in water supply in the last 10 days?	17.6
10	Is the water obtained from more than one source?	35.3
HOUSEHOLD PIPED WATER: 41 SITES INSPECTED		
1	Is the tap sited outside the house (e.g. in the yard)?	12.2
2	Is the water stored in a container inside the house?	19.5
3	Are any taps leaking or damaged?	4.9
4	Are any taps shared with other households?	7.3
5	Is the area around the tap unsanitary?	17.1
6	Are there any leaks in the household pipes?	7.3
7	Do animals have access to the area around the pipe?	4.9
8	Have users reported pipe breaks in the last week?	4.9
9	Has there been discontinuity in water supply in the last 10 days?	17.1
10	Is the water obtained from more than one source?	24.4

Five questionnaires, each with ten questions, were developed to determine sanitary risk, and they were used in sanitary inspections of all water-supply points visited. The ten questions were formulated with "yes" or "no" answers, which made it simple for the interviewer to fill out the questionnaire.

The five sanitary inspection forms and corresponding ten questions that were used in Tajikistan, as well as the frequency of individual risk factors for the different water supply technologies, are shown in Table 3.13. The most frequent risks included discontinuity in utility piped supplies (56.4%); a generally low level of protection for the springs visited (44.3% unprotected); unsanitary water-storage practices at household level; and water consumption from more than one source (35.3%). The data obtained during sanitary inspection can be used for an in-depth analysis of the most significant risk factors at the level of rayons or individual supplies, which would help to identify priorities for future rehabilitation, maintenance or education programmes that aim to improve the safety of drinking-water sources.

Table 3.14 **Risk-to-health matrix for water supplies**[a]

SI score	Utility piped supplies				Protected springs				Total			
	TTC count (cfu/100 ml)				TTC count (cfu/100 ml)				TTC count (cfu/100 ml)			
	<1	1-10	11-100	>100	<1	1-10	11-100	>100	<1	1-10	11-100	>100
0-2	1 038	100	0	0	121	28	6	2	1 159	128	6	2
3-5	91	35	1	0	146	15	3	0	237	50	4	0
6-8	10	11	0	0	7	4	1	1	17	15	1	1
9-10	0	0	0	0	0	0	0	0	0	0	0	0

[a] cfu = colony-forming unit. SI = sanitary inspection. TTC = thermotolerant coliform.

VERY LOW	LOW	MEDIUM	HIGH

3.6 Risk-to-health analysis

A relative measure of health risk was obtained from an analysis of the sanitary inspection and water quality data (Table 3.14, Table 3.15). The analysis combined information about the longer-term risks of future microbiological contamination (from the sanitary inspections) with the "snapshot" data of current thermotolerant coliform levels in drinking-water. Such ranking of supplies is a powerful tool that supports rational decision making and priority setting for interventions to improve water safety.

Table 3.15 **Overall risk-to-health classification for water supplies**

Risk category	Utility piped supplies		Protected springs		Total	
	No. of supplies	Proportion (%)	No. of supplies	Proportion (%)	No. of supplies	Proportion (%)
Very low	1 038	80.7	121	36.2	1 159	71.5
Low	191	14.9	174	52.1	365	22.5
Medium	45	3.5	28	8.4	73	4.5
High	12	0.9	11	3.3	23	1.4

Only 1.4% and 4.5% of all water supplies investigated could be categorized as "high" or "medium" risk, respectively (Table 3.15). Generally, the risk-to-health status was better for utility piped supplies than for protected springs, mainly as a result of the low level of protection for springs (Table 3.13).

3.7 Analysis of proxy parameters

Selected water-quality parameters were examined to determine if one parameter could be used as a proxy indicator for the other. The following parameters were analysed for correlation:

- Faecal contamination (thermotolerant coliforms) and turbidity;
- Thermotolerant coliforms and faecal streptococci;
- Conductivity, and nitrate, fluoride and arsenic.

Pearson's *r* was used to measure the strength of association. This correlation coefficient measures the linear association between two variables. If the data lie exactly along a straight line with positive slope, then $r = 1$; if they lie exactly along a straight line with negative slope, then $r = -1$; if there is no correlation, then $r = 0$. The main limitations of Pearson's *r* are that it measures only a linear association between two variables; it assumes a normal data distribution; and it is not resistant to outliers. The justifications for using it are that *r* can be easily calculated in Microsoft Excel, and that the RADWQ snapshot nature does not justify using a more complicated analysis.

The only significant correlation was between thermotolerant coliforms and faecal streptococci ($r = 0.52$). For the other pairs of variables the correlations were negligible (Table 3.16).

Table 3.16 **Analysis of proxy parameters**[a]

Technology	Pearson's *r*				
	TTC *vs.*		Conductivity *vs.*		
	Turbidity	FS	NO_3	F	As
Utility piped supplies	-0.05	0.42	0.07	0.01	N.A.
Protected springs	0.13	0.99	0.06	0.02	N.A.
Totals	0.00	0.52	0.08	0.02	N.A.

[a] FS = faecal streptococci. N.A. = data not available. TTC = thermotolerant coliforms.

3.8 Household water quality

The RADWQ survey also tested the quality of water consumed in households, to assess the extent to which water was contaminated after leaving the source. Household water was matched to a source, which meant that this part of the RADWQ survey only tested water from households with a known water supply. As a result, 10% of the total sample size of 1600 (i.e. 160 households) were included in the survey, with the households being proportionally distributed by broad area and by water-supply technology. Testing included in-house or in-yard taps, if the households were connected to a utility piped supply; and containers in households where water was stored before consumption.

Thermotolerant coliforms

As shown in Table 3.17, 85.4% and 91.6% of household taps and household containers, respectively, complied with the WHO guideline value and the national standard for thermotolerant coliforms. At most sites, there was little deterioration in the water quality between source and household (Table 3.18). For example, the microbiological quality of household water samples deteriorated in only 6.9% of all cases.

Table 3.17 **Overall compliance of household water quality with the Tajikistan national standard and WHO guideline value for thermotolerant coliforms**

Technology	No. of samples	Compliance (%)
Household piped water	41	85.4
Household container	119	91.6

Table 3.18 **Comparison of thermotolerant coliform counts for source and household water**

TTC[a] count in household water compared to the source	Household piped water		Household container		Total	
	No. of samples	Proportion (%)	No. of samples	Proportion (%)	No. of samples	Proportion (%)
Lower	2	4.9	3	2.5	5	3.1
Equal	35	85.4	109	91.6	144	90.0
Higher	4	9.8	7	5.9	11	6.9

a TTC = thermotolerant coliform.

Risk-to-health matrixes

Most households tested could be classified as "very low" or "low" (94.6%), according to the the relative risk-to-health classification system (Table 3.19, Table 3.20). Households classified either as "medium" or "high" (5.6%) are candidates for targeted hygiene education programmes to eliminate or reduce the risk factors identified during sanitary inspections.

Table 3.19 **Risk-to-health matrix for household water quality**[a]

SI score	Utility piped supplies				Protected springs				Total			
	TTC count (cfu/100 ml)				TTC count (cfu/100 ml)				TTC count (cfu/100 ml)			
	<1	1-10	11-100	>100	<1	1-10	11-100	>100	<1	1-10	11-100	>100
0-2	30	2	0	0	91	6	0	1	121	8	0	1
3-5	5	4	0	0	17	3	0	0	22	7	0	0
6-8	0	0	0	0	1	0	0	0	1	0	0	0
9-10	0	0	0	0	0	0	0	0	0	0	0	0

a cfu = colony-forming unit. SI = sanitary inspection. TTC = thermotolerant coliform.

VERY LOW	LOW	MEDIUM	HIGH

Table 3.20 **Overall risk-to-health classification for household water quality**

Risk category	Household piped water		Household container		Total	
	No. of supplies	Proportion (%)	No. of supplies	Proportion (%)	No. of supplies	Proportion (%)
Very low	30	73.2	91	76.5	121	75.6
Low	7	17.1	23	19.3	30	18.8
Medium	4	9.8	4	3.4	8	5.0
High	0	0.0	1	0.8	1	0.6

Nitrate

Approximately one third of all source waters and 100% of water samples collected from households were tested for nitrate. As with the source waters, water in none of the households investigated exceeded the WHO guideline value or national standard value. A comparison of source water and household water quality for nitrate is shown in Table 3.21. Of the 73 samples for which such a comparison was possible, 42.5% showed either the same nitrate concentration in source and household waters, or showed a difference in concentration of no more than 10% (i.e. the estimated precision of the nitrate test). One third of the samples showed an increase, and 23.3% a decrease, in concentration beyond the 10% margin.

The RADWQ survey data do not allow an in-depth analysis of causes at the sites that showed changes in water quality between source and household. In general terms, an increase in nitrate concentration may be due to oxidation of reduced nitrogen species in the water (e.g. ammonia or nitrite), and/or to intrusion of nitrogen species into the distribution system. A decrease in nitrate concentration may be due to denitrification processes under reducing conditions.

Table 3.21 **Nitrate concentrations in corresponding source and household water supplies**

NO_3 level in household water relative to source		Household piped water		Household container		Total	
		No. of samples	Proportion (%)	No. of samples	Proportion (%)	No. of samples	Proportion (%)
Higher by	>10%	2	11.1	15	27.3	17	23.3
	≤10%	2	11.1	4	7.3	6	8.2
Equal		3	16.7	15	27.3	18	24.7
Lower by	≤10%	1	5.6	6	10.9	7	9.6
	>10%	10	55.6	15	27.3	25	34.2

Free residual chlorine

It is recommended that chlorinated water supplies be tested for free residual chlorine, as this directly influences the microbiological quality of water. Very low residual chlorine is cause for concern, because the level of protection against microbial contamination is reduced.

A total of 130 household samples were tested for free residual chlorine, of which 34.5% showed the same concentration in source and household waters, or decreases/increases in concentration by ≤10% (Table 3.22). One third of the samples showed an increase of more than 10% in free chlorine concentration between source and household samples, and one third a decrease of more than 10%. The latter result was expected and explained by the use of chlorine as disinfectant and/or oxidant. It is difficult to explain why one third of the water samples showed an increase in residual chlorine between source and household, except as measuring mistakes and/or wrong assignment of water supply scheme numbers to household samples and water sources.

Table 3.22 **Free chlorine concentrations in corresponding source and household water supplies**

Free chlorine in household water compared with the source		Household piped water		Household container		Total	
		No. of samples	Proportion (%)	No. of samples	Proportion (%)	No. of samples	Proportion (%)
Higher by	>10%	13	32.5	29	32.2	42	32.3
	≤10%	1	2.5	1	1.1	2	1.5
Equal		9	22.5	32	35.6	41	31.5
Lower by	≤10%	2	5.0	0	0.0	2	1.5
	>10%	15	37.5	28	31.1	43	33.1

Copper

The most significant health effects from high doses of copper are gastrointestinal bleeding, renal failure and possibly liver failure, and nausea and diarrhoea at lower doses. Copper also affects the acceptability of water as it imparts both taste and colour at concentrations >2.4 mg/l and stains laundry and sanitary waters at concentrations >1 mg/l. Copper can enter the body via the ingestion of contaminated food and water. Copper in drinking-water usually derives from pipes used in household plumbing and from copper-containing solders. However, there are natural sources of copper in groundwater, and some industrial discharges may also contain copper. Copper concentrations in water supplies range from ≤0.0005 to ≥30 mg/l, the higher concentrations usually being associated with corrosion of interior plumbing. The WHO guideline value is 2.0 mg/l.

All water samples collected from households met the national standard and WHO guideline value (Table 3.23). This is explained by the fact that the use of copper containing materials in plumbing was discontinued in Tajikistan.

3.9 Quality control procedures

Analytical quality control is particularly important in microbiological testing, because microorganisms are discrete particles that can vary individually, in contrast to chemicals where variation occurs at the molecular level and which is typically below the limit of detection in routine analytical methods. Aseptic technique is the most important way to ensure the quality of results. Evaluating whether aseptic technique has been followed is easily accomplished using a simple form (provided in the RADWQ Handbook). Field teams assessed aseptic technique weekly throughout the RADWQ project. The evaluation was supplemented with field visits by the coordinators of the Republican SES and UNICEF staff to monitor progress.

A duplicate split-sample approach was used in quality control tests of microbiological analyses. For any single result, a range of acceptable results from a second analysis can be defined assuming a Poisson distribution for the bacteria in the water. In this approach, a 200 ml sample is mixed thoroughly and then divided into two 100 ml subsamples. The count from the first sample is recorded and the 95% confidence limit for the second (paired) count is recorded from the quality control table for microbiological tests (provided in the RADWQ handbook). The count from the second sample is then recorded alongside the first and if the second reading falls outside the confidence intervals it is highlighted. It should be stressed that a second value outside the 95% confidence limits does not indicate the sample is contaminated and that the results should be rejected. Quality control tests were carried out on each day’s microbiological analysis.

A split-sample approach was also used in quality-control tests of the chemical analyses. A reasonable level of precision for these assessments was 90% (i.e. the results of both tests should be within 10% of the average value). This was calculated by finding the difference between the first result and the average, and then dividing this by the average and multiplying by 100. If the second result was outside of the 90% compliance range, the data were marked as suspect. Quality control checks for chemical analyses (i.e. pH, conductivity, turbidity, free residual chlorine, nitrate, fluoride and iron) were carried out once per week.

Quality control data were not properly recorded and filed at the beginning of the assessment, mainly because there were no forms available. Instead, field teams recorded the quality control results in their regular notebooks. The data were not entered into the SanMan database, but kept in files.

Table 3.23 **Compliance of household water supplies with the Tajikistan national standard and WHO guideline value for copper**[a]

Broad area	Household piped water			Household container			Total		
	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)	No. of samples	Compliance WHO GV (%)	Compliance nat. std. (%)
RRS & Dushanbe	14	100.0	100.0	35	100.0	100.0	49	100.0	100.0
Khatlon	14	100.0	100.0	16	100.0	100.0	30	100.0	100.0
Sughd	10	100.0	100.0	28	100.0	100.0	38	100.0	100.0
GBAO	2	100.0	100.0	8	100.0	100.0	10	100.0	100.0
National	40	100.0	100.0	87	100.0	100.0	127	100.0	100.0

[a] GV = guideline value. nat. std. = national standard. GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

4 Conclusions and recommendations

4.1 Drinking-water quality

The RADWQ results show that drinking-water in Tajikistan is generally of high quality. Of the 1620 sites tested, 87.2% complied with the WHO guideline value and the national standard for thermotolerant coliforms, with utility piped supplies showing slightly better compliance (88.6%) than protected springs (82.0%). If arsenic, fluoride and nitrate were included in the analysis, the overall compliance was 86.9% and 65.9% for WHO guideline values and national standards, respectively.

In contrast to the RADWQ results, national surveillance statistics indicate that compliance with the national standard for bacteriological parameters is much lower: only 69.0% and 66.5% of the water samples taken from utility piped systems in 2003 and 2004, respectively (Table 1.3). The reason for this discrepancy is unclear, but may include:

- Many rayon and city SESs were unable to follow standard procedures for the storage and transportation of microbial water samples. The recommended maximum storage time and temperature were frequently exceeded, owing to a lack of adequate technical equipment and transportation.
- The national data may better reflect seasonal variations, because the data include results for the spring season, in which thaw and heavy rainfalls frequently reduce the quality of surface water sources. In contrast, the RADWQ study mainly took place in autumn and winter.

