# 4.4 Present Status of Computerization

We inspected all the computerized systems used in Chirchik City Vodokanal to assess the environment and practical utilization of computers in its business activities.

We reviewed the computerized tariff collection system in particular detail. We inspected how the computerized tariff collection systems are actually used by reviewing the tariff collection procedures.

## 4.4.1 Computer Systems at Chirchik City Vodokanal

### (1) Outline of Computer Systems

Chirchik City Vodokanal is using six separate computers which are not connected with each other in a network. The following departments use computers: Sales Department, Accounting Department and Planning Department. The Sales Department is divided into three section: one is for enterprises, the second is for households (owners of private houses) and the third is for users living in apartments buildings.

Management of Chirchik Vodokanal decided on the introduction of the computers and the Vodokanal bought its computers out of its own budget at that time.

Chirchik City Vodokanal does not have a separate department for the maintenance of their systems. The systems are maintained by only one external computer specialist who renders services to other organizations as well. They usually call him when necessary.

The computer specialist prepared all the software programs for Chirchik City Vodokanal based on its specifications. Vodokanal keeps the documentation on file and the computer specialist has retained the entire system program.

They keep their files basically in the computers of computer and on paper, because they have to delete electronic data information periodically. So, if necessary, they can calculate tariffs manually and issue handwritten bills. They have maintained tariff information on the apartment users in the computer for only two years, because Chirchik City Vodokanal discontinued the assistance of JEK in the fourth quarter of1996, and started to collect the tariffs themselves, and the tariff collection system for apartment users was introduced on January 1st, 1997.

They do not have computer security or a backup system. If the electronic data is deleted, they must recover the data from the manually maintained book.

They recognize the necessity for more computers and a local area network, as well as the importance of security measure and a backup system.

## (2) System Functions

The system functions and the specifications of the four systems which Chirchik City Vodokanal is now using are shown in the following table.

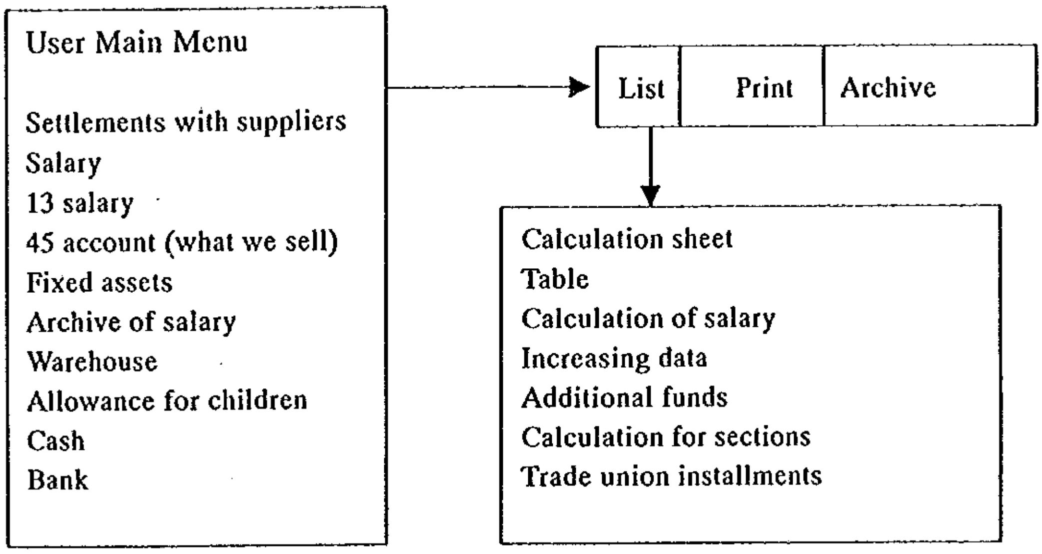
**Table 4.4.1 System Functions**

| Computerized System | System Functions |
|---|---|
| Collection System (Apartment Users) | To keep information on users living in apartments and to monitor the collection of tariffs |
| Collection System (House Users and Enterprises) | To keep information on private residences and enterprises and to monitor the collection tariffs |
| Accounting System | To calculate payments, salaries, and each section's financial sheets, etc. and to keep information on finance fixed assets, etc. |
| Planning and Economic System | To plan the staff schedule, future costs, etc. |

The menu flows of two systems other than the Collection Systems are as follows:.

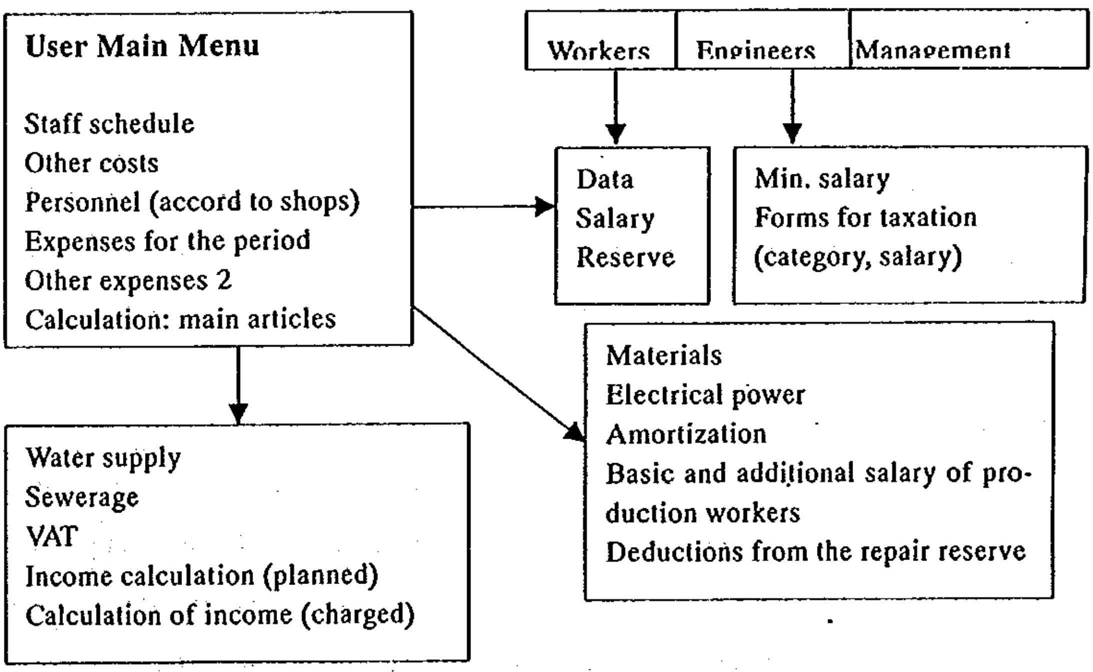
The accounting Department has one computer. The program main menu contains settlements with suppliers, salary calculation, fixed assets accounting, allowances for children, etc.

Figure 4.4.1 Accounting System Menu




The planning Department also uses one computer. This department is engaged in planning expenses and forecasting profit for the next year. The menu contains the staff schedule, information about the personnel, their qualifications, expenses for a certain period, etc.

Fig 4.4.2 Planning and Economic System Menu Flow



The system specifications are shown in Table 4.4.2. The information about the database, the number of programs and the total size of the programs is not identified.

Table 4.4.2 System Specification

| System | Department | OS | Data-base | Number of Programs | Total Size (kb) | Hardware | Number of Units | Date of Prep. |
|---|---|---|---|---|---|---|---|---|
| Collection System (House Users and Enterprises) | Sales Dept. | MS-DOS | - | - | - | 486 Samsung | 2 | 1989 |
| Planning and Economic System | Planning Dept. | MS-DOS | - | - | - | 386 Takai Display–Samsung | 1 | 1992 |
| Collection System (Apartment Users) | Sales Dept. | MS-DOS | - | - | - | Pentium, processor-X Ring Inc., display – Samsung | 2 | 1997 |
| Accounting System | Accounting Dept. | MS-DOS | - | - | - | 486 Samsung | 1 | 1998 |

(3) Collection System

The collection System is utilized by the Sales Department. Two computers are installed for the Collection System for apartment users. The other two computers are installed for the Collection System for house users and enterprises.

1) Apartment Users

All users are registered into the systems. Sales Department inputs the user's name, address, number of residents, privileges and so forth. They also record the amount of payment for each month or quarter, unpaid tariffs, calculation for the current quarter, date of payment, availability of water meters, past tariff data, and the controller's names, etc.

They can print out a list of their users, a summary table of the users with outstanding tariffs for one apartment, and the reports of the Mahallas (a community of residents living in a certain district) upon request.

The system can utilize a tariff table stored in its memory. Therefore it can calculate amounts by inputting the figures from the water mater readings. They can maintain such a table if the law changes.

The main menu is shown in Fig 4.4.3.

**2) House and Enterprise Users**

The main menu contains house and enterprise users. The information about houses includes the names, addresses, availability of cars, cattle, indoor or outdoor water pipes, sewage, baths and water meters. This information is also used for the calculation of the tariffs. The basic functions are similar to the apartment users' system.

All enterprises served by Chirchik Vodokanal are included in the card index. The program contains each enterprise's requisites, contract with Vodokanal, special codes, penalties charged, branches of industry to which the enterprise belongs, tariffs, etc.

This system can also utilize a tariff table stored in its memory. The table is more detailed and thus the system can do more complicated calculations.

The main menu is shown in Fig 4.4.4.

Fig 4.4.3 Tariff Collection System for Apartment User Menu Flow

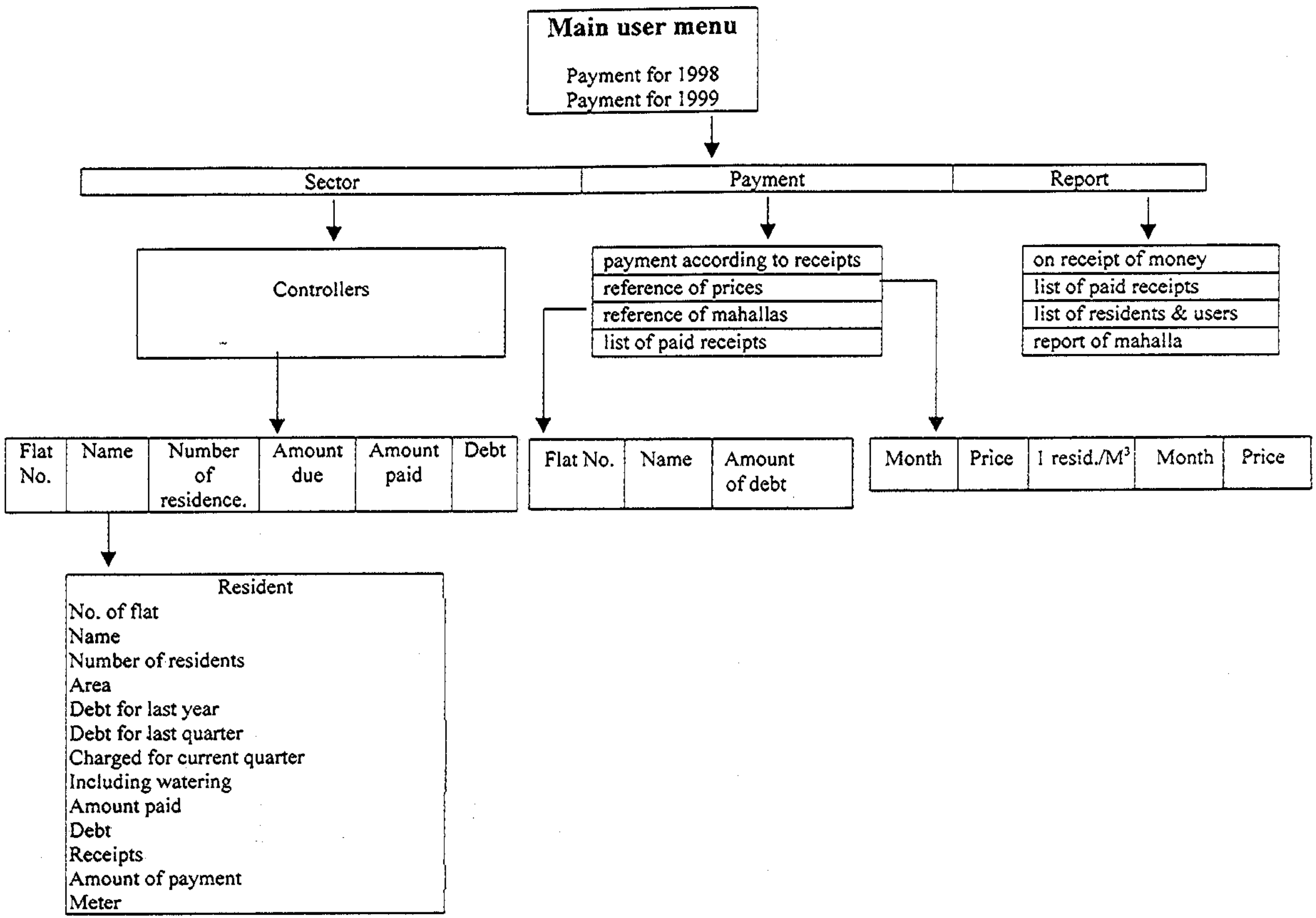
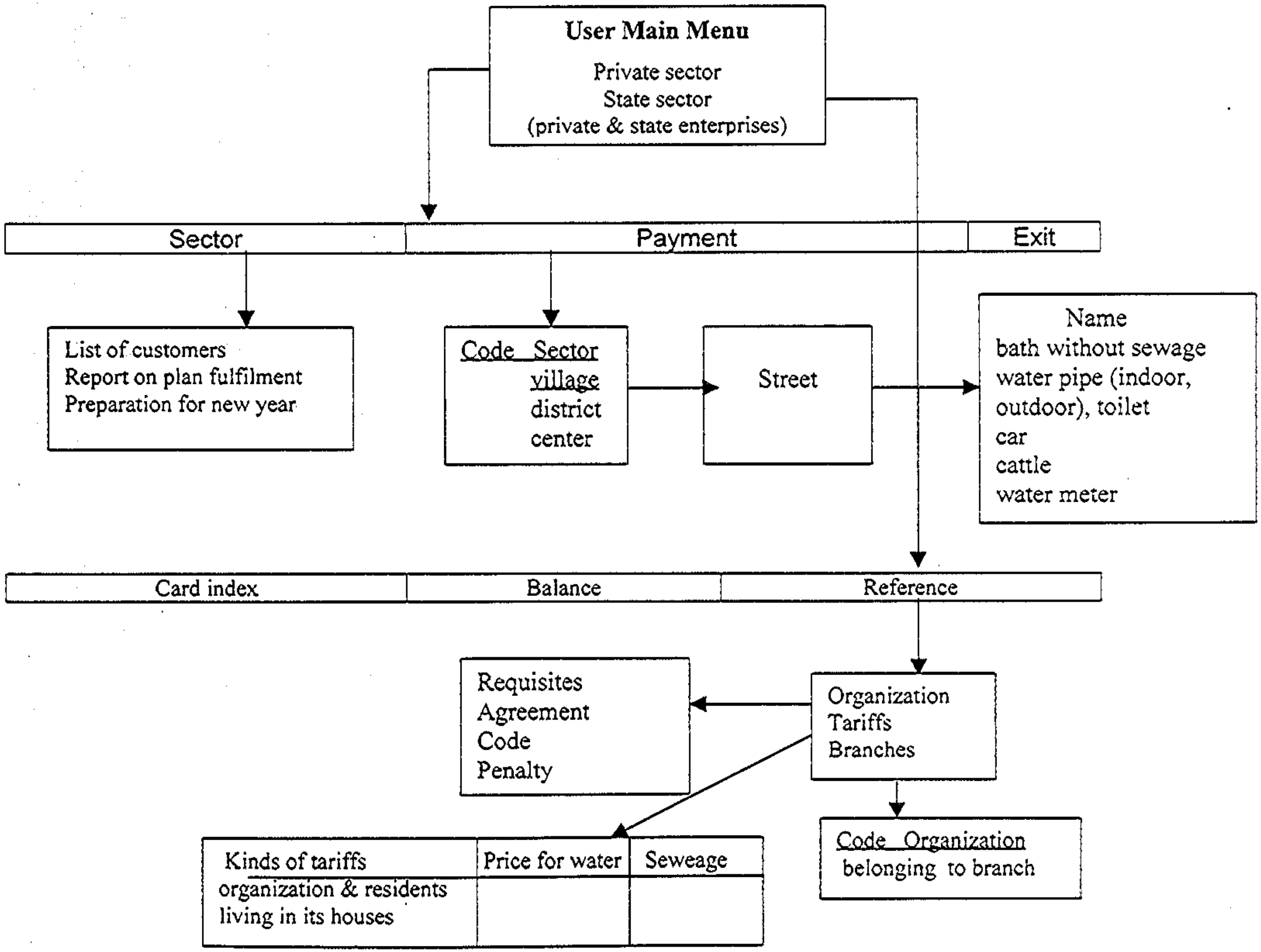


Fig 4.4.4 Tariff Collection System for Resident and Enterprise User Menu Flow



### 4.4.2 Tariff Collection Procedures

We review each procedure along the flow of operations. Before that, we explain that there are four categories of water sales revenue. They are industry, communal service sector, house, and apartments.

Industry includes production companies, private enterprises, etc. The communal services sector consists of budgetary organizations and self-supporting organizations. "House" refers to the owner of a private house and "apartments" is the residents of state apartment buildings.

#### (1) Industry, Communal Services Sectors

We review the tariff collection procedures for the industry and communal services sector and houses and apartments in turn.

The tariff collection procedures for the industry and communal service sector are shown in Fig. 4.4.5.

#### 1) Application for Water Supply

When a new enterprise moves to a location in Chirchik, they must obtain the technical conditions for connection to the city water supply and sewage systems from the Production Board of Chirchik City Vodokanal. The new user fills in an application form for water supply that includes a contract with Vodokanal. It must also pay a fee for their documentation.

The production and Technical Department checks all the documents. If they are appropriate, Emergency Service Department installs a water meter at the user's expense and seals the water unit. Then the Production and Technical Department passes the documents to the Sales Department. The Sales Department concludes the contract and inputs the user's information into the computer.

If a new building does not have a water meter, the new user must install one at its own expense.

## 2) Changes in Conditions

If the conditions of the users are changed, they must outline any changes in a letter to Chirchik Vodokanal.

When an enterprise moves away from Chirchik, the Sales Department checks its settlement status record it the computer. If it has outstanding tariffs and there is no legal successor (new user), the Sales Department should collect any unpaid tariffs as soon as possible.

However if a legal successor moves in, it must mater an application to Chirchik Vodokanal for the issuance of a contract under its own name. If the former enterprise has outstanding tariffs and has not paid these, the unpaid tariff will be transferred to the new owner in the reissued contract. After this, the Sales Department inputs all the undated information into its computer system.

## 3) Billing

Vodokanal draws money from the user's bank account without acceptance of user. If it sends payment order to a bank from 22nd to 25th of the month and enterprises should pay for water within 5 days or by the end of the month. Usually the user pays for current month.

First of all controller belonging to Sales Department visits enterprises once a month to read the water meters and makes the Akt.

Akt includes meter reading, pipe diameter, water consumption, sewerage, working condition of meter and availability of seal. The controller and the user must sign Akt.

Sales Department input the figures of water consumption. The computer calculates each user's amount and the summary amount. The books of Vodokanal contain calculations too.

After printing out from system, payment documents are signed by Accounting Department and sent to the bank. Vodokanal submits to the bank two kinds of documents: payment 4 copies of order and 2 copies of invoice.

### 4) Receipt of Tariff

Vodokanal has the right to collect payment for public utilities from all enterprises via banks by means of payment order without acceptance of user.

If the enterprise has a bank account, Vodokanal will withdraw the amount of the tariff from its account, and if no account in the bank, the enterprise must pay the tariff in cash. Now 44 percent of enterprises pay tariff through banks and the rest of enterprises offset it (budgetary organization and factory only).

After withdrawing, the bank sends all information about payers and non-payers to the Sales Department of Vodokanal. The bank information is of two kinds: the data for each enterprise and the summary list.

Within those 5 days the department enters the settlement information into computer on the bases of bank' lists.

Sales Department calculates money and checks someone who has paid every day. And every month after 6th of the next month gives documents to Accounting Department.

### 5) Outstanding Tariff Control

Vodokanal cashier visits the bank every day to obtain the information on recent receipts. The Sales Department also notes these every day. Every month the computer prints out a list of the outstanding tariff users.

All enterprises are required to remit their payments by the end of the current month. In the case of nonpayment, Vodokanal notifies them and issues a warning concerning cutting off the water supply and the sewer line. If in 5 days the user still does not pay, Vodokanal cuts off the water and sewage service five days later.

The enterprise can send a letter of guarantee to Vodokanal. In this case, the water supplied may be restored.

### (2) Houses

The tariff collection procedures for houses are shown in Fig. 4.4.6.

#### 1) Application for Water Supply

According to a government decree, water meters must be installed everywhere by 2004.

Newcomers must fill in an application form at Chirchik Vodokanal. The production and Emergency Service Department checks the document and draws up a contract for the installation of a water meter. And the Technical Department designs the scheme for the water meter.

Private sector users must pay for the installation of the water meters Payments can be made directly to the Accounting Department at cash offices and the Emergency Service Department then puts a seal on the water unit.

The Sales Department drafts a contract with the user and issues a Customer Book. Water meter readings should start from the point of the previous owner is final reading. Vodokanal checks the reading, and inputs the information including the figures into both the Customer Book and the Vodokanal computer system.