Although the high level of compliance for thermotolerant coliforms is good news on the one hand, the significance of the data is limited due to the snapshot nature of the RADWQ results. Clean water supplies can become contaminated with faeces as a result of heavy rains, thaws or spills; a failure to properly treat the water; a lack of chlorine; and low pressure or pipe breaks in the distribution system. If not adequately controlled, such events can lead to drinking-water becoming contaminated with microbes, potentially leading to outbreaks of waterborne disease. Such outbreaks are regularly reported in Tajikistan, for example the typhoid fever outbreaks in 1996 and 1997 (Anonymous, 1998; Mermin et al., 1999; Tarr et al., 1999). The RADWQ findings rarely reflect such events, but rather provide baseline information on water quality that can be used in conjunction with the results of the sanitary inspections to develop regional or national strategies for improving long-term water safety.

Chemical pollutants

The chemicals included in the RADWQ survey were nitrate, fluoride and arsenic (Section 3.2). For both arsenic and nitrate, compliance with the WHO guideline values and national standards was 100% for all technologies investigated in all broad areas. Maximum concentrations were 22.8 mg/l and <10 µg/l for nitrate and arsenic, respectively. These results are consistent with the data from the Tajik surveillance system.

Fluoride compliance with the WHO guideline value of 1.5 mg/l was 99.7%, whereas compliance with the national drinking-water standard of 0.7 mg/l was only 73.8%. The maximum fluoride concentration found was 1.95 mg/l and the median value was 0.50 mg/l. The highest concentrations were detected in Sughd, where the level of compliance was the lowest of all oblasts (51.9%).

Sanitary risk factors

The results for the survey of sanitary risk factors were not unexpected and confirm previous and current knowledge about the technical status and sanitary conditions of water supplies in Tajikistan. The most frequent risk factors in the distribution systems of utility piped supplies were discontinuity in the last ten days (56.4%), collecting potentially contaminated water from around the sample sites (16.7%), and damaged or corroded inspection covers (Table 3.13). The risk-to-health analysis revealed that 95.6% of utility piped supplies could be classified in the "very low" or "low" risk-to-health category (Table 3.15).

For protected springs, the most significant sanitary risk factors were a missing or broken protective fence (63.2%); animals having access to within ten meters of the spring (52.4%); and faulty masonry protecting the spring (37.7%). Sanitary inspections confirmed that 44.3% of the springs visited were not "protected" and thus should not have been included in the RADWQ survey, but when the survey was designed information on the protection of individual springs was unavailable. Of all the springs visited, 11.7% were classified in the "medium" or "high" risk-to-health categories, which means they need particular attention when planning interventions to improve the sanitary conditions of springs.

4.2 Project management and implementation

- Implementation of the RADWQ project was facilitated by the managerial and technical support of the UNICEF country office to the Republican SES, the national implementing agency. A lack of staff time limited the input and support of the local WHO liaison office.
- The initial budget for implementing the RADWQ survey in Tajikistan was too small, but the UNICEF country office provided additional funding so that the project could be implemented without delay.
- Being away from the workplace and home for weeks or months during the fieldwork poses an extra burden for team members (and their families). Future RADWQ programmes should include cost-of-living and travel allowances, to compensate field-team members for extra expenditures they incur and provide them with an incentive.
- Much time and effort was spent translating documents (e.g. handbook, presentations, guidance notes of the consultant, report forms, field-team reports, final report) from English to Russian, or vice versa. Most of the translation work was undertaken by the staff of the UNICEF country office. Future RADWQ programmes should account for translation costs in countries where English is not the mother tongue.
- The international consultants provided excellent training and remote support. Potential areas for improving training include:
  - All guiding documents (e.g. presentations, handbooks, test kit manuals) should be available in Russian prior to training for the RADWQ study.
  - More emphasis should be given to testing equipment under real field conditions before starting the project.
  - More emphasis should be given to practical exercises in using sanitary inspection forms. Not all of the questions were easily understood, particularly those for water treatment works, where the terminology was unclear. Most of the field team members had no experience using sanitary inspection forms.
  - More detailed explanations are needed on how to charge batteries.
- Comments from the field teams included:
  - The timing of the fieldwork could have been better. Field implementation mainly took place in autumn and winter when weather and road conditions led to problems in accessing the sampling sites and in maintaining the electricity supply. If future RADWQ surveys are implemented in winter, the cluster size would need to be smaller than that used in the present study, particularly for the rural areas.
  - Communication between local authorities and field teams was difficult or practically impossible (such as when field teams needed local advice). Mobile phones would have improved communications and increased the effectiveness of the fieldwork.
  - Supplies of methanol and distilled water were unreliable in the field and not always available at the rayon SES. Planning of future RADWQ projects in Tajikistan should ensure these supplies.
  - It is recommended that the RADWQ handbook includes a checklist of items needed for fieldwork, other than the field-testing equipment itself – items such as gloves, lighters, pens, notebooks, record forms, tissues, sterile distilled water, methanol and sampling bottles.
  - In the winter, power was available for only a few hours a day in many regions, which made it difficult for the field teams to charge the incubator storage battery.

- Most of the spring locations in the mountainous areas were difficult to access by car and team members frequently had to walk to reach the sampling point. Because the test kits are heavy to carry, future field teams should have at least one man on board.
- The report forms used in the project were useful and might also be used in regular water-quality monitoring.
- The field teams frequently encountered transportation problems (e.g. breakdowns, lack of fuel). Cars could not always cope with the weather and road conditions, and not all sampling sites could be easily reached.
- It was difficult to find places to sleep in rural areas.

4.3 Field kits

- Some consumables provided with the Wagtech test-kits (e.g. pH buffers and conductivity standard solutions) leaked during transportation and damaged many of the membrane filters by soaking them. Fortunately, Wagtech replaced both the spilled solutions and the membrane filters within two weeks after the training.
- A sealing gasket was missing from a filtration apparatus, but Wagtech again provided a replacement within two weeks.
- The digital arsenator was not used in the RADWQ project because of the low concentrations of arsenic in the water sources investigated.

4.4 Added value of the project and potential future uses

- "*The experience gained in the project is not only made for the folders, but will have a life after the project*." (Dr Aliev Samaridin, Chief Doctor of the Republican SES, and RADWQ project coordinator).
- The RADWQ project fostered collaboration between the institutions concerned with providing drinking-water and/or dealing with drinking-water quality issues, particularly between the rayon SES, local authorities and Vodokanal agencies. Thus, the project reinforced awareness of water quality issues and of the impact of water quality on public health. The project also triggered discussions about viable monitoring approaches in Tajikistan, and it re-emphasized the important role of government bodies in that task.
- A working group, led by the Republican SES, will look into the details of the sanitary risks and will give recommendations for remedial actions/preventative measures to improve the water supplies. This analysis will also provide input to the development of sanitary norms that are currently being developed in Tajikistan.
- National project team members (e.g. laboratory staff, coordinators) are now better qualified in water-quality analysis, particularly in the use of field testing equipment, and they acquired practical experience in implementating surveys to monitor water-quality. Thus, the project contributed to building the capacity of government bodies in planning and implementing water-quality assessments. The effects of this achievement will continue beyond the end of the project.
- For the first time in Tajikistan, the RADWQ project provided a statistically representative picture of drinking-water quality and sanitary conditions. The data provide good baseline information for optimizing national approaches to water-quality monitoring and intervention strategies for improving water safety in the country.
- With support from international donor agencies, the Republican SES plans to extend the RADWQ study to evaluate drinking-water quality and sanitary conditions at unimproved sources and in rayons not covered by the pilot study. The goals are to gain a more representative picture of the quality of the water actually consumed by the majority of the Tajik population, and to compare water quality of improved and unimproved sources.
- The field testing equipment provided through the RADWQ project will continue to be used by the Tajik government for routine water-quality monitoring. The portable test kits proved to be very useful under Tajik conditions, where the lack of transportation and an unreliable power supply frequently hamper efficient monitoring by standard procedures. The test kits complement laboratory based analyses and help rayon SESs fulfil their responsibilities to monitor the water

quality. The Republican SES hopes to attract additional funding in the near future to ensure a continuous supply of consumables, and to purchase additional test kits for rayon SESs. The improvement of rayon SES laboratories remains a high priority.

- The introduction of an electronic database (i.e. SanMan) for recording and analysing water-quality data was the first of its kind in Tajikistan. It was received positively, because previously all monitoring data for drinking-water quality were recorded on paper only. The Republican SES wishes to continue using the SanMan database, and in the long term to extend its use to the oblast and rayon SESs, and develop a unified, electronic database and national reporting scheme. The Republican SES is interested in developing a Russian version of the database if funding can be raised.

4.5 Suggestions for improving the RADWQ methodology

- The RADWQ handbook was not always clear and self-explanatory in its description of the methodology. It is therefore suggested that the relevant sections in the handbook be improved, using the presentation materials and worked examples the international consultants prepared for the training course. A Russian language resource and training package on implementing RADWQ projects would also be helpful.
- In Tajikistan, the survey methodology could be largely followed from the RADWQ handbook. As required by the methodology, the rayon database provided information about the numbers of supply schemes per technology and the prevailing population served at three administrative levels. As outlined in Section 2.2, however, two deviations had to be made. First, when determining the number of supply zones in the utility piped supplies, it was necessary to reduce the zone size from 5000 to 2500 people, otherwise the total number of supply zones required (according to primary stratification) could not have been reached in Tajikistan. Second, a repeat sampling approach was taken for utility piped supplies, in which each sampling point was visited twice. This halved the number of sampling points or clusters needed for the study. These changes allowed the survey to move forward, and it is recommended that design flexibility be allowed in future RADQW projects, particularly for smaller countries where the population served by utility supplies is relatively small.
- The RADQW methodology could better consider the issue of seasonality. Assessments should cover at least two seasons, to give a more realistic picture of the water quality in a region or country, and to develop a better understanding of water-quality changes over the year. The issue of seasonality could be addressed by a repeat sampling approach, in which each water supply/sampling point selected is visited twice. This would keep the overall sample size constant, but not increase costs and time for carrying out the assessment. However, the number of clusters to be selected would be halved, and thus the geographical spread of the assessment reduced.
- The RADQW survey considered only improved water souces, even though in Tajikistan more than half of the population consumes water from unimproved sources. While this was a legitimate approach for the pilot study, future rapid assessments should include all supply technologies that serve more than 5% of the population.
- The standard set of sanitary risk inspection forms need to be better adapted to the local conditions, as not all of the questions were applicable or relevant to the Tajik situation.

In conclusion, the parameters used in the RADQW assessment were sufficient to produce a snapshot of water quality in Tajikistan.

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Annex 1. Rayon database of utility piped supplies and springs[a]

Broad area (oblast)	Sampling unit (rayon)	Total pop. (*N*)	Utility piped supplies								Springs		
			Population. Served (STAT)	Proportion (STAT)	Number UPS (STAT)	RADWQ number (STAT)	Population served (INV)	Proportion (INV)	Number UPS (INV)	RADWQ number (INV)	Population served (STAT)	Proportion (STAT)	Number (STAT)
RRS & Dushb	Dushanbe	641 075	627 348	97.9%	23	251	594 253	92.7%	7	240	825	0.1%	1
RRS & Dushb	Garm	89 317	20 158	22.6%	2	8	20 158	22.6%	2	9	48 493	54.3%	81
RRS & Dushb	Gissar	224 119	87 313	39.0%	24	35	73 236	32.7%	15	37	27 289	12.2%	38
RRS & Dushb	Jirgital	55 850	40 275	72.1%	12	16	40 275	72.1%	11	21	9 868	17.7%	13
RRS & Dushb	Leninskiy	294 881	169 645	57.5%	24	68	157 890	53.5%	22	73	39 432	13.4%	38
RRS & Dushb	Rogun	30 636	13 436	43.9%	4	5	9 771	31.9%	1	4	13 436	43.9%	16
RRS & Dushb	Kofarnigan	245 260	108 850	44.4%	20	44	59 292	24.2%	2	24	51 220	20.9%	33
RRS & Dushb	Tursunzade	200 773	141 313	70.4%	27	57	141 868	70.7%	29	70	7 601	3.8%	20
RRS & Dushb	Fayzabad	74 310	21 635	29.1%	8	9	21 635	29.1%	7	12	52 483	70.6%	59
RRS & Dushb	Darband	61 058	10 573	17.3%	4	4	8 381	13.7%	3	4	45 118	73.9%	51
RRS & Dushb	Varzob	54 368	3 682	6.8%	1	1	3 682	6.8%	1	2	23 680	43.6%	56
RRS & Dushb	Tavildara	14 560	4 731	32.5%	2	2	2 590	17.8%	2	2	4 160	28.6%	31
RRS & Dushb	Tajikabad	34 398	18 279	53.1%	9	9	15 217	44.2%	5	9	0	0.0%	0
RRS & Dushb	Shakhrinau	87 994	41 777	47.5%	8	17	40 904	46.5%	6	19	4 462	5.1%	7
Subtotal		**2 108 599**	**1 309 015**	**62.1%**	**168**	**526**	**1 189 152**	**56.4%**	**113**	**526**	**328 067**	**15.6%**	**444**
Khatlon	Bokhtar	254 946	106 937	41.9%	21	43	62 895	24.7%	2	27	0	0.0%	0
Khatlon	Yavan	136 200	84 155	61.8%	13	34	84 155	61.8%	2	35	12 243	9.0%	17
Khatlon	Vakhsh	131 174	33 899	25.8%	6	14	43 703	33.3%	3	19	2 061	1.6%	5
Khatlon	Kumsangir	92 111	2 915	3.2%	2	2	3 813	4.1%	1	2	0	0.0%	0
Khatlon	Qabadiyan	129 846	27 841	21.4%	14	14	25 435	19.6%	6	13	0	0.0%	0
Khatlon	Kolkhozabad	132 698	30 717	23.1%	9	12	28 122	21.2%	5	13	0	0.0%	0
Khatlon	Khoja Maston	115 107	9 795	8.5%	21	21	7 845	6.8%	3	5	0	0.0%	0
Khatlon	Shaartuz	87 332	20 622	23.6%	12	12	32 371	37.1%	8	17	0	0.0%	0
Khatlon	Panj	89 995	8 505	9.5%	23	23	5 589	6.2%	3	4	0	0.0%	0
Khatlon	Jillikul	73 142	5 476	7.5%	3	3	5 476	7.5%	1	3	0	0.0%	0
Khatlon	Gozimalik	75 188	15 435	20.5%	3	6	15 106	20.1%	3	8	0	0.0%	0
Khatlon	Sarband	33 460	15 400	46.0%	4	6	11 680	34.9%	1	5	0	0.0%	0
Khatlon	Nurek	42 800	19 750	46.1%	3	8	28 907	67.5%	2	12	4 958	11.6%	8
Khatlon	Beshkent	25 297	0	0.0%	1	1	0	0.0%	0	0	3 646	14.4%	7
Khatlon	Shurabad	45 496	11 068	24.3%	6	6	11 791	25.9%	4	6	25 111	55.2%	38
Khatlon	Vosse	154 124	140 270	91.0%	21	56	56 813	36.9%	17	32	4 402	2.9%	11
Khatlon	Dangara	104 902	51 294	48.9%	8	21	12 713	12.1%	5	7	20 736	19.8%	23
Khatlon	Kulyab	163 746	78 898	48.2%	12	32	97 344	59.4%	12	43	2 342	1.4%	13
Khatlon	Muminabad	69 365	28 072	40.5%	17	17	26 527	38.2%	14	19	39 653	57.2%	46
Khatlon	Moskovskiy	112 780	73 201	64.9%	27	29	106 397	94.3%	23	54	2 330	2.1%	6
Khatlon	Farkhor	121 926	48 384	39.7%	12	19	36 292	29.8%	7	17	0	0.0%	0
Khatlon	Sovietskiy	52 478	15 684	29.9%	2	6	13 989	26.7%	2	7	22 308	42.5%	44
Khatlon	Khovaling	41 506	19 578	47.2%	9	9	8 923	21.5%	7	7	21 116	50.9%	93
Khatlon	Baldjuvan	23 056	8 700	37.7%	1	3	8 785	38.1%	1	4	14 918	64.7%	109
Subtotal		**2 308 675**	**856 596**	**37.1%**	**250**	**397**	**734 671**	**31.8%**	**132**	**359**	**175 824**	**7.6%**	**420**
Sughd	Asht	116 137	75 174	64.7%	22	30	57 371	49.4%	15	31	18 732	16.1%	10
Sughd	Ayni	72 531	25 900	35.7%	14	14	25 665	35.4%	12	15	15 076	20.8%	19
Sughd	Ganchi	120 369	85 577	71.1%	17	34	89 732	74.5%	19	44	12 441	10.3%	6
Sughd	Zafarabad	53 041	50 720	95.6%	4	20	16 334	30.8%	3	8	0	0.0%	0
Sughd	Isfara	205 291	125 638	61.2%	16	50	32 569	15.9%	8	17	0	0.0%	0
Sughd	Kanibadam	169 000	91 440	54.1%	10	37	72 023	42.6%	9	34	0	0.0%	0
Sughd	Matchinskiy	91 500	85 326	93.3%	19	34	38 130	41.7%	13	21	5 032	5.5%	8
Sughd	Nauskiy	103 479	66 108	63.9%	18	26	118 457	114.5%	18	56	1 281	1.2%	4
Sughd	Jabor Rasulov	104 342	63 998	61.3%	18	26	29 416	28.2%	10	18	554	0.5%	2
Sughd	Penjakent	201 393	125 791	62.5%	13	50	66 162	32.9%	14	32	25 085	12.5%	49
Sughd	Istravshan	193 032	131 276	68.0%	20	53	117 690	61.0%	10	53	12 896	6.7%	16
Sughd	Gafurova	497 660	374 252	75.2%	43	150	201 790	40.5%	21	92	13 244	2.7%	9
Sughd	Shakhristan	27 498	25 391	92.3%	5	10	10 404	37.8%	5	6	4 220	15.3%	11
Sughd	K. Mastchonskiy	18 617	0	0.0%	0	0	0	0.0%	0	0	18 617	100.0%	55
Subtotal		**1 973 890**	**1 326 591**	**67.2%**	**219**	**534**	**875 743**	**44.4%**	**157**	**427**	**127 178**	**6.4%**	**189**
GBAO	Shugnon	62 600	26 637	42.6%	7	11	25 657	41.0%	6	14	4 271	6.8%	13
GBAO	Murgab	15 925	0	0.0%	0	0	0	0.0%	0	0	0	0.0%	0
GBAO	Ishkashim	26 102	2 698	10.3%	1	1	2 698	10.3%	1	2	6 120	23.4%	19
GBAO	Roshtkalla	23 724	3 544	14.9%	1	1	3 544	14.9%	1	2	6 655	28.1%	41
GBAO	Rushon	24 531	4 993	20.4%	1	2	4 993	20.4%	1	2	17 624	71.8%	83
GBAO	Vanj	28 360	3 650	12.9%	1	1	3 650	12.9%	1	2	9 450	33.3%	47
GBAO	Darvoz	24 060	4 110	17.1%	1	2	4 110	17.1%	1	2	7 990	33.2%	53
Subtotal		**205 302**	**45 632**	**22.2%**	**12**	**18**	**44 652**	**21.7%**	**11**	**24**	**52 110**	**25.4%**	**256**
TJK		**6 596 466**	**3 537 834**	**53.6%**	**649**	**1 475**	**2 844 218**	**43.1%**	**413**	**1 336**	**683 179**	**10.4%**	**1 309**

[a] INV = data derived from the rayon database. STAT = data derived from the republican SES. UPS = utility piped supply.

Annex 2. Inventory of utility piped supplies[a]

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
RRS & Dushanbe	**RRS & Dushanbe**	**141**	**134**	**1 280 775**	**140**	**526**
Dushanbe city	Юго-западный Душанбе водоканал	1	1	235 000	1	94
	Напорный водопровод Душанбе водоканал	1	1	65 000	1	26
	Кафарнигонский водопровод	1	1	189 000	1	76
	Самотечный водопровод	1	1	94 312	1	38
	Водопровод поселок Гипрозем	1	0	458	0	0
	Водопровод ПО Памир	1	0	2 800	1	0
	Водопровод Арматурного Завода	1	1	2 600	1	2
	Водопровод Завода ЖБК и СТ	1	0	6 100	1	0
	Водопровод поселок Комсомольский	1	0	3 957	1	0
	Мясоконсервный комбинат	1	0	1 567	1	0
	ДСУ 5	1	0	1 348	1	0
	Плодокомбинат	1	0	411	0	0
	Завод ДМК -1 КООП Домостроитель	1	0	2 456	1	0
	АТП-1 Минстрой	1	0	7 250	1	0
	ДПХБО МинЛегпром	1	0	635	1	0
	А/б 10	1	0	584	1	0
	Школа интернат №2 МинОбр	1	0	636	1	0
	водопровод Варзоб совет по Туризму	1	0	1 853	1	0
	ПО Таджик цемент	1	1	2 450	1	1
	Пионерский лагерь Шарора	1	1	5 891	1	3
	Завод ОЗНТ	1	0	1 456	1	0
	ПО таджикмебель	1	0	1 560	1	0
	Subtotal:	**22**	**7**	**627 324**	**20**	**240**
Garm	Навобод	1	1	12 764	1	6
	Нимич Джафо	1	1	7 394	1	3
	Subtotal:	**2**	**2**	**20 158**	**2**	**9**
Gissar	с-к Карл Маркс	1	1	7 586	1	4
	Калинина	1	1	988	1	1
	Л.Муродова	1	1	12 218	1	5
	Москва	1	1	6 822	1	3
	Дзержинский	1	0	234	0	0
	Учхоз	1	1	2 351	1	1
	НПО земледелие	1	1	8 200	1	4
	УВК Гиссар	1	1	11 564	1	5
	Таджикводоканал	1	1	10 586	1	5
	50 лет октября Сельхозводопровод	1	1	4 415	1	2
	фирма Файзбахш	1	1	550	1	1
	Школа интернат Ватан	1	0	0	0	0
	Лесная школа интернат	1	0	230	0	0
	УПК слепых	1	1	1 529	1	1
	фирма Фарух	1	1	1 920	1	1
	сельхозтехника	1	0	407	0	0
	радиостанция	1	0	373	0	0
	ХШМПРО	1	1	2 660	1	2
	ОТБТПС	1	0	384	0	0
	ПМК-7	1	1	1 214	1	1
	ТУББАЛЬНИЦА	1	0	0	0	0
	Санатория Шамбары	1	0	0	0	0
	Лепрозорий	1	1	633	1	1
	с-к Ленинизм	1	0	0	0	0
	Subtotal:	**24**	**15**	**74 864**	**15**	**37**
Jirgital	ОТР Орджоникидзеабад	1	1	14 078	1	6
	С-з Намуна	1	1	6 395	1	3
	С-з Коммунизм	1	1	1 677	1	1
	С-з Куприк-боши	1	1	1 355	1	1
	С-з Бустон	1	1	3 644	1	2
	С-з Опорный пункт	1	1	983	1	1
	С-з Ляхш	1	1	1 423	1	1
	С-з Янги Шахр	1	1	5 433	1	3
	С-з Одинаев	1	1	1 774	1	1
	С-з Шестопалов	0	1	0	0	0
	С-з 60 лет Октября	1	1	1 482	1	1
	С-з Кызыл Суу	1	1	2 031	1	1
	Subtotal:	**11**	**12**	**40 275**	**11**	**21**
Leninskiy	пос. Сомониен	1	1	24 600	1	10
	пос. Новобод	1	1	6 780	1	3
	Навобод в.ч.	1	0	450	0	0
	пос. Нефтяник	1	1	6 800	1	3
	пос. РМЗ	1	1	1 420	1	1
	пос. ДПФ	1	1	3 280	1	2
	пос. Хлопзавод	1	1	3 100	1	2
	пос. МИС	1	1	5 250	1	3

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
	пос. Радиостанция	1	1	5 490	1	3
	пос. Райсельхозтехникум	1	1	4 230	1	2
	РКПБ 1	1	1	720	1	1
	Кос. Им. Пулотова	1	1	12 290	1	5
	Кос. Россия	1	1	20 110	1	9
	Кос. Победа	1	1	2 009	1	1
	Сов. Кирова	1	1	2 065	1	1
	Сов. Ленинград	1	1	1 110	1	1
	Сов. Коммунизм	1	1	14 605	1	6
	Сов. Р. Давлятов	1	1	12 090	1	5
	Сов. Варзоб	1	1	16 040	1	7
	Сов. Шайнак	1	1	7 150	1	3
	Сов. Конезавод	1	1	5 790	1	3
	Завод Неруд. Материал	1	0	380	0	0
	Мехкарьер	1	1	2 111	1	1
	Автобаза	1	1	850	1	1
	Subtotal:	**24**	**22**	**158 720**	**22**	**73**
Rogun	АООТ "РГС" г. Рогун	1	1	9 771	1	4
	П. Оби-гарм	0	1	4 448	1	0
	ЦГБ	0	0	0	0	0
	Subtotal:	**1**	**2**	**14 219**	**2**	**4**
Kofarnigan	Гор. Водопровод УВК Кофарнигон	1	1	45 000	1	18
	К-з Фирдавси уч Байнал	1	1	14 292	1	6
	К-з Бахор уч. Мачитон	0	1	13 845	1	0
	К-з К. Исмоилов уч. Туркобод	0	1	3 158	1	0
	К-з Ленин уч. Ходжабойкул	0	1	1 940	1	0
	к-з Джавони уч. Амоншайхи	0	1	1 981	1	0
	к-з Дусти уч. Тангаи	0	1	7 214	1	0
	к-з Гулистон уч. Бошкарасу	0	1	0	0	0
	водопровод ЮГГЭ поселок Разведчиков	0	1	2 705	1	0
	Псицефабрика поселок Навруз	0	1	6 600	1	0
	Автоколонна 2929 поселок Яккатол	0	1	0	0	0
	РКТБ 3 поселок Мачитон	0	1	2 600	1	0
	Инфекционная больница к-з Бустон	0	1	0	0	0
	АГРЭ поселок Разведчиков	0	1	1 215	1	0
	ДСК гор. Кофарнигон	0	1	0	0	0
	МРМ Сельхозтехника гор. Вахдат	0	1	1 810	1	0
	К-з К. Исмоилов уч. Эскигузар	0	1	2 042	1	0
	Д/О Ромит "Родник"	0	1	0	0	0
	Д/О Явроз "Родник"	0	1	0	0	0
	к-з Заргар уч. Заргар	0	1	3 740	1	0
	К-з Х. Азимов уч. Андигон	0	1	2 721	1	0
	Subtotal:	**2**	**21**	**110 863**	**15**	**24**
Tursunzade	Пахтаобод УВК	1	1	4 065	1	2
	Пахтаобод МРМ	1	1	1 670	1	1
	к-з Дусти уч. Куйбишев	1	1	4 854	1	2
	к-з Дусти уч. Батош	1	1	2 000	1	1
	к-з Дусти уч. Янгиарык	1	1	2 034	1	1
	к-з Назиров уч. Красин	1	1	5 806	1	3
	к-з Назиров уч. Ворошилов	1	1	2 373	1	1
	к-з Назиров уч. Захматкаш	1	1	3 725	1	2
	к-з Назиров уч. Чиртак	0	0	0	0	0
	к-з Мирзоев уч. Кирова	1	1	8 568	1	4
	к-з Мирзоев уч. Заркамар	1	1	7 841	1	4
	к-з Мирзоев уч. А. Курган	1	1	6 365	1	3
	к-з Мирзоев уч. Свердлов	1	1	2 451	1	1
	к-з Мирзоев уч. Москва	1	1	5 262	1	3
	к-з навруз уч. Микоян	1	1	2 043	1	1
	к-з навруз уч. Челюскин	1	1	1 472	1	1
	к-з навруз уч. Чапаева	1	1	4 050	1	2
	к-з навруз уч. Тошгузар	1	1	3 860	1	2
	к-з Буриева уч. К. Нишон	1	1	3 113	1	2
	к-з Буриева уч. К. Нишон-2	1	1	3 345	1	2
	к-з Буриева уч. Лохути	1	1	5 573	1	3
	к-з Буриева уч. Байналминал	1	1	4 188	1	2
	к-з Буриева уч. Чкаловск	1	1	2 198	1	1
	к-з Буриева уч. Гомиш	0	0	0	0	0
	с-з Эфиронос уч. Центр	1	1	2 764	1	2
	с-з Эфиронос уч. Крупская	1	1	2 216	1	1
	с-з абдурахмонова уч. Буденный	1	1	2 483	1	1
	с-з абдурахмонова уч. Саркор	1	1	4 175	1	2
	с-з Правда уч.Асбоб	1	1	3 317	1	2
	Дом Интернат уч. Батош	0	0	0	0	0
	г. Турсунзаде УВК Чинор	1	1	10 032	1	5
	ХПВ ТАДАЗ	1	1	30 025	1	13
	РМЦ ТАДАЗ	1	0	75	0	0