#### 2) Change in Conditions

If house user moves from Chirchik to another city, he is required to go immediately to Vodokanal with his house book and Customer Book. The Sales Department checks whether or not the user has outstanding tariff and a successor collects the tariff.

When the living conditions of a user change, he writes a letter explaining this and Vodokanal reregisters his Customer Book. If necessary, they check the water meter as well. They then input the all pending information into the computer system.

3) Billing

Individual users who do not have water meters usually pay their fixed rate water tariff for the whole year. They can also pay for any period they want, but usually once per quarter. Individual users who have water meters pay quarterly according to their water meter.

A controller visits every house to check the water meter figures and users are required to pay the current month's bill before the 10th of the next month. There are 2 ways of issuing the bill. The user can make the calculations himself and then the controller verifies these and stamps his Customer Book. Alternatively, the controller can come to the house, read the water meter and obtain the agreement of the homeowner. Under both method the user has to pay according to the record entered and stamped in his Customer Book.

4) Receipt of Tariff

A user can pay the tariff in three ways, once a year in many cases. He can go to a cash office or a post office to pay. It is also possible to pay the amount to the controller in cash when he comes to the residence. The user may also come to Chirchik Vodokanal to pay the tariff.

In any case, the user gets his Customer Book stamped and this proves his payment. Even if a controller collects the tariff in cash, he sends the cash to the Accounting Department and the department has to entrust the money to a cash office.

Payments collected through cash offices or post offices are transferred to the bank account of Chirchik Vodokanal. The bank then sends a summary list to the Sales Department.

Information on cash receipts must be input into the computer according by the controller's sector, to enable each controller to identify the outstanding tariff users in his sector.

### 5) Outstanding Tariff Control

Vodokanal has various ways of monitoring payments. The first way is search the computer records, and the second one is going directly to the user and checking his Customer Book. Each controller has his own permanent users (in his service area) and his collection plan. He checks who has paid and who has not paid and visits the user who have not paid.

At the end of each quarter the controller checks the payment status and the next day, hands out notifications to any users with outstanding tariffs. In case of non-payment, the controller delivers a second notification in seven days, and then after three days, Vodokanal can cut off the user's water or can apply to the court.

## (3) Apartments

The tariff collection procedures for residents of apartment are almost the same as those for private houses. They are shown in Fig. 4.4.4.

### 1) Application for Water Supply

If a new user moves in an apartment unit, he must come to Vodokanal with the Housing Book and reregister the Customer Book in his name. He may continue using the Customer Book of the previous resident.

The Sales Department then inputs the new user's registration data into the computer.

There is a problem with installing a water meter in each flat, because of the scheme of the apartment building and the water intake pipes, etc.

### 2) Changes in Conditions

The tariff collection procedure is almost the same as that for private houses.

### 3) Billing

The tariff collection procedure is almost the same as that for private houses.

### 4) Tariff Collection

The tariff collection procedures are almost the same as those for private houses.

Basically, apartment residents pay according to a fixed rate system. Once per month or once per quarter, he goes to the Vodokanal, the post office, a cash office or a blanch of a bank to pay the tariff. Until October 1996, Vodokanal collected the payments through JEK, but now they collect the tariff by themselves.

"Mahalla" is a community of residents living in a certain district. It assists to the Vodokanal in collecting the payments for public utilities. In conformity with the government decrees, it has a plan for such collection: if the plan is completed 100%, Mahalla receives 20% of the amount, and if the plan achieved 75%, they receive 10%.

### 5) Outstanding Tariff Control

The tariff collection procedure is almost the same as that for private houses.

It is difficult to cut off water to entire apartment buildings. They can cut off only the whole part of the block or the whole block of apartments, but this would be unfair to other users living in the same block who have paid for their water supply.

### 4.4.3 Analysis of Tariff Collection Systems

#### (1) Analysis of Computer Systems at Chirchik City Vodokanal

##### 1) The Computer Section Needs to Be Empowered

The four sub-systems have been installed since 1989 when the Collection System was implemented. The systems are operated by Vodokanal's staff who are the end-users and no major problems have occurred. System maintenance is handled by an external computer expert and the documents are not properly maintained within Vodokanal. It can be assumed that the current system cannot be extensively modified.

**i) Lack of Computer Specialists**

Chirchik City Vodokanal does not have an Information Technology Section or a computer specialist, and the end-users themselves maintain and operate the computer system. It seems that no major technical problems have occurred up to the present.

However, it is thought that the current staff may not be sufficient to maintain and operate a much larger computer system if it is developed and implemented. It is difficult for only the end-users to maintain a complex system in addition to their main duties. On the other hand, it is risky for Vodokanal to rely solely on external human resources for maintenance of the computer system. It is recommended that Chirchik Vodokanal recruit a computer specialist but an entire computer section may not be necessary at this stage.

**ii) Lack of Security and Backup System**

Currently, even in the case of system failure, Chirchik Vodokanal's business will not be affected because the information is recorded both manually and electronically. However, when a larger computer system is implemented and operated to improve the efficiency of Vodokanal's business in the future, a system failure may interrupt the Vodokanal's business.

The current system does not have a recovery facility in the case of loss of data. In addition, no adequate security system has been implemented. At the moment, six stand-alone computers are utilized and, thus, system security may not be a major concern. When a large computer system with a network has been implemented and is operating, it will be necessary to consider security measures and a backup system.

Physical security is another item to review; for example, limiting access to the computer room, prohibiting installation of unauthorized software, etc.

**2) It is difficult to modify the system according to the new tariff policy**

Even if Chirchik Vodokanal does not develop a new system, the current computers may not be compatible with handling the new tariff policy and systems modification will be required to some extent.

**i) Change in the Water Tariff Table**

If the proposed tariff table is adopted, it is assumed that the formulas of tariff calculation should be revised.

If the water meter system is implemented and replaces the simple fixed rate system (multiplying a unit price by the number of users), the computer system must be substantially modified or a new program developed from scratch.

**ii) Increase in Transactions**

If a water meter is installed at each user's house, more data will be input into the computer system to be processed. It is necessary to improve the current system in order to process a large amount of data. For example, input screens should be modified to capture more data. There are currently only four computer terminals and they are too few to accomplish efficient work by the computer system. The volume of transactions is expected to increase and therefore it is necessary to revise the specifications for the computer hardware.

Furthermore, implementing a new way of data collection to improve efficiency, e.g., a hand-held terminal, or an optical character reader (OCR), should be considered.

### 3) Many tasks are duplicated manually

The current computer system is utilized efficiently mainly to generate the payment orders, which are submitted to the banks. This is similar to the status at Tashkent City Vodokanal. This task is automated and the computerized information is efficiently used. Although the computer system at Chirchik City Vodokanal can produce an aging analysis list, the number of computer terminals is limited and it was observed that the system is not being efficiently utilized.

Many other tasks, however, are performed manually and the data capture for the computer system is done later. These tasks are duplicated on paper and in the computer system. It is also assumed that certain tasks in the whole process are not computerized and therefore the manual tasks are fragmented between the computerized and non-computerized tasks. The number of computer terminals is so few that the controllers can hardly obtain access to the computer system for their own business.

#### i)Duplicate Tasks Done by the Controllers

The current computer system has several functions: recording the meter readings, calculating the amount billed, summarizing various statistical data, and producing an aging analysis list. However, the controllers record all this information manually in their notebooks and it would seem that the current system is hardly being utilized efficiently.

For example, if a controller were to use the information output from the computer system, most tasks would be conducted more efficiently, namely, meter reading, data capturing, reporting, generating of the payment orders which are submitted to banks, confirming the payment and compiling the summary. In fact, however, the functions of the current computer system are not fully utilized, and the work is largely done on paper. It was observed that the computer system is utilized for data storage, not as a processing machine.

#### ii) Data Exchange with Banks

The information exchanged between Vodokanal and banks is all on paper. The payment orders, which are submitted to the banks by Vodokanal, are printouts from the computer system. On the other hand, information is received in the form of printouts from the banks' computer systems.

It will surely improve the accuracy and efficiency of data exchange if computer storage such as floppy are disks utilized, though the computer systems of banks need to be modified. Such electronic information can also be utilized for outstanding tariff control.

#### iii) Data Transfer to the Accounting Department

The monthly data on sales and credit is submitted to the Accounting Department in the form of paper memos. There is no distinction between advance receipts and remittance for accounts receivable.

The Study Team has proposed that the information held in the computer system be fully utilized and that the balance of each user's account be electronically transferred to the Accounting Department for accurate and appropriate processing.

### 4) Computer Hardware

The current system is running on a platform of 386, 486 or Pentium CPU and MS-DOS operating system. The harddisk and memory capacity is uncertain but it is assumed that they are not large because the computers are many years old and are outdated. Mainstream computers currently run post-Pentium – Windows system. It would be difficult to maintain Chirchik Vodokanal's current system in case of a breakdown.

## (2) Analysis of Tariff Collection Procedure

### 1) Every user is served and administered by one controller who is a generalist

Each user is served and administered by one controller; namely, controllers are given their assignments by user (i.e., the controller is a generalist), not by task (i.e., the controller is a specialist). This means that every task (such as meter reading, collection of the tariffs, updating the Customer Book, etc.) for one user is done by one controller. The advantage of this generalist system is that the controller can understand the detailed conditions of the users. However, after the water meters are installed at all houses, the clerical workload will increase. It will thus be necessary to review how the tasks are assigned to the controllers.

**i) Improvement of Efficiency of Business**

The more water meters are installed, the more controllers must visit for the meter readings. It will become complicated to calculate the water tariff and process the payment as the fixed system will be abolished and the tariffs will vary according to the amount of water used. It is assumed that more clerical manpower will be required.

It is recommended that each controller become specialized in a particular task (the controller is a specialist for a particular task) rather than be assigned to a particular group of users (the controller is a generalist handling all tasks) so that the business procedures can be improved efficiently. For example, one controller does the meter readings and another controller focuses on tariff collection.

As for tariff collection, it is recommended that financial institutions such as banks, post offices and cash offices be utilized as collection agencies instead of direct tariff collection by the Chirchik Vodokanal staff. It is suggested that, if possible, the automatic deduction service of banks be implemented for water tariff collection. The whole tariff collection procedures will be improved efficiently by utilizing computer programs to calculate the water tariff and to monitor users whose bills are unpaid.

It is essential to restructure the tariff collection procedures by introducing specialists in order to improve efficiency.

**ii) Internal Controls**

It is generally known that incorrect or fraudulent operations may be monitored and prevented by segregating the controllers who bill the users from the controllers who collect from the users. Namely, if two or more controllers serve the same user, casual errors or misconduct can be prevented through this method of internal control.

**2) Time to read Water Meters**

It takes a lot of time to read the water meters because the meter readings are taken by the controller and the user together. Under the fixed rate system, it may be necessary to do a crosscheck by the controller and the user, as the penalty is severe.

**i) Introducing Meter Reading by the Controller Only**

If a water meter is installed at each user's house, there will be no need to ask the user to confirm the meter reading in the presence of the controller. If the controller can read the meter without the presence of the user, the meter reading will not be delayed in terms of whether or not the user is at home. Hence, greater efficiency will be achieved.

It is essential that the meters be installed outside if the controller is to read the meter by himself. If possible, there should be rules as to where a water meter can be installed.

**ii) Introducing Bills to Replace the Customer Book**

Currently a Customer Book, which belongs to each user in the general public, is maintained to record the water amount used and the tariff. By using the Customer Book systems there is no need to issue bills, but this requires the user to attend the meter readings.

If a controller were to issue a bill specifying the description of the services rendered instead of maintaining the Customer Book, there would be no need for the users to attend the meter readings. This would also reduce the time spent on meter reading and improve the overall efficiency of the water supply business.

## 4.5 Water Supply System and Operation and Maintenance

### 4.5.1 History

The centralized water supply systems of Chirichik was built in 1930 having a supply capacity of 75,000 cu.m/day, using groundwater source in the Chirchik River basin, excluding surface water source.

The project "surface-source water supply of the Chirchik City" was implemented by the Uzgi-prokommuninj-project institute in 1970. It was approved by the Ministry of Habitation and Utility Service of the UzSSR in 1972.

Construction of the water treatment plant performed by the Stroitrest (Construction trust) No.160 of the Ministry of Construction of the UzSSR.

Installation services were undertaken by the "Uzorgcommunenergonaladka" as stated in the contract No.255/89 from 8 August 1989 with Chirchik City Vodokanal. Installation was started in September 1990, and finished in December 1991.

The City's demand in drinking water was estimated to reach 250,000 cu.m/day. The project was designed to serve for the future water demand and implemented step by step in 1991. But, the City's water demand did not increase so much; nowadays water distribution volume of Vodokanal is about 120,000 cu.m/day. Thus, construction of Chirchik surface WTP was delayed as only first step capacity at 59,000 cu.m/day.

### 4.5.2 Water Supply Network and Plants Location in the City

Locations of water treatment plant and its water sources in Chirchik City were shown in Figure 4.5.1. Existing water sources are; one (1) surface water intake pump station at surface water treatment plant, three (3) groundwater intake facilities and three (3) city wells. Each capacity of these sources is shown in Table 4.5.1.

Distribution pumps are provided at the WTP and respective intake facilities, aside from two buster pump stations.

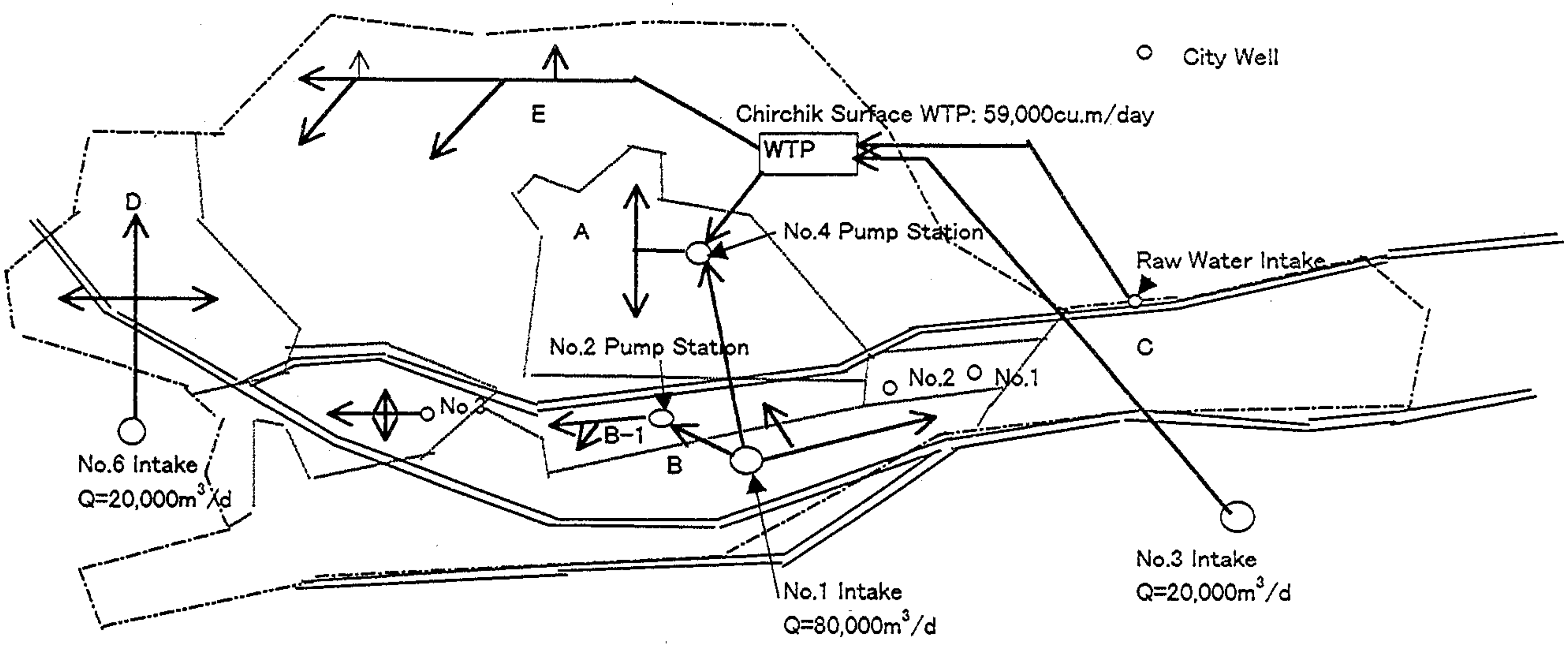



Figure 4.5.1 The Plan of Water Supply System in Chircik City

**Table 4.5.1 Existing Water Sources**

| Name | Nominal Capacity (cu.m/day) | Fact Capacity (cu.m/day) | Water Source |
|---|---|---|---|
| Chirchik WTP | 59,000 | 59,000 | Surface water |
| No.1 intake | 80,000 | 19,200 | Groundwater |
| No.3 intake | 20,000 | 12,000 | Groundwater |
| No.6 intake | 20,000 | 18,000 | Groundwater |
| City well | | 3,000 | Groundwater |
| Total | 179,000 | 111,200 | |

### 4.5.3 Pump Stations

Chirchik water supply system is characterized by remarkably small volume of reservoirs compared to the total distribution volume, as shown in Table 4.5.2.

**Table 4.5.2 Volume of Distribution Reservoir**

| Name | Volume (cu.m) | Remarks |
|---|---|---|
| Chirchik WTP | 5,000 x 2 | |
| No.1 Intake | 500+1,000 | |
| No.2 Booster PS | 350 | |
| No.3 Intake | 1,000 | |
| No.6 Intake | 0 | |
| No.4 Booster Pump Station | (750 x 2) | |
| Total | 14,350 | Not working |

An overall retention time of these reservoirs is 1.92 hours (=14,350/179,000x24). Owing to this insufficient storage capacity, the distribution pumps are required to have the maximum distribution volume and their operations are very complicated. Overall retention fact time of these reservoirs Is 3.18 hours(=14,350/108,200×24)

Factories and residential section locate generally in low land along Chirchik River and most of residential section locates relatively in high land that is higher than low land at about 80 m in Chirchik City. Therefore, total head of lifting pump at No.1 intake facility transmitting water to the Chirchik WTP reservoir (Komsomolsk PS) is 82 m high. Roles of each pump station are shown in Table 4.5.3.

Pump stations and these water sources are shown Table D.4.5.1.

Table 4.5.3 Roles of Pump Stations

| Name | Pump Head (m) | Distribution Area | Role |
|---|---|---|---|
| No.1 PS: high | 120 | A | Distribution to Komsomolsk PS |
| No.1 PS: low | 60 | B | Distribution to B area |
| No.2 PS | 80 | B-1 | Boost to B-1 area |
| No.3 PS | 65 | C | Distribution to C area |
| No.4 PS | 30, 40 | A | Boost to A area |
| No.6 PS | 70 | D | Distribution to D area |
| Komsomolsk PS | 60 | E | Distribution to E area |
| City Well No.1 | 50 | B-1 | Distribution to B-1 area |
| City Well No.1 | 50 | B-1 | Distribution to B-1 area |
| City Well No.1 | 50 | D-1 | Distribution to D-1 area |

### 4.5.4 Water Treatment Plants and Water Sources

#### (1) Chirchik Surface WTP

##### 1) Water Source

Chirchik Surface WTP that flow chart is shown in Figure 4.5.2 is only one WTP in Chirchik City fed from SDK-NDK channel.

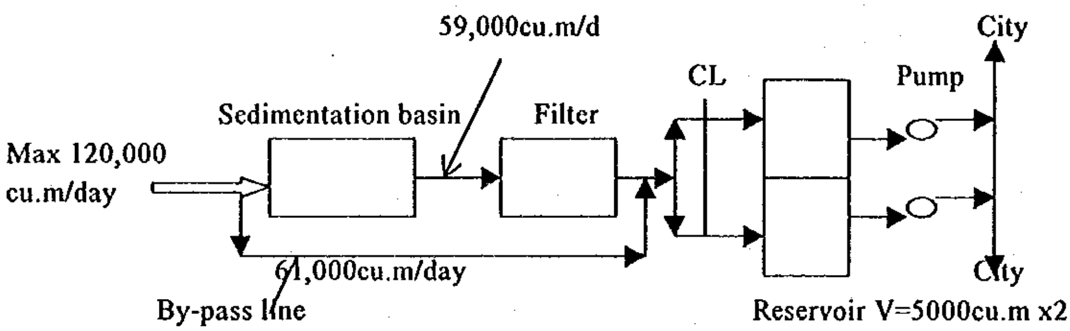



Figure 4.5.2 Flow Sheet of Chirchik WTP

The intake site area is 14.6 hectare and 645m above sea level and WTP site area is 59.1 hectare and 670m above sea level.

When the supply from the SDK channel is interrupted for short time, the intake is performed from the "Iskander" channel fed from the GMK channel.

Raw water is transferred by pump from the SDK-NDK water intake to the "Komsomolski" unit, where raw water is treated and disinfected.

The stream flow of SDK-NDK irrigation channel varies from 50 to 260 cu.m/sec and channel Iskander reaches average 3 cu.m/sec.

Water source of these irrigation channels is huge Charvak Dam Lake having storage volume of 2 billion cu.m.

Chirchik Surface WTP has a treatment capacity of 59,000 cu.m/day and its flow chart is shown Figure 4.5.2 and Figure D.4.5.1.