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
	Subtotal:	**30**	**29**	**141 943**	**29**	**70**
Fayzabad	МПЖКХ Файзобод	1	1	9 283	1	4
	ГППЗ к. Лолаги	1	1	3 617	1	2
	ОКТ- 24 к. Дубеда	1	1	1 163	1	1
	к. Мехрабад	1	1	2 226	1	1
	к. Тагназари	1	1	1 011	1	1
	к. Боги - Мири	1	1	2 647	1	2
	к. Чукурак	1	1	1 688	1	1
	Минер источник Файзобод к. Мехробод	0	0	0	0	0
	Subtotal:	**7**	**7**	**21 635**	**7**	**12**
Darband	УВК Комсомолобод	1	1	4 785	1	2
	Лабижар	1	1	1 350	1	1
	Лолазор	1	1	2 246	1	1
	Subtotal:	**3**	**3**	**8 381**	**3**	**4**
Varzob	Варзоб кала	1	1	3 682	1	2
	Subtotal:	**1**	**1**	**3 682**	**1**	**2**
Tavildara	Коммунальный водопровод	1	1	1 860	1	1
	с-з Чилдара	1	1	730	1	1
	Subtotal:	**2**	**2**	**2 590**	**2**	**2**
Tajikabad	УВК Таджикабад	1	1	5 670	1	3
	УВК Таджикабад-2	1	1	2 981	1	2
	Водопровод Фатхобод	1	1	3 000	1	2
	Мазоришинг	1	1	2 449	1	1
	Дарои Мазори Боло	1	1	1 117	1	1
	Subtotal:	**5**	**5**	**15 217**	**5**	**9**
Shakhrinau	пос. Октябрьская	1	1	7 104	1	3
	пос. Шахринав	1	1	7 468	1	3
	РДТС Каратаг	0	0	0	0	0
	К-з им. Ленина	1	1	17 504	1	8
	ПАПО Шахринав	1	1	6 653	1	3
	Винкомбинат	1	1	730	1	1
	Консервный цех Кишоварз	1	0	0	0	0
	Чуптуринская птицефабрика	1	1	1 445	1	1
	Subtotal:	**7**	**6**	**40 904**	**6**	**19**
Khatlon Oblast		**152**	**207**	**994 908**	**203**	**359**
Bokhtar	к-з Коммунизм уч. Дильбар	0	0	0	0	0
	к-з Коммунизм уч. Гулистон	0	0	0	0	0
	с-з Ф. Саидов 1 отделение	0	1	6 120	1	0
	с-з Ф. Саидов 2 отделение	0	0	0	0	0
	с-з Ф. Саидов 3 отделение	0	1	4 960	1	0
	с-з Ф. Саидов 4 отделение	0	0	0	0	0
	с-з Ф. Саидов 4 отделение бригада 17	0	0	0	0	0
	с-з Ф. Саидов 2 отделение бригада 18	0	0	0	0	0
	ВФТНИИЗ	0	0	0	0	0
	с-з Сабзавод	0	0	0	0	0
	с-з Сабзавод уч. Бин-Кано	0	0	0	0	0
	к-з Коммунизм уч. Ворошилова	1	1	5 320	1	3
	к-з Н. Сафаров уч. 18 лет Октября	0	1	2 260	1	0
	УВК. Исмоили Сомони	0	1	7 350	1	0
Kurgan-Tyube city	МПУВ	1	1	57 575	1	24
	Маслоэкстрационный завод	1	0	0	0	0
	Консервный завод	0	0	0	0	0
	Малочный завод	0	0	0	0	0
	Пив Завод	0	0	0	0	0
	Subtotal:	**3**	**6**	**83 585**	**6**	**27**
Yavan	Водопровод Кафарниган	1	1	23 000	1	10
	вод-од Парчасой ТХП №1	1	0	0	0	0
	вод-од Парчасой УЭМВ с-з №1	1	1	61 155	1	25
	Subtotal:	**3**	**2**	**84 155**	**2**	**35**
Vakhsh	Вахш УВК	1	1	19 166	1	8
	Вахш УЭМВ 1	1	1	20 900	1	9
	Сов. Киров 1 отд	1	1	3 637	1	2
	Сов. Киров 3 отд	0	1	2 256	1	0
	Сов. Киров 4 отд	0	0	0	0	0
	Сов. Вахш	0	0	0	0	0
	Subtotal:	**3**	**4**	**45 959**	**4**	**19**
Kumsangir	Кумсангир УВК. Пос Дусти	1	1	3 813	1	2
	УВК. Нижний Пяндж	1	0	65	0	0
	Subtotal:	**2**	**1**	**3 878**	**1**	**2**
Qabadiyan	УВК Кабадиян МКХ РТ	1	1	5 320	1	3
	С-з 50 лет СССР уч. Хает	1	1	3 100	1	2
	С-з 50 лет СССР уч. Большевик	1	1	3 120	1	2
	С-з 50 лет СССР уч. Чаркурган	0	1	3 220	1	0
	К-з Околтин уч. Янгиюль	1	1	5 000	1	2
	К-з Чкалова	0	1	5 148	1	0
	К-з Навои уч. Калинин	1	1	4 526	1	2

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
	К-з Шахоб уч. Ленин	1	1	4 369	1	2
	К-з Коммунизм уч. Центр	0	1	5 414	1	0
	К-з Коммунизм уч. Социализм	0	1	4 200	1	0
	К-з Гулистон	0	1	5 206	1	0
	К-з Пахтакор уч. Истиклолият	0	1	14 534	1	0
	к-з Тельман уч. Горький	0	1	15 646	1	0
	к-з Бобогулов уч. Бештемир	0	1	7 110	1	0
	Subtotal:	**6**	**14**	**85 913**	**14**	**13**
Kolkhozabad	ПГТ Исаева	1	1	11 900	1	5
	пос. Орзу	0	0	0	0	0
	к-з Бегов	1	1	3 518	1	2
	к-з С. Джумаева	1	1	4 944	1	2
	к-з Исанкулова	0	1	2 595	1	0
	к-з Авгонова	0	0	0	0	0
	к-з Ленина	1	1	7 199	1	3
	к-з Горького	0	0	0	0	0
	с-з Иттифок уч. Узун	1	1	561	1	1
	Subtotal:	**5**	**6**	**30 717**	**6**	**13**
Khoja Maston	с-з Курбанов уч. 1 май	0	1	5 143	1	0
	с-з Курбанов уч. Коммунизм	0	1	4 282	1	0
	к-з Калинин уч. Калинин	0	1	7 165	1	0
	к-з Калинин уч. Навди	0	1	2 431	1	0
	к-з Азербайджан уч. Политотдел	0	1	7 415	1	0
	к-з Гайрат уч. Социализм	0	1	9 632	1	0
	к-з Гайрат уч. Тут	0	1	2 073	1	0
	к-з Гайрат уч. Чапаев	0	1	4 792	1	0
	с-з Навобод	0	1	1 364	1	0
	к-з Ленин уч. Янгидехкон	0	1	4 087	1	0
	к-з Ленин уч. Арал	0	1	4 419	1	0
	к-з Дусти уч. Яккатут	0	1	1 911	1	0
	к-з Дусти уч. Пушкин	0	1	2 869	1	0
	к-з Азербайджан уч. Заря востока	0	1	2 145	1	0
	СПТУ 37	0	0	311	0	0
	к-з комсомол уч. Правда	1	1	2 800	1	2
	Молокопункт	0	0	23	0	0
	КВШИ МПО	1	0	375	0	0
	ПМК 7 п. Куйбышевск	0	0	0	0	0
	Райшолк	1	1	3 500	1	2
	ПКЛО	1	1	1 545	1	1
	Subtotal:	**4**	**17**	**68 282**	**17**	**5**
Shaartuz	пос. Шаартуз	1	1	10 900	1	5
	к-з. Айвадж	1	1	7 694	1	4
	к-з Ломоносов уч. Лолазор	0	1	4 500	1	0
	к-з Ломоносов уч. Соят	0	1	4 980	1	0
	к-з Ломоносов уч. Ленин Юли	1	1	1 680	1	1
	к-з Ломоносов уч. Чуянчи	1	1	2 500	1	1
	к-з Янги Турмуш уч. Берляш	0	1	4 200	1	0
	к-з Янги Турмуш уч. К. Маркс	1	1	2 831	1	2
	к-з Бакиров уч. Пахтаобад	1	1	2 600	1	2
	к-з Бакиров уч. Султонобод	1	1	2 060	1	1
	к-з Бакиров уч. Малинина	1	1	2 106	1	1
	к-з Джураев уч. 1 мая	0	1	1 903	1	0
	с-з Ватан	0	1	2 110	1	0
	Subtotal:	**8**	**13**	**50 064**	**13**	**17**
Panj	Пяндж УВК	0	0	0	0	0
	к-з 1 мая уч. Тугул	1	1	2 700	1	2
	к-з 1 мая уч. Гулистон	0	1	4 350	1	0
	к-з 1 мая уч. Чечка	0	1	3 867	1	0
	к-з 1 мая уч. Тельман	0	1	2 480	1	0
	МТФ 1	0	1	4 022	1	0
	к-з Ленин уч. Комсомол	0	1	3 555	1	0
	к-з Ленин уч. Янги турмуш	0	1	1 790	1	0
	к-з Правда уч. Бурка	0	1	2 090	1	0
	к-з Правда уч. Сельга	0	1	400	0	0
	МТФ 2	1	1	1 400	1	1
	к-з Маданият уч. Куйбишева	0	1	2 342	1	0
	к-з Маданият уч. Энгельс	1	1	1 489	1	1
	к-з Дзержинский уч. Турдышех	0	1	2 670	1	0
	к-з Дзержинский уч. Сафедорон	0	1	1 820	1	0
	к-з Дзержинский уч. Сармантой	0	1	1 860	1	0
	к-з Калинина уч. Кульдим	0	1	1 970	1	0
	к-з Калинина уч. Кирова	0	1	1 700	1	0
	к-з Калинина уч. Кизил Юлдуз	0	1	4 550	1	0
	к-з Э. Рахмонова уч. Тенгиз	0	1	4 550	1	0
	к-з Пограничник уч. Кумсай	0	1	4 900	1	0
	с-з Пяндж	0	1	800	1	0

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
	с-з Авангард	0	1	880	1	0
	Subtotal:	**3**	**22**	**56 185**	**21**	**4**
Jillikul	пос. Джилликуль	1	1	5 476	1	3
	к-з Султонов	0	1	0	0	0
	с-з Гараути	0	1	0	0	0
	Subtotal:	**1**	**3**	**5 476**	**1**	**3**
Gozimalik	сов. Уялы уч. Коммунизм	1	1	1 801	1	1
	сов. Уялы уч. Буденый	1	1	2 830	1	2
	Фахрабадский Каскад	1	1	10 475	1	5
	Subtotal:	**3**	**3**	**15 106**	**3**	**8**
Sarband	Водопровод г. Сарбанд МКХ	1	1	11 680	1	5
	К-з Одинаев УЭМВ	0	0	0	0	0
	Главносортировочный водопровод	1	0	0	0	0
	Станция осветления ВТЗ	1	0	0	0	0
	Subtotal:	**3**	**1**	**11 680**	**1**	**5**
Nurek	Нурекская ГЭС	1	1	19 800	1	8
	Нурекская ГЭС Туткаули Нав	1	1	9 107	1	4
	УСН HES Sangtuda	1	0	300	0	0
	Subtotal:	**3**	**2**	**29 207**	**2**	**12**
Beshkent	Бешкентский: с-з Олтиной	0	0	0	0	0
	Subtotal:	**0**	**0**	**0**	**0**	**0**
Shurabad	Пос. Шурабад	1	1	6 335	1	3
	Сарчашма	1	1	2 420	1	1
	Догистон	1	1	1 910	1	1
	Мишкорон	1	0	320	0	0
	Дашти Чум	1	0	450	0	0
	Чагам	1	1	1 126	1	1
	Subtotal:	**6**	**4**	**12 561**	**4**	**6**
Vosse	пос. Воссе комм. Вод-д	1	1	19 194	1	8
	Геологоразведка	1	0	0	0	0
	Пив завод	0	0	0	0	0
	Дом Инвалидов	1	0	393	0	0
	Арал	0	1	1 823	1	0
	Хулбук	0	1	3 051	1	0
	Правда	1	1	2 931	1	2
	Воссеобод	1	1	3 493	1	2
	Файзобод	1	1	3 700	1	2
	Кадучи	1	1	5 203	1	3
	Кирова	1	1	2 462	1	1
	Эмомали	1	1	2 303	1	1
	центр Ленин	1	1	2 887	1	2
	Карл Маркс Гелот	1	1	1 114	1	1
	Учкун	1	1	1 260	1	1
	Дарнайчи	1	1	1 344	1	1
	Тугарак	1	1	3 178	1	2
	Москва	1	1	1 101	1	1
	Ильич	1	1	650	1	1
	Шобика	1	1	1 502	1	1
	Тоскала	0	1	3 674	1	0
	Крупская	1	1	3 552	1	2
	Кафтархона	1	1	939	1	1
	Муллониез	0	1	1 915	1	0
	Subtotal:	**19**	**21**	**67 669**	**21**	**32**
Dangara	пос. Себистон	1	1	5 347	1	3
	Гиджовак	1	1	1 981	1	1
	уч. Гулистон	1	1	2 400	1	1
	уч. Бахор	1	1	1 283	1	1
	уч. Оксу	0	1	3 773	1	0
	Пушинг	0	1	3 437	1	0
	Корез	1	1	1 702	1	1
	Гаргара	0	1	2 016	1	0
	Subtotal:	**5**	**8**	**21 939**	**8**	**7**
Kulyab	Чангалбоши	1	1	54 314	1	22
	Тебалай	1	1	26 580	1	11
	Горторг	0	0	0	0	0
	вод-д КОСТО	0	0	0	0	0
	к-з Хамадони уч. Навобод	0	1	1 322	1	0
	Зираки	1	1	1 961	1	1
	Джеркала	1	1	1 796	1	1
	к-з Амиршиев уч. Лавова	1	1	1 419	1	1
	Дагана	1	1	1 422	1	1
	Лагман	0	1	1 619	1	0
	к-з Хатлон уч. Гулистон	1	1	1 622	1	1
	Луликуталь	1	1	1 170	1	1
	с-з Назаров уч. Кухнапар	1	1	2 122	1	1
	Сароceб	1	1	1 475	1	1