Facilities and structures lists of Komsomolsk Intake PS are shown Table 4.5.4. That intake PS has 5 pumps and these dimensions are shown Table 4.5.5.

Table 4.5.4 Facilities and Structure of Komsomolsk Intake PS

| Item | Suction Pipe | Intake Pump | Suction Pipe | Intake Pipe | Pump House | Electrical Facility | |
|---|---|---|---|---|---|---|---|
| Type | Steel pipe | Centrifugal pumps | Steel pipe | Steel pipe | Prefabricated building | Standing panel | Power plant |
| Numbers of Facility | 5 | 5 | 5 | 2 | 1 | 5 | 1 |
| Dimension | Dia 800 mm | See Table 4-5 | Dia 800 mm | Dia 1,000 mm | Approx. W-15 m, L-50 m, H-9 m | | |

Table 4.5.5 List of Intake Pumps

| Name | Pump No. | Role | Type | Dimension Cu.m/hr(min) x m-H x mm-D x kW | Numbers of Unit |
|---|---|---|---|---|---|
| Intake Pump Station | 1 | W | D1250/65 | 1,250(20.8) x 65 x 450,350 x 250 | 1 |
| | 2 | S | D1250/65 | 1,250(20.8) x 65 x 400,300 x 200 | 1 |
| | 3 | W | D1250/65 | 1,250(20.8) x 65 x 450,350 x 250 | 1 |
| | 4 | S | D1250/65 | 1,250(20.8) x 65 x 450,400 x 315 | 1 |
| | 5 | W | D2500/68 | 2,500(41.2) x 68 x 500,400 x 500 | 1 |
| | | | | Total 5,000cu.m/hr = 120,000 cu.m/day | |

Note: W -Working S -Stand-by

**2) Structure**

WTP's main structures are sedimentation tank, filter basin, reservoir tank, administrative building and others. These lists are shown Table 4.5.6.

**3) Sedimentation Facility**

Configuration of sedimentation facility is shown in Table 4.5.7.

Table 4.5.6 Major Structures of WTP

| Facility | Coagulation & Intake Building | Flocculation Chamber | Sedimentation Basin | Filter | Filter Building | Reservoir |
|---|---|---|---|---|---|---|
| Type | Brick Structure | Detour, Prefabricated concrete | Horizontal, Prefabricated concrete | Rapid, Prefabricated concrete | Prefabricated building | Ground, Prefabricated concrete |
| Numbers of Unit | 1 | 5 | 5 | 5 | 1 | 2 |
| Dimension | Approx. W-8 m x L-32 m x H-8 m | W-6 m x L-16.5 m x H-4.5 m = 393 cu.m | W-6 m x L-57 m x H-4.5 m = 1247 cu.m | W-4.5 m x L-11.7 m = 52.7 sq.m | W-24 m x L-36 m x H-12 m | 5,000 cu.m |
| Facility | Sludge Tank | Adm. Building | Chlorination Building | Washing Facility Building | Storehouse | Distribution Pump House |
| Type | Underground, Prefabricated Concrete | 2 stories, Prefabricated Building | Prefabricated Building | Prefabricated Building | Prefabricated Building | Sub-basement, Prefabricated Building |
| Numbers of Unit | 1 | 1 | 1 | 1 | 1 | 1 |
| Dimension | ------ | Approx. W-10 m x L-25 m | Approx. W-7 m x L-12 m | Approx. W-10 m x L-20 m | Approx. W-10 m x L-30 m | Approx. W-15 m x L-40 m |

Table 4.5.7 Configuration of Sedimentation Facilities

| Item | Rapid Mixer | Alum & Alkaline Feeder | Inlet Gate or Valves | Flocculator |
|---|---|---|---|---|
| Type | Vertical Mixing | Manual feeding | Motorized valve | Chamber |
| Number | 2 | -- | 5 | 5 |
| Item | Rapid Mixer | Alum & Alkaline Feeder | Inlet Gate or Valves | Flocculator |
| Dimension | W3.3m x L-13.8 m x H-3.6 m, Triangular shape, V = 28.6 cu.m | Handled by Motorized hoist, being used when needed. | Dia.:500mm | V: 333 cu.m, Retention time: 41 min. |
| Item | Sludge Collector | Sedimentation Basin | Electrical Facilities | |
| Type | Made hole pipe | Horizontal flow | Control panel | |
| Number | 5 | 5 | 1 | |
| Dimension & Note | Dia.:150 mm | V: 1,247 cu.m Retention time: 2.5 hr Average Horizontal flow Velocity: 4.7 mm/sec | Manual Operation of valve | |

In this country, coagulant is not applied until raw water turbidity reaches to a certain level, even in the rapid sand filtration process. Thus, when coagulant is to be utilized, raw water is led to the rapid mixing tank made of steel plate and the porous mixing pipe having diameter of 20 mm, and finally conveyed to the flocculation basin. On the other hand, when coagulant is not applied, raw water flows into the sedimentation basin from the center of receiving chamber.

Horizontal flow type parallel flocculation chambers are separated by two (2) units of walls and have buffer walls for flocculation.

Sediments accumulated in flocculation chambers and sedimentation basins are drained from porous pipes and sent to sludge lagoon.

4) **Filtration Facility**

Configuration of filtration system is shown in Table 4.5.8.

Filter size is shown in Figure D.4.5.2. and D.4.5.3

**Table 4.5.8 Configuration of Filtration System**

| Item | Filter | Filter Media | Gate and Valve | Filter Washing Blower |
|---|---|---|---|---|
| Type | Quick | Quartz sand | Motorized valve | Volume |
| Numbers of Unit | 5 | 5 | 5 | 2 |
| Dimension | Area: 53.7 sq.m, Filtration speed: 220 m/day (no reserve), Washing method: air bubbling & back wash | Area: 53.7 sq.m, Thickness of Media:1.8-2 m | Inlet: dia.400 mm, Outlet:dia.500mm, Drain:dia.800 mm, Backwash:dia.800 mm (Pipe:dia.400 mm) Air-wash: dia.250 mm | Q: 12 cu.m/m, Pressure: 0.4 kg/sq.cm, Power: 40 kW, Dia.: 100 mm |
| Item | Filter Washing Pump | Electrical Facility | Booster Pump | Washing Velocity |
| Type | Centrifugal | Control panel | Centrifugal | Air & water |
| Numbers of Unit | 2 | 5 | 1 | --- |
| Dimension | Q: 6.6 cu.m/m, H: 22 m, Dia.: 250, 200 mm, KW: 37 | Manual operation of valve & washing Facilities | Boost flow velocity from filter to reservoir | Air-bubbling: 27 cu.m/sq.m/m, Backwash:, 14 cu.m/sq.m/hr, (2 unit working) |

When five (5) filters are operated, filtration velocity becomes 220 m/day, while four (4) filters are operated and one (1) filter is reserved, the said velocity increases to 275 m/day. Filter material is composed of quartz with a total thickness of 1.8 m to 2.0 m.

Filter is cleaned by means of air bubbling and back water washing at velocities of 27 m/hr (= 0.45 cu.m/sq.m/min = 7.5 L/sq.m/sec) and 14 m/hr (= 0.23 cu.m/sq.m/min = 3.9 L/sq.m/sec), respectively.

Inconsistency of design/installation was observed that diameter of backwashing water pipe was 400 mm, while that of valve was 800 mm. When the aforementioned two (2) pumps are operated at flow rate of 13.2 cu.m/min, flow velocity (1.75 m/sec) of backwashing water in the former 400 mm pipe is deemed appropriate. Although, pipe diameter and flow rate are matching each other, the valve was designed/installed assuming higher flow velocity or substituted by the originally designed one. It shall be noted that the hydraulic and capacity calculation document shows the usage of larger capacity of backwashing pump.

5) Other Facilities

Other major facilities, such as chlorination, sludge treatment, transmission/distribution facilities are shown in Table 4.5.9.

Chlorination facility utilizes 50 kg of gas cylinder and processes chlorine gas through evaporator – flow meter – ejector and applies just before distribution reservoir. Leaked chlorine gas is removed by exhaust fan and treated in a tower containing ceramic media for neutralization.

Sludge and wastewater from sand filter are drained into sludge tank. Supernatant is returned to the raw receiving well. Settled sludge is treated at drying bed (about 1 ha) and dried sludge is finally disposed in every 5 year period.

Distribution pumps consist of large and small types as shown in Tables 4.5.9 and 4.5.10, respectively.

Two (2) units of distribution reservoirs (5,000 cu.m x 2 units), as shown in Table 4.5.3, have sufficient capacity as clear water reservoir, but insufficient as distribution reservoir.

In accordance with the plan the reservoir should to have capacity 22,300 cu.m ( 2 reservrvoir-each10,000cu.m).

Table 4.5.9 Configuration of Other System

| Item | Chlorination Facility | | | |
|---|---|---|---|---|
| | Chlorinator | Chlorinated Water Pump | Chlorine Neutralization Facility | Electrical Facility |
| Type | Evaporation with gas cylinder | Centrifugal | Centrifugal | Control panel |
| Number | 2 | 2 | 1 | 1 |
| Item | Sludge Treatment Facility | | | |
| | Concentrated Sludge Pump | Water Returning Pump | Electrical Facilities | Sludge Drying Bed |
| Type | Centrifugal | Centrifugal | Control panel | Drying bed |
| Number | 2 | 2 | 1 | 1 |
| Years of Usage | 9 | 9 | 9 | 9 |
| Dimension | --- | --- | --- | 1ha |
| Item | Distribution Facility | | | |
| | Distribution Pump 1 | Distribution Pump 2 | Motorized Valve | Electrical Facility |
| Type | Centrifugal | Centrifugal | Motorized valve | Control panel & power panel |
| Number | 2 | 2 | 12 | 4 |
| Dimension | Q: 41.2 cu.m/m<br>H: 60 m<br>D:500,400mm kW: 500 | Q: 20.8 cu.m/m<br>H: 60 m<br>D: 400, 300 mm<br>KW:250 | Dia.:<br>600 to 1,000 mm | ---- |

Table 4.5.10 List of Distribution Pumps

| Name | Pump No. | Role | Type | Dimension cu.m/hr(min) x mH x D mm x kW | Number |
|---|---|---|---|---|---|
| Distribution Pump, Station | 1 | W | D1250 | 1,250(20.8) x 60 x 400,300 x 250 | 1 |
| | | S | D1250 | 1,250(20.8) x 60 x 400,300 x 250 | 1 |
| | 2 | W | D2500 | 2,500(41.2) x 60 x 500,400 x 500 | 1 |
| | | S | D2500 | 2,500(41.2) x 60 x 500,400 x 500 | 1 |
| Total Capacity | | | | 3,750 cu.m/hr = 90,000 cu.m/day | |

Note: W –Working S –Stand-by

### (2) Intake Plants of Groundwater

#### 1) No.1 Intake (Central Intake/ No.1 Pump Station)

Groundwater in Chirchik City yields from the quaternary deposit along with the Chirchik River. The depth of aquifer is seen at 15 m to 20 m or 25 m to 30 m and the average depth of well is about 30 m.

No.1 Intake plant having daily discharge of 80,000 cu.m/day is the largest deepwell source being located at the sandbank of the Chirchik River. Configuration of this source facility having an area of 70 ha at the altitude of about 593 m is shown in Figure 4.5.3, FigureD.4.5.4 and Table 4.5.11.

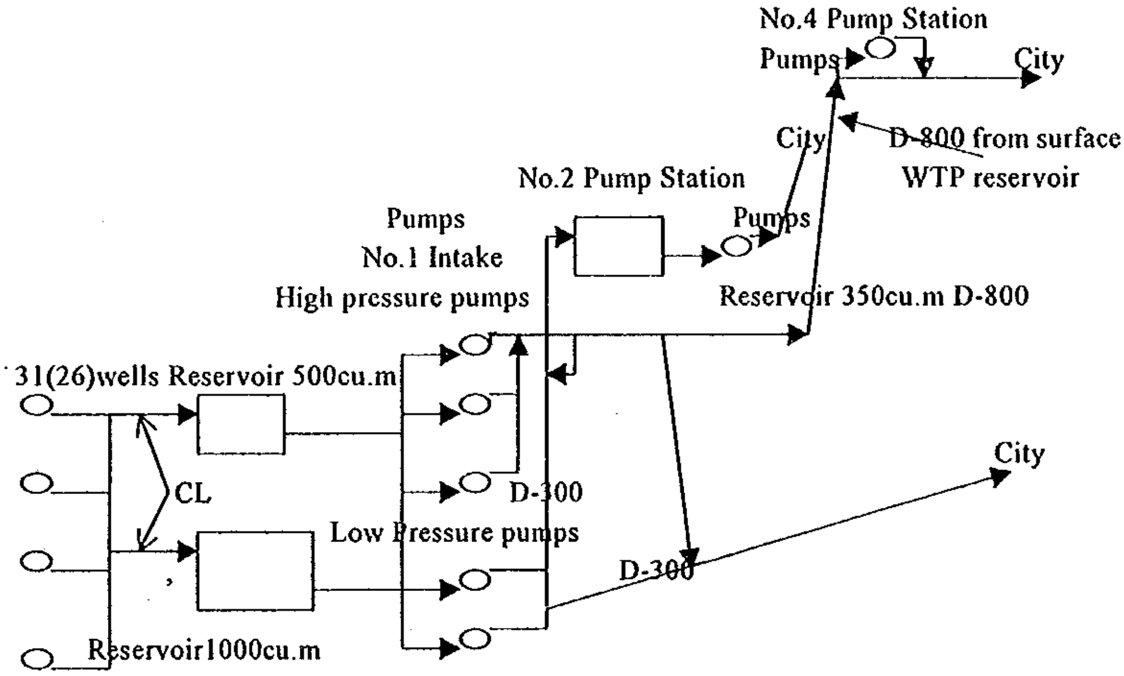



**Figure 4.5.3 Flow Sheet of No.1 Intake, No.2 Pump Station and No.4 Pump Station**

**Table4.5.11 Wells and These Facilities List**

| Item | Wells | Intake Pump | Electrical Facilities | Pump House | Reservoir |
|---|---|---|---|---|---|
| Type | Deep Well | Submergible type | Control panel | Brick structure | Reinforced concrete |
| Numbers of Unit | 31 (5) | 31 (5) | 31 | 20 | 2 |
| Dimension | Dia; 356 mm<br>Depth; 30 m | Q: 2.4 cu.m/m<br>H: 45 m<br>D: 125 mm<br>kW: 32 | ---- | 6 m x 6 m | V=<br>1,000 cu.m<br>+500 cu.m |

Note: ( ) Stand-by

A total 31 wells are located and 5 out of the total are reserved as stand-by. All of them have a diameter of 356 mm with 30 m of total depth. Each well is equiped with pump house and control panel. An average production capacity of well is about 3,077 cu.m/day, based on the nominal production volume of 80,000 cu.m/day by 26 operating wells.

Although the reservoir has a storage capacity of 1,500 cu.m, it is deemed to have a function of only pump pit due to insufficient retention time at 30 min. against the total daily production. The factual time of renovation will be 1.9 hours (=1,500cu.m /19,200x24) approximately 2 hours at existing load of pumps.

A remarkable feature of this source facility is that the well site being situated on the sandbank is used as filter media of riverbed water.

Table 4.5.12 shows a list of distribution pumps and their appurtenance facilities.

**Table 4.5.12 Distribution Pumps and Facilities**

| Item | Distribution Pump | | | |
|---|---|---|---|---|
| Type | Centrifugal | Centrifugal | Centrifugal | Centrifugal |
| Number | 3 (1) | 1 | (1) | 1 |
| Dimension | Q: 20.8 cu.m/min<br>H: 120 m<br>D: 400, 300 mm<br>KW: 630 | Q: 20.8 cu.m/min<br>H: 60 m<br>D: 400, 300 mm<br>kW: 500 | Q: 8.3 cu.m/min<br>H: 120 m<br>D: 250, 200 mm<br>KW: 250 | Q: 3.3 cu.m/min<br>H: 120 m<br>D: 125 mm<br>kW: 100 |

| Item | Electrical Facility | Pump House(1) | Pump House(2) | Chlorinator | Chlorinator Building |
|---|---|---|---|---|---|
| Type | Control panel | Brick structure | Prefabricated Building | Evaporation with gas cylinder | Brick structure |
| Dimension | | Approx (1)W8mxr 20m (2)W8mxr 12m | Appr. W12mxr 24m | 50kg cylinder | Appr. W6mxr 12m |

Note;( ) Stand-by

Pumps are classified into two types by their pumping head and pumps with high discharge head are used to transmit water to No.4 pump station (booster pump station) for supply to the City. No. 4 pump station having an altitude of about 665 m is about 72 m higher from No.1 pump station.

Pumps with low discharge head are directly supplying water to moderately middle height of service area being shown as "B" in Figure 4.5.1.

### 2) No.3 Intake (Aranchin Intake/No.2 Pump Station)

No. 3 Intake plant (Aranchin Intake) having 12,000 cu.m/day of transmission capacity in an area of 18 ha at an elevation of about 612 m is located at right-bank of the Chirchik River.

The transmission/distribution pipeline from this pump station is connected with the reservoir at WTP and is capable to supply water to service area "C" shown in Figure 4.5.1. Thus, service area "C" avails of water supply from both facilities.

Configuration of pump station is show in Figure 4.5.4, Figure D.4.5.5.and Table 4.5.13. All of eight (8) deepwells are utilized continuously. An average production capacity of well is about 1,500 cu.m/day based on the total production of 12,000 cu.m/day by 8 deepwells.

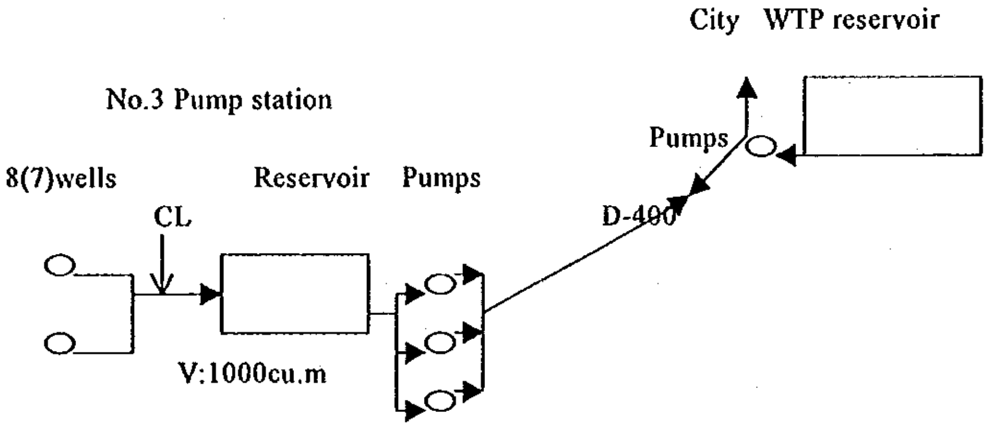



**Figure 4.5.4 Flow Sheet of No.3 Intake**

Reservoir in this pump station has a storage capacity of 1,000 cu.m which is equivalent to retention time of 2 hours. Although it's storage capacity is larger than that of No. 1 Intake, its insufficient as distribution reservoir.

**Table 4.5.13 Deepwells and Their Appurtenant Facilities**

| Item | Well | Intake Pump | Electrical Facility | Pump House | Reservoir |
|---|---|---|---|---|---|
| Type | Deepwell | Submergible | Control panel | Brick Structure | Reinforced concrete |
| Numbers Of Unit | 8 | 8 | 8 | 8 | 1 |
| Dimension | Dia: 356 mm<br>Depth: 30 m | Q: 1.7 cu.m/m<br>H: 50 m<br>D: 125 mm<br>KW: 32 | ---- | 5 m x 4 m | V=<br>1,000 cu.m |

Table 4.5.14 presents transmission pump (as booster pump) and its appurtenant facilities.

Table4.5.14 Distribution Pumps and Facilities

| Item | Distribution Pumps | | | |
|---|---|---|---|---|
| Type | Centrifugal | Centrifugal | Centrifugal | |
| Number | 1 | 2 (1) | 1 | |
| Dimension | Q:8.3 cu.m/min<br>H: 70 m<br>D: 250, 200 mm<br>KW: 200 | Q: 3 cu.m/min<br>H: 70 m<br>D: 125 mm<br>kW: 75 | Q: 4.2 cu.m/min<br>H: 70 m<br>D: 125 mm<br>KW: 125 | |
| Item | Electrical Facility | Pump House | Chlorinator | Chlorinator Building |
| Type | Control panel | Brick Structure | Evaporation with gas cylinder | Brick structure |
| Numbers | 9 | 3 | 2 | 1 |
| Dimension | | Appr. W6mxr 45m | 50kg cylinder | Appr. W6mxr 12m |

Note: ( ) Stand-by

The pump has discharge head of 70 m. When the water level of reservoir in the Surface WTP at 675 m is taken into account, there is a gap of ground elevation at 63 m from No.3 Intake and is deemed to be difficult to transmit water properly owing this elevation gap and friction loss in pipeline.

Normally, water is supplied from No.3 Intake to service area "C" and the reservoir at Surface WTP takes over its role when No. 3 Intake encounters some problem. An elevation of service area is about 40 m higher than that of this Intake.

3) No.6 Intake ( No.6 Pump Station)

No. 6 Intake plant is located in the downstream of the Chirchik River in the suburb of Chirchik City and has function of intake and distribution pump station with an area of 4.32 ha at an elevation of about 568 m.

This Intake plant is catering for the service area "D" as shown in Figure 4.5.1 which is same as the role of No. 3 Intake as the intake and distribution pump station.

Configuration of this Intake plant is shown in Figure 4.5.5 and Figure D.4.5.6, while their facilities are shown in Table 4.5.15. A total of 6 wells are located and one out of them is for stand-by.

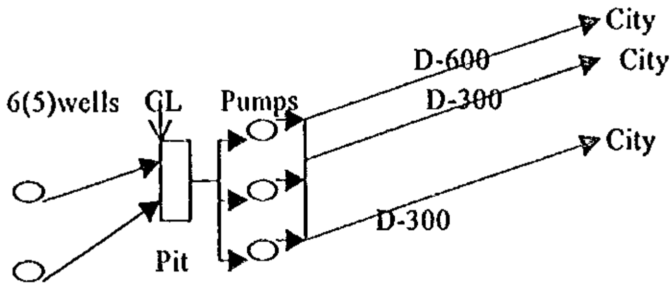



Figure 4.5.5 Flow Sheet of No.6 Intake

The total intake amount is about 18,000 cu.m/day or equivalent to 4,000 cu.m/day per well, which is comparatively larger production rate than other sources.

Table 4.5.15 Wells and Appurtenant Facilities

| Item | Well | Intake Pump | Electrical Facility | Pump House | Pump Pit |
|---|---|---|---|---|---|
| Type | Deepwell | Submergible | Control panel | Brick structure | Reinforced concrete |
| Number | 6 (1) | 6 (1) | 6 | 8 | 1 |
| Dimension | Dia: 356 mm<br>Depth: 30 m | Q: 2.9 cu.m/min<br>H: 40 m<br>D: 125 mm<br>KW: 32 | ---- | 5 m x 4 m | V=60 cu.m |

Note: ( ) Stand-by

Actual design of resrvoir is just for pump pit owing to its limited storage capacity and deemed to be difficult to operate unless water is overflowing continuously.

Distribution pump being used to boost water and its appurtenance facilities are shown in Table 4.5.16.

Table 4.5.16 Distribution Pumps and Facilities

| Item | Distribution Pump | | |
|---|---|---|---|
| Type | Centrifugal | Centrifugal | Centrifugal |
| Number | 2 (1) | 1 | 1 |
| Dimension | Q: 8.3 cu.m/min<br>H: 70 m<br>D: 250, 200 mm<br>KW: 200 | Q: 8.3 cu.m/min<br>H: 70 m<br>D: 250 mm<br>KW:200 | Q: 8.3 cu.m/min<br>H: 70 m<br>D: 250 mm<br>kW: 250 |

| Item | Electrical Facility | Pump House | Chlorinator | Chlorinator Building |
|---|---|---|---|---|
| Type | Control panel | Brick structure | Dissolved Hypochlorine | Brick Structure |
| Numbers | 9 | 3 | 1 | 1 |

Note: ( ) Stand-by

4) City Wells

There are three (3) units of city wells within chirchik City and being used as supplemental sources. No. 1 City Well is located in the southeast of the City, while No. 2 is near Chirchikselmash and No. 3 is near Chirchik City Vodokanal Office. Each of them is directly connected to the distribution pipeline from well pump. The composition of these sources is shown in Table 4.5.17.

Table 4.5.17 City Wells

| Item | Well | Intake Pump | Electrical Facility | Chlorinator | Pump House |
|---|---|---|---|---|---|
| Type | Deepwell | Submergible | Control panel | Dissolved Hypochlorine | Brick structure |
| Numbers Of Unit | 1 | 1 | 1 | 1 | 1 |
| Dimension | Dia.: 356 mm<br>Depth: 30 m | Q: 2.9 cu.m/min<br>H: 40 m<br>D: 125 mm<br>KW: 32 | ---- | | 4 m x 5 m |

### 4.5.5 Booster Pump Station and Distribution Pipeline

(1) No.2 Pump Station

There are two booster pump stations in Chirchik City, namely No.2 and No.4 Pump Stations. No.2 Pump Station as shown in Figure 4.5.1 serves for service area "B-1" by transmitting water received from No.1 Pump Station. This pump stations has an area of 0.1 ha with pump facilities shown in Figure 4.5.3 and Table 4.5.18.

Table 4.5.18 No.2 Pump Station

| Item | Distribution Pump | | | Electrical Facility | Reservoir | Pump House |
|---|---|---|---|---|---|---|
| Type | Centrifugal | Centrifugal | Centrifugal | Control Panel | Reinforced Concrete | Brick Structure |
| Numbers Of Unit | 1 | 2 (1) | 1 | 4 | 1 | 1 |
| Dimension | Q: 3.0 cu.m/min<br>H: 80 m<br>D: 125 mm<br>KW:75 | Q: 8.3 cu.m/min<br>H: 70 m<br>D: 250, 200 mm<br>KW: 200 | Q: 8.3 cu.m/min<br>H: 70 m<br>D: 250, 200 mm<br>kW: 160 | | T:350cu.m | Appr. W6mxr 12m+ W3 x 8m |

(2) No.4 Pump Station

No.4 Pump Station is a strategic facility, which receives water from No. 1 Pump Station and Surface WTP, and boost water to service area "A-1" which is located in relatively elevated area of the City, as shown in Figure 4.5.1. This pump station has an area of 1.5 ha and has relevant facilities as shown in Figure 4.5.3, Figure D.4.5.7 and Table 4.5.19, respectively.

Although there are two units of distribution reservoirs having capacity of 750 cu.m each, but are not used regularly. Water is transmitted directly through the pipeline. These pumps start when pressure goes down to two(2) kg/sq.sm

**Table 4.5.19 No.4 Pump Station Facilities List**

| Item | Distribution Pump | | Electrical Facility | Pump House |
|---|---|---|---|---|
| Type | Centrifugal | Centrifugal | Control panel | Brick structure |
| Number | 2 (1) | 2 (1) | 4 | 1 |
| Dimension | Q: 3.0 cu.m/min<br>H: 30 m<br>D: 125 mm<br>KW: 28 | Q: 8.3 cu.m/min<br>H: 40 m<br>D: 200, 250 mm<br>kW: 125 | Appr.<br>W 6mxr 15m | |

(3) Distribution Pipeline

A list of transmission/distribution pipeline from each pump station is shown in Table 4.5.20.

**Table 4.5.20 Transmission and Distribution Pipelines from PS**

| Item | Unit | Chirchik Surface WTP | | | No.1 Pump Station | |
|---|---|---|---|---|---|---|
| Role | | Intake | Distribution | | Transmission | Distribution |
| Material | --- | Steel | Steel | Steel | Steel | Steel |
| Daimeter | Mm | 1,000 | 600 | 1,000 | 800 | 300 |
| Number | --- | 2 | 1 | 1 | 1 | 2 |
| Length | Km | 1.75 | 0.56 | 0.56 | 20 | 4.5 |
| Connected Plant | --- | WTP | No.3 PS | (No4 PS) | No.4 PS (No.2PS) | (No.2 PS) |

| Item | Unit | No.2 Pump Station | No.3 Pump Station | No.6 Pump Station | |
|---|---|---|---|---|---|
| Role | | Distribution | Distribution | Distribution | Distribution |
| Material | --- | Steel | Steel | Steel | Steel |
| Daimeter | Mm | 350 | 400 | 600 | 300 |
| Number | --- | 1 | 1 | 1 | 1 |
| Length | Km | 2.5 | 2.25 | 0.85 | |
| Connected Plant | --- | | WTP Reservoir | | |

All of these pipes are made of steel owing to stand for more than the maximum of 10 kg-f/sq.cm from discharge head of pumps. The total length of these pipelines is about 37 km.

Table 4.5.21 also presents a list of distribution network in the City, in terms of pipe material, years of installation by diameter. Design service life of pipe materials in Uzbekistan is set forth at 42 years for cast iron and 18 years for steel and asbestos, in accordance with the ex. USSR's standards. Thus, when the said service life is taken into account, about 113 km or about 50%, out of the total 212 km, of distribution network are deemed to be replaced. In addition, smaller diameter (less than 100 mm) of distribution pipe is made of steel and problems are seen that 12 % of them have been used for more than 42 years of their service life. Although there is no available data on pipes shown in Table 4.5.21, there seems to be problem on superannuating pipe materials.

**Table 4.5.21 Distribution Pipelines**

| Material | | Unit | Steel | | | | |
|---|---|---|---|---|---|---|---|
| Diameter Range | | --- | 50 to 100 | 150 to 200 | 300 to 400 | ≧500 | Total |
| Length | Total | Km | 55.79 | 22.36 | 16.21 | 12.82 | 107.18 |
| | Usage(>18years) | Km | 27.74 | 14 | 8.52 | 12.3 | 62.56 |
| | Usage(>42years) | Km | 6.96 | 1.51 | 12.3 | 0 | 20.77 |
| | Necessary Replace | Km | 34.7 | 15.51 | 20.82 | 12.3 | 83.33 |
| Material | | | Ductile Iron | | | | |
| Diameter Range | | --- | 50 to 100 | 150 to 200 | 300 to 400 | ≧500 | Total |
| Length | Total | Km | 37.24 | 45.41 | 7.48 | 0 | 90.13 |
| | Usage(>18years) | Km | 14.2 | 20.2 | 7.16 | 0 | 41.56 |
| | Usage(>42years) | Km | 3.8 | 11.1 | 0 | 0 | 14.9 |
| | Necessary Replace | Km | 3.8 | 11.1 | 0 | 0 | 14.9 |
| Material | | | Asbestos Cement | | | | |
| Diameter Range | | --- | 50 to 100 | 150 to 200 | 300 to 400 | ≧500 | Total |
| Length | Total | Km | 0 | 12.95 | 2.2 | 0 | 15.15 |
| | Usage(>18years) | Km | 0 | 6.9 | 2.2 | 0 | 9.1 |
| | Usage(>42years) | Km | 0 | 5.9 | 0 | 0 | 5.9 |
| | Necessary Replace | Km | 0 | 12.8 | 2.2 | 0 | 15 |
| Material | | | All | | | | |
| Diameter Range | | --- | 50 to 100 | 150 to 200 | 300 to 400 | ≧500 | Total |
| Length | Total | Km | 93.03 | 80.72 | 25.89 | 12.82 | 212.46 |
| | Usage(>18years) | Km | 41.94 | 41.1 | 17.88 | 12.3 | 113.22 |
| | Usage(>42years) | Km | 10.76 | 18.51 | 12.3 | 0 | 41.57 |
| | Necessary Replace | Km | 38.5 | 39.41 | 23.02 | 12.3 | 113.23 |

### 4.5.6 Operation and Maintenance

#### (1) Staffing and Operation & Maintenance of Facilities

##### 1) Staffing for O&M

About 400 personnel are employed by Vodokanal of Chirchik City. Staffs assigned to operation and maintenance of respective facilities and stationed at the headquarters of Vodokanal for repair works are summarized in Table 4.5.22.

Approximately half of total employees are assigned for O&M and repair works. Engineers shown in the above table are included in the numbers of staff assigned to respective facilities. A total of 21 staffs are also assigned for night-shift work owing to the nature of water supply services.

It is noteworthy that a total of 80 staffs are allocated to repair works which cover repair and rehabilitation of pipeline facilities and sub-letting of works to private contractors is not observed.

##### 2) Staffing and O&M of Surface WTP

The largest number of staffs are assigned to the Surface WTP as shown in Table 4.5.22, while the plant produces only 59,000 cu.m/day or 33% of the total of 179,000 cu.m/day in the City. This staffing arrangement owes to the facts that:

**Table 4.5.22 Staff Arrangement for O & M**

| Assigned Facilities | Total | Laboratory | Operation & Machine | Electric | Repair | Engineer | Numbers of Staff | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Daytime | Night |
| Vodokanal | 69 | | | | 69 | 5 | 69 | |
| Surface WTP | 74 | 16 | 42 | 7 | 9 | 4 | 44 | 10 |
| No.1PS | 20 | 0 | 14 | 4 | 2 | 2 | 8 | 4 |
| No.3PS | 8 | 0 | 8 | 0 | 0 | 0 | 2 | 2 |
| No.6PS | 8 | 0 | 8 | 0 | 0 | 0 | 2 | 2 |
| Komsomolsk PS | 4 | 0 | 4 | 0 | 0 | 0 | 1 | 1 |
| No.2PS | 4 | 0 | 4 | 0 | 0 | 0 | 1 | 1 |
| No.4PS | 4 | 0 | 4 | 0 | 0 | 0 | 1 | 1 |
| City Wells | 3 | 0 | 3 | 0 | 0 | 0 | 3 | 0 |
| Total | 194 | 16 | 87 | 11 | 80 | 11 | 131 | 21 |

- Water analysis laboratory is located at the plant,
- Treatment process of surface water is very complicated in comparison to deepwell facility,

- This plant occupies more than 60% of the actual transmission volume in the total supply volume.

By presence of these staffs, the plant is well cleaned and facilities are regularly checked according to well-established schedule at the utmost extent.

However, troubles beyond control of these staffs are seen, such as malfunctioning of stand-by unit and manual operation of automatic valve due to difficulty to purchase spare parts being caused by lack of fund. In addition, deterioration of facilities throughout the Surface WTP is observed, though it has passed only 9 years since its inauguration, which is also seen in Tashkent City, due to usage of second-hand equipment and materials for new construction or expansion work. It is understood that the construction work was just coincided with the independence of the country resulting difficulty in procurement of equipment and materials and unwilling use of second-hand equipment and materials as well as modification of original design.

3) **Staffing and O&M of Intake Plants and Pump Stations**

Among others, No. 1 Intake is allocated considerably large number of O&M staffs due to its larger water production and complexity of facility and equipment. Repair staff including electrician are also regularly stationed at this pump station.

In this regard, not only daily operation, but also most of technical trouble shooting and basic repair work are performed by themselves. However, major repair work is supported by repair staff from Vodokanal.

Other Intakes, such as Nos. 3 and 6, are assigned 6 staffs each and 2 members at each pump station are positioned for 12 hours assigned under 2-shift rotation. For the booster pump stations and the intake pump station at the Surface WTP have 8 staffs each and one member is stationed under 2 shift rotation for 12 hours assignment. Engineers are not assigned to these facilities and managers of these facilities are stationing at No.1 Intake and Vodokanal. Repair works are undertaken by staffs from Vodokanal, except for simple one.

These Intakes and Pump Stations are kept clean but all facilities are deteriorated and periodical repair works are needed for daily operated equipment, such as pumps. Though most of the stand-by units are left non-functional due to the lack of spare parts caused by the shortage of budget, operational units are well-maintained by daily maintenance works.

## (2) Water Volume Control

### 1) Water Distribution Volume of each Water Source

Table 4.5.23 shows the water distribution record by water sources from 1997 to 1999.

Table 4.5.23 Water Distribution Record (Unit : 1,000 cu.m)

| Year | Month | Surface WTP | No.1 PS | No.3 PS | No.6 PS | City Well | Total |
|---|---|---|---|---|---|---|---|
| 1999 | May | 1,860 | 340 | 360 | 580 | 60 | 3,200 |
| | Apr. | 1,850 | 630 | 370 | 530 | 50 | 3,430 |
| | Mar. | 1,800 | 800 | 350 | 400 | 50 | 3,400 |
| | Feb. | 1,850 | 750 | 300 | 500 | 50 | 3,450 |
| | Jun. | 1,870 | 830 | 350 | 500 | 100 | 3,650 |
| 1998 | Dec. | 1,860 | 410 | 370 | 500 | 100 | 3,240 |
| | Nov. | 1,800 | 400 | 330 | 510 | 100 | 3,140 |
| | Oct. | 1,890 | 190 | 350 | 510 | 100 | 3,040 |
| | Sep. | 1,830 | 340 | 320 | 520 | 100 | 3,110 |
| | Aug. | 1,870 | 360 | 340 | 530 | 100 | 3,200 |
| | July | 1,500 | 300 | 340 | 500 | 100 | 2,740 |
| | June | 1,860 | 300 | 340 | 500 | 100 | 3,100 |
| | May | 1,700 | 318 | 350 | 500 | 100 | 2,968 |
| | Apr. | 1,830 | 520 | 350 | 500 | 100 | 3,300 |
| | Mar. | 1,830 | 830 | 350 | 550 | 100 | 3,660 |
| | Feb. | 1,989 | 211 | 350 | 500 | 100 | 3,150 |
| | Jun. | 1,980 | 640 | 340 | 450 | 100 | 3,510 |
| 1997 | Dec. | | | | | | 0 |
| | Nov. | | | | | | 0 |
| | Oct. | 1,850 | 300 | 300 | 500 | 100 | 3,050 |
| | Sep. | 1,910 | 300 | 240 | 500 | 100 | 3,050 |
| | Aug. | 1,890 | 300 | 260 | 500 | 100 | 3,050 |
| | July | 1,960 | 300 | 200 | 500 | 100 | 3,060 |
| | June | 1,620 | 600 | 300 | 500 | 100 | 3,120 |
| | May | | | | | | 0 |
| | Apr. | | | | | | 0 |
| | Mar. | 1,800 | 800 | 350 | 400 | 50 | 3,400 |
| Total | | 42,199 | 10,769 | 7510 | 11480 | 2060 | 74,018 |
| Months | | 22 | 22 | 22 | 22 | 22 | 22 |
| Average /month | | 1,918.1 | 489.5 | 341.4 | 521.8 | 93.6 | 3,364.5 |
| Average /day | | 63.9 | 16.3 | 11.4 | 17.4 | 3.1 | 112.1 |
| Range | Max | 1,989.0 | 830.0 | 370.0 | 580.0 | 100.0 | 3,660.0 |
| | /day | 66.0 | 27.7 | 12.3 | 19.3 | 3.3 | 122.0 |
| | Min | 1,500.0 | 190.0 | 200.0 | 400.0 | 50.0 | 2,740.0 |
| | /day | 50.0 | 6.3 | 6.7 | 13.3 | 1.7 | 91.3 |
| Capacity /day | | 59 | 80 | 20 | 20 | -- | 179 |

Water volume is calculated based on pump capacity and operation time. According to this table, average monthly distribution volume is 3,365,000 cu.m, while monthly treated water distribution volume from Surface WTP is 1,918,000 cu.m, which is equivalent to 57 % of the total volume. It is extremely biased. On capacity base, distribution volume ratio shouldered by Surface WTP will be 59,000/179,000 x 100=33%.

Monthly average water distribution volume of surface WTP is often exceeds its capacity. When the raw water turbidity is low, raw water is only disinfected and pumped to reservoirs without any sedimentation and filtration. It is supposed that distribution volume bigger than its treatment capacity was enabled by such by-pass operation. As to other sources, distribution volume of No.1 Intake, which has the biggest capacity is small and almost same as No.6. No.3 is the smallest. City well, considered as supplemental source, is well operated.

**2) Operation of Chirchik Surface WTP**

Nominal treatment capacity of Surface WTP is 59,000cu.m/day but when the raw water quality is good, by-pass operation described in Figure 4.5.2 will be possible.

**3) Operation of Pump Station**

**i) No.1 Intake, No.2,No.4 Pump Station**

Relation between No.1 Intake, No.2 Pump Station and No.4 Pump Station is as presented in Figure 4.5.3. Groundwater pumped from 26 units of wells belongs to No. 1 Intake will be distributed to the city through No. 4 pump station by pumps having pump head of 120 m and by distribution pipe with diameter of 800 mm. Pumped water will be mixed with water coming from reservoir of surface WTP.

If quality of treated water from surface WTP is aggravated, distribution ratio of No. 1 Intake will be raised. Thus, main water source for the city is surface WTP, supplemented by No.1 Intake. As to No.4 pump station, pumps are only operated when the water pressure increased more than 4 kg/sq.cm.

The other route is comprised of pumps having pump head of 60 m and 2 lines of distribution pipe with diameter of 300 mm. One pipeline is supplying water to the lower area of the city and the other is connected to the reservoir of No.2 pump station. Even if the operation of these low-pressure pumps is suspended, water supply will be secured by by-pass line coming from high-pressure pumps. Since the operational status of these 2 pipelines will directly affect on the operation of the whole system, they must be well maintained. Water supply to No.4 pump station is maintained by reservoir of surface WTP.

Current pumping volume of No.1 Intake is 74,000 cu.m/day. Although pump operation is supposed to be controlled based on the calibration of float type water level indicator installed in reservoir, basically, reservoir shall be operated with constant overflowing, receiving greater incoming water volume than outgoing volume.

ii) No.3 Intake

As shown in Figure 4.5.4, No.3 Intake supplies water to service area directly. Supplemental water is coming from reservoir of surface WTP. In this pump station, pumps with capacity of 500 cu.m/hr and 180 cu.m/hr are operated alternatively. As of the site survey conducted on August 10, 1999, water level declined during the operation of pump with capacity of 500 cu.m/hr, while it rose by the operation of pump having capacity of 180 cu.m/hr. Therefore, the pumped water volume is less than 500 x 24 = 12,000 cu.m/day. A present, one pump-out of eight pumps is malfunctioned and if it recovered, total ump capacity will be 12,000 x 8/7 = 13,700cu.m/day, far beyond the nominal consideration..

iii) No.6 Intake

No.6 Intake supplies water to the service area directly (See Figure 4.5.5). Water is pumped by 2 units of pumps with capacity of 500cu.m/hr an and the total volume will be 500x2x24=24,000cu,m/day

### (3) Water Quality Control

Water quality control is one of the most important elements in water supply, as well as water volume control. In case of the water treatment plant, water quality can be controlled by plant operation, while in case of potable groundwater, only chlorine dozing rate can be controlled. Thus, water quality control and water quality monitoring shall be conducted with close relation as described follows:

### 1) Water Quality Control

Water quality control at Surface WTP is performed as follows:

i) In case of ordinary raw water quality, turbidity is below 15mg/L, coagulation process will be omitted. Raw water will pass through flocculation basin, chemical sedimentation tank and rapid filter, then will be disinfected by chlorine and sent to the reservoir for distribution.

ii) When the turbidity is constantly exceeds 15 mg/l, solid alum ($Al_3(SO_4)_2$-$H_2O$) will be resolved by rapid agitator and dozed. Solid chlorine will also be resolved and dozed.

iii) When the raw water quality is excellent as comply with the national drinking water standards, raw water will be sent to the reservoir by by-pass operation, skipping sedimentation and filtration process.