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
	Чорбог	1	1	2 115	1	1
	Чорбог	1	1	1 348	1	1
	Subtotal:	**12**	**14**	**100 285**	**14**	**43**
Muminabad	пос. Муминабад ком. Вод-д	1	1	12 535	1	6
	Дехбаланд	1	1	1 203	1	1
	Шахринав	1	1	2 100	1	1
	Кульчашма	1	1	1 161	1	1
	Боггаи	1	1	780	1	1
	Туту	1	1	1 743	1	1
	ГЭШ	1	1	2 470	1	1
	Чукурак	1	1	760	1	1
	Гофилобод-Навобод	1	1	500	1	1
	Мамандион	1	1	704	1	1
	Охджар	1	1	820	1	1
	Ходжаи Нур	1	1	742	1	1
	Гуломобод-Навобод	1	1	504	1	1
	Шулулу	1	1	505	1	1
	Балхови	1	0	346	0	0
	Личак	1	0	210	0	0
	Рискидара	1	0	134	0	0
	Subtotal:	**17**	**14**	**27 217**	**14**	**19**
Moskovskiy	УВК пос. Москва	1	1	16 991	1	7
	Файзабад	1	1	9 326	1	4
	Хлоппункт	1	1	3 165	1	2
	Тагноб	1	1	2 930	1	2
	Чойлобкамар	1	0	449	0	0
	Давлатобод	1	1	4 621	1	2
	Тудани	1	1	728	1	1
	Сафедоб	1	1	1 971	1	1
	Анджиркон-Кодара	1	1	2 207	1	1
	Садвинсовхоз Чубек 1 2 3	1	1	6 971	1	3
	Садвинсовхоз Чубек 4	1	1	590	1	1
	Буденный	1	1	1 501	1	1
	Дараи Калот	1	1	18 061	1	8
	Чапаев	1	1	4 404	1	2
	Мехнатобод	1	1	15 753	1	7
	Янгиюль	0	1	563	1	0
	Хаети Нав	1	1	1 703	1	1
	Тугул	0	1	2 064	1	0
	Турдиев центр	1	1	3 773	1	2
	Советобод	1	1	2 022	1	1
	Сайед	0	1	905	1	0
	Ферма	0	0	275	0	0
	Бешкаппа	1	1	558	1	1
	Окмазор	1	1	5 260	1	3
	Комсомол	1	1	1 351	1	1
	Плодопитомник	1	1	1 351	1	1
	Рыбхоз	1	0	290	0	0
	Конс. Завод	1	0	450	0	0
	Хлопкозавод	0	1	590	1	0
	ЖБИ	1	0	50	0	0
	Сельхозтехника	1	1	580	1	1
	Грав. Сорт. Завод	1	1	580	1	1
	Кирпич завод	0	0	0	0	0
	Subtotal:	**27**	**27**	**112 033**	**27**	**54**
Farkhor	пос. Фархор коммун. Вод-д	1	1	21 693	1	9
	уч. Финский	0	1	2 210	1	0
	уч. Победа-коммунизм	0	1	1 300	1	0
	уч. Иттифок	0	1	2 816	1	0
	уч. Гиссар	0	1	2 186	1	0
	уч. Сурхоб	0	1	1 954	1	0
	уч. Ленин	0	1	1 257	1	0
	уч. Калинин	0	0	0	0	0
	уч. Москва	0	1	2 885	1	0
	Шуркул	1	1	1 600	1	1
	уч. Победа-С. Сафаров	1	1	2 080	1	1
	Карл Маркс	1	1	2 622	1	2
	30 лет октября	1	1	1 500	1	1
	Кизилсу	1	1	2 128	1	1
	Гулшан	1	1	4 669	1	2
	Уртабуз	1	0	0	0	0
	Subtotal:	**8**	**14**	**50 900**	**14**	**17**
Sovietskiy	пос Совет комм. Вод-д	1	1	7 737	1	4
	с-з Совет 2 уч. Чорубкул	1	1	6 252	1	3
	с-з Совет 1	0	0	0	0	0
	с-з Галаба уч. Танобчи	0	0	0	0	0

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
	Subtotal:	**2**	**2**	**13 989**	**2**	**7**
Khovaling	пос. Ховалинг Комм. Вод-д	0	0	0	0	0
	Лохути	1	1	1 625	1	1
	Чукурак	1	1	1 125	1	1
	Джонбахш	1	1	1 580	1	1
	Дороби	1	1	1 570	1	1
	Хонако	1	1	1 400	1	1
	Зардаки	1	1	641	1	1
	Шейхмезон	1	1	400	0	0
	Сефарк	1	1	982	1	1
	Subtotal:	**8**	**8**	**9 323**	**7**	**7**
Baldjuvan	Балджувон	1	1	8 785	1	4
	Subtotal:	**1**	**1**	**8 785**	**1**	**4**
Sughd Oblast		**203**	**163**	**919 380**	**161**	**427**
Asht	p-k Shaydon Консервний завод	1	0	0	0	0
	к-к Шайдон Аштского района	1	1	13 253	1	6
	дж. Jarbulok Selkhoztehnika	1	1	3 550	1	2
	дж. Jarbulok ПККХ им.. К. Назаров	1	1	2 980	1	2
	дж. Камишкурган Solzavod	1	0	211	0	0
	дж. Jarbulok Leskhoz	1	1	850	1	1
	Янгисарой дж. Джарбулок	1	0	397	0	0
	Aksukon	1	0	468	0	0
	к-к Asht к-х им. Назарова	1	1	6 190	1	3
	Dusti	1	1	3 276	1	2
	Uzbekagjar к-х им. Назарова	1	1	2 242	1	1
	Guliston	1	1	720	1	1
	Tajik Акжар к-х им. Назарова	1	1	2 477	1	1
	дж. Jarbulok ООО "Ашт" Янгисарой	0	0	0	0	0
	к-х им. Иттифок Kurkuduk	1	1	4 271	1	2
	Jigda к-х им. Иттифок	1	1	2 971	1	2
	Akkan Верхний к-х им. Калинина	1	1	3 781	1	2
	к-к Дагана к-з им. Сино	1	1	750	1	1
	к-к Бахмал к-з Сино	1	0	499	0	0
	Аккан к-з им. Калинина	1	1	910	1	1
	к-к Ошоба	1	1	9 150	1	4
	Subtotal:	**20**	**15**	**58 946**	**15**	**31**
Ayni	к-к Зарефшан III	1	1	1 567	1	1
	к-з Узбекистан к-к Урмитан	1	1	1 247	1	1
	к/с Узбекистан к-к Урметан	1	1	1 644	1	1
	к-з Согдиен к-к Дар-Дар	1	1	2 111	1	1
	к-з Узбекистан к-к Урмитан	1	1	1 441	1	1
	Водопровод Рудник	1	1	1 254	1	1
	Водопровод к-ка Гюжун	1	1	2 112	1	1
	к-з Узбекистон детсад	1	1	1 863	1	1
	к-з Согдиён к-к Зеробод	1	1	2 789	1	2
	Зоосун	1	1	2 456	1	1
	Фабрика Анзобский ГОК	1	1	4 662	1	2
	к-з Россия к-к Джел	1	1	2 519	1	2
	Центральной районной больницы	1	0	235	0	0
	название	0	1	0	0	0
	Subtotal:	**13**	**13**	**25 900**	**12**	**15**
Ganchi	Ганчи ГППВК	1	1	17 524	1	8
	к-к Яхтан уч. Якубов	1	1	1 833	1	1
	пос. Даштикон	1	1	1 130	1	1
	к-к Кизили дж. Яхтан	1	1	3 879	1	2
	к-к Басманда. К-з Курбонов	1	1	7 386	1	3
	к-к Калининабад. К-з Иттифок	1	1	3 972	1	2
	к-к В. Дальян к-з Свердлов	1	1	5 239	1	3
	к-к Н. Дальян с-з Дальян	1	1	6 503	1	3
	дж. Обиборик Дамкора к-к Арбоб	1	1	4 915	1	2
	к-к Музум с-з Саломов	1	1	5 378	1	3
	п. Кучкина дж. Муджун	1	1	2 213	1	1
	к-к Газантарок	1	1	9 393	1	4
	к-к Какай Дуст дж. Мирзобой	1	1	8 310	1	4
	к-к В. Хуштоир	1	1	1 817	1	1
	к-к Н. Хуштоир	1	1	1 867	1	1
	к-к Сурхоб с-з Сурхоб	1	1	1 606	1	1
	к-к Хавутак В. Амбаргал	1	1	1 255	1	1
	к-к Уртакурган дж. Муджун	1	1	3 202	1	2
	к-к В. Янгиарык дж. Калининабад	1	1	2 310	1	1
	Subtotal:	**19**	**19**	**89 732**	**19**	**44**
Zafarabad	Зафарабад УВК	1	1	12 335	1	5
	пос. Бахт	1	1	2 879	1	2
	по. Хаети Нав	1	1	1 120	1	1
	Subtotal:	**3**	**3**	**16 334**	**3**	**8**
Isfara	Коммунальный водопровод г. Исфара (Гумбази) закрытый	1	1	2 490	1	1

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
	Коммунальный водопровод г. Исфара (Мулдон) Открытый	1	1	3 000	1	2
	г. Шураб (открытый)	1	1	8 019	1	4
	пос. Нефтеабад (открытый)	1	1	3 675	1	2
	пос. Ким (открытый и закрытый)	1	1	1 614	1	1
	Вдп Химзавод (ведомств)	1	0	340	0	0
	Гидрометаллуригический завод	1	0	247	0	0
	Консервного завода	1	0	141	0	0
	Железной дороги	1	0	420	0	0
	с-з Иттифок Чоркух	0	1	7 945	1	0
	с-з Иттифок Октябрь	0	1	1 715	1	0
	к-з Правда к-к Ворух (открытый)	1	1	1 430	1	1
	Зокирхужа Хасанов	0	1	11 385	1	0
	к-за Мукаррамова	0	1	9 107	1	0
	Дружба ТСХВС	1	1	5 325	1	3
	Чоркух-Исфара ТСХВС	1	1	7 016	1	3
	Subtotal:	**12**	**12**	**63 869**	**12**	**17**
Kanibadam	Канибадам УВК ГУП ХМК	1	1	21 322	1	9
	дж. Артыкова АО Иран вод-од Шахидкарагатак	1	1	5 741	1	3
	к-к Кучкак дж. Хамрабаева	1	1	18 534	1	8
	к-к Кизилнур дж. Патар	1	1	3 962	1	2
	к-к Ниязбек дж. Шарипова	1	1	6 987	1	3
	к-к Янги - Равот дж. Пулотон	1	1	2 945	1	2
	к-к Шуркурган дж. Артыкова АО Иран	1	1	5 529	1	3
	пос. Галаба дж. Патар	1	1	1 875	1	1
	пос. Дусти дж. Патар	1	1	5 128	1	3
	Subtotal:	**9**	**9**	**72 023**	**9**	**34**
Matchinskiy	пос. Бустон. УВК	1	1	18 176	1	8
	дж. Обурдон АХД Фирдауси	1	1	1 170	1	1
	дж. Обурдон вод-од УВК АХД Султонов	1	1	2 176	1	1
	Аузикенг дж. Эргашев	1	1	1 189	1	1
	пос. Бустон УВК ЦРБ	1	0	278	0	0
	пос. Такяли	1	1	993	1	1
	дж. Матчо АХД Х. Амиров	1	1	1 776	1	1
	АХД Сомониен дж. Мастчо	1	1	1 560	1	1
	Во-од Зарафшон	1	1	667	1	1
	пос. Кургсой	1	1	2 453	1	1
	Во-од около Маслозавод	1	1	851	1	1
	Хлоппункт Гулистон	1	0	489	0	0
	СУБ Мастчо	1	0	353	0	0
	АХД Калинин	1	1	2 055	1	1
	пос. ТСХТ	1	0	344	0	0
	СУБ Оббурдон	1	0	276	0	0
	пос. Бустон ул. С. Акрамов около СПТУ 35	1	1	3 175	1	2
	АХД Хакикат	1	0	399	0	0
	Спикацытный завод Круксай	1	1	1 889	1	1
	Subtotal:	**19**	**13**	**40 269**	**13**	**21**
Nauskiy	ПГТ Нау УВК-1	1	1	15 475	1	7
	ПГТ Нау УВК-2	1	1	6 125	1	3
	ПГТ Нау УВК-3	1	1	7 089	1	3
	к-к Куштегирмон	1	1	3 156	1	2
	АО Дехкон пос. Нау	1	1	1 080	1	1
	АО Улжабаева к-к Самгар	1	1	891	1	1
	к-к Куркат	1	1	18 954	1	8
	к-к Октеппа дж. Октеппа	1	1	9 671	1	4
	к-к Метартагаяк	1	1	18 120	1	8
	Нау дж. Тагаяк	1	1	11 410	1	5
	Агропромкомбинат пос. Нау	1	1	1 525	1	1
	к-к Андарсай	1	1	6 120	1	3
	уч. Мехнатобод	1	1	2 765	1	2
	уч. Хавотаг	1	1	1 862	1	1
	к-к Саидкурган дж. Октеппа	1	1	8 640	1	4
	Хлебзавод пос.Нау	1	1	1 485	1	1
	Пос Наусельмаш	1	1	2 124	1	1
	Райагропромтехснаб пос. Нав	1	1	1 965	1	1
	Subtotal:	**18**	**18**	**118 457**	**18**	**56**
Jabor Rasulov	УВК Пролетарск	1	1	12 660	1	6
	Хлопзавод	1	0	389	0	0
	Янгикишлак АО Турдибоев	1	0	370	0	0
	Янгикишлак АО Турдибоев	1	1	692	1	1
	Кирпичный завод	1	0	182	0	0
	ЦРБ	1	0	491	0	0
	ППФ Парандапарвар Дигмой	1	0	390	0	0
	Облтуббольница	1	1	1 000	1	1
	Дом инвалидов	1	0	420	0	0
	ПО Паранапарвар к-к Дигмой	1	1	1 089	1	1
	ХРПМ пос. Пролетарск	1	1	950	1	1

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
	АО Саматов уч. Янтокзор дж. Янгихаёт	1	1	1 500	1	1
	уч.Чирик	1	1	5 840	1	3
	АО Турдибоев Таджикабад	1	1	1 705	1	1
	КООП Дигмой к-к Куланбош	1	1	1 000	1	1
	Гулакандоз АО "к-х Самадов"	1	1	2 980	1	2
	пос. Пролетарск ЖДС	1	0	482	0	0
	Subtotal:	**17**	**10**	**32 140**	**10**	**18**
Penjakent	МПУВК г.Пенджикент	1	1	35 475	1	15
	дж. Амондара к-к Майкатта	1	1	890	1	1
	дж.Ери к-к Ери	1	1	2 980	1	2
	водопровод Шашкат дж. Рудаки	1	0	138	0	0
	пос. Согдиана СП "Зарафшан" к-к Филмандар	1	1	4 980	1	2
	дж. Х.Хасан к-к Шурча	1	1	1 220	1	1
	дж. Колхозчиен к-к Навабад	1	1	2 350	1	1
	к-к Маргидар	1	1	980	1	1
	водопровод Шурнова к-к Чимкурган	1	0	450	0	0
	водопровод Чимкурган	1	0	389	0	0
	водопровод МГРЭ	1	1	2 231	1	1
	дж. Суджино уч. Дашт	1	1	2 120	1	1
	водопровод Мазар и Колхозчиен	1	1	1 670	1	1
	дж. Рудаки к-к Некнот	1	0	193	0	0
	к-к Советоьад дж. Вару	1	1	3 008	1	2
	водопровод Могиен	1	1	4 156	1	2
	Sor	1	1	2 094	1	1
	Amondara	1	1	2 008	1	1
	Subtotal:	**18**	**14**	**67 332**	**14**	**32**
Istravshan	Ура-тюбе УВК	1	1	71 237	1	29
	Санат-Хавотаг	1	1	180	0	0
	ТСХТ п.Истаравшан	1	0	0	0	0
	Пансионат	1	0	345	0	0
	АТК №3 пос Истравшан	1	1	2 100	1	1
	МПМК	1	0	259	0	0
	с-з Ура-Тюбе к. К-Калон	1	1	5 772	1	3
	с-з Москва МТФ	1	0	83	0	0
	АТП-36 пос. Истравшан	1	1	10 004	1	5
	к. Чорбог	1	1	2 361	1	1
	с-з 20 Парт съезд к. Гулизард	1	1	2 534	1	2
	к. Тобкон	1	1	2 544	1	2
	с-з Чапаев к. Вогот	1	1	5 687	1	3
	с-з Рохи Ленин к. махалиэш	1	1	13 872	1	6
	Птицефабрика	1	0	256	0	0
	s-z Kommunist k. Курганча	1	1	1 579	1	1
	s-z Istravshan УХРСУ	1	0	0	0	0
	s-z Istravshan УХРСУ	1	0	0	0	0
	Subtotal:	**18**	**11**	**118 813**	**10**	**53**
Gafurova	Водопровод Винзавод	0	0	450	0	0
	Окарик 2	0	0	480	0	0
	к-х Убайдуллоев. уч. Катаган	1	0	110	0	0
	Пулчукур	1	1	58 000	1	24
	Расулиен	1	1	1 200	1	1
	Д. Холматов	1	0	490	0	0
	уч. Калинина ПУВК	1	1	1 990	1	1
	Унчи уч. Анарик	1	0	350	0	0
	к-х Джумаева Исписор	1	1	2 112	1	1
	г.Гафурова АООТ Оби Рохат	1	0	96	0	0
	к-х Мичурин джамоат А-Калъача	1	1	780	1	1
	к-х Бобокалонов дж. Гозиен	1	1	1 218	1	1
	г.Гафурова АООТ Комрон	1	1	980	1	1
	дж.Кистакуз АО "Азизова и Таджикистан "	1	1	4 302	1	2
	Кистакуз АО "Шарбати Кистакоз "	1	0	0	0	0
	дж.Пахтакор уч.Д.Холматов	1	0	380	0	0
	дж.Исмоилов к-х Кушатов	1	0	158	0	0
Taboshari city	Талсай	1	1	7 770	1	4
	Такмак	1	1	5 283	1	3
	Уткенсу	1	1	2 715	1	2
Chkalovsk city	УЖКХ	1	1	25 200	1	11
Kayrakum city	УВК Кайрокум	1	1	12 490	1	5
	МЖКХ	1	1	650	1	1
	пос. Кансай	1	1	4 800	1	2
	пос. Чойрух-Дайрон	1	1	3 900	1	2
	пос. Адрасман	1	1	1 800	1	1
	пос. Алтитопкан	1	1	6 000	1	3
	АТРУ В. Поселок Алтинтопкан	1	0	110	0	0
	АТРУ Н. Поселок Алтинтопкан	1	0	275	0	0
Khujand city	ГУП Водоканал ниже 34 микрорайона	1	1	29 000	1	12
	ДП Объёри	1	1	2 600	1	2