Table 4.5.24 shows the annual disbursement schedule for chemicals and electricity in the year of 1999.

**Table 4.5.24 Consumption Plan for Coagulant and Electricity in 1999**

| Month | Surface WTP | | | | |
|---|---|---|---|---|---|
| | Q (1,000 cu.m) | Liquid Chlorine (tons) | Alum (tons) | Hypochloride (tons) | Electricity (Th kW/h) |
| January | 1,800 | 2.7 | 19 | | 1,530 |
| February | 1,800 | 2.7 | 40 | | 1,530 |
| March | 1,800 | 2.7 | 40 | 2.7 | 1,530 |
| April | 1,800 | 2.7 | 40 | 2.7 | 1,530 |
| May | 1,800 | 2.7 | 40 | 2.7 | 1,530 |
| June | 1,800 | 2.7 | 40 | 2.7 | 1,530 |
| July | 1,800 | 2.7 | | | 1,530 |
| August | 1,800 | 2.7 | | | 1,530 |
| September | 1,800 | 2.7 | | | 1,530 |
| October | 1,800 | 2.7 | | | 1,530 |
| November | 1,800 | 2.7 | | | 1,530 |
| December | 1,800 | 2.7 | 19 | | 1,530 |
| Total | 21,600 | 2.4 | 238 | 10.8 | 18,360 |
| Average | 1,800 | 2.7 | 34 | 2.7 | 1,530 |

Solid alum. will not used for 5 month, namely from July up to November, while hypochloride will only be used for 4 month, from March to June. Above-mentioned Case iii)will only occurs during July and August. In cases of i) and ii) volume of plant production will be 60,000 cu.m/day while 120,000 cu.m/day can be produced in case of iii) As aforementioned, water quality control of groundwater is only done by fixed rate chlorine dozing, nothing particular.

**2) Observation of Water Quality**

**i) National Regulation on Drinking Water**

This section is same as 3.5.6, (3), 2), i).

**ii)Water Quality Test in Surface WTP**

Sampling points are as follows:

a) Water sources

b) WTP Inflow

c) After Sedimentation

d) After Filtration

e) Upper End of the Network

f) First Point of Outlet

Out of these points, major sampling points are a), b) and e) and analysis tabulated on Table 4.5.25 are conducted. However, indices such as Polyphosphates, Coagulant, Residual Aluminum are only required when chemical dozing is carried out.

**iii)Water quality test for groundwater**

Basically, groundwater is sampled from No. 1, 3 and 6 Intake and City Well on everyday basis is analyzed in the laboratory of surface WTP. Analysis indices and frequency are shown in Table 4.5.26. As to all wells belong to pump stations, groundwater quality test is performed on indices tabulated on Table 4.5.27.

**Table 4.5.25 Analyzing Items and Frequency in Surface WTP**

| Item | Tem-perature | Odor | Taste | Color | Turbidity | PH | Oxygen Ability | Ammonia Nitrogen |
|---|---|---|---|---|---|---|---|---|
| Unit | ℃ | | | | mg/L | | Mg/L | mg/L |
| Frequency | C | C | C | C | A | B | C | C |
| Item | Nitrite | Nitrate | Hard-ness | Dissolved Oxygen | BOD | Calcium | Magnesium | Alkalinity |
| | Mg/L | Mg/L | Mg/L | mg/L | mg/L | Mg/L | Mg/L | mg/L |
| Frequency | C | E | C | E | E | E | E | C |
| Item | Sulfate | Solid Total | Chloride | Iron | Fluorine | Copper | Zinc | Lead |
| | Mg/L | Mg/L | Mg/L | mg/L | mg/L | Mg/L | Mg/L | mg/L |
| Frequency | E | E | E | E | E | E | E | E |
| Item | Arsenic | Chlorine | Chlorine Demand | Residual Chlorine | Manganese | Polyphosphates | Coagulant | Residual Aluminum |
| | Mg/L | Mg/L | Mg/L | mg/L | mg/L | Mg/L | Mg/L | mg/L |
| Frequency | E | D | D | A | E | F | F | F |

A: One time/hr, B: 8times/day, C: 2times/day, D: 3times/month, E: One time/month

**Table 4.5.26 Analyzing Items and Frequency of Ground Water**

| Item | Temperature | Odor | Taste | Color | Turbidity | pH | Oxygen Ability | Ammonia Nitrogen |
|---|---|---|---|---|---|---|---|---|
| Unit | ℃ | | | | mg/L | | Mg/L | mg/L |
| Frequency | A | A | A | A | A | A | A | A |
| Item | Nitrite | Nitrate | Hardness | Calcium | Magne-sium | Alkalin-ity | Sulfate | Solid Total |
| Unit | Mg/L | mg/L | mg/L | mg/L | mg/L | Mg/L | mg/L | mg/L |
| Frequency | A | C | A | C | C | C | C | C |
| Item | Sulfate | Solid Total | Chloride | Iron | Fluorine | Chlorine | Chlorine Demand | Chlorine Rest |
| Unit | mg/L | mg/L | mg/L | mg/L | mg/L | Mg/L | mg/L | mg/L |
| Frequency | C | C | C | C | C | C | C | A |

A: One time/day C: One time/month

**Table 4.5.27 Analyzing Items and Frequency of Wells**

| Item | Tem-perature | Odor | Taste | Color | Turbidity | pH | Oxygen Ability | Ammonia Nitrogen |
|---|---|---|---|---|---|---|---|---|
| Unit | ℃ | | | | mg/L | | mg/L | mg/L |
| Frequency | A | A | A | A | A | A | A | A |
| Item | Nitrite | Nitrate | Hardness | Calcium | Magne-sium | Alkalin-ity | Sulfate | Solid Total |
| Unit | mg/L | mg/L | mg/L | mg/L | mg/L | Mg/L | mg/L | mg/L |
| Frequency | A | A | A | A | A | A | A | A |
| Item | Sulfate | Solid Total | Chloride | Iron | Fluorine | Copper | Zinc | Lead |
| Unit | mg/L | mg/L | mg/L | mg/L | mg/L | Mg/L | mg/L | mg/L |
| Frequency | A | A | A | A | A | A | A | A |
| Item | Molyb-denium | Arsenic | | | | | | |
| Unit | mg/L | mg/L | | | | | | |
| Frequency | A | A | | | | | | |

A: 2 times/year

iv) **Water quality test results of Surface WTP**

Results of water quality test in Surface WTP are summarized by sampling points. For example, Table D.4.5.2 shows the results on June, 1999.

Table D.4.5.3 (1) - (3) are showing the results on major sampling points, namely Water Sources, WTP Inflow and Upper End of the Network. The record covers one year started from July, 1998 up to June, 1999.

Monthly average turbidity is low as a whole, more or less than 5 mg/L, but higher values can be found in spring, thawing season. High pH owes to the geological structure of water source, catchment area of Charvak Dam Lake, which is comprised of Limestone. Since the source is located in high elevation, low water temperature is another characteristic.

v) **Water quality test results on groundwater**

Existing groundwater intake facilities are No.1 ,No.3, No.6 Intake and 3 wells in City Well. Periodical water quality test same to the surface water is also carried out on groundwater. For example, Table D.4.5.4 shows the results on June, 1999. Further, Table D.4.5.5 (1) to (7) are showing the results in major sampling points including some points in distribution network in the City. Table D.4.5.6 shows the test results of above-mentioned 3 Intake Plants.

As these groundwater are containing few Iron and Manganese, they look quite clarified. However, they actuary contain many solvent, mainly Sulfate. Out of these wells, quality of groundwater taken from No. 6 Intake and City Wells is inferior and in many times it exceeds the standards for Hardness and Nitrate, 7 mg/L and 45g/L, respectively.

### (4) Cost of O&M

#### 1) Consumption of Materials and Electricity

Coagulant consumption in 1997 and 1998 by facilities are shown in Table 4.5.28.

Solid alum is used as coagulant and liquid chlorine contained in 50 kg cylinder and solid chlorine are used for disinfection. Although the yearly consumption fluctuation is small in liquid chlorine, those of in coagulant and solid chlorine is remarkable.

### Table 4.5.28 Coagulant Consumption

| Plant No. | Distribution Volume | Dosage | Year | Dosing Rate | | Dosing Volume | |
|---|---|---|---|---|---|---|---|
| Unit | Cu.m/year | | | mg/L | kg/day | t/month | t/year |
| Surface WTP | 21,600,000 | Liquid chlorine | 1998 | 1.15 | 90 | 2.7 | 32.4 |
| | 20,700,000 | | 1997 | 1.5 | 86 | 2.6 | 31.1 |
| | 21,600,000 | Alum | 1998 | 22 | 1320 | 39.6 | 237.6 |
| | 20,700,000 | | 1997 | 16.8 | 840 | 25.2 | 101 |
| | 21,600,000 | Hypochloride | 1998 | 1.5 | 90 | 2.7 | 10.8 |
| | 21,600,000 | | 1997 | 1.5 | 50 | 1.5 | 18 |
| No.1 PS | 5,100,000 | Liquid chlorine | 1998 | 1 | 20 | 0.6 | 5.7 |
| | 4,900,000 | | 1997 | 1 | 14 | 0.42 | 4.9 |
| No.3 PS | 4,080,000 | Liquid chlorine | 1998 | 1 | 14.2 | 0.43 | 4.1 |
| | 3,240,000 | | 1997 | 1 | 9.2 | 0.28 | 3.3 |
| No.6 PS | 6,000,000 | Hypochloride | 1998 | 1 | 33 | 1 | 12 |
| | 6,000,000 | | 1997 | 1 | 33.3 | 1 | 12 |
| City Wells | 1,200,000 | Hypochloride | 1998 | 1 | 5 | 0.15 | 2 |
| | 960,000 | | 1997 | 1 | 5.5 | 0.17 | 2 |
| Total | | Liquid chlorine | 1998 | | 124.2 | 3.73 | 42.2 |
| | | | 1997 | | 109.2 | 3.3 | 39.3 |
| | | Alum | 1998 | | 1320 | 39.6 | 237.6 |
| | | | 1997 | | 840 | 25.2 | 101 |
| | | Hypochloride | 1998 | | 128 | 3.85 | 24.8 |
| | | | 1997 | | 88.8 | 2.67 | 32 |

Table D.4.5.7 shows the production volume of the plants and disbursement plan for chemicals and electricity in 1998 and 1999.

### Table 4.5.29 Cost for Coagulant and Electricity

| Item | Distribition Volume | Liquid Chlorine | | Hypochloride | | Alum | | Electricity | | Total | Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| UnitCost | | 95,000Sum/T | | 86,500Sum/T | | 12,200Sum/T | | 2,900Sum/1000kwh | | | |
| Unit | Cu.m/day | T | 1000 Sum | T | 1000 Sum | T | 1000 Sum | 1000kwh | 1000Sum | 1000Sum | Sum/cu.m |
| January | 3,550 | 4.65 | 402 | 1.2 | 104 | 19 | 232 | 3,017 | 8,749 | 9,487 | 2.67 |
| February | 3,450 | 4.45 | 385 | 1.2 | 104 | 40 | 488 | 2,933 | 8,506 | 9,483 | 2.75 |
| March | 3,350 | 4.25 | 368 | 3.9 | 337 | 40 | 488 | 2,847 | 8,256 | 9,449 | 2.82 |
| April | 3,250 | 4.05 | 350 | 3.9 | 337 | 40 | 488 | 2,763 | 8,013 | 9,188 | 2.83 |
| May | 3,100 | 3.75 | 324 | 3.9 | 337 | 40 | 488 | 2,634 | 7,639 | 8,788 | 2.83 |
| June | 3,100 | 3.75 | 324 | 3.9 | 337 | 40 | 488 | 2,636 | 7,644 | 8,793 | 2.84 |
| July | 3,100 | 3.75 | 324 | 1.2 | 104 | 0 | 0 | 2,634 | 7,639 | 8,067 | 2.60 |
| August | 3,100 | 3.75 | 324 | 1.2 | 104 | 0 | 0 | 2,636 | 7,644 | 8,072 | 2.60 |
| September | 3,100 | 3.75 | 324 | 1.2 | 104 | 0 | 0 | 2,634 | 7,639 | 8,067 | 2.60 |
| October | 3,100 | 3.75 | 324 | 1.2 | 104 | 0 | 0 | 2,636 | 7,644 | 8,072 | 2.60 |
| November | 3,350 | 4.25 | 368 | 1.2 | 104 | 0 | 0 | 2,847 | 8,256 | 8,728 | 2.61 |
| December | 3,350 | 4.25 | 368 | 1.2 | 104 | 19 | 232 | 2,848 | 8,259 | 8,963 | 2.68 |
| Total | 38,900 | 48.4 | 4,187 | 25.2 | 2,180 | 238 | 2,904 | 33,065 | 95,889 | 105,160 | 2.70 |
| Average | 3,242 | 4.0 | 349 | 2.1 | 182 | 19.8 | 242 | 2,755 | 7,991 | 8,764 | 2.70 |

It is shown in the table that electricity occupies the most (95 %) of the cost, while disbursement for chemical is minimal. Consumed electricity per supplied water volume is quite big as follows:

33,065 × 1000 kwh/38,900 × 1000 cu.m = 0.85 kwh/cu.m

95,889 × 1000 Sum/38,900 × 1000 cu.m = 2.5 Sum/cu.m

**2) Repair Cost**

Comparison of Vodokanal's annual budget and actual output from July, 1998 to June, 1999 is shown in Table 4.5.30. Sewerage system repair cost is also included here but very small amount. This owes that main repair works were done by the staff of Vodokanal.

**Table4.5.30 Annual Repair Cost**

| Repair Item | | Budget (1,000 Sum) | Disbursement (1,000 Sum) |
|---|---|---|---|
| Pipes | | 6,830 | 514 |
| Building | | 2,700 | 3,104 |
| Facilities | Work | 5,300 | 1,399 |
| | Purchase | 23,600 | 1,091 |
| Car and Truck | | 300 | 0 |
| Total | | 38,730 | 6,108 |

However, the fact that annual repair budget with amount of 38,700,000 Sum was secured, means that equivalent repair works were also anticipated. Comparing to the electricity and chemical budget, this amount is not small and assuming that the repair works for the water supply system occupies 70 % of whole repair budget, repair cost per supply volume will be as follows;

38,730,000 × 0.70 ≒ 27,000,000 Sum

27,000/38,900 = 0.7 Sum/cu.m

### 4.5.7 Study on Existing Water Supply System

#### (1) Whole Distribution System

##### 1) Water Sources and Distribution Volume

Capacities of each WTP and water sources located in Chirchik City are shown in Table 4.5.31. The water source of Chirchik WTP is SDK-NDK canal that is upstream of the Boz-su canal, downstream of the irrigation canal from Charvak Dam Lake.

The nominal capacity of Chirchik WTP is 59,000 cu.m/day, when water quality of the canal is pure and that turbidity is less than 1.5 mg/L, most of water pass through sedimentation basin, filter and disinfected water is distributed to the city.

Chirchik WTP's actual distribution capacity is 120,000 cu.m/day because intake pump capacity is 120,000 cu.m/day.

Measured water distribution volume of Chirchik WTP, No.1 Intake, No.3 Intake, No.6 Intake are shown in Table 4.5.31 and Figure D4.5.8.

According to this result, total water distribution volume is more than 193,000 cu.m/day (Distribution volume of Chirchik WTP is 113,000 cu.m/day).

Table 5.4.31 Capacity of WTP

| Name | Capacity (cu.m/day) | Maximum Capacity (cu.m/day) | Flow Measured result (cu.m/day) | Water Sources |
|---|---|---|---|---|
| Chirchik | 59,000 | 120,000 | 113,000 | SDK-NDK Canal |
| No.1Intake | 80,000 | 40,000 | 35,000 | Groundwater |
| No.3Intake | 20,000 | 18,000 | 18,000 | Groundwater |
| No.6Intake | 20,000 | 27,000 | 27,000 | Groundwater |
| City Well | --- | 3,000 | --- | Groundwater |
| Total | 179,000 | 208,000 | 193,000 | |

Measurement was conducted in summer season from 28 to 29 July, so this measured volume was probably showing maximum value.

Maximum volume of whole city is 196,000 cu.m/day to adding 3,000 cu.m/day of city wells.

##### 2) Pipe-line Network and Plant Disposition

Pipeline network of Chiríchik City is shown in Figure D.4.5.9.

The study team measured distribution volumes indicated in the figure on July 1999. Chirchik surface WTP is located at the highest elevation in the city area and the distribution volume is the largest, so this WTP is the most important plant.

The distribution volume of Chirchik WTP is 113,000cu.m/day, and this amount corresponds to 57.7 % ( = 113,000/196,000 × 100) of total supply amount against the city.

Elevation of Chirchik WTP is 670 m and that of Intake PS is 645 m, so uplift of Intake pumps is 25 m. Elevations of No.1Intake, No.3 Intake and No.6 Intake is 593m, 612 m, and 568 m respectively, and elevations of buildings and housings lived by water users range from 630 m to 670 m. Therefore electric consumption of these intakes is relatively large because an uplift height is large.

All supply water conveyed from the reservoir of Chirchik WTP is distributed to the city areas by a pumped distribution system and the pressure is approx. 5kgf/sq.cm.

The distribution line has to sustain a high pressure for users dwelled in faraway places with high elevation. Therefore, user living in places with lower elevation and near-by distribution pumps usually has very high pressure in water supply system.

Electric consumption of Chirchik City Vodokanal for water supply is 0.85 kwh/cu.m and it is much consumption. Assuming that most of electricity were consumed by pumps, discharge head would be calculated as below.

$kw = 0.163 \times Q \cdot H / \eta$ where: Q: Quantity (cu.m/min) = 0.0167 cu.m/hour

H: water head (m)

$\eta$ :Pump efficiency (0.7)

$H = kw \times \eta / (0.163 \times Q) = 1 \times 0.7 / (0.163 \times 0.0167) = 257m$

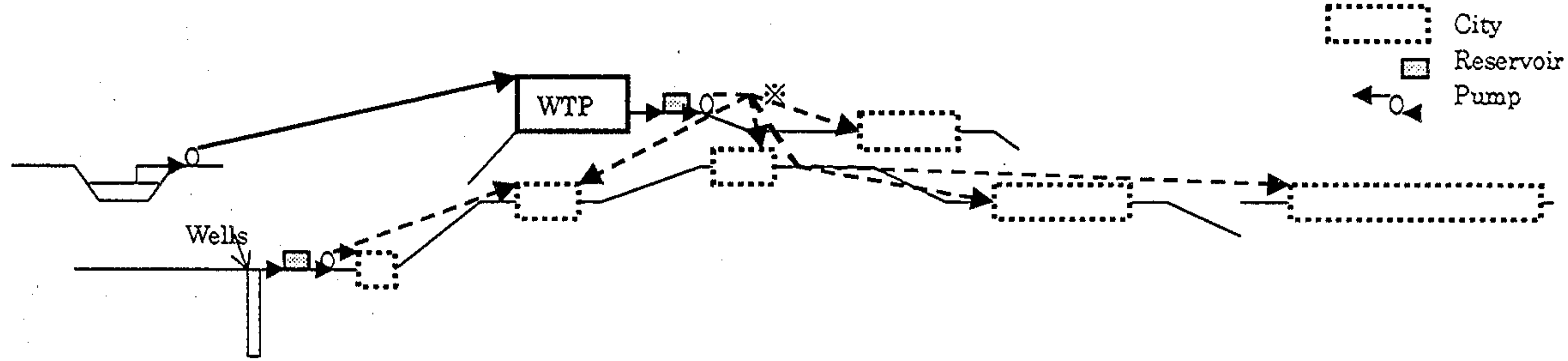
The result of the calculation presents very low efficiency.

This model is shown in Figure 4.5.6.

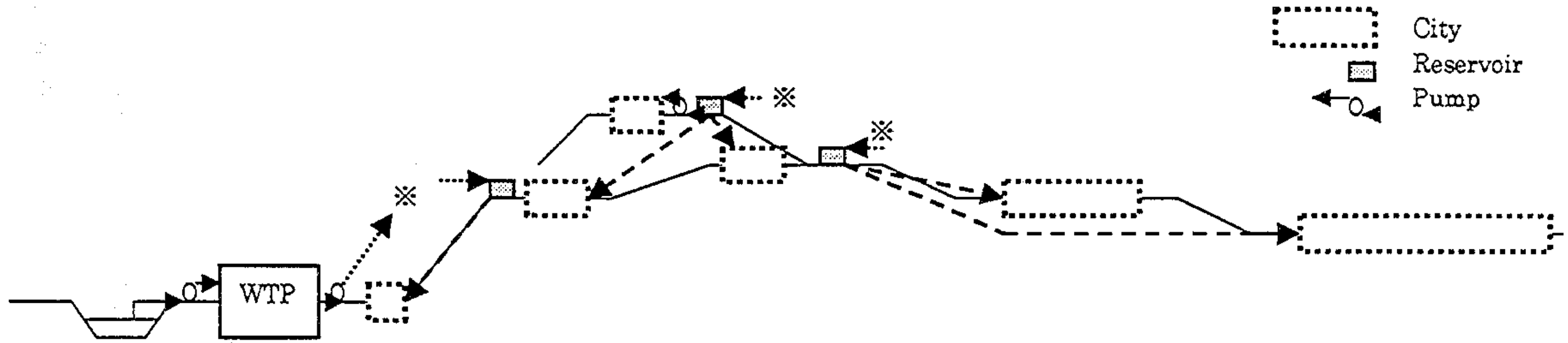
The water supply system of Chirchik City is transmitted by booster pump system with high pressure to all user, while other cities' system only pumps up supply water to service reservoirs located at proper elevations and reservoir water is distributed to each user by gravity.

Figure .4.5.6 Location Plan of Water Supply System

Case of Chirchik




Ordinary Case



Also this model shows that the capacity of reservoir is very small only with the retention time of 1.9 hours, while other cities have the retention time of 8 to 12 hours.

Pipeline network and disposition problems are described below.

- All supply water is distributed to the city area by pumped distribution system in although the supply areas can be conveyed by gravity.
- Pumping efficiency for water supply in Chirchik City is very low.
- Reservoir volume is too small.

**(2) Plants and These Facilities**

**1) WTP and Groundwater Intake**

**i) Chirchik Surface water WTP**

**a) Characteristic**

Characteristics of Chirchik WTP are described below.

- Chirchik WTP completed in 1990 is only one (1) surface WTP in chirchik City and nominal capacity is relatively small with 59,000cu.m (=59,000 /179,000=0.33),to total capacity of Chirchik City' system. But real treated volume of the WTP is occupied approx. 60 % of the whole Chirchik distribution volume.
- Plant is new but facilities and structures are aging because it is supposed that majority of materials and equipments were of second-hand.
- Flow Chart is shown in Figure4.5.7, and this system flow is an ordinary one as surface water WTP. .
- Capacity of intake pump is about 120,000 cu.m/day, and when turbidity of raw water is sufficiently low (>1.5 mg/litter) , it can fully pump up to WTP and conduct by-pass operation to sedimentation basins and filters and distribute to city with disinfection.

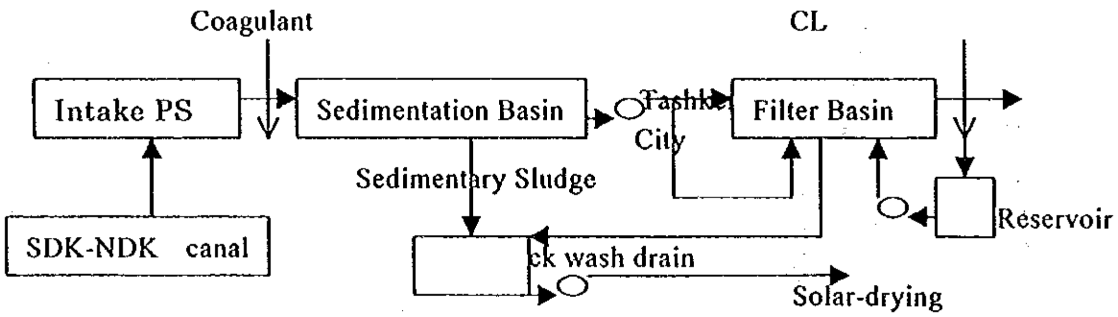



**Figure 4.5.7 Flow Chart of Chirchik WTP**

- Coagulant, aluminium sulfate is used for the system. When the turbidity of raw water is comparative low, the coagulant is not injected to the basin if raw water keeps the drinking standard, 1.5 mg/litter. It is said when inlet water of filter is less turbidity than 10 mg/litter turbidity, outlet of filter can keep less than 1.5mg/litter in Chirchik WTP.
- Since water quality of raw water is good except for a spring season, the system can be operated without the addition of coagulant during the numbers of days more than 70 % through a year.
- Drainage sludge and back wash drainage are settled and concentrated, and supernatant is reused and sludge is dried by sun light.
- Chlorination is conducted by liquid chlorine stored in 50 kg cylinder, and dissolved hy-pochlorine is used for raw water with high turbidity.
- Filter layer is single and is washed by mixing solution of air and water, and the filtration speed is 220m/day.
- The reservoir volume is 10,000cu.m and the retention time is 4 hours for the nominal capacity, but 2 hours for maximum capacity of 120,000cu.m/day.
- The coagulant throws in two (2) tanks that is located at high position in the building by man power, and a part of raw water circulates in this tanks.

b) Problem

Facilities function and management problems are described below.

- Water supply system is in good maintenance condition but are generally deteriorated and some of stand-by and automatic facilities aren't repaired due to the budget shortage.
- Automatic circuits of electric equipment are mostly out of order and are operated by manual. In addition, the measurement equipment such as flow meters is also broken down.
- All distribution water is conveyed by pumped distribution system in spite of reservoir's location with high elevation in city area.
- The reservoir volume is too small for service.
- Coagulant powder injection is not constantly conducted by a mechanical system but is intermittently carried out by man power.

ii) No.1 Intake

a) Characteristic

The characteristics of the No.1 Intake are described below.

- Th e nominal capacity of this intake plant is 80,000 cu.m/day but the distribution volume is usually less than 20,000 cu.m/day because the electricity cost of intake and distribution is very high. It is said that real and average intake capacity of well sources is approx. 60,000 cu.m/day.
- Well pumps are submerged type and installed in 1996 pumps so these are relatively new but this pump model has an average operating life from three (3) to five (5) years.
- Disinfected groundwater is distributed to both the high elevation and the low districts and is boosted to city area by booster pumps of No.4PS and No.2PS.

Maximum pumping head is 120 m and very high.

- Distribution pump stations are located at three (3) sites because the intake facilities have often repeated to enlarge.
- Reservoir volume is 1,500 cu.m and the detention time for distribution volume, 20,000 cu.m/day is 1.8 hours.
- Quality of intake water is good.

b) Problem

Facilities function and management problems are described below.

- Water supply system is in good maintenance condition but are generally deteriorated and some of standby pumps are in no repaired condition.
- Automatic circuits of electric equipment are mostly out of order and are operated by manual. Especially, on-off operation of pumps is by manual.

Therefore, pumps are operated in the condition that intake volume exceeds distribution volume with overflowing from reservoir.

- Distribution pumps is complicated to control because distibution pump stations are located at thee sites due to repeated expansion.
- Electricity cost is very high because booster pumps with high heads are used.

iii) No.3 Intake (PS)

a) Characteristic

Characteristics of No.1 Intake are described below.

- Intake capacity is nominally 20,000 cu.m/day, usually 12,000 cu.m/day, and maximum 18,000 cu.m/day.
- There are two kinds of distribution pumps with large and small capacities, capacity of the former exceeds the total capacity of well pumps and that of the latter is smaller than that of well pumps. Therefore, operators are alternatively operating by their judgments based on observation of water level in the reservoir.
- Reservoir volume is 1,000 cu.m and the detention time for distribution volume of 12,000 cu.m/day is 2 hours
- Quality of intake water is the best of other water supply systems in the city area.

b) **Problem**

Facilities function and management problems are described below.

- Water supply system is in good maintenance condition but is generally deteriorated and some of standby pumps is in no repaired condition.
- Automatic circuits of electric equipment are mostly out of order and are operated by manual. Especially on-off operation of pumps is by manual. Therefore, operators is operating by their judgment based on observation of water level in the reservoir.

iv) **No.6 Intake**

a) **Characteristic**

Characteristics of No.6 Intake are described below.

- Distribution capacity is nominally 20,000 cu.m/day, usually 18,000 cu.m/day, and maximum 27,000 cu.m/day.
- Some wells are located in the outside of No.6 Intake.
- Two kinds of well pumps, submersible pumps and ground type pumps are installed.
- Solid and dissolved hypochlorine is used for disinfection.
- Water quality is not so good for an over value of nitrate against Uzbekistan Standard because the Intake is located in agricultural area.
- Reservoir volume is only 60cu.m (detention time is four(4) minutes to nominal capacity), so is too small.

b) Problem

Facilities function and management problems are described below.

- Water supply system is in good maintenance condition but are generally deteriorated and some of standby pumps are in no repaired condition.
- Automatic circuits of electric equipment are mostly out of order and are operated by manual. Especially on-off operation of pumps is by manual. Therefore, pumps are operating in the condition that intake volume exceeds distribution volume with overflowing from reservoir.
- Quality of nitrate exceeds Uzbekistan Standard.
- Reservoir volume is too small.

v) City well

City wells are separately located in the city area and well pumps directly convey by boosting distribution pipelines. Each pumping capacity is about 1,000cu.m/day, and solid hypochlorine is used for disinfection. The system has not so big problems because the system has not complicated facilities and distribution water from another WTP or Intake is distributed same area. But below problem is considered.

- When pressure of distribution line for pumping is very high, pumping volume is very little.

2) Pump Station

i) Characteristic

No.2PS and No.4PS are located in Chirchik City.

No.2PS pumps up distribution water to the city area, which is transmitted from No.1 Intake to the reservoir.

No.4PS is boosting distribution water from No.1 Intake and Chirchik WTP, and its booster pumps operate only at the low pressure time of below 2 kgf/sq.cm.

ii) Problem

Problems are presented below.

- Water supply facilities are generally deteriorated, some standby pumps are in no repaired condition and electric equipment are mostly out of order.

### (3) Water Supply Pipe-line Network

#### 1) Pipeline Network

##### i) Characteristic

Water supply pipe-line network of Chirchik is shown in Figure D.4.5.9.

Total length of pipelines in Chirchik City is approx. 250km as of 1999 and nominal pipeline length per each diameter and their materials are shown in Table 4.5.32.

Installation year of transmission pipes is unknown, but needful replacement length to steel, asbestos and cast iron pipe is shown in Table 4.5.32 and service life in Uzbekistan is set forth at 18 years for steel pipe and 42 years for cast iron.

This table shows a serious situation that needful length of distribution pipes for replacement occupies a half of total length.

In Japan, durable period in the inner and outer lining steel pipes are 25 years but this is not conformed in that of Tashkent and Chirchik Cities due to no outer lining.

In this case, it will be proper that durable period of steel pipes will be estimated to be less than 20 years.

Such steel pipe is used for water supply, the pipes can easily be rusted by high dissolved oxygen and residual chlorine including in supply water. Annual reduction of pipe thickness caused by corrosion will be 0.1 to 0.2mm.

In this condition, partial corrosion can easily occur due to potential electric difference. The corrosion can make holes in pipes with thickness of 6 to 7 mm within the usage duration time of 10 years.

Cast iron pipes are relatively hard to corrode due to thick pipes, but water leakage is frequently occurred in Tashkent City. This is because of the applied connection method," faucet joint" that drives fiber into joint and blocks by lead. Therefore, steel pipes are mostly adopted for new installation. In Japan, ductile iron pipes and vinyl chloride pipes are used as distribution pipes and few leakage is occurred due to rubber ring connection.

##### ii) Problem

Problems of pipeline network are described below.

- There are many old pipes and majority of pipe materials is a steel with low durability. The inner pipes are not coated for corrosion proof.

Table 4.5.32 Pipelines of Chirchik Water Supply

| Material | | Unit | Transmission pipes : Steel | | | | |
|---|---|---|---|---|---|---|---|
| Diameter Range | | --- | 300 | 350 to 400 | 600 | 800-1000 | Total |
| Length | | Km | 7.50 | 4.75 | 1.41 | 23.31 | 36.97 |
| Material | | Unit | Distribution pipes : Steel | | | | |
| Diameter Range | | --- | 50 to 100 | 150 to 200 | 300 to 400 | ≧500 | Total |
| Length | Total | Km | 55.79 | 22.36 | 16.21 | 12.82 | 107.18 |
| | Usage(>18years) | Km | 27.74 | 14 | 8.52 | 12.3 | 62.56 |
| | Usage(>42years) | Km | 6.96 | 1.51 | 12.3 | 0 | 20.77 |
| | Necessary Re-place | Km | 34.7 | 15.51 | 20.82 | 12.3 | 83.33 |
| Material | | | Distribution pipes : Cast Iron | | | | |
| Diameter Range | | --- | 50 to 100 | 150 to 200 | 300 to 400 | ≧500 | Total |
| Length | Total | Km | 37.24 | 45.41 | 7.48 | 0 | 90.13 |
| | Usage(>18years) | Km | 14.2 | 20.2 | 7.16 | 0 | 41.56 |
| | Usage(>42years) | Km | 3.8 | 11.1 | 0 | 0 | 14.9 |
| | Necessary Re-place | Km | 3.8 | 11.1 | 0 | 0 | 14.9 |
| Material | | | Distribution pipes : Asbestos Cement | | | | |
| Diameter Range | | --- | 50 to 100 | 150 to 200 | 300 to 400 | ≧500 | Total |
| Length | Total | Km | 0 | 12.95 | 2.2 | 0 | 15.15 |
| | Usage(>18years) | Km | 0 | 6.9 | 2.2 | 0 | 9.1 |
| | Usage(>42years) | Km | 0 | 5.9 | 0 | 0 | 5.9 |
| | Necessary Re-place | Km | 0 | 12.8 | 2.2 | 0 | 15 |
| Material | | | Distribution pipes : All | | | | |
| Diameter Range | | --- | 50 to 100 | 150 to 200 | 300 to 400 | ≧500 | Total |
| Length | Total | Km | 93.03 | 80.72 | 25.89 | 12.82 | 212.46 |
| | Usage(>18years) | Km | 41.94 | 41.1 | 17.88 | 12.3 | 113.22 |
| | Usage(>42years) | Km | 10.76 | 18.51 | 12.3 | 0 | 41.57 |
| | Necessary Re-place | Km | 38.5 | 39.41 | 23.02 | 12.3 | 113.23 |

- " Faucet Joint" which causes leakage relatively easily, is adopted for connection of cast iron pipe.

**2) Pipeline Network and PS**

**i) Relation with Pipeline and PS**

Disposition between pipeline network and PS relates in mutual relationship. Booster PS needs mitigating low water pressure caused by insufficient flow capacity of pipelines. Diameter and route (grade, length) of distribution pipeline are generally decided for gravity flow so that booster PS is not necessary. In some cases, construction of booster PS is more economical in cost than enlargement or replacement of pipelines.

As the case of Chirchik City, it is economical to divide into some districts with elevation difference by 30 m as supply areas because the system can take a reasonable disposition. Pumps with small capacity can be suitable for transmission of treated water to the reservoir and users can be served with low water pressure in distribution pipes. The low pressure may result in little water leakage.

Chirchik WTP is located at the highest elevation in the city area and has advantage to be able to distribute supply water to the larger areas by gravity, instead of minimizing the boosted distribution areas. Therefore, actual situation shall be improved.

Furthermore, pipe diameter used in pipe connections is often too small.

ii) problem

Problems of pipelines and PSs are described below.

- In the case of Chirchik City with large difference of land elevation, most areas will be possible to be distributed not by pumps but by gravity.
- Chirchik WTP is located in the highest elevation in the city area but this advantage for gravity system didn't effectively make use of .
- Though pipes have relative large discharges, pipe diameter is often too small.

### (4) Estimate of Water Volume and Quality Control and O&M

#### 1) Water Volume Control

Roughly estimated flow balance of the whole water supply system in Tashkent City is shown in Figure D4.5.10 (1) and the detailed balance is shown Figure D4.5.10 (2).

As shown in the figure, trunk flows indicate to go from Chirchik WTP toward west to outer area of the city area. Calculated pressure balance of distribution pipelines in the city on July 27 to 28 is shown in Figure D.4.5.11. This figure indicates many low pressure zones in spite of measured very high pressure. This results from the reasons why calculated pressure was very low and the flow data measured on July 27 to 28 were maximum values. Flow volume measured on August, 28 to 29 was probably small but measured pressure was high.

Distribution volume of Tashkent City fluctuates in every season and distribution volume of Chirchik WTP reduces in the midnight by adjusting pump operation as shown in Figure D.4.5.8. Thus, water leakage of distribution pipes, housings, and buildings decreases because pressure in the nighttime is down sharply.

### i) Chirchik Surface Water WTP

In Chirchik WTP, operating number of pumps is controled by distribution volume and by operator's judgement. Seasonal pump operation pattern has already scheduled by types and numbers of pumps. Chirchik surface water WTPs are the most important facilities which supply 60% of total water demand.

Operational Problems are presented below.

- ump has to operate with operator's observation in water level of the reservoir because he judges on-off of pump switch.
- There is no proper judgment base for operation of distribution pumps, excluding for only outlet pressure of distribution pumps.

### ii) Groundwater Intake

Groundwater intakes consist of No.1, No.3, and No.6 Intake PSs and three wells. In three Intake PSs of No.1, No.3, and No.6, the reservoir receives groundwater from well sources and directly distributes to the city area, together with No.2 and N.4 PS.

Operational Problems are presented below.

- Pump has to operate with operator's observation in water level of the reservoir because he judges on-off of pump switch. Volume control didn't basically conducted
- There is no proper judgment base for operation of distribution pumps, excluding for outlet pressure of the pumps.

iii) Distribution Network

No.4 PS boosts supply water to distribution pipelines so as to retain the water pressure of over 2kgf/sq.cm. Therefore, volume control is not conducted.

No.2 PS can't also conduct volume control because storage capacity of 350 cu.m in the reservoir against the pump capacity of 1,000 cu.m/hour is too small.

2) Water Quality Control

i) Drinking Water Quality Criteria

WHO Guideline for drinking water quality are shown in Table D3.5.4 (1)~(3). This guideline is very severe for the indices that harmful for human body while, it is generous for the indices non-toxic but represents comfort. Recently, many indices were added after the confirmation of existence and toxicity of organic compounds.

Table 3.5.43 shows water quality analysis indices measured by both Tashkent and Chirchik Vodacanal on surface and ground water, respectively.

In these tables, standards of Uzbekistan, WHO, Japan are also indicated. Although there are no remarkable differences between each standard, adopted indices are different.

Uzbekistan standard doesn't include organic chloride compounds and agricultural chemicals. Considering the Aral Sea's contamination by agricultural chemical, it might be serious problem in future environmental preservation. However, since Tashkent and Chirchik City are located in most upstream of the river basin, there will be no influence by this contamination.

On general indices and metal, Uzbekistan standard seems appropriate compared with international standard.

Present problems are as follows :

a) There are no standards for organic chloride compounds and agricultural chemicals, which have become international problems.

b) Since these compounds needs microanalysis, analysis is difficult and analysis equipment is also highly advanced. They can't be analyzed by existing equipment in Chirchik.

### ii) Chirchik Surface Water WTP

As surface water WTP, there are Chirchik WTP and Boz-su WTP. Chirchik WTP adopted sedimentation + rapid filter method and rapid filter has single-layer structure with capacity of 220 m/sq.m/day.

In sedimentation + rapid filter method, set up of coagulant dosage rate is the important point. In Uzbekistan, minimum dosage rate enables standard turbidity of filtered effluent, less than 1.5 mg/L, is adopted. So about two third of the year, when turbidity of raw water is low, coagulant dosage is not performed.

Economical operation needs set up of these minimum dosage rates according to the raw water quality, water quality analysis shall be done precisely and strictly.

If coagulant is not used, diameter of turbid materials will be several μ mm and such turbidity can not be removed by existing filter materials with diameter of 0.4～1 mm.

But actually raw water turbidity of 10 mg/L is reduced to 1.5 mg/L in Chirchik WTP and Boz-su WTP. In Uzbekistan, back-washing rate is less than 20 m/hr.

It's very low compared with Japanese case and in such rate filter materials will not be suspended. It is supposed that this low back-washing rate have created filters with high capture capacity.

Since this system needs such a delicate adjustment, coagulation and filtration process is controlled by chemical dosage rate based on most efficient indices, turbidity of filtered effluent analyzed on every hours. As to chlorine, residual chlorine is also measured frequently to comply with appropriate concentration.

Water quality analysis was conducted on treated water from Chirchik WTP which was sampled in city. Samples were sent to the laboratory of chirchik WTP and Japanese laboratory. The results are shown in Table 4.5.33 and Japanese one is furnished with public certification. As to water quality there are no problem. While pH is high, Langelier's index is negative. This means that the water is corrosive and seemed to be affected by free carbonic acid.