Rayon	Water supply	Working condition	RADWQ inclusion (TYPE)	Serving capacity	RADWQ inclusion (SIZE)	RADWQ zones
	ГУП Водоканал ниже 18 микрорайона	1	1	29 000	1	12
	Subtotal:	**30**	**21**	**204 689**	**21**	**92**
Shakhristan	кишлак Сароби ФДХ	1	1	2 253	1	1
	к-к Канкух	1	1	778	1	1
	к-к Кахор Кингон	1	1	2 033	1	1
	к-к Бураген	1	0	472	0	0
	Короби Кумкурган	1	1	2 480	1	1
	к-к Шахристан Маслозавод	1	0	0	0	0
	Коммунальный водопр.	1	1	2 860	1	2
	Subtotal:	**7**	**5**	**10 876**	**5**	**6**
Kuhistoni Mastchonskiy		0	0	0	0	0
	Subtotal:	**0**	**0**	**0**	**0**	**0**
GBAO		**12**	**12**	**49 942**	**13**	**24**
Shugnon	Ведомственный	1	1	3 957	1	2
Khorog city	Коммунальный водопровод	1	1	2 870	1	2
	Коммунальный водопровод	1	1	13 560	1	6
	Ведомственный ММК	1	1	2 612	1	2
	Аэропорт Ведомственный	1	0	980	1	0
	Ведомственный ДСУ	1	1	2 008	1	1
	Обл. Больница	1	1	650	1	1
	Subtotal:	**7**	**6**	**26 637**	**7**	**14**
Murgab	Коммунальный водопровод	0	1	4 310	1	0
	Subtotal:	**0**	**1**	**4 310**	**1**	**0**
Ishkashim	Коммунальный водопровод	1	1	2 698	1	2
	Subtotal:	**1**	**1**	**2 698**	**1**	**2**
Roshtkalla	Коммунальный водопровод	1	1	3 544	1	2
	Subtotal:	**1**	**1**	**3 544**	**1**	**2**
Rushon	Коммунальный водопровод	1	1	4 993	1	2
	Subtotal:	**1**	**1**	**4 993**	**1**	**2**
Vanj	Коммунальный водопровод	1	1	3 650	1	2
	Subtotal:	**1**	**1**	**3 650**	**1**	**2**
Darvoz	Коммунальный водопровод	1	1	4 110	1	2
	Subtotal:	**1**	**1**	**4 110**	**1**	**2**
TJK		**508**	**516**	**3 245 005**	**517**	**1 336**

[a] TYPE = type of water-supply technology (defined in Section 4.2). SIZE = “0” for water supplies serving fewer than 500 people, and “1” for supplies serving more.

Annex 3. Soviet standard GOST 2874-82 “drinking-water” [a]

Microbiological and related parameters

Parameter	Unit	WHO guideline value	National standard
Thermotolerant coliforms	cfu/100 ml	0	0
Faecal streptococci	cfu/100 ml	0	0
Turbidity [b]	NTU	<1 for chlorination <5 for drinking	1.5 mg/l
pH			6.0–9.0
Chlorine free	mg/l		0.3–0.5
Chlorine total	mg/l		0.8–1.2

Physical and chemical parameters

Parameter	Unit	WHO guideline value	National standard
Appearance		Acceptable	
Conductivity [b]	µS/cm	1.4	
Iron (Fe) [b]	mg/l	0.3	0.3
Nitrate (NO_3)	mg/l	50	45
Arsenic (As)	mg/l	0.01	0.05
Fluoride (F)	mg/l	1.5	0.7
Copper (Cu)	mg/l	2.0	1.0

[a] The hygienic requirements and quality control standards issued by the USSR National Standards Committee on 18 October 1982 are still used in Tajikistan as the national standards. cfu = colony-forming unit.

[b] There is no guideline value. The values for iron, turbidity and conductivity were adopted because drinking-water is acceptable at these values. The values were used in the RADWQ project. µS = microSiemens.

Annex 4. Steps of the RADWQ survey

Primary stratification[a]

Technology category	Population served STAT (%)	Population served INV (%)	Included in RADWQ	Reasons for including or excluding	Primary stratification number
Utility piped supplies	58.9	41.8	YES	Improved technology: MORE than 5% of population	1 282
Community-managed piped supplies	0.0	0.0	NO	Improved technology: LESS than 5% of population	0
Boreholes or tubewells	1.4	1.4	NO	Improved technology: LESS than 5% of population	0
Protected dug wells	2.2	2.2	NO	Improved technology: LESS than 5% of population	0
(Protected) springs	9.6	10.4	YES	Improved technology: MORE than 5% of population	318
Transported water	2.4	2.4	NO	Improved technology: LESS than 5% of population	0
Community rainwater systems	0.0	0.0	NO	Improved technology: LESS than 5% of population	0
Open sources (rivers, channels, ariks)	25.5	41.8	NO	Unimproved technology according to JMP	0
Totals	100.0	100.0			1 600

[a] INV = data derived from the rayon database. STAT = data derived from the republican SES.

Secondary stratification

Broad area (oblast)[a]	Utility piped supplies						Protected springs					
	RADWQ number	Proportion (%)	Sec. Strat. No.[a]	Cluster size	Weeks or clusters required	Household samples	RADWQ number	Proportion (%)	Sec. Strat. No.	Cluster size	Weeks or clusters required	Household samples
RRS & Dushanbe	526	39.4	253	30	9	5.0	444	33.9	108	20	6	2.0
Khatlon	359	26.9	173	20	9	3.0	420	32.1	103	15	7	2.0
Sughd	427	32.0	205	20	11	4.0	189	14.4	46	15	4	1.0
GBAO	24	1.8	12	12	1	1.0	256	19.6	63	12	6	1.0
Totals	1 336	100.0	643		30	13	1 309	100.0	320		23	6

[a] GBAO = Gorno-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination. Sec. Strat. No. = secondary stratification number.

Total team weeks	**83**
Utility piped supply 1st sampling round	30
Utility piped supply 2nd sampling round	30
Protected spring	23
Total weeks for field implantation (83 weeks with 4 teams)	**21**

Selection of sampling units or rayons by proportional weighting

Example: utility piped supply in broad area 1 (RRS & Dushanbe)

Clusters required:	9
Cluster size:	30
Total number:	526
Sampling interval:	58.4
Random number:	12

Proportional weighting table (original)

Map no.	Rayon	RADWQ number	Cumulative number
6	Dushanbe	240	240
1	Garm	9	249
5	Gissar	37	286
2	Jirgital	21	307
6	Leninskiy	73	380
10	Rogun	4	384
7	Kofarnigan	24	408
4	Tursunzade	70	478
8	Fayzabad	12	490
3	Darband	4	494
9	Varzob	2	496
13	Tavildara	2	498
11	Tajikabad	9	507
12	Shakhrinau	19	526

Proportional weighting table (consolidated)[a]

Map no.	Rayon or geographical area	RADWQ number	Cumulative number
3 8 7 10 13	Darband Fayzabad Kofarnigan Rogun Tavildara	46	46
6	Dushanbe	240	286
1 2 11	Garm Jirgital Tajikabad	39	325
5 12 9	Gissar Shakhrinau Varzob	58	383
6	Leninskiy	73	456
4	Tursunzade	70	526

[a] Data in the consolidated table were used to select the sampling units. Rayons in the original version of the table, in which the number of supply zones was below the cluster size, were consolidated into one geographical area by merging with neighbouring rayons, to give the consolidated version of the table. The order of rayons or geographical areas was set alphabetically in the consolidated version of the table.

Cluster no. for UPS in broad area 1 [a]	Calculation for proportional weighting	Rayon	Samples per rayon
1	12	Darband/Tavildara/Rogun/Fayzabad/Kofarnigan	30
2	70.4	Dushanbe	30
3	128.9	Dushanbe	30
4	187.3	Dushanbe	30
5	245.8	Dushanbe	30
6	304.2	Garm/Jirgital/Tajikabad	30
7	362.7	Gissar/Varzob/Shakhrinau	30
8	421.1	Leninskiy	30
9	479.6	Tursunzade	13

[a] UPS = utility piped supply.

Rayons included in the RADWQ survey [a]

Broad area	Technology	Cluster number	Rayon/Sampling area	Samples per cluster
RRS & Dushanbe	UPS	1	Darband/Tavildara/Rogun/Fayzabad/Kofarnigan	30
RRS & Dushanbe	UPS	2	Dushanbe	30
RRS & Dushanbe	UPS	3	Dushanbe	30
RRS & Dushanbe	UPS	4	Dushanbe	30
RRS & Dushanbe	UPS	5	Dushanbe	30
RRS & Dushanbe	UPS	6	Garm/Jirgital/Tajikabad	30
RRS & Dushanbe	UPS	7	Gissar/Varzob/Shakhrinau	30
RRS & Dushanbe	UPS	8	Leninskiy	30
RRS & Dushanbe	UPS	9	Tursunzade	13
RRS & Dushanbe	PS	10	Darband/Rogun	18
RRS & Dushanbe	PS	11	Fayzabad	18
RRS & Dushanbe	PS	12	Garm/Jirgital	18
RRS & Dushanbe	PS	13	Gissar	18
RRS & Dushanbe	PS	14	Shakhrinau/Tursunzade	18
RRS & Dushanbe	PS	15	Varzob	18
Khatlon	UPS	1	Bokhtar	20
Khatlon	UPS	2	Dangara/Farkhor	20
Khatlon	UPS	3	Gozimalik/Khoja Maston/Yavan	20
Khatlon	UPS	4	Khovaling/Muminabad/Shurabad	20
Khatlon	UPS	5	Kulyab	20
Khatlon	UPS	6	Moskovskiy	20
Khatlon	UPS	7	Moskovskiy	20
Khatlon	UPS	8	Sarband/Vakhsh	20
Khatlon	UPS	9	Vosse	13
Khatlon	PS	10	Baldjuvan	15
Khatlon	PS	11	Baldjuvan	15
Khatlon	PS	12	Khovaling	15
Khatlon	PS	13	Khovaling	15
Khatlon	PS	14	Moskovskiy/Shurabad	15
Khatlon	PS	15	Muminabad	15
Khatlon	PS	16	Sovietskiy	13
Sughd	UPS	1	Asht	20
Sughd	UPS	2	Gafurova	20
Sughd	UPS	3	Gafurova	20
Sughd	UPS	4	Ganchi	20
Sughd	UPS	5	Ganchi	20
Sughd	UPS	6	Isfara/Kanibadam	20
Sughd	UPS	7	Istravshan/Zafarabad	20
Sughd	UPS	8	Jabor Rasulov/Nauskiy	20
Sughd	UPS	9	Jabor Rasulov/Nauskiy	20
Sughd	UPS	10	Matchinskiy	20
Sughd	UPS	11	Penjakent	5
Sughd	PS	12	Asht/Gafurova/Matchinskiy	15
Sughd	PS	13	Ganchi/Shakhristan/Nauskiy/Jabor Rasulov	15
Sughd	PS	14	Kuhistoni Mastchonskiy	15
Sughd	PS	15	Penjakent	1
GBAO	UPS	1	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	12
GBAO	PS	2	Darvoz	12
GBAO	PS	3	Darvoz	12
GBAO	PS	4	Roshtkalla	12
GBAO	PS	5	Rushon	12
GBAO	PS	6	Rushon	12
GBAO	PS	7	Vanj	3

[a] GBAO = Gorno-Badakhshan Autonomous Oblast. PS = protected spring. RRS = rayons under direct republican subordination. UPS = utility piped supply.

Annex 5. Field-team members [a]

Field team	Name	Position in the project
RRS & Dushanbe	Nasurdinov, Rakhmonali	Bacteriologist
	Babadjanova, Sara	Bacteriologist
	Baronina, Ekaterina	Chemist
Sughd	Mavlyuda, Domulodjanova	Chemist
	Mumina, Dadabaeva	Bacteriologist
Khatlon	Saidalieva, Sharifamoh	Bacteriologist
	Yakubova, Menzifa	Chemist
GBAO	Salomatshoeva, Mukhabbat	Chemist
	Sharifkhonova, Mavzuna	Bacteriologist

[a] GBAO = Gordo-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Annex 6. Example of a sampling plan for field teams [a]

WSS Nr.	Country code	Oblast	Oblast code	Name of cluster (Rayon)	Cluster code	Sample code	Sample type	Sampling rounds	Sampling day	Appearance Turbidity pH Conductivity	TTC	FS	Cl *free*	Cl *total*	NO3	As F Fe	Cu
TJK40101	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	01	UPS	2	Mon	1	1		1	1	1	1	
TJK40102	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	02	UPS	2	Mon	1	1		1			1	
TJK40103	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	03	UPS	2	Mon	1	1		1			1	
TJK40104	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	04	UPS	2	Tue	1	1		1		1	1	
TJK40105	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	05	UPS	2	Tue	1	1		1			1	
TJK40106	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	06	UPS	2	Tue	1	1		1			1	
TJK40107	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	07	UPS	2	Tue	1	1		1	1	1	1	
TJK40108	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	08	UPS	2	Wed	1	1		1			1	
TJK40109	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	09	UPS	2	Wed	1	1		1			1	
TJK40110	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	10	UPS	2	Wed	1	1		1		1	1	
TJK40111	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	11	UPS	2	Wed	1	1		1			1	
TJK40112	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	12	UPS	2	Thu	1	1	1	1			1	
TJK40113	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	13	Household 1	2	Thu	1	1		1	1	1	1	1
TJK40114	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	14	Household 2	2	Thu	1	1		1		1	1	1
TJK40115	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	15	Household 3	2	Fri	1	1		1		1	1	1
TJK40116	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	16	Household 4	2	Fri	1	1		1		1	1	1
TJK40117	TJK	GBAO	4	Shugnon/Ishkashim/Roshtkalla/Rushon/Vanj/Darvoz	01	17	Household 5	2	Fri	1	1		1		1	1	1
TJK40201	TJK	GBAO	4	Darvoz	02	01	PS	1	Mon	1	1				1	1	
TJK40202	TJK	GBAO	4	Darvoz	02	02	PS	1	Mon	1	1					1	
TJK40203	TJK	GBAO	4	Darvoz	02	03	PS	1	Mon	1	1					1	
TJK40204	TJK	GBAO	4	Darvoz	02	04	PS	1	Tue	1	1				1	1	
TJK40205	TJK	GBAO	4	Darvoz	02	05	PS	1	Tue	1	1					1	
TJK40206	TJK	GBAO	4	Darvoz	02	06	PS	1	Tue	1	1					1	
TJK40207	TJK	GBAO	4	Darvoz	02	07	PS	1	Wed	1	1				1	1	
TJK40208	TJK	GBAO	4	Darvoz	02	08	PS	1	Wed	1	1					1	
TJK40209	TJK	GBAO	4	Darvoz	02	09	PS	1	Wed	1	1					1	
TJK40210	TJK	GBAO	4	Darvoz	02	10	PS	1	Thu	1	1				1	1	
TJK40211	TJK	GBAO	4	Darvoz	02	11	PS	1	Thu	1	1					1	
TJK40212	TJK	GBAO	4	Darvoz	02	12	PS	1	Thu	1	1	1				1	
TJK40301	TJK	GBAO	4	Darvoz	03	01	PS	1	Mon	1	1				1	1	
TJK40302	TJK	GBAO	4	Darvoz	03	02	PS	1	Mon	1	1					1	
TJK40303	TJK	GBAO	4	Darvoz	03	03	PS	1	Mon	1	1					1	
TJK40304	TJK	GBAO	4	Darvoz	03	04	PS	1	Tue	1	1				1	1	
TJK40305	TJK	GBAO	4	Darvoz	03	05	PS	1	Tue	1	1					1	
TJK40306	TJK	GBAO	4	Darvoz	03	06	PS	1	Tue	1	1					1	
TJK40307	TJK	GBAO	4	Darvoz	03	07	PS	1	Wed	1	1				1	1	
TJK40308	TJK	GBAO	4	Darvoz	03	08	PS	1	Wed	1	1					1	
TJK40309	TJK	GBAO	4	Darvoz	03	09	PS	1	Wed	1	1					1	
TJK40310	TJK	GBAO	4	Darvoz	03	10	PS	1	Thu	1	1				1	1	
TJK40311	TJK	GBAO	4	Darvoz	03	11	PS	1	Thu	1	1					1	
TJK40312	TJK	GBAO	4	Darvoz	03	12	PS	1	Thu	1	1	1				1	
TJK40401	TJK	GBAO	4	Roshtkalla	04	01	PS	1	Mon	1	1				1	1	
TJK40402	TJK	GBAO	4	Roshtkalla	04	02	PS	1	Mon	1	1					1	
TJK40403	TJK	GBAO	4	Roshtkalla	04	03	PS	1	Mon	1	1					1	
TJK40404	TJK	GBAO	4	Roshtkalla	04	04	PS	1	Tue	1	1				1	1	
TJK40405	TJK	GBAO	4	Roshtkalla	04	05	PS	1	Tue	1	1					1	
TJK40406	TJK	GBAO	4	Roshtkalla	04	06	PS	1	Tue	1	1					1	
TJK40407	TJK	GBAO	4	Roshtkalla	04	07	PS	1	Wed	1	1				1	1	
TJK40408	TJK	GBAO	4	Roshtkalla	04	08	PS	1	Wed	1	1					1	
TJK40409	TJK	GBAO	4	Roshtkalla	04	09	PS	1	Wed	1	1					1	
TJK40410	TJK	GBAO	4	Roshtkalla	04	10	PS	1	Thu	1	1				1	1	
TJK40411	TJK	GBAO	4	Roshtkalla	04	11	PS	1	Thu	1	1					1	
TJK40412	TJK	GBAO	4	Roshtkalla	04	12	PS	1	Thu	1	1	1				1	

WSS Nr.	Country code	Oblast	Oblast code	Name of cluster (Rayon)	Cluster code	Sample code	Sample type	Sampling rounds	Sampling day	Appearance Turbidity pH Conductivity	TTC	FS	Cl *free*	Cl *total*	NO3	As Cu F Fe
TJK40501	TJK	GBAO	4	Rushon	05	01	PS	1	Mon	1	1				1	1
TJK40502	TJK	GBAO	4	Rushon	05	02	PS	1	Mon	1	1					1
TJK40503	TJK	GBAO	4	Rushon	05	03	PS	1	Mon	1	1					1
TJK40504	TJK	GBAO	4	Rushon	05	04	PS	1	Tue	1	1				1	1
TJK40505	TJK	GBAO	4	Rushon	05	05	PS	1	Tue	1	1					1
TJK40506	TJK	GBAO	4	Rushon	05	06	PS	1	Tue	1	1					1
TJK40507	TJK	GBAO	4	Rushon	05	07	PS	1	Wed	1	1				1	1
TJK40508	TJK	GBAO	4	Rushon	05	08	PS	1	Wed	1	1					1
TJK40509	TJK	GBAO	4	Rushon	05	09	PS	1	Wed	1	1					1
TJK40510	TJK	GBAO	4	Rushon	05	10	PS	1	Thu	1	1				1	1
TJK40511	TJK	GBAO	4	Rushon	05	11	PS	1	Thu	1	1					1
TJK40512	TJK	GBAO	4	Rushon	05	12	PS	1	Thu	1	1	1				1
TJK40601	TJK	GBAO	4	Rushon	06	01	PS	1	Mon	1	1				1	1
TJK40602	TJK	GBAO	4	Rushon	06	02	PS	1	Mon	1	1					1
TJK40603	TJK	GBAO	4	Rushon	06	03	PS	1	Mon	1	1					1
TJK40604	TJK	GBAO	4	Rushon	06	04	PS	1	Tue	1	1				1	1
TJK40605	TJK	GBAO	4	Rushon	06	05	PS	1	Tue	1	1					1
TJK40606	TJK	GBAO	4	Rushon	06	06	PS	1	Tue	1	1					1
TJK40607	TJK	GBAO	4	Rushon	06	07	PS	1	Wed	1	1				1	1
TJK40608	TJK	GBAO	4	Rushon	06	08	PS	1	Wed	1	1					1
TJK40609	TJK	GBAO	4	Rushon	06	09	PS	1	Wed	1	1					1
TJK40610	TJK	GBAO	4	Rushon	06	10	PS	1	Thu	1	1				1	1
TJK40611	TJK	GBAO	4	Rushon	06	11	PS	1	Thu	1	1					1
TJK40612	TJK	GBAO	4	Rushon	06	12	PS	1	Thu	1	1	1				1
TJK40701	TJK	GBAO	4	Vanj	07	01	PS	1	Mon	1	1				1	1
TJK40702	TJK	GBAO	4	Vanj	07	02	PS	1	Mon	1	1					1
TJK40703	TJK	GBAO	4	Vanj	07	03	PS	1	Tue	1	1					1
TJK40704	TJK	GBAO	4	Vanj	07	04	Household 1	1	Tue	1	1				1	1
TJK40705	TJK	GBAO	4	Vanj	07	05	Household 2	1	Wed	1	1				1	1
TJK40706	TJK	GBAO	4	Vanj	07	06	Household 3	1	Wed	1	1				1	1
TJK40707	TJK	GBAO	4	Vanj	07	07	Household 4	1	Thu	1	1				1	1
TJK40708	TJK	GBAO	4	Vanj	07	08	Household 5	1	Thu	1	1				1	1

[a] FS = faecal streptococci. GBAO = Gordo-Badakhshan Autonomous Oblast. PS = protected spring. TTC = thermotolerant coliforms. UPS = utility piped supply. The country, oblast, cluster and sample codes are defined at the end of Section 2.3.

Annex 7. Fieldwork plan

Initial fieldwork plan

Project week	Team "RRS"	Team "Khatlon"	Team "Sughd"	Team "GBAO"
1	RRS Cluster 02 Round 1	GBAO Cluster 02	GBAO Cluster 04	GBAO Cluster 01 Round 1
2	RRS Cluster 03 Round 1	GBAO Cluster 03	GBAO Cluster 07	GBAO Cluster 05
3	RRS Cluster 04 Round 1	Khatlon Cluster 01 Round 1	Sughd Cluster 02 Round 1	GBAO Cluster 06
4	RRS Cluster 05 Round 1	Khatlon Cluster 08 Round 1	Sughd Cluster 03 Round 1	GBAO Cluster 01 Round 2
5	RRS Cluster 08 Round 1	Khatlon Cluster 02 Round 1	Sughd Cluster 01 Round 1	RRS Cluster 06 Round 1
6	Khatlon Cluster 03 Round 1	Khatlon Cluster 01 Round 2	Sughd Cluster 10 Round 1	RRS Cluster 12
7	RRS Cluster 07 Round 1	Khatlon Cluster 08 Round 2	Sughd Cluster 12	RRS Cluster 01 Round 1
8	RRS Cluster 13	Khatlon Cluster 02 Round 2	Sughd Cluster 02 Round 2	RRS Cluster 10
9	RRS Cluster 15	Khatlon Cluster 05 Round 1	Sughd Cluster 03 Round 2	RRS Cluster 11
10	RRS Cluster 09 Round 1	Khatlon Cluster 09 Round 1	Sughd Cluster 01 Round 2	RRS Cluster 01 Round 2
11	RRS Cluster 14	Khatlon Cluster 06 Round 1	Sughd Cluster 10 Round 2	RRS Cluster 06 Round 2
12	RRS Cluster 02 Round 2	Khatlon Cluster 07 Round 1	Sughd Cluster 08 Round 1	Sughd Cluster 06 Round 1
13	RRS Cluster 03 Round 2	Khatlon Cluster 04 Round 1	Sughd Cluster 09 Round 1	Sughd Cluster 07 Round 1
14	RRS Cluster 04 Round 2	Khatlon Cluster 12	Sughd Cluster 04 Round 1	Sughd Cluster 11 Round 1
15	RRS Cluster 05 Round 2	Khatlon Cluster 13	Sughd Cluster 05 Round 1	Sughd Cluster 15
16	RRS Cluster 08 Round 2	Khatlon Cluster 15	Sughd Cluster 13	Sughd Cluster 11 Round 2
17	Khatlon Cluster 03 Round 2	Khatlon Cluster 05 Round 2	Sughd Cluster 08 Round 2	Sughd Cluster 14
18	RRS Cluster 07 Round 2	Khatlon Cluster 09 Round 2	Sughd Cluster 09 Round 2	Sughd Cluster 06 Round 2
19	RRS Cluster 09 Round 2	Khatlon Cluster 06 Round 2	Sughd Cluster 04 Round 2	Sughd Cluster 07 Round 2
20	Khatlon Cluster 10	Khatlon Cluster 07 Round 2	Sughd Cluster 05 Round 2	Khatlon Cluster 16
21	Khatlon Cluster 11	Khatlon Cluster 04 Round 2		Khatlon Cluster 14

Actual fieldwork plan [a]

Project week	Datre	Team "RRS"	Team "Khatlon"	Team "Sughd"	Team "GBAO"
1	18–24 Oct	GBAO Cluster 04	GBAO Cluster 02	Deployment in collective cotton picking work	GBAO Cluster 01 Round 1
2	25–31 Oct	GBAO Cluster 07	GBAO Cluster 03	Deployment in collective cotton picking work	GBAO Cluster 05
3	1–7 Nov	Deployment in collective cotton picking work	Deployment in collective cotton picking work	Deployment in collective cotton picking work	GBAO Cluster 06
4	8–14 Nov	RRS Cluster 01 Round 1	Deployment in collective cotton picking work	Sughd Cluster 11 Round 1	GBAO Cluster 01 Round 2
5	15–21 Nov	RRS Cluster 07 Round 1	Khatlon Cluster 01 Round 1	Sughd Cluster 14	RRS Cluster 12
6	22–28 Nov	RRS Cluster 10	Khatlon Cluster 08 & 09 Round 1	Sughd Cluster 15	
7	29 Nov–5 Dec	RRS Cluster 01 Round 2	Khatlon Cluster 02 & 03 Round 1	Sughd Cluster 01 & 02 Round 1	RRS Cluster 13
8	6–12 Dec	RRS Cluster 06 Round 1 & Round 2	Khatlon Cluster 04 & 05 Round 1	Sughd Cluster 10 Round 1	
9	13–19 Dec	RRS Cluster 07 Round 2	Khatlon Cluster 06 & 07 Round 1	Sughd Cluster 12 & 13	RRS Cluster 11
10	20–26 Dec	RRS Cluster 08 Round 1	Khatlon Cluster 10	Sughd Cluster 03 Round 1	RRS Cluster 15
11	27 Dec–2 Jan	RRS Cluster 09 Round 1	Khatlon Cluster 11	Sughd Cluster 08 Round 1	The GBAO field team returned, but couldn't continue the assessment in RRS for family reasons
12	3–9 Jan	RRS Cluster 02 Round 1	Khatlon Cluster 12	Sughd Cluster 09 Round 1	
13	10–16 Jan	RRS Cluster 03 Round 1	Khatlon Cluster 13	Sughd Cluster 04 Round 1	
14	17–23 Jan	RRS Cluster 04 Round 1	Khatlon Cluster 14	Sughd Cluster 05 & 07 Round 1	
15	24–30 Jan	RRS Cluster 05 Round 1	Khatlon Cluster 15	Sughd Cluster 06 Round 1	
16	31 Jan– 6 Feb	RRS Cluster 08 & 09 Round 2	Khatlon Cluster 16	Sughd Cluster 02 Round 2	
17	7–13 Feb	RRS Cluster 14	Khatlon Cluster 01 & 08 Round 2	Sughd Cluster 03 Round 2	
18	14-20 Feb	RRS Cluster 02 Round 2	Khatlon Cluster 02 Round 2	Sughd Cluster 08 Round 2	
19	21–27 Feb		Khatlon Cluster 03 Round 2	Sughd Cluster 09 Round 2	
20	28 Feb– 6 Mar	Official holidays			
21	7–13 Mar	Khatlon Cluster 09 Round 2	Khatlon Cluster 05 Round 2	Sughd Cluster 01 Round 2	
22	14–20 Mar	RRS Cluster 03 Round 2	Khatlon Cluster 04 Round 2	Sughd Cluster 04 & 05 Round 2	
23	21–27 Mar	RRS Cluster 04 Round 2	Khatlon Cluster 06 Round 2	Sughd Cluster 06 & 07 Round 2	
24	28 Mar–3 Apr	RRS Cluster 05 Round 2	Khatlon Cluster 07 Round 2	Sughd Cluster 10 Round 2	
25	4–8 Apr			Sughd Cluster 11 Round 2	

[a] All changes in cluster order were undertaken to finish the assessment in remote districts first. Acronyms: GBAO = Gordo-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Annex 8. Example of a monthly progress report

SEVENTH NARRATIVE REPORT

Rapid Drinking-Water Quality Assessment Project in Tajikistan
(15 February 2005)

I. BACKGROUND

The following points summarize the 6th Narrative Report (situation for 31 January 2005):

- **Assessment in RRS** continued from mid-January 2005 in Dushanbe city with 70 samples taken. Of 674 planned analyses, 466 (69.1%) were implemented since the launch of the project in the RRS broad area. The plan is to cover two clusters with 25 analyses over the next two weeks (in Tursunzade and Varzob).
- **Assessment in Sughd** continued from mid-January in Ganchi Istravshan and Zafarabad districts with 65 samples. In total, 280 out of 515 (54.3%) planned analyses in Sughd district were implemented since the launch of the project. Over the next two weeks, the plan is to finalize 55 analyses for three clusters (in Isfara and Gafurova districts).
- **Assessment in Khatlon** continued at the beginning of January 2005 with 48 analyses in Moskovskiy, Shyrabad, Muminabad and Sovetskiy districts. In total, 253 analyses were completed by 15 January 2005, with a further 48 analyses planned by mid-February.
- **Results of 1121 analyses** from four broad areas were available by 31 January 2005. The data represented 62.98% of the total number of analyses (1780). Data was inserted into the SanMan database and the forms filed.
- **Monitoring field visits** were undertaken over a two-week period (16–31 January 2005) by Republican SES officials to:
  - **RRS** (1 field trip undertaken by Gulom Erdanov, SES data manager).
  - **Khatlon** (1 field trip undertaken by Sara Babadjanova, bacteriologist from the Republican SES).