Problems in surface WTP are as follows :

### Table 4.5.33 Analyzed Result of Distribution Water in Chirchik WTP

| No. | Item | Unit | Uzbekistan criteria | By Chirchik WTP | Japanese criteria | By Japanese laboratory |
|---|---|---|---|---|---|---|
| 1 | Temperature | | | 16.5 | | |
| 2 | Colour | | 20 | 0 | 5 | 1 |
| 3 | Taste | | | 0 | Normal | Normal |
| 4 | Odour | | | 0 | Normal | Normal |
| 5 | Turbidity | mg/L | 1.5 | 0.75 | 2 | 1.2 |
| 6 | pH | | 6 to 9 | 8.2 | 5.8-8.5 | 7.1 |
| 7 | Chlorine rest | mg/L | 0.3-0.5 | | 0.2<,<1 | <0.1 |
| 8 | Aluminium rest | mg/L | 0.5 | | 0.2 | <0.02 |
| 9 | Ammonia | mg/L | Non | ND | | |
| 10 | Hardness | mg/L | 7 | 1.65 | | |
| 11 | Hardness(as CaCo3) | mg/L | | | 300 | 86 |
| 12 | Alkalinity | mg/L | | 1.5 | | |
| 13 | Nitrite | mg/L | 45 | ND | | |
| 14 | Nitrate | mg/L | | 2.2 | | |
| 15 | Chloride | mg/L | | 5 | | |
| 16 | Chrorine ion | mg/L | | | 200 | 0.8 |
| 17 | Sulfate | mg/L | 500 | 45.6 | | |
| 18 | Fluoride | mg/L | 1.5 | 0.2 | | |
| 19 | Iron | mg/L | 0.02 | ND | 0.3 | <0.03 |
| 20 | Solid total dissolved | mg/L | 1000 | 165 | 500 | 107 |
| 21 | Colonies quantity | | <100 | | | |
| 22 | Coli- index | | | | | |
| 23 | Coliform count | | | | Non | Non |
| 24 | Total colonies | Number/mL | | | 100 | 0 |
| 25 | Copper | mg/L | 1 | ND | 1 | <0.1 |
| 26 | Molibdenium | mg/L | 0.25 | | | |
| 27 | Polyphosphates | mg/L | 3.5 | ND | | |
| 28 | Orthophosphates | mg/L | | | | |
| 29 | Zinc | mg/L | 5 | ND | 1 | <0.1 |
| 30 | Lead | mg/L | 0.03 | ND | | |
| 31 | Arsenic | mg/L | 0.05 | ND | | |
| 32 | Manganesum | mg/L | 0.1 | ND | 0.05 | <0.005 |
| 33 | Phenol | mg/L | | | 0.2 | <0.05 |
| 34 | Chrome | mg/L | | | | |
| 35 | Magnium | mg/L | | 0.3 | | |
| 36 | Calcium | mg/L | | 1.35 | | |
| 37 | Free carbon dioxide | mg/L | | | 20 | 10.6 |
| 38 | Sodium | mg/L | | | 200 | 0.9 |
| 39 | BOD | mg/L | | 2.9 | | |
| 40 | Anion surface active agent | mg/L | | | 0.2 | <0.02 |
| 41 | Oxigen dissolved | mg/L | | 9.4 | | |
| 42 | Potassium permaganate | mg/L | | | 10 | 1.6 |
| 43 | Oxidity | mg/L | | 0.72 | | |
| 44 | Langerlier's index | mg/L | | | >-1 | -1 |

a) Ordinary, rapid filter is operated without coagulant dosage even though the turbidity removal efficiency is reduced. So, plant operation shall be conducted with close monitoring to turbidity of filtered water, to comply with the standard, 1.5 mg/L.

b) Analysis results will be reflected on coagulant dosage rate but since retention time of sedimentation tank is long, it will take time until coagulant effect appears.

c) The same person who conducted water quality analysis will order the change in operation. This means "water quality controller" is also acting as "operation supervisor". Thus, there will be no "mutual monitoring effects".

d) The existence or concentration of agricultural chemicals and organic chloride compounds shall be examined.

### iii) Groundwater WTP

As to groundwater, quality can be controlled by a) chlorine dosage rate and b) prevention of over-pumping.

However, since there will be no possibility of saline water intrusion in Tashkent, case b) can be omitted and thus, only case a) shall be controlled strictly. In most WTPs, residual chlorine is frequently monitored to reflect on chlorine dosage operation, so it can be said that pumped groundwater quality is properly controlled. As to water quality indices, there are no problems to groundwater from No.1 and No.3 Intake. But concentration of nitrate and hardness exceed the standard of Uzbekistan to water from No.6 Intake.

Nevertheless, the followings can be pointed out :

a) Existence or concentration of organic chlorine compounds shall be examined.

b) In case of City wells, solid chlorine is dissolved and injected into wells. In such cases, standards are needed to maintain proper dosage amount.

c) Quality of groundwater from No.6 station exceed to standard for nitrate and hardness as shown Table4.5.34.

**Table 4.5.34 Nitrate and Hardness Analyzed Value from No.6 Intake**

| Year | | | | | | 1998 | | | | | | 1999 | Ave. | Criteria |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | Jul. | Aug. | Sep. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May. | Jun. | | |
| Nitrate | 64.2 | 48.7 | 47.8 | 57 | 66.4 | 55.4 | 77.5 | 73.1 | 10.6 | 11.7 | 66.8 | 40 | 51.6 | 45 |
| Hadness | 6.4 | 6.0 | 6.0 | 6.5 | 6.5 | 6.8 | 7.3 | 7.2 | 7.1 | 7.2 | 6.6 | 6.4 | 6.67 | 7.0 |

iv) Distribution Network

In Chirchik city, there are many quantitative problems, rather than qualitative ones, in distribution network. Problems are caused by corrosion and leakage in steel pipes which has no inner lining. Problems are as follows :

a) AS shown in Table 4.5.33, treated water from Kadrirya WTP has corrosive nature. So, steel pipe is rusted and distributed water becomes rusty color.

b) Injected chlorine is consumed by rust, not used by disinfection. Sanitary safety is endangered and epidemic danger is risen.

c) Above-mentioned effects is accelerated by water supply interruption caused by low water pressure and leakage repair works.

3) O&M

i) Staff of Chirchik Water Supply System

Table 4.5.35 shows the comparison of number of staff engaged in water supply management in Tashkent and Japanese large-scale cities having the population exceeding one million (source : "Large-scale City Management Guidelines" Yokohama City Water Works Bureau). As shown in the table, Tashkent has six times of staff per population, 2.8 times per distribution volume compared with Japanese cities.

Table 4.5.35 Comparison of Staff in Japanese Large- scale Cities with Chirchik

| No | Item | | Yoko-hama | Sapporo | Sendai | Toukyo | Kawasaki | Nagoya | Kyoto | Average | Chirchik |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ① | Population ×1000 | | 3,660 | 1,840 | 1,283 | 11,303 | 1,316 | 2,313 | 1,598 | 3,330 | 146 |
| ② | Distribution Volume cu.m/d ×1000 | | 1,781 | 785 | 506 | 6,960 | 1,026 | 1,424 | 1,050 | 1,933 | 179 |
| ③ | Staff | Total | 2,553 | 872 | 555 | 5,561 | 971 | 1,788 | 1,059 | 1,908 | |
| ④ | | Intake | 107 | 0 | 5 | 178 | 24 | 36 | 37 | 55 | |
| ⑤ | | WTP | 302 | 125 | 132 | 797 | 129 | 220 | 183 | 270 | |
| ⑥ | | Distribution | 450 | 114 | 91 | 1,389 | 195 | 566 | 127 | 419 | |
| ⑦ | | Control and repair Total | 859 | 239 | 228 | 2,364 | 348 | 822 | 347 | 744 | 194 |
| | | ①/⑦ | 4,261 | 7,699 | 5,627 | 4,781 | 3,782 | 2,814 | 4,605 | 4,796 | 752 |
| | | ②/⑦ | 2,073 | 3,285 | 2,219 | 2,944 | 2,948 | 1,732 | 3,026 | 2,604 | 922 |
| | | ①/⑦' | | | | | | | | 3,742 | 752 |
| | | ②/⑦' | | | | | | | | 2,061 | 922 |

When middle scale size cities are compared with large scale cities, the former cities are more staff number per capita than latter's. The rate of staff number per capita (= 1/1.263) is calculated as that staff number of population of exceeding one million( average 2.8 million) divides by staff number of population of 100,000 to 25,000(average 174 thousands) in Table 4.5.36 (from Water Supply Statistics in Japan).

Therefore this value multiplies by average staff number per capita is shown in Table 4.5.35. Chirchik has five times of staff per population, 2.2 times per distribution volume compared with this calculated value.

**Table 4.5.36 Staff Number Rate per Population**

| Population scale | Design population① Person | Personal number② Person | ①／② | Rate |
|---|---|---|---|---|
| <1million | 2,801,208 | 1,582 | 1,770 | 1.0 |
| 100,000 to 250,000 | 174,276 | 77 | 2,237 | 1.263 |

**ii) WTP and Intake**

Within limited budget, needful facilities that are not directly indispensable are left to be out of order or can't be repaired for long time. However, many electrical instruments, such as automatic pump operator, flow measure, water level indicator, which deemed indispensable for WTP's operation, are left non-functioning. Thus, plant operation is managed by manual that needs more staff. Since they are not automated, many staff is necessary even during nighttime.

Existing problems are as follows :

a) Automation is not introduced even initial level operation, such as auto ON-OFF pump operation by electrode. So, there's high possibility that operator's decision mistake might cause accident. Large number of operation supervisor is needed therefore.

b) There's tendency that malfunction in electric instruments are left non-functioning.

c) It's hard to operate the plants to cope with hourly demand fluctuation.

**iii) PS**

There are No.2 and No.4 PS in Chirchik City. Since none of them are automated, 4 staffs are allocated in day/night shifts to each PS.

Problems of PS's are common as WTP.

iv) Pipe-line Network

Table4.5.37 shows conducted repair and check list of mainly pipe-lines for one year from 1998 to 1999.

However, pipe repair and reinstallation budget in 1998 fiscal year only 6,800,000 Sum and real expenditure was only 500,000 Sum, which must be said that Chirchik City Vodokanal could not conduct repair or reconstruction with purchase of expensive materials and equipment.

Problems are as follows:

a) No sufficient budget for repair, investigation and replacement of deteriorated pipe.

b) Superannuated pipes that passed over 50 years from their installation needs systematic survey and replacement. Even though partially carried out, it's not enough.

c) Review of overall pipeline allocation and preparation of reallocation plan is needed.

**Table 4.5.37 Repair and Inspection of Water Supply Facilities in Chirchik**

| Kind of Work | 1998 | | | | | 1999 | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aug. | Sep. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | |
| Repair of fire hydrants | 2 | | | | | 1 | 5 | 4 | 1 | 11 | 2 | 3 | 29 |
| Replacement of fire hydrants | 2 | 3 | | | | 2 | | 2 | 1 | 9 | 2 | | 21 |
| Repair of valve | 2 | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| Replacement of valve | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 |
| Repair of well | 10 | 10 | 10 | 10 | 10 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 85 |
| Cleaning of wells | 60 | 20 | 50 | 50 | 20 | | 10 | 10 | 10 | 10 | 10 | 10 | 260 |
| Examination of water pipe network (m) | 6200 | 7300 | 5200 | 6200 | 7300 | 5300 | 6600 | 4500 | 7700 | 6600 | 4500 | 7700 | 75100 |
| Replacement of water pipe (m) | | 285 | 4 | 80 | | 120 | 38 | | | | 404 | 50 | 981 |
| Pipe laying(m) | | 170 | | | 82 | | | | | | | | 252 |
| Wells built | 1 | | | | | | | 1 | | | 1 | | 3 |
| Received applications | 39 | 36 | 32 | 41 | 36 | 20 | 25 | 21 | 19 | 46 | 42 | 27 | 384 |
| Replacement of stop valve | | | | | | 1 | 4 | 4 | 4 | | | | 13 |

### 4.5.8 Progress and Improvement for Water Supply System

#### (1) Reduction of Water Consumption

##### 1) Protection of Water Leakage

**i) In-house Leakage**

Water consumption shall be reduced to deduct in-house leakage both in Tashkent and Chirchik. As aforementioned, actual water consumption in ordinary household is 300 L/cap/day at daily maximum but meter reading is over 600 L/cap/day. This is caused by in-house leakage mainly from toilet.

Through campaign is needed to raise the residents' awareness and to let them know that "you will lose your money if you don't lessen your in-house leakage". Although meter installation will be the most effective and reliable countermeasure, it will take time. Emergency measure shall also be prepared.

**ii) Office Leakage**

In school and governmental offices must have large volume of leakage. Large percentage of enterprises, paying higher water tariff, are not equipped with meters and leakage is also deemed large. Leakage prevention measures shall be taken immediately.

**iii) Road Leakage (Pipeline)**

Leakage from roads is still occupies large percentage of total leakage volume. Introduction of leakage detector is needed for effective detection of leakage points and repair works. Replacement plan shall be prepared, for instance ; all steel pipes passed 50 years after their installation must be replaced.

##### 2) Ban of Waste

This problem will naturally be solved if meter reading is carried out certainly. Inclined tariff system can be adopted for high income levels. Campaign fro, viewpoint of water resources preservation is also important.

#### (2) Plants and These Location

##### 1) WTP and Intake

Allocation of Chirchik WTP is highest elevation in the city therefore this location is good. And Intakes of groundwater need to be located along Chirchik River for collecting groundwater. However, some improvement is necessary for the followings, i) capacity expansion of reservoir, ii) acceleration of automation and iii) grasp of distribution volume, chemical dosage and storage volume. Each items will be explained below :

i) Capacity Expansion of Reservoir

At present, small capacity and non-automation of reservoirs doesn't make any inconvenience in Chirchik city, since supplied volume from WTPs is almost constant except for reduction of distribution volume by manual in nighttime. However, if large hourly water demand fluctuation appears resulting from countermeasures described in clause (1), the existing facilities can't cope with it.

Assuming that hourly demand fluctuation corresponds to total daily average demand, appropriate capacity of reservoir can be calculated as 8 to 12 hours' retention time, according to the Japanese facility design guideline. Considering the present retention time of 1.92 hours to 179,000cu.m/day of nominal distribution volume, it is recommended that tentative retention time shall be set as 4 hours and then 6 to 8 hours, gradually. It can be said that the retention time of reservoirs is already three hours because average distribution volume is about 110,000 cu.m/day (14,350/110,000x24).

But real distribution volume in summer was approx. 200,000 cu.m/day, therefore retention time is calculated by nominal distribution volume.

Figure3.5.12 shows the deference between daily average demand and hourly fluctuated demand and its accumulation in case of daily average demand of 1,000 cu.m/hr and hourly maximum demand of 2,000 cu.m/hr. As shown in the figure, if hourly maximum demand is appropriately 2 times of daily average demand, reservoir can supply water constantly with retention time of 6 hours receiving water from WTP, constantly daily average demand. If retention time is 4 hours, supply volume from WTP shall be increased to 1.1 times of daily average demand.

WTP and Intakes in Chirchik, treated water is pumped from every WTP to reservoirs. Basically, these reservoirs shall be considered as "pump pit" and their capacity calculated by retention time (0.5 hour each) shall be omitted from total reservoir capacity.

Based on above concept, necessary reservoir capacity was calculated in Table 4.5.38 (1) by total distribution capacity of 179,000 cu.m/day.

That Intake capacity of No.1, No.3 and No.6 are measured in July and WTP capacity is subtracted these measured capacity from total nominal capacity. And capacities to be expanded were also calculated by retention time of 4 and 6. They are indicated in Table 4.5.38 (2).

Allocation plan was prepared for the retention time of 4 hours. Proposed site was selected within the site of Chirchik WTP on elevation of 475m and two site of distributed from No.1 and No.6 Intake on elevation of 470m to 450m, and each service reservoirs volume are 4,000 cu.m. They are shown in Figure8.7.1.

Table 4.5.38(1) Effective Volume of Reservoir

| Name | Capacity<br>Cu.m/day | Reservoir volume<br>cu.m | 1/2hr<br>Cu.m | Effective volume<br>cu.m |
|---|---|---|---|---|
| Chirchik WTP | 99,000 | 10,000 | 2,060 | 7,940 |
| No.1 Intake | 35,000 | 1,500 | 730 | 770 |
| No.3 Intake | 18,000 | 1,000 | 375 | 620 |
| Mo.6 Intake | 27,000 | 60 | 560 | 0 |
| No.2 PS | (25,000) | 350 | 520 | 0 |
| No.4 PS | (16,000) | 0 | 330 | |
| WTP·Intake | 179,000 | | | 9,330 |
| | | | | ↓ |
| | | | | 10,000 |

Table 4.5.38(2) Needed Constructing Reservoir Volume

| Retention time (hours) | Needed volume | Needed constructing volume |
|---|---|---|
| 4 | 18,000 | 8,000 |
| 6 | 22,000 | 12,000 |

To 8.7.2 (4) 4)

### ii) Acceleration of automation

As aforementioned, expansion of reservoir capacity and automatic pump operation is indispensable to cope with fluctuated distribution volume. In concrete, automatic pump ON-OFF operation according to the water level is needed for surface WTP, shown in Figure 4.5.8.

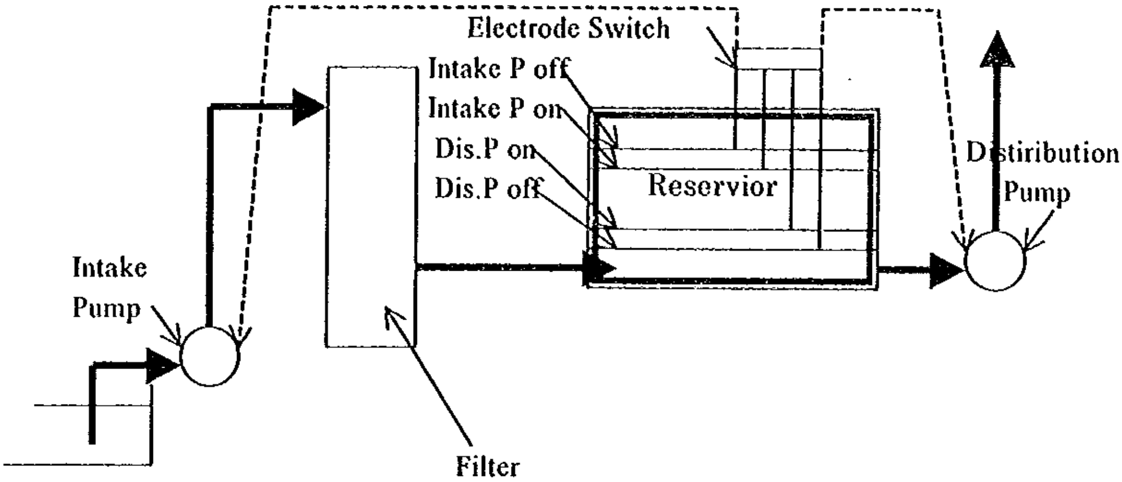



**Figure 4.5.8 Automatic Operation of Pumps in Surface Water WTP**

Although this automation is simple as system, in case of self-priming pump requires large initial power, some electrical devices might be needed to lower this. In case of groundwater WTP, automation will be as shown in Figure 4.5.9.

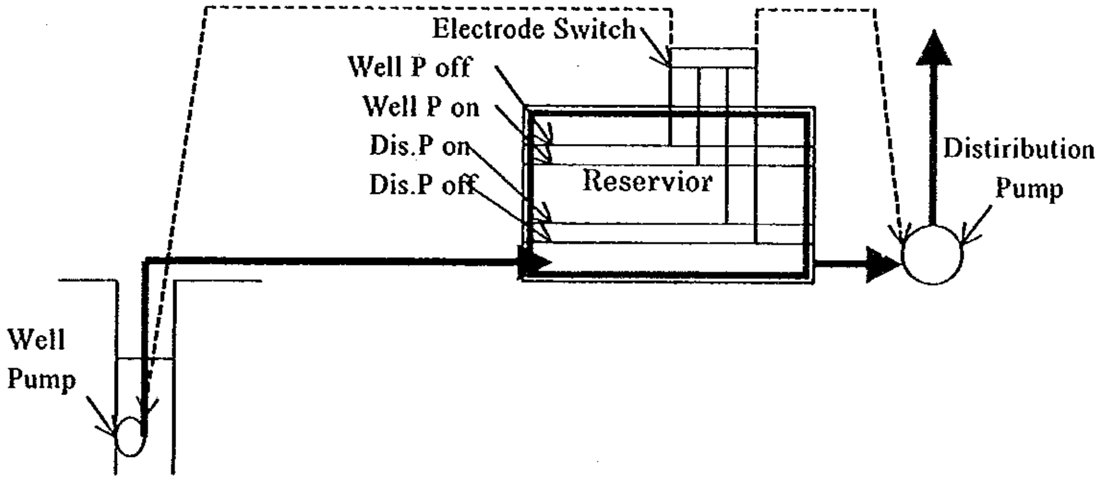



**Figure 4.5.9 Automatic Operation of Pumps in Groundwater Intake**

**iii) Grasp of Control Information**

**a) Distribution volume**

As water flow meters were already installed in major distribution trunks, electric instruments shall be rearranged for precise measurement. Recorder and integrating meter shall also be installed.

b) Chemical dosage

In case of Boz-su WTP, coagulant has to be lifted and threw in tank by human power on high stand, thus this dosing method has problems for continual and quantitative dosing. Therefore coagulant facilities shall improve that dissolved tank install on ground and quantitatively inject to allow punctual monitoring of dosage rate.

Facilities of disinfection have to enlarge to correspond with capacity of 120,000 cu.m/day, because present facilities correspond with 59,000 cu.m/day.

c) Storage volume

Water level indicator shall be installed in important reservoir. Mechanical type is applicable also but electrical type is preferable because water level can be monitored in control room.

d) Distribution pressure

Water users think that there is enough pressure in him tap, is the most important. Therefore, because the water supply facilities must operate to meet this thing, it is necessary that the operation person grasps the pressure of the spot with being dominant in the city. Thus, the pressure gauges are installed in the major points in the city and it is desirable to cable to the operation room.

2) Distribution System

The most needed examination for the existing distribution system is to review the present system to study the possibility of gravity water supply and necessity of PS, assuming that water demand in households and offices will be decreased resulting from countermeasures described later. In long-term span, pipeline network which makes booster PS unnecessary shall be designed and formulated.

Variable elements are as follows:

i) Population and per capita water consumption

ii) In house, office and road leakage

As results, per capita water consumption will decrease and hourly fluctuation will be come larger (See Figure D3.5.12)

At present system, apartment house has no elevated tank and water is directly supplied by pumping. This caused high water pressure and made number of booster PS large.

Although booster PS for apartment is still constructed, economical examination shall be carried out to determine which is efficient; elevated tank or Booster PS.

PS with reservoir shall be automated by electrode switch and booster PS shall be automated by pressure switch installed on incoming and outgoing pipelines. However, since pressure switch is unstable, it shall be operated carefully.

3) Pipeline Network

AS aforementioned, pipe-line shall be reviewed by future distribution volume. Considering the pipe material, some of the existing pipes shall be replaced immediately. So, long term replacement plan shall be prepared and implemented.

(3) Proposed Improvement for O&M

1) Plants

As a whole, number of maintenance staffs in WTPs are large, facilities are all manual operated and repair works are also carried out by themselves, it can't be said "excessive" indiscriminately. Further, since labor cost is low and it corresponds only 10 % of total O & M cost, it is not a big burden as of now. Aside from the above-mentioned issue, there are the following items to be solved;

i) Not only machinery, but also electric instruments, such as automation circuit and flow meter, shall properly be maintained for daily use.

ii) Present coagulation operation too much stuck to economical efficiency and the turbidity of treated water is always close to the effluent standard. Coagulant injection is needed to assure better effluent quality.

iii) As to the maintenance of equipment, the basic method is "repair if they are broken". Preventive maintenance, which replaces worn out parts in daily maintenance work to prevent future break down, is preferable.

2) Water Supply Pipe-line Network

**i) Distribution Pipeline**

Pipe-line is inspected annually, but repair work of pipe leakage usually don't conduct immediately within limitted budget.

The followings are the points to be improved ;

a) Leakage shall be repaired immediately therefore budget shall be distributed.

b) Preparation and implementation of leakage detection plan is needed.

c) Replacement plan based on the results of leakage detection plan shall be established.

**ii) Water User**

Prevention of in-house, office leakage and ban of waste is the largest theme of Chirchik City Vodokanal as Tashkent.

In concrete, the following improvement is needed;

a) Conference for emergency countermeasure against in-house leakage

b) Actual leakage status survey in apartment and detached houses

c) Water usage survey in large scale consuming houses

d) Water usage survey in houses where meter reading is extremely small.

e) Improvement in water supply appurtenance in housing and water conservation campaign

f) Prepare countermeasures for water supply appurtenance (soft and hard aspects)

g) Standardization of meter installation (with structure allows convenient and reliable meter reading)

h) Acceleration of meter installation

## 4.6 Summary of CWS (Chirchik Water Services)

### 4.6.1 Summary of Issues in CWS

Summing up the present situation of Chirchik Water Services mentioned so far in Chapter 4, the estimated future scenarios can be summarized as shown in Figure 4.6.1 and 4.6.2. Also, these current issues can be tackled by central and local government levels. The countermeasures is shown in Figure 4.6.3. The current issues Chirchik is facing are basically the same as in Tashkent. Therefore, the issues generated by the differences between Chirchik and Tashkent are mentioned.

#### (1) Management Problems

##### 1) High Volume of Population Consumption

The current water consumption in Tashkent as a whole including the consumption of industries, exceeds 1000 liter per capita a day. The result of the study showed that population especially consumes ? liter a day. This figure far exceeds the level of worldwide standard, which is 200 - 250 liter. A leading cause of it is the water leakage ( waste of water) in the residential premises including toilets. To tackle this issue, the same plan as in Tashkent is now afoot to install meters in the all population accommodations. However this plan has not worked out effectively as it puts enormous load on the users as shown in Figure 3.3.3 below. This burden also applies to the users in stand-alone houses and meters have not been installed in most of the apartments.

Meters installment cost and the load

As in Tashkent, the installment cost per a meter costs 18,000Sum and it is regarded that all the users bear the cost.. However, compared with the population's average income per a month in Chirchik that is; a nominal income is 10,000 to 13,000 Sum, and the survey result shows around 10,000 Sum, this means that 18,000 is a enormous load on the population.

Considered that the average monthly income of Chirchik is lower than that of Tashkent, this puts extremely heavy load.

**2) Cross Subsidy**

The water charge disparity between the population and companies is getting bigger than Tashkent as Chirchik is an industrial city. Therefore, the cross subsidy for water supply cost between the population and companies are wider than Tashkent. Although the central government enumerated a target to resolve this cross subsidy, this gap tends to be widening as a result of that meters have not been installed.

**3) Incomplete Self-Supporting System.**

Chirchik Vodokanal used to belong to Vodokanal in Tashkent. It became a separate company as a result of that Tashkent Vodokanal used to run it as a profit unit and the efficiency in the operation went up. Therefore, it has the equivalent discretion right for management as Tashkent City Vodokanal. However, Chirchik Vodokanal still has to rely on the local government because of the reasons below, to operate based on supporting system under the market economy.

- New investment by government budget (reservation of deficit funds)
- No functions to operate on a self-financing basis
- No plan over the mid- and long-term
- Presence of unpaid receivables by budget organization
- Problem of bearing the expense cost for social safety net.

**4) Shortage of cash for salary payment**

The reasons below as mentioned in 3) are the causes to deteriorate its cash flow, producing shortage of cash for salary payment and late payment to the suppliers.

- Presence of unpaid receivable by budget organization

**5) Low Consciousness for Accountability**

In terms of information disclosure by Chirchik Vodokanal, they do not also implement adequate measures because of the following points in the same ways as Tashkent..

- The company's news letter to introduce the water works services has not prepared yet.
- Annual report with a particular emphasis on financial conditions has not prepared yet.
- Cash flow statement has not prepared yet.

As above, the improvements in terms of disclosing information on Vodokanal, are needed not only to serve accountability as a public enterprise but also to operate on a self-financing basis when investment in plant and machinery is required.

**6) Inefficient Operating Activity**

Chirchik Vodokanal is also making efforts under the constraints, such as collecting charges with meters yet-to-be installed, deteriorating facility built in the time of the former USS, and moreover operating the business as efficient as possible within the limited budget. However, Chirchik Vodokanal holds the same problems as Tashkent as below.

- There is a certain limit of the use of automatic deduction from the bank accounts
- A computer system is not introduced.
- Management accounting is not implemented.
- Improvements for business operation in the process towards market economy is behind.
- Automation of facility operating is slow.
- Improvements on incentives of workers.

## (2) Technical Problems

**1) Economically inefficient water supply system**

For the case Chirchik faces same kinds of problems as Tashkent as below.

- The inefficient operation method which spends a large volume of electricity and increases the maximum power of operation because of the water supply by direct pressure.
- The low level of estimated disparity in water consumption between the day and night although this can not reach the conclusion..

**3) High rate of leakage**

The biggest cause is waste of water from water tanks in toilets. In this case, there seems a problem in JEK ability in maintaining and repairing..

4) **Old facilities**

As in Tashkent, many of the current facilities were build in the time of the Soviet Union and the level of decaying is even worse than the facilities in Tashkent. Although Chirchik Vodokanal is trying hard to maintain and repair the facilities, the estimated cost for that is far less than needed and the maintenance cost for these facilities is regarded to increase in geometrical progression in future.

5) **Concrete investment measure in future**

There is no data on the period of technical durability left about the old facilities currently used. Otherwise, any concrete investment measure can not be drafted to meet the actual situations.

6) **Technical agenda in installing meters**

Chirchik also holds the same technical problems in installing meters as Tashkent. It is necessary to install meter after selecting meter and standardizing installment method etc. based on this result.

### 4.6.2 Analysis and Simulation of Future Scenarios of CWS

The points below are the summary of futures issues, which CWS will face if it keeps ignoring the current issues discussed so far. These issues are the same as Tashkent, but the issue of old facilities needs to be tackled sooner. Also, as Chirchik Vodokanal has not introduced a computer system to increase the efficiency in operation, it is expected to produce enormous effect by the introduction.

#### (1) Management Problem

1) **High Volume of Population Consumption**

The increasing volume of water consumption including water leakage and waste of water by population, adding population growth, will in the end require development of water resources in future. Also the increasing water supply caused by the increase in water consumption facilitates the facilities decrepit, the future maintenance cost increase, and san earlier replacement of the site. At present, these cost have not been estimated and the government would face enormous financial burden.

The increase in water supply causes the rise in the whole manufacturing cost. If these expenses are financed by water charge like a remedy treatment as it is now, the water charge will have to be increased far more than it needs to be and will possibly exceed far the level of justice in public fares.

**2) Cross Subsidy**

It is regarded that the presence of cross subsidy is rationalized at a certain scope by comparing the level of wages for the population and the corporation's affordability under the present economic conditions in Uzbekistan. However, unreasonable shift to the corporations will lead to weaken the competitiveness of the industries in the global economy and to decline its economic power in Uzbekistan in the end. Also, water works business relied on the income from the corporations will be an element to impede stable financial operation of Vodokanal. If this cross subsidy is persisted unreasonably, it will involve even more burden on corporations and hinder a vicious circle.

**3) Incomplete Self-Supporting System**

If the situations remained the same, the low level of the self-supporting system today presents that it would not conform with the water works business under the market economy in future. In short, Vodokanal may tend to rely on the government for raising capital and management responsibility and , in this way, would not be based on a self-supporting system as a corporation.

**4) Shortage of cash for salary payment**

If the unstable condition, in which the salary payment for the employees delays, persists, they would not be able to obtain credibility of the outside investors and face the difficulty in aiming self-supporting system.

**5) Low Consciousness for Accountability**

In future, with the aim of self-supporting system Vodokanal will need substantial information disclosure with a particular emphasis on financial conditions in order to obtain credibility of the outside investors. At this point the current information disclosure is not adequate and it is difficult to operate on self-financing basis under the current condition.

Also, in completing substantial information disclosure, Vodokanal would let its own management status clear and encourage self-help efforts to improve its management. Moreover, apart from the information disclosure including the financial condition, issuing new letters would be also an important way to disclose and let the population deepen the understandings of the water works business. If the current condition stays the same, the PL with population would remain lacking. This is not desirable in terms of improving the level of consciousness about water conservation.

### 6) Inefficient Operating Activity

The inefficient operating activity at current level shows that it is difficult to operate on a self-supporting basis under the future market economy and it seems that a kind of subsidiary by the government will be needed.

## (2) Technical Problems

### 1) Economically inefficient water supply system

If leakage from facilities inside houses is reduced after usage-based rate introduced, it would create a change in the amount of water consumption during day and night. On the other hand, as the current water facilities are operated manually, the capacity of the reservoir is too small to adjust the volume. Also, if the current way of distributing by direct pressure by pump is continued, it needs to maintain the facilities up to maximum power operation and it would produce idle cost. These cost will rebound in the form of water charge in the end.

### 2) High rate of leakage

Ignoring the high rate of leakage would lead to a rise in water supply and production cost. There is likely to be a new water resource development caused by the rise in water supply and waste of water resource. The useless operation of the facilities leads to further deterioration and a steep rise in maintenance cost.

### 3) Old facilities

Ignoring the old facilities without enough repairing and maintenance would involve a steep rise in maintenance cost in future and there is likely to impede the stable water supply.

### 4) Concrete investment measures in future

There is no statistical data on the period of technical durability left for the old facilities at current use. This means that the stable water supply service in future is not guaranteed and it is likely to be no capital allowance prepared for the use of re-investment.

5) **Technical agenda in installing meters**

If meter installment plan proceeds without solving the technical problems in installing meters, bad conditions of meters will be found just after installed, and collection of charge based on usage-based rate will be overdue, and then another meter needs to be installed. This would intervene the stable water works service and it implies that the investment for installing meters would be wasted.

### 4.6.3 Approach for Progress and Improvement of Water Service of Chirchik City

The following same approach as Tashkent is taken in Chirchik to settle on a reform measure for the issues mentioned above.

**(1) The final goal is established as follows.**

Vodokanal is to realise that the water service business is balanced between public nature to promote public welfare and economic nature to run an efficient management and sound operation under the market economy in Uzbekistan. The former, the public nature means that Vodokanal offers a water works business to supply water under the certain pressure and quality for the users and the water charge for this service should be fair and appropriate. The latter, economic nature means a business operation on a self-supporting basis, preparing for possibility of privatization.

However, based on the current circumstances the state of Uzbekistan holds, it is difficult to achieve this final goal in one jump. Therefore, our measure needs to be divided into the following stages.

| | |
|---|---|
| The first stage | Provision of requirements for self-supporting system |
| The second stage | Establishment of the business operation on self-supporting system and preparation for privatization. |
| The third stage | Operation of the self-supporting system and examination of privatization |

## 4.7 The Current Status of Water Supply

### 4.7.1 Outline of Water Supply Services and Facilities

An outline of water supply services is presented in Table 4.7.1.

It is estimated that thousand people were served with water supply services according to the data of Chirchik Vodokanal. The major character of water supply services of Chirchik is that the volume of water supply per capita is extremely large and the average annual volume is 777 liter per capita a day.

**Table 4.7.1 Outline of Water Supply Works and Facilities in Chirchik City**

| Item | Units | Value | Remarks |
|---|---|---|---|
| Service Area | sq.km | 30 | |
| Population Served | People | 146,000 | estimated |
| Rate of Service Coverage | % | 100 | |
| Number of Service Connections | Number | 466,339 | |
| Total Length of Pipes | Km | 248 | 1998 |
| Total Production Capacity | cu.m/day | 179,000 | Nominal |
| Total Annual Water Supply Volume | $10^3$cu.m | 38,700 | Feb. '98-Mar.'99 |
| Maximum Daily Water Supply Volume | cu.m/day | 196,000 | |
| Average Daily Water Supply Volume | cu.m/day | 113,400 | Aug.'98-Jul.'99 |
| Water Supply Volume per Capita – Maximum | L/cap./d | | |
| Water Supply Volume per Capita – Minimum | L/cap./d | | |
| Staff Numbers of Water Supply Service | People | 295 | |
| Water Pressure in the City | Kgf/$cm^2$ | 1.0 to 4.5 | |
| Water Sources | SDK-NDK Canal and Groundwater | | |
| WTPs | Surface Water WTP:1, Groundwater WTP:3 | | |

### 4.7.2 Financial Condition and Cost Analysis

The financial condition of Chirchik Vodocanal's water supply services is similar to the case of Tashkent Vodocanal presented in 3.7.2. Especially, the rate of the power costs is extremely high.

### 4.7.3 Tariff Policy and Charge Collection

The Chirchik Vodocanal's current status of revenue from charge collection is examined as below. The status follows the similar way as Tashkent Vodokanal introduced in 3.7.3 part from the actual price of the revenue.

Vodocala increased the tariff rate in 1988 and 1999 and unit cost of revenue is lower than the one in the current tariff table. Also, as installation program of water meters has not proceeded, the actual volume of water consumption can not be measured. Thus, unit cost was to be determined by the volume of accounted water. As presented in Table 4.10, the sales unit of general public is less than the unit cost. On the other hand, the sales unit of production industry and other users far exceeded than those of the unit cost. The rate of tariff disparity to the users in Chirchik is 7.8 and this rate is fairly high compared with to that of international standard, which is around 2%.

As mentioned before, tariff of the general users is not calculated by metered rate, but by fixed rate system which pay water bills no matter how much volume of water is consumed. Therefore, this system does not generate an incentive of conserving water and does not lead them to take any positive actions even if water leakage was found inside an apartment blocks.

**Table 4.7.2 The Status of Revenue from Collection of Charges - Chirchik Vodokanal**

| | Annual volume Of water consumption | Revenue (1,000 thousands in Sum | Sales unit (sum/m³) | Unit cost (sum/ m³) |
|---|---|---|---|---|
| Volume of accounted water | | | | |
| General users | 22,337 | 31,635 | 1.4 | 3.9 |
| Public organizations corporations i.e., restaurants | 4,685 | 68,502 | 14.6 | 3.9 |
| Production industry | 4,040 | 86,552 | 21.4 | 3.9 |
| Subtotal | 31,062 | 186,419 | 6.0 | 3.9 |
| | 7,706 | 0 | | |
| Total | 38,768 | 186,419 | | |

Unit cost was determined as:

Annual costs on water works services/volume of accounted water

=1,447 million sum/687 million m3 = 2.1 sum/ m3

### 4.7.4 Analysis of Water Supply and Consumption

The element of water supply and consumption is analyzed in chapter 5.3, however the overview is described below and the status of the whole water supply works should be presented in this section.

The composition of water consumption is segregated into three categories; individual, large consumer and leakage of pipeline as presented in Figure 4.7.1. The compositions of water supply volume by individual and large consumers are also shown.

**Figure 4.7.1 Composition of Water Consumption by Groups**

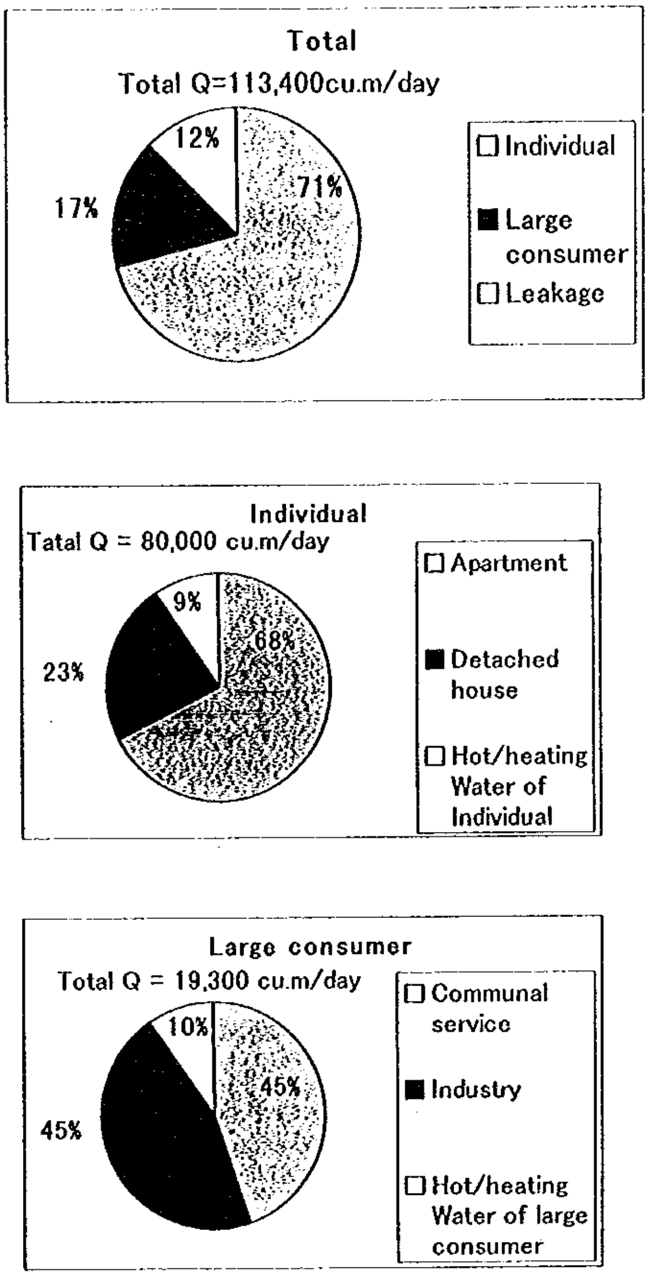
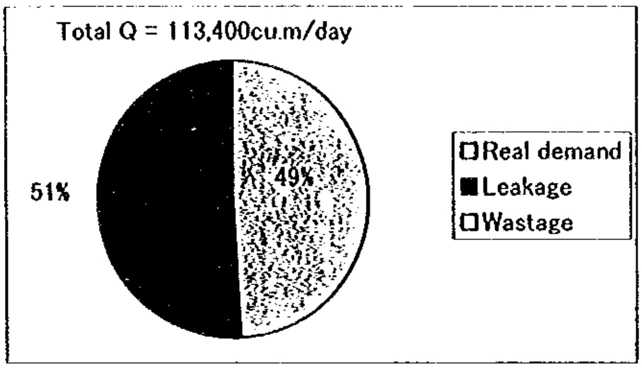


Figure 4.7.2 Compositions of Account-for and Unaccount-for Water




### 4.7.5 Facilities of Water Supply Service, and its Operation and Maintenance

The location of WTPs and other facilities of Chirchik Vodokanal is presented in Figure 4.5.1.

The capacity of WTPs shown in the figure is 179,000 m/d and this rate falls below the maximum volume of supplying water, that is 196,000 $m^3$/d. Thus, it is clear that the facilities have been operating beyond these capacities.

Many of these facilities are aging and replacement of these facilities tends to stagnate because of lack of funds. The annual budget prepared for repair and improvement of Chirchik Vodokanal is approximately 6 million sum which is less than 1/10 of the costs actually needed. The degrading condition of water distribution pipes network is especially serious and more than 100 cases of interruptions caused by intensive water leakage, were annually recorded.

### 4.7.6 Issues

Chirchik Vodokanal confronts important issues that are similar to those of Tashkent Vodokanal and please refer to 3.7.6.