II. FIELD IMPLEMENTATION

Field teams continued working from 1 February 2005, according to workplans in the 6th Narrative Report (summarized below):

Table 1 **Summarized field plan of analyses for three broad areas, for 1–15 February 2005**

Week	Broad area	No. of UPS[a] samples	No. of PS samples	Total no. of analyses
1	RRS	0	25	25
2	Sughd	55	0	55
3	Khatlon	0	48	48
	Totals	55	73	128

[a] Acronyms: PS = protected spring. RRS = rayons under direct republican subordination. UPS = utility piped supply.

The tables below describe progress for the two weeks, 1–15 February 2005.

1. RRS oblast

Assessment in RRS continued from 1 February 2005 in Varzob, Tursunzade and Leninskiy districts, and covered the second round of 62 UPS and 11 PS analyses.
In total, 539 analyses have been completed in RRS, or 79.97% of the 674 analyses planned in this broad area.
Two laboratories were utilized during these two weeks, and 73 analyses were completed instead of the 25 that had been planned.

Table 2. **Number of planned and completed analyses for the two weeks, 1–15 February 2005**

No.	Planned				Completed					
	Cluster	Districts	Type[a]	No. of analyses	Cluster	Districts	Type	No. of samples	No. of rounds completed	Total no. of analyses
1	7	Varzob	PS	14	7	Varzob	UPS	14	2	14
2	14	Tursunzade	PS	11	8	Leninskiy	UPS	30	2	30
3					9	Tursunzade	UPS	18	2	18
4					14	Tursunzade	PS	11		11
Total:				25	Total:					73

[a] PS = protected spring. UPS = utility piped supply.

Table 3. **Total number of analyses completed in RRS by 15 February 2005** [a]

#	Implemented						Remarks
	Cluster	District	Type	No. of samples	No. of rounds done	Total no. of analyses	
1	1	Darband		6	2		
		Tavilda		6	2		
		Rogun		6	2		
		Fayzabad		6	2		
		Kafernigan	UPS	6	2	60	
2	6	Garm		10	2		
		Jirgital		10	2		
		Tajikabad	UPS	10	2	60	
3	7	Gissar		11	2		
		Varzob		14	2		
		Shahrinav	UPS	10	2	70	
4	8	Leninskiy	UPS	30	2	60	
5	9	Tursunzade	UPS	18	2	36	
6	10	Darband		9			
		Rogun	PS	9	1	18	
7	11	Fayzabad	PS	18	1	18	
8	12	Jirgital		12			
		Garm	PS	11	1	23	
9	13	Gissar	PS	18	1	18	
10	14	Shahrinav		7			
		Tursunzade	PS	11	1	18	
11	15	Varzob	PS	23	1	23	
12	2	Dushanbe	UPS	35	1	35	
13	3	Dushanbe	UPS	20	1	30	
14	4	Dushanbe	UPS	35	1	35	
15	5	Dushanbe	UPS	30	1	35	
Total number of analyses completed:						539	

[a] PS = protected spring. RRS = rayons under direct republican subordination. UPS = utility piped supply.

The following analyses are planned by the end of February 2005 in the RRS broad area:

- Cluster 2: Dushanbe (35 UPS) 2nd round

2. Sughd oblast

Assessment in Sughd continued from 1 February 2005. In Isfara, 10 first round samples were taken for UPS, and in Gafurova, 45 second round UPS samples were taken. At present, only 10 analyses have been submitted to the Republican SES, but it is planned to send the other 45 samples in the coming days. Analyses have been completed for 290 of the 515 (56.31%) planned in Sughd.

Table 4. **Number of planned and completed analyses for the two weeks, 1–15 February 2005**

No.	Planned				Implemented					
	Cluster	Districts	Type [a]	No. of analyses	Cluster	Districts	Type	No. of samples	No. of rounds done	Total no. of analyses
1	2	Gafurova	UPS	20	6	Isfara	UPS	10	1	10
2	3	Gafurova	UPS	25						
3	6	Isfara	UPS	10						
Total:				45	Total:					10

[a] UPS =utility piped supply.

Table 5. **Total number of analyses completed in Sughd by 15 February 2005**

No.	Implemented						Remarks
	Cluster	Districts	Type [a]	No. of samples	No. of rounds done	Total no. of analyses	
1	1	Asht	UPS	20	1	20	
2	2	Gafurova	UPS	20	1	20	
3	3	Gafurova	UPS	25	1	25	
4	4	Ganchi	UPS	20	1	20	
5	5	Ganchi Kanibadam	UPS	25	1	25	
6	6	Isfara Istravshan	UPS	20	1	20	
	7	Zafarabad Jabor Rasulov	UPS	20	1	20	
	8	Naunskiy Jabor Rasulov	UPS	25	1	25	
	9	Naunskiy	UPS	20	1	20	
	10	Matcha	UPS	20	1	20	
	11	Penjakent	UPS	10	1	10	
7	12	Asht Matcha Gafurova	PS	15	1	15	
8	13	Ganchi Shahristan Nauskiy Jabor Rasulov	PS	15	1	15	
9	14	Kuhistoni Matchonskiy	PS	15	1	15	
10	15	Penjakent	PS	20	1	20	
Total number of analyses completed:						290	

[a] PS = protected spring. UPS = utility piped supply.

The following analyses are planned by the end of the month:

- Cluster 2: Gafurova (20 UPS) 2nd round results to be submitted.
- Cluster 3: Gafurova (25 UPS) 2nd round results to be submitted.
- Cluster 1: Asht (20 UPS) 2nd round.

3. Khatlon oblast

The assessment in Khatlon was ongoing from the beginning of February in Moskovskiy & Shurabad, Muminabad and Sovetskiy districts. The results were delayed, but are planned to be finalized by the 7th narrative report. In total, 346 analyses of 489 planned (70.76%) have been completed in Khatlon.

Table 6. **Number of planned and completed analyses between 16 January and 15 February 2005**

No.	**Planned**				**Implemented**					
	Cluster	Districts	Type [a]	No. of samples	Cluster	Districts	Type	No. of samples	No. of rounds	Total no. of analyses
1	14	Moskosvkiy Shurabad	PS	15	14	Moskosvkiy Shurabad	PS	15	1	15
2	15	Muminabad	PS	15	15	Muminabad	PS	15	1	15
3	16	Sovetskiy	PS	18	16	Sovetskiy	PS	18	1	18
					1	Bokhtar	UPS	20	2nd	20
					8	Sarband Vakhsh	UPS	25	2nd	25
Total:				48	Total:					93

[a] PS = protected spring; UPS = utility piped supply.

Table 7. **Total number of analyses completed in Khatlon by 15 February 2005**

No.	Implemented						Remarks
	Cluster	Districts	Type [a]	No. of samples	No. of rounds	Total no. of analyses	
1	1	Bokhtar	UPS	20	2	40	
2	2	Dangara Farhor	UPS	20	1	20	
3	3	Gozimalik Khoja Maston Yavan	UPS	25	1	25	
4	4	Khovaling Muminabad Shurabad	UPS	20	1	20	
5	5	Kulyab	UPS	25	1	25	
6	6	Moskovskiy	UPS	20	1	20	
7	7	Moskovskiy	UPS	20	1	20	
8	8	Sarband Vakhsh	UPS	25	2	50	
9	9	Vosse	UPS	13	1	13	
10	10	Baljuvan	PS	15	1	15	
11	11	Baljuvan	PS	15	1	15	
12	12	Khovaling	PS	15	1	15	
13	13	Khovaling	PS	20	1	20	
	14	Moskovskiy Shurabad	PS	15	1	15	
	15	Muminabad	PS	15	1	15	
	16	Sovetskiy	PS	18	1	18	
Total no. analyses completed:						346	

[a] PS = protected spring. UPS = utility piped supply.

The following analyses are planned by the end of the month:

- Cluster 3: Gozimalik. Khoja-Maston, Yavan (25 UPS) 2nd round.

The planned and completed analyses for 15 February 2005, as well as the percentage of completed analyses, are shown in Table 8 for each broad area.

Table 8. **Total number of planned and completed analyses**

No.	Broad area	Total no. of analyses	Actual no. of analyses completed by 31 January 2005	Completed analyses (% of total)
1	GBAO[a]	102	102	100.0
2	RRS & Dushanbe	674	539	80.0
3	Sughd	515	290	56.3
4	Khatlon	489	346	70.8
	Total:	1 780	1 277	71.7

[a] GBAO = Gordo-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

Remarks:
The Sughd team is continuing the assessment in Gafurova and should have the results in the coming days. The number of analyses shown in the table are the actual number of results available.

Table 9. **Number of completed analyses, compared to the number completed in the previous narrative reports**

No.	Broad area	Total no. of analyses planned	No. and proportion of completed analyses in the narrative reports											
			2nd	(%)	3rd	(%)	4th	(%)	5th	(%)	6th	(%)	7th	(%)
1	GBAO[a]	102	102	100.0	102	100.0	102	100.0	102	100.0	102	100.0	102	100.0
2	RRS	674	183	27.2	218	32.3	331	49.1	396	58.8	466	69.1	539	80.0
3	Sughd	515	50	9.7	135	26.2	170	33.0	215	41.7	280	54.4	290	56.3
4	Khatlon	489	0	0.0	148	30.3	218	44.6	253	51.7	253	51.7	346	70.8
	Total:	1780	335	18.8	603	33.9	821	46.1	966	54.3	1101	63.0	1277	71.7

[a] GBAO = Gordo-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination.

III. MONITORING

Within the two-week period only one monitoring visit was undertaken by Pirnazar Shodmonov (head of the sanitary department) to Tursunzade and Varzob districts. Nevertheless, the field teams continue to call UNICEF and SES for consultation, as when Khatlon and RRS teams visited the UNICEF office for consultations on quality control procedures. The field teams now follow quality-control procedures and submit completed forms regularly.

The main difficulties during this period related to the winter. The field teams emphasized the difficulty in reaching sources, especially springs, even with a car. In Tursunzade district, for example, the team had to leave the car and walk up the mountains to get the water sample.

Annex 9. Project budget [a]

No.	Description of expense	Expense
	First budget instalment: October–December 2004 (3 months)	
	Sanitary inspection training	
1	Transportation	1 548.14
2	Coffee-break	137.00
3	Stationery	45.00
4	DSA	828.00
	Assessment in GBAO	
5	Transportation: car rent	4 073.00
6	DSA	2 208.00
	Meeting on discussion of first results in Dushanbe	
7	Transportation: GBAO - Dushanbe - GBAO	851.00
8	Coffee-break	137.00
9	DSA	828.00
	Assessment in Dushanbe and RRS	
10	Transportation: car rent	7 296.00
11	DSA	14 536.00
	Assessment in Sughd	
12	Transportation: car rent	2 736.00
13	DSA	2 208.00
14	***Personnel incentives***	5 193.00
	Subtotal (TJS)	**42 624.14**
	Subtotal (USD)	**14 021.00**
	Second budget instalment: January–March 2005 (3 months)	
	Assessment in Dushanbe and RRS	
1	Transportation expenses	3 672.00
2	DSA	2 019.80
	Assessment in Sughd	
3	Transportation expenses	8 446.56
4	DSA	6 242.40
	Assessment in Khatlon	
5	Transportation expenses	3 672.00
6	DSA	3 121.20
7	***Personnel incentives***	3 396.60
	Subtotal (TJS)	**30 570.56**
	Subtotal (USD)	**9 990.38**
	Third budget instalment: April–May 2005 (1.5 months)	
	Assessment in Dushanbe and RRS	
1	Transportation expenses	1 224.00
2	DSA	183.60
	Assessment in Sughd	
3	Transportation expenses	3 482.84
4	DSA	1 836.00
	Assessment in Khatlon	
5	Transportation expenses	1 224.00
6	DSA	918.00
7	Personnel incentives	4 452.30
	Final meeting on discussion of results in Dushanbe	
	Transportation	
8	Transportation: GBAO - Dushanbe - GBAO	1 557.78
9	Coffee-break	287.00
10	DSA in Dushanbe	1 652.40
11	Stationery for participants	49.50

No.	Description of expense	Expense
	Monitoring of activities	
12	Transportation to districts	2 514.07
13	DSA for monitors (17 days)	3 231.00
14	Communication expenses	1 250.00
15	Stationery for personnel (developing of reports)	459.00
16	Photo expenses	612.00
	Subtotal (TJS)	**24 933.49**
	Subtotal (USD)	**8 148.20**
	Grand total (TJS)	**98 128.19**
	Grand total (USD)	**32 159.58**

[a] DSA = Daily Subsistence Allowance; GBAO = Gordo-Badakhshan Autonomous Oblast. RRS = rayons under direct republican subordination. TJS = Tajikistan somonis. USD = US dollars.

Annex 10. Daily report forms

RADWQ Daily Report Sheet
Microbiological data

Oblast:

Rayon:

Date:

Name of analyst:

WSS No.	Sample no.	Water supply technology	Town/Village	Local name	Sample point	Time	Appearance	TTC (cfu/100 ml)	Faecal streptococci (cfu/100 ml)	Turbidity (NTU)	pH	Chlorine (mg/l)		SI score
												Free	Total	

Comments:

Signature of analyst:

RADWQ Daily Report Sheet
Chemical data

Oblast:

Rayon:

Date:

Name of analyst:

WSS No.	Sample No.	Water supply technology	Town/Village	Local name	Sample point	Time	Conductivity (µS/cm)	Nitrate (mg/l)	Arsenic (mg/l)	Iron (mg/l)	Fluoride (mg/l)	Copper (mg/l)

Comments:

Signature of analyst:

